CONESTOGA-ROVERS & ASSOCIATES

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Report

REMEDIAL DESIGN/REMEDIAL ACTION (RD/RA) WORKPLAN (REVISED MARCH 25, 2014)

VRI SITE

Prepared for: GE-Corporate Environmental Programs

Conestoga-Rovers & Associates
651 Colby Drive
Waterloo, Ontario N2V 1C2

February 2014 • 018631 • Report No. 14

Partners in Sustainability

CERTIFICATION

I, Robert G. Adams, certify that I am currently a New York State-registered Professional Engineer and that this report, ***Remedial Design/Remedial Action (RD/RA) Work Plan,*** February 2014, was prepared in substantial accordance with applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

Robert G. Adams

Robert G. Adams, P.E.
CRA Infrastructure & Engineering, Inc.
Registration No. 064918

02/06/14
Date

Table of Contents

Page

List of Figures
(Following Text)

List of Tables
(Following Text)

List of Appendices

Section 1.0 Introduction

This Remedial Design/Remedial Action Work Plan (RD/RA Work Plan) provides for the implementation of the remedial alternative for the Von Roll USA, Inc. (VRI) site (the Site) located on the north side of West Campbell Road in the town of Rotterdam, Schenectady County (see Figure 1.1 for the Site location). Past Site activities, including radar testing and production of insulating materials for the electrical industry, allegedly resulted in the release of volatile organic compounds (VOCs). The VOCs, primarily xylene and trimethyl-benzenes, were identified in the groundwater in the area around monitoring well VRI-1.

This RD/RA Work Plan has been prepared by Conestoga-Rovers & Associates (CRA) to implement the remedial action. It is expected that a Consent Order will be entered requiring General Electric (GE) to prepare and implement an RD/RA Work Plan for the Site consistent with the Record of Decision (ROD).

This RD/RA Work Plan has been prepared in general accordance with the following guidance, directives, and other publications, where appropriate:

- Consent Order, Index A4-0800-12-12, December 2013
- 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

Based on the previous investigation activities conducted at the Site, xylenes (total), 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, isopropylbenzene and n-propylbenzene (and to a lesser extent ethylbenzene and methylene chloride) were detected in the area of VRI-1 at concentrations exceeding the NYSDEC Class GA groundwater quality standards as presented in 6 NYCRR Parts 700-705 and in the NYSDEC TOGS 1.1.1 document titled "Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations."

A Focused Feasibility Study (FFS) (March 2012, revised November 2012) was prepared for the Site that identifies and evaluates potential remedial alternatives to address the constituents of interest in the groundwater at the Site. Following NYSDEC review and approval of the FFS Report, the NYSDEC issued a ROD that identified the NYSDEC preferred Site remedy and included a responsiveness summary to public comments and concerns raised during the public comment period. The selected remedy for the Site is

based on groundwater treatment using in-situ chemical oxidation (ISCO). Xylenes were also detected in one soil sample collected at VRI-1 at the approximate depth of 55-57 ft bgs. This corresponds to the depth of the groundwater table. Therefore this area of impacted groundwater will be addressed by the ISCO injections around monitoring well VRI-1.

This RD/RA Work Plan was prepared to fulfill GE's requirement for a RD/RA Work Plan under the Consent Order that is expected to be signed by GE and the NYSDEC.

The RD/RA Work Plan is organized as follows:

Section 1.0 – Introduction

Section 2.0 – Background Information

Section 3.0 – Remedial Action Objectives

Section 4.0 - Remedial Action Components

Section 5.0 – Remedial Action Project Plans

Section 6.0 – Remedial Design

Section 7.0 – Reporting

Section 8.0 – Contingency Plan

Section 9.0 – Schedule

Section 2.0 Background Information

2.1 Site Location and Description

The Site is an industrial property located off the north side of West Campbell Road in the Town of Rotterdam, Schenectady County, New York and is identified as part of Tax Lot 22.12 A(C) in the Schenectady County, New York tax maps. A Site location map is presented as Figure 1.1. The Site is currently owned by VRI.

The Site contains several manufacturing buildings with paved parking areas. The approximate boundaries of the Site are shown on Figure 2.1. Active manufacturing operations are conducted at the Site.

Access to the Site is limited by a chain-link fence surrounding the Site. The Site is accessible from West Campbell Road from a paved driveway that enters the southeastern portion of the Site. The Site is serviced by municipal water and sewer.

South of the Site there is an active sand removal operation and a one-story commercial office. The north end of the facility is bordered by a steep embankment (the Bellevue Bluff) and a railroad track. An undeveloped wooded area is located to the west of the Site while to the east there is a self-storage business.

2.2 Site History

Prior to GE purchasing the Site in the early 1940s the property was occupied by a harness racing track and was also used for agricultural purposes. Upon GE purchasing the Site it was developed into a radar development and testing facility. GE operated the facility as a radar development plant until 1960 when the GE Insulating Materials group began operation of the Site. In March 1988 GE sold the facility and it was renamed Insulating Materials Incorporated (IMI). IMI continued producing electrical insulation products and the operations remained generally consistent with prior manufacturing operations. VRI subsequently purchased the Site in 1995 and it is currently being used to manufacture solid and liquid insulating materials and tapes for the electrical industry.

Discussions between NYSDEC and General Electric about this site began in the 1980s. Based on a 1989 Assessment of Environmental Conditions Report, NYSDEC and GE negotiated a scope of work for an additional field investigation. This investigation was implemented in accordance with an Order-on-Consent signed in March 1992. Based on the results of the field investigation, completion of a full remedial investigation was recommended.

General Electric signed a Consent Order for a full Remedial Investigation/Feasibility Study (RI/FS) in June of 2001.

The RI determined that there was not a significant contaminant source area on the Site; however, there were elevated levels of organic compounds in the groundwater at monitoring well VRI-1. Groundwater analytical results from the RI and subsequent monitoring events are shown in Figure 2.2 and 2.3.

NYSDEC issued a ROD in March 2013. In the ROD, NYSDEC selected a remedy that included groundwater treatment in the VRI-1 area using ISCO injection. The area identified for remediation is shown on Figure 2.4. The components of the remedy as specified in the ROD are as follows:

- COVER SYSTEM - A Site cover currently exists and will be maintained to allow for industrial use of the Site. Any Site redevelopment will maintain a Site cover, which may consist either of the structures such as buildings, pavement, sidewalks comprising the Site development or a soil cover in areas where the upper one foot of exposed soil will exceed the applicable soil cleanup objectives (SCOs). Where a soil cover is required it will be a minimum of one foot of soil, meeting the SCOs for cover material as set forth in 6 NYCRR Part 375-6.7(d). The soil cover will be placed over a demarcation layer, with the upper six inches of the soil of sufficient quality to maintain a vegetation

layer. Any fill material brought to the Site will meet the requirements for the identified Site use as set forth in 6 NYCRR Part 375-6.7(d).

- IN- SITU CHEMICAL OXIDATION -In-situ chemical oxidation is a technology used to treat volatile organic compounds in the soil and groundwater. A chemical oxidant will be injected into the subsurface via injection wells or an infiltration gallery. The method of injection and depth of injection is determined by the location of the contamination. As the chemical oxidant comes into contact with the contaminant, an oxidation reaction occurs that breaks down the contaminant into relatively benign compounds such as carbon dioxide and water. Several chemical oxidants are commercially available. For the purpose of this remedy, sodium persulfate will be the chemical oxidant evaluated. At this Site, the chemical oxidant will be applied through injection wells screened from 60 to 75 feet to target xylene and trimethyl-benzenes. It is estimated that seven injection points will be installed and that the chemical oxidant will be injected during two separate events over several months. Groundwater monitoring will be conducted to assess performance of the treatment during the injection period and for an extended duration after the injections, as determined by the NYSDEC. Current estimates are based on semi-annual monitoring for two years and annual monitoring for three years.
- INSTITUTIONAL CONTROL -Imposition of an institutional control in the form of an environmental easement will be executed for the controlled property that requires the remedial party or Site owner to complete and submit to the Department a periodic certification of institutional and engineering controls in accordance with Part 375-1.8(h)(3); allows the use and development of the controlled property for industrial uses as defined by Part 375-1.8(g), although land use is subject to local zoning laws; restricts the use of groundwater as a source of potable or process water, without necessary water quality treatment as determined by the NYSDOH or County DOH; requires compliance with the Department-approved Site Management Plan.
- SITE MANAGEMENT PLAN - A Site Management Plan is required that includes:
  - An Institutional and Engineering Control Plan that identifies all use restrictions and engineering controls for the Site and details the steps and media-specific requirements necessary to ensure the following institutional and/or engineering controls remain in place and effective.
  - A Monitoring Plan to assess the performance and effectiveness of the remedy.

GE has entered into a Consent Order with NYSDEC to conduct and implement this RD/RA Work Plan. The objective of this RD/RA Work Plan is to present a plan for the implementation of the remedial alternative set forth in the NYSDEC ROD, dated March 2013.

Section 3.0 Remedial Action Objectives

As stated in the ROD, the remediation goals for the Site are to:

- Restore groundwater aquifer to pre-disposal/pre-release conditions, to the extent practicable
- Prevent ingestion/direct contact with contaminated soil
- Mitigate impacts to public health resulting from existing potential soil vapor intrusion into buildings at the Site

Further, the remediation goals for the Site include attaining to the extent practicable:

- Ambient groundwater quality standards or Site background

Section 4.0 Remedial Action Components

The primary components of the selected remedial action are as follows:

- Groundwater treatment
- Groundwater sampling
- Maintaining a Site Cover
- Site Management Plan
- Imposition of an environmental easement
- Annual certification of the institutional and engineering controls

A description of each of the remedial action components is presented in the following subsections.

4.1 Groundwater Treatment

The area requiring groundwater treatment is presented in the ROD and includes an area of approximately 2,500 square feet. ISCO has been selected as the groundwater treatment technology for the Site. ISCO is a proven treatment technology that involves delivering oxidizing agents to the impacted media. The oxidant will degrade organic constituents in the media to non-toxic byproducts. ISCO involves the construction of an oxidant delivery system followed by oxidant application to treat the VOCs in the groundwater.

Base catalyzed sodium persulfate will be used as the oxidant for ISCO at this site. Sodium persulfate can be injected at concentrations up to 30 percent. It can be used to oxidize a wide range of organic compounds and will continue to react with organic compounds for up to a month after application.

A process schematic is provided on Figures 4.1. Section 6.2 provides a description of the design for the groundwater treatment system.

4.2 Groundwater Sampling

Groundwater monitoring will be conducted to assess the overall groundwater quality during and following the remedial action (see Monitoring Plan) and also to specifically evaluate the progress of the treatment system. Refer to Section 6.3 for the Monitoring Plan. Samples will be submitted for analysis of TCL, VOCs, and Non-Standard VOCs (1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, isopropylbenzene, and n-propylbenzene) using EPA Method 8260. A proposed groundwater sampling plan is presented in Table 4.1

Samples will be collected and analyzed in accordance with the Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP) presented in Appendices B and C, respectively.

4.3 Site Cover

A site cover currently exists on Site and the cover will be maintained to allow for the continued industrial use of the Site. Any future redevelopment of the Site will require that the Site cover be maintained, which may consist either of the structures such as buildings, pavement, sidewalks comprising the Site development or a soil cover in areas where the upper one foot of exposed surface soil will exceed the applicable soil cleanup objectives (SCOs). Where a soil cover is required it will be a minimum of one foot of soil, meeting the SCOs for cover material as set forth in 6 NYCRR Part 375-6.7(d). The soil cover will be placed over a demarcation layer, with the upper six inches of the soil of sufficient quality to maintain a vegetation layer. Any fill material brought to the site will meet the requirements for the identified site use as set forth in 6 NYCRR Part 375-6.7(d).

4.4 Site Management Plan

A Site Management Plan (SMP) will be developed concurrently with the ISCO field work and submitted to NYSDEC for approval.

4.5 Implementation of Environmental Easement

An institutional control in the form of an environmental easement will be implemented at the Site. The easement will: (a) require compliance with the approved Site Management Plan; (b) limit the use and development of the controlled property to industrial uses only as defined by Part 375-1.8(g), although

land use is subject to local zoning laws; (c) restrict use of groundwater as a source of potable or process water, without necessary water quality treatment as determined by the NYSDOH or County DOH; and (d) require the property owner to complete and submit an annual certification to the NYSDEC. Where soil, soil gas, and groundwater concentrations reach unrestricted use levels, the appropriate institutional controls could be removed in accordance with applicable regulations.

4.6 Annual Certification of the Institutional and Engineering Controls

The property owner will provide an annual certification, prepared and submitted by a professional engineer or environmental professional acceptable to the NYSDEC, which will certify that the institutional controls and engineering controls in place are unchanged from the previous certification and that nothing has occurred that would impair the ability of the controls to protect public health or the environment or constitute a violation or failure to comply with any operation and maintenance or Site management. Components of the remedy will continue to be implemented until the remedial objectives have been achieved, or until the NYSDEC determines that continued operation is technically impracticable or not feasible or that the significant threat to the environment or human health that gave rise to the property being placed on the DEC registry of inactive hazardous waste disposal sites has been eliminated.

Section 5.0 Remedial Action Project Plans

This section provides an overview of the following Project Plans that are presented as appendices to this RD/RA Work Plan:

- Appendix A – Health and Safety Plan
- Appendix B – Quality Assurance Project Plan
- Appendix C – Field Sampling Plan
- Appendix D – Waste Management Plan

The aforementioned Project Plans are designed to provide the procedures and protocols that are necessary to support the remedial activities. All work will be conducted in accordance with the Project Plans.

5.1 Health and Safety Plan

A Site-specific Health and Safety Plan (HASP) is required to ensure that all remedial activities are performed safely and in accordance with applicable regulatory requirements, and that all persons, the general public, and the environment are protected from exposure to Site-related VOCs. The health and

safety requirements for the remedial activities were developed in accordance with 29 CFR 1910 and are provided in the HASP presented in Appendix A. The HASP includes:

- General requirements
- Personnel
- Levels of protection
- Safe work practices and safeguards
- Medical surveillance
- Personal and environmental air monitoring
- Personal protective equipment
- Personal hygiene
- Decontamination of personnel and equipment
- Site work zones
- Contaminant control
- Contingency and emergency planning
- Logs, reports, and recordkeeping
- Community Air Monitoring Plan

5.2 Quality Assurance Project Plan

The field and laboratory quality assurance objectives, protocols, and procedures supporting the waste characterization and end-point sampling activities are provided in the QAPP presented in Appendix B. The QAPP includes:

- Project description
- Project organization
- Project responsibilities
- Sampling and custody procedures
- Calibration procedures
- Quality assurance (QA) objectives
- Analytical procedures
- Data analysis and reporting
- Internal quality control (QC) checks
- Performance and system audits

- Preventative maintenance
- Method-specific procedures for assessing data precision, accuracy, and completeness
- Laboratory corrective actions
- Quality assurance (QA) reports

5.3 Field Sampling Plan

A FSP is required to ensure that sampling and analyses are performed to established and accepted protocols. All sampling and analyses will be conducted as part of a quality assurance program to ensure that accurate and precise analytical results are obtained. All sampling and analysis activities will be completed in accordance with the FSP presented in Appendix C. The FSP includes:

- Number of samples to be collected
- Sampling protocols
- Sample collection locations
- Special sample collection equipment and techniques (if required)
- Analytical method to be used

5.4 Waste Management Plan

A Site-specific Waste Management Plan (WMP) is required to ensure that waste generated during remedial activities is handled in accordance with the RD/RA Work Plan and applicable regulatory requirements. The WMP is presented in Appendix D.

Section 6.0 Remedial Design

The following sections present a detailed description of the ISCO injection system. The ISCO injection is the only Remedial Action described in Section 4.0 that requires active remediation.

6.1 Temporary Decontamination Facilities

A temporary decontamination pad(s) will be constructed to provide for the decontamination of equipment that may contact contaminated materials. The temporary decontamination pad will be constructed at a location approved by VRI. Procedures for decontaminating equipment are presented in Appendix A.

Potable water will be obtained from an existing water supply.

Construction fencing will be installed to protect the work area.

6.2 In Situ Chemical Oxidation System

The area requiring groundwater treatment is presented in the ROD and includes an area approximately 2,500 square feet.

ISCO will be employed as the groundwater treatment technology for the Site. ISCO is a proven treatment technology that involves delivering oxidizing agents to the impacted media. The oxidant will degrade organic constituents in the media to non-toxic byproducts. ISCO involves the construction of an oxidant delivery system followed by oxidant application to treat the VOCs in the groundwater.

The injection well layout is presented on Figure 4.1. The following paragraphs provide a description of the groundwater treatment system.

The ISCO delivery system for the groundwater will consist of a network of 6 vertical 2-inch diameter injection wells spaced in a circle surrounding well VRI-1 with a diameter of approximately 40 ft. Dispersion of injected oxidizing agents will result in treating the approximate treatment area of 2,500 square feet. An additional injection well will be installed in close proximity to well VRI-1. Field adjustments may be required to avoid subsurface and/or overhead utility interferences. The injection wells will be constructed of Schedule 40 PVC. The wells will have a screened interval of 15 feet. The screen size is No. 20 slot. The proposed screened interval will be from 55 to 70 ft bgs. This will insure that the screen is in the saturated zone. Injection wells will be installed using hollow stem auger drilling methods. Sodium persulfate will be brought on Site as a powder and mixed with water using an educator to entrain the powder into the water. Approximately 405 gallons of a ~25 percent sodium persulfate solution mixed with approximately 335 gallons of a ~25 percent sodium hydroxide solution, for a total of approximately 740 gallons of solution, will be injected into each well in order to treat the groundwater. Two injections will be made at each injection well with the second injection occurring approximately 6 months after the initial injection. The sodium persulfate solution and the sodium hydroxide solution will be mixed at the Site in a trailer-mounted tank equipped with a mixer (either a paddle type or jet mixer). The solution will be pumped from the tank to one or more wells at a time through a manifold with multiple outlets. Each outlet will have a flow meter to determine the volume pumped to each well. All of the ISCO injection equipment will be portable. Once the injection program is complete, the tank, pump and piping will be cleaned and removed from the Site. To wash the tanks of any leftover reagent the tank will be washed with clean water and the remnants of this wash will be injected into the injection wells. The major components of the ISCO system are detailed below.

Wells

Description: 7 wells penetrate up to 70 ft bgs. The wells are constructed of 2-inch Schedule 40 PVC. The bottom 15 feet of piping is No. 20 slot PVC screen in order to distribute the chemical injection within the saturated zone.

Oxidant Tank

Description: Horizontal freestanding PVC tank manufactured by IMG Inc., or equivalent
Capacity: 335 gallons minimum
Dimensions: 44 inches diameter, 56-inch length minimum
Suitable for outdoor use

Pump

Description: Oxidant transfer pump as manufactured by Goulds, or equivalent
Model: 3196 STX
Size: 1 x 1 1/2-6
Capacity: 50 gpm at 20 feet TDH
1/2 hp, 230 V, 1,750 rpm

Mixer

Description: Mixer unit, as manufactured by IMG, or equivalent
Model: MD-2, single propeller
1/2 hp TEFC motor, 115/230 V, 350 rpm

Following each injection the groundwater will be monitored in accordance with Section 6.3. Additional injections will be performed if groundwater monitoring indicates that residual VOC concentrations are above the cleanup criteria and it is necessary to eliminate any remaining significant threat to the environment.

The proposed layout of the ISCO system is shown in Figure 4.1.

6.3 Groundwater Monitoring Plan

Groundwater monitoring will be conducted to assess the overall groundwater quality during the remedial action and also to specifically evaluate the progress of the ISCO treatment system. Groundwater samples will be collected in accordance with the following schedule:

- One round of groundwater samples will be collected and analyzed before ISCO treatment commences (wells VRI-1, VRI-2, GT-9, and injection well next to VRI-1)
- Year 1- approximately 4 months after each injection for a total of two monitoring events (seven injection wells, VRI-1, VRI-2, GT-9)
- Year 2 – semi-annual for total of two monitoring events (seven injection wells, VRI-1, VRI-2, GT-9, VRI-3, VRI-4, VRI-9, GT-14, GT-15, GT-16, GT-7)
- Years 3 to 5 – annual for total of three monitoring events (VRI-1, VRI-2, GT-9, VRI-3, VRI-4, VRI-9, GT-14, GT-15, GT-16, GT-7)

Samples will be analyzed for TCL VOCs and Non-Standard VOCs (1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, isopropylbenzene, and n-propylbenzene) using EPA Method 8260. The proposed locations of the wells are shown in Figure 4.1. At the end of the 5 year period an evaluation will be conducted to evaluate remedy effectiveness. It is anticipated that at the end of the 5-year monitoring period, the seven injection wells will be abandoned.

The groundwater sampling schedule is presented in Table 4.1.

Samples will be collected and analyzed in accordance with the QAPP and FSP.

6.4 Permits

The following permit will be required for the RA:

- Underground Injection Control (UIC) Permit – USEPA/NYSDEC

With regard to the UIC permit, USEPA will be notified in accordance with 40 CRA 144 prior to conducting the subsurface chemical injections. A letter will be submitted explaining the scope of work (type of oxidant, number of injection wells, amount of material to be injected, number of injection rounds, byproducts, and presence of nearby drinking wells).

Section 7.0 Reporting

7.1 Progress Reports

Unless otherwise agreed to by the NYSDEC, monthly progress reports will be prepared to provide information regarding Site activities and remediation progress. One draft version for client review and one final version for submittal to NYSDEC will be written by the 10th of each month. Monthly reporting will commence on the first month following award of the contract and continue until the completion of the on-Site remedial activities (i.e., until completion of the ISCO injections). It is anticipated that semi-annual progress reports can be submitted for the second year following the initial ISCO injection to coincide with the semiannual groundwater monitoring and that annual reports can be submitted for the 3 years following to coincide with the annual groundwater monitoring. Each report will include: all actions taken during the period, actions to be conducted during the upcoming period, all approved modifications to the Work Plan, schedule changes, results of sampling events, QA/QC information, progress and schedule updates, and a summary of activities related to the Citizen Participation Plan. Copies of the progress reports will be provided to the property owner.

Electronic data deliverables (EDDs) for the groundwater data will be submitted to NYSDEC.

7.2 Final Engineering Report

Upon completion of remedial activities a final engineering report using the DEC format will be prepared and submitted to the NYSDEC for review. The Final Engineering Report will include a certification by a Professional Engineer licensed to practice in the State of New York that all activities have been performed in full accordance with the final design.

Section 8.0 Contingency Plan

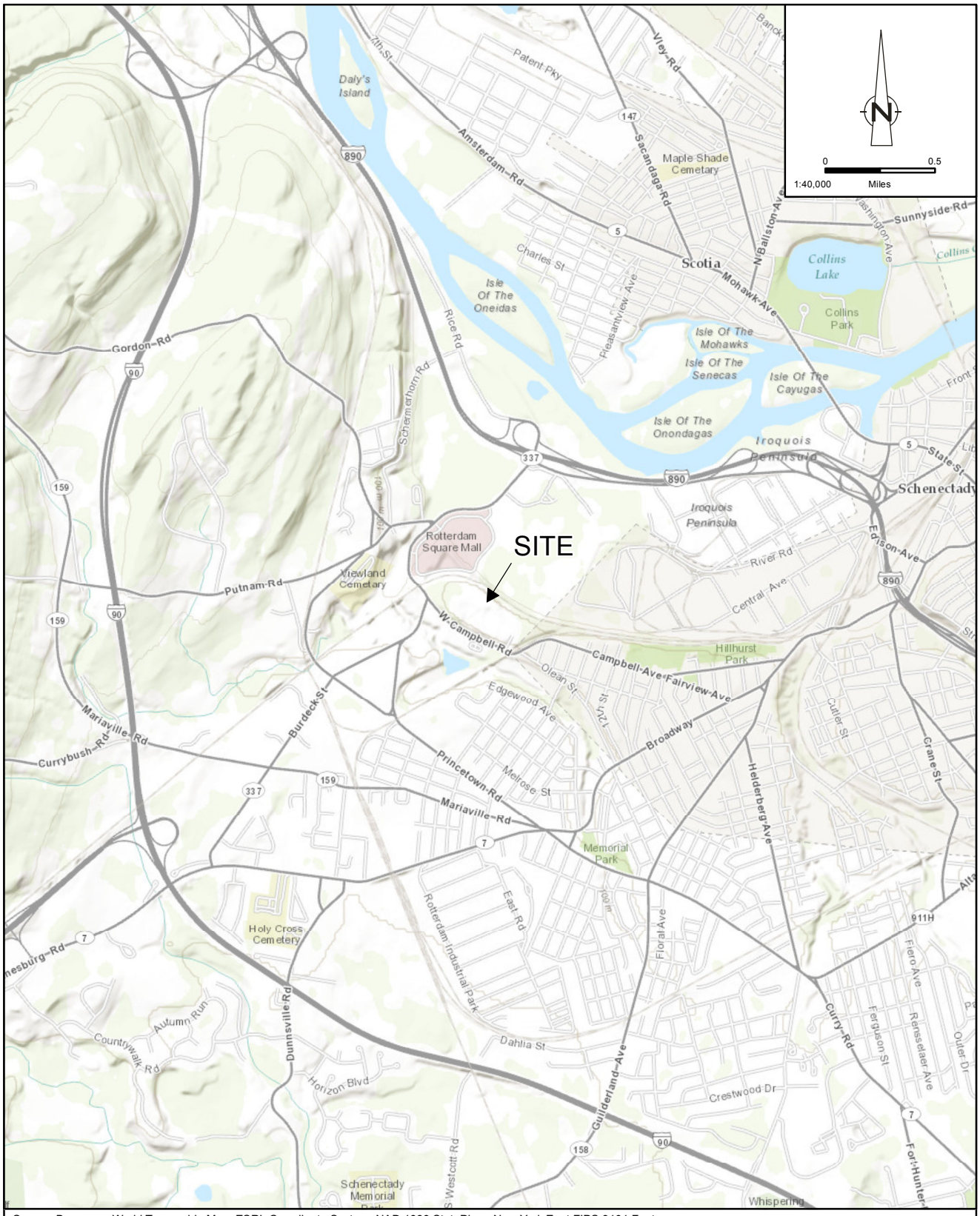
Should the RA fail to achieve any of its objectives or otherwise fail to eliminate any significant threat to the environment or human health The following Contingency Plan will be implemented.

The Contingency Plan for the groundwater treatment system will include one or more of the following:

- Additional ISCO injections
- Installation of additional injection wells
- Modifications to the sodium persulfate solution (i.e., higher strength) to achieve additional treatment

Section 9.0 RA Implementation Schedule

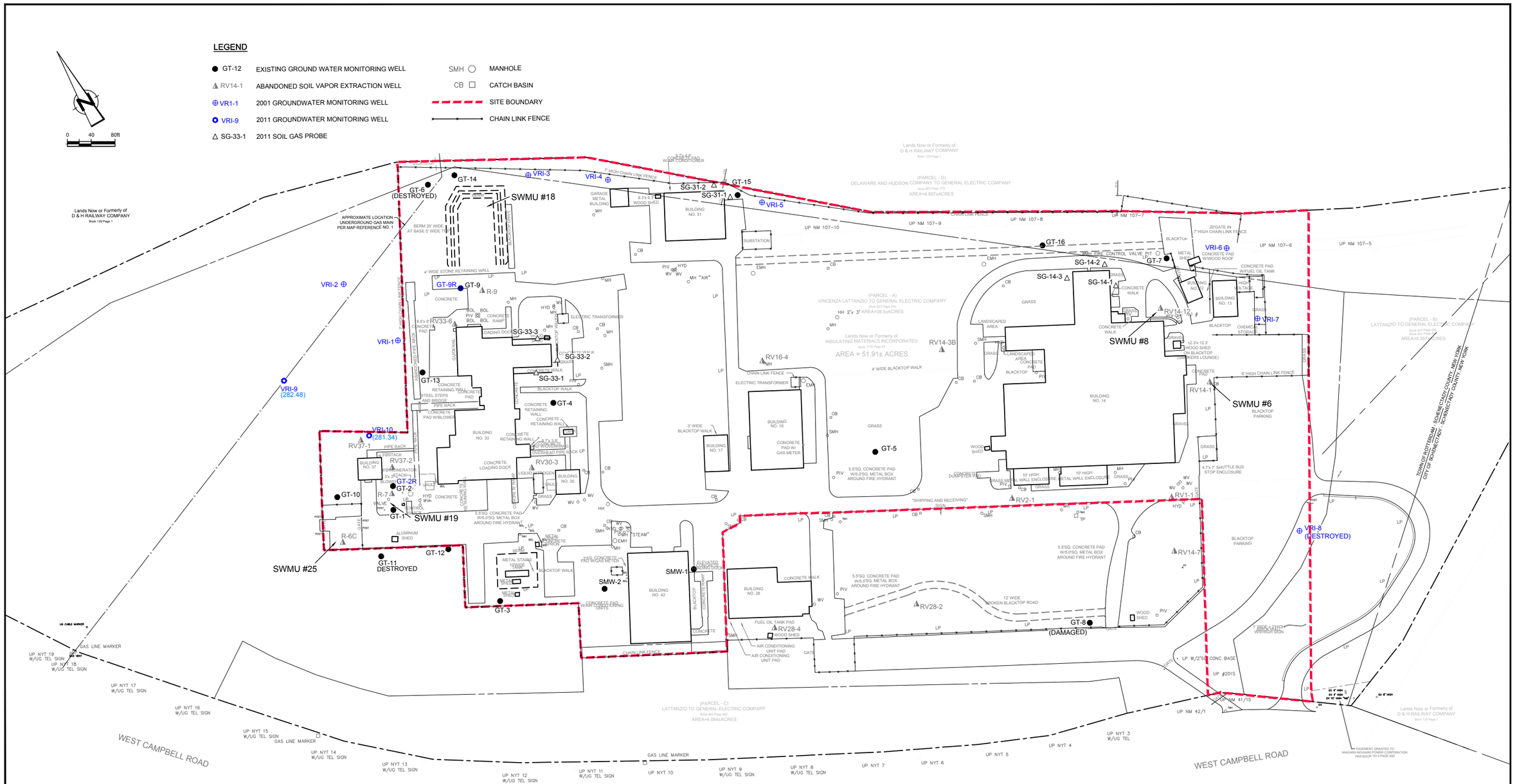
A schedule for implementing the RA is presented on Figure 9.1. The RA implementation schedule will be modified if necessary to coincide with favorable weather conditions for the implementation of the RA work.



Source: Basemap, World Topgraphic Map, ESRI; Coordinate System: NAD 1983 StatePlane New York East FIPS 3101 Feet

figure 1.1

SITE LOCATION
VRI-RIVERVIEW FACILITY
Schenectady, New York



SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

Approved

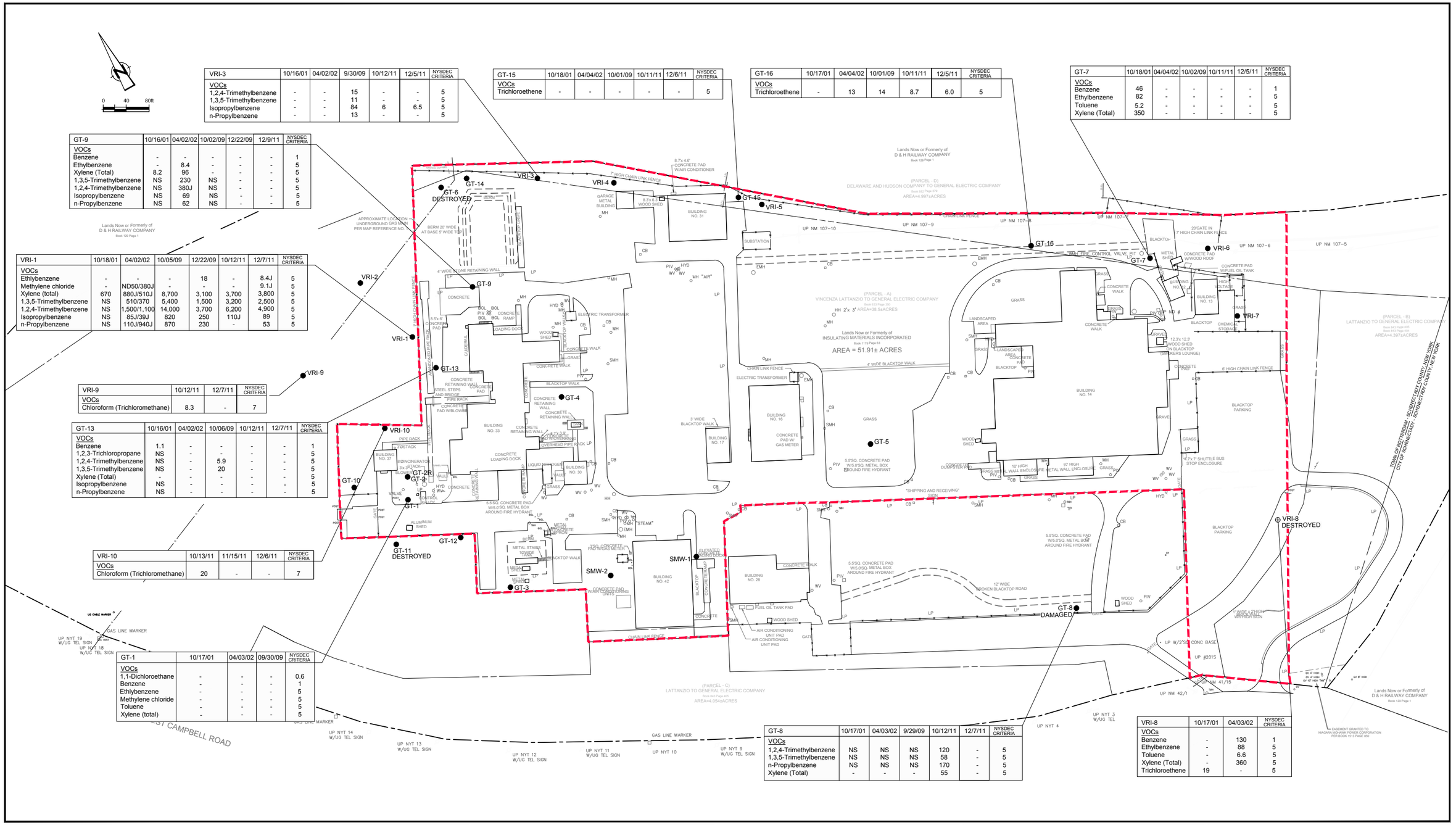
VRI-RIVERVIEW FACILITY
Schenectady, New York

SITE PLAN

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: FEBRUARY 2012
Project Manager: J.K.P.	Reviewed By: J.H.	Designed By:	Drawn By: G.R.B.
Scale: AS SHOWN	Project No: 18631-50	Report No: 014	Drawing No: figure 2.1

18631-50(014)GN-WA001 FEB 21/2014



VRI-3	10/16/01	04/02/02	9/30/09	10/12/11	12/5/11	NYSDEC CRITERIA
VOCs						
1,2,4-Trimethylbenzene	-	-	15	-	-	5
1,3,5-Trimethylbenzene	-	-	11	-	-	5
Isopropylbenzene	-	-	84	6	6.5	5
n-Propylbenzene	-	-	13	-	-	5

GT-15	10/18/01	04/04/02	10/01/09	10/11/11	12/6/11	NYSDEC CRITERIA
VOCs						
Trichloroethene	-	-	-	-	-	5

GT-16	10/17/01	04/04/02	10/01/09	10/11/11	12/5/11	NYSDEC CRITERIA
VOCs						
Trichloroethene	-	13	14	8.7	6.0	5

GT-7	10/18/01	04/04/02	10/02/09	10/11/11	12/5/11	NYSDEC CRITERIA
VOCs						
Benzene	46	-	-	-	-	1
Ethylbenzene	82	-	-	-	-	5
Toluene	5.2	-	-	-	-	5
Xylene (Total)	350	-	-	-	-	5

GT-9	10/16/01	04/02/02	10/02/09	12/22/09	12/9/11	NYSDEC CRITERIA
VOCs						
Benzene	-	-	-	-	-	1
Ethylbenzene	-	8.4	-	-	-	5
Xylene (Total)	8.2	96	-	-	-	5
1,3,5-Trimethylbenzene	NS	230	NS	-	-	5
1,2,4-Trimethylbenzene	NS	380J	NS	-	-	5
Isopropylbenzene	NS	69	NS	-	-	5
n-Propylbenzene	NS	62	NS	-	-	5

VRI-1	10/18/01	04/02/02	10/05/09	12/22/09	10/12/11	12/7/11	NYSDEC CRITERIA
VOCs							
Ethlybenzene	-	-	-	18	-	8.4J	5
Methylene chloride	-	ND50/380J	-	-	-	9.1J	5
Xylene (total)	670	880J/510J	8,700	3,100	3,700	3,800	5
1,3,5-Trimethylbenzene	NS	510/370	5,400	1,500	3,200	2,500	5
1,2,4-Trimethylbenzene	NS	1,500/1,100	14,000	3,700	6,200	4,900	5
Isopropylbenzene	NS	85J/39J	820	250	110J	89	5
n-Propylbenzene	NS	110J/940J	870	230	-	53	5

VRI-9	10/12/11	12/7/11	NYSDEC CRITERIA
VOCs			
Chloroform (Trichloromethane)	8.3	-	7

GT-13	10/16/01	04/02/02	10/06/09	10/12/11	12/7/11	NYSDEC CRITERIA
VOCs						
Benzene	1.1	-	-	-	-	1
1,2,3-Trichloropropane	NS	-	-	-	-	5
1,2,4-Trimethylbenzene	NS	-	5.9	-	-	5
1,3,5-Trimethylbenzene	NS	-	20	-	-	5
Xylene (Total)	-	-	-	-	-	5
Isopropylbenzene	NS	-	-	-	-	5
n-Propylbenzene	NS	-	-	-	-	5

VRI-10	10/13/11	11/15/11	12/6/11	NYSDEC CRITERIA
VOCs				
Chloroform (Trichloromethane)	20	-	-	7

GT-1	10/17/01	04/03/02	09/30/09	NYSDEC CRITERIA
VOCs				
1,1-Dichloroethane	-	-	-	0.6
Benzene	-	-	-	1
Ethlybenzene	-	-	-	5
Methylene chloride	-	-	-	5
Toluene	-	-	-	5
Xylene (total)	-	-	-	5

GT-8	10/17/01	04/03/02	9/29/09	10/12/11	12/7/11	NYSDEC CRITERIA
VOCs						
1,2,4-Trimethylbenzene	NS	NS	NS	120	-	5
1,3,5-Trimethylbenzene	NS	NS	NS	58	-	5
n-Propylbenzene	NS	NS	NS	170	-	5
Xylene (Total)	-	-	-	55	-	5

VRI-8	10/17/01	04/03/02	NYSDEC CRITERIA
VOCs			
Benzene	-	130	1
Ethylbenzene	-	88	5
Toluene	-	6.6	5
Xylene (Total)	-	360	5
Trichloroethene	19	-	5

LEGEND

- VRI-1 GROUNDWATER MONITORING WELL
- SMH MANHOLE
- CB CATCH BASIN
- SITE BOUNDARY
- CHAIN LINK FENCE

J ESTIMATED VALUE
ND NOT DETECTED AT ASSOCIATED CONCENTRATION
NA NOT ANALYZED
NS NOT SAMPLED

LOCATION ID	VRI-8	10/17/01	NYSDEC CRITERIA
PARAMETER	VOCs		
	Benzene	-	1
	Ethylbenzene	-	5
	Toluene	-	5
	Xylene (Total)	-	5
	Trichloroethene	19	5

SAMPLE DATE
NYSDEC GROUNDWATER CLASS GA CRITERIA EXCEEDANCES (µg/L)
CONCENTRATION (µg/L)
NO EXCEEDANCE OF CRITERIA/NOT ANALYZED

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

Approved

VRI-RIVERVIEW FACILITY
Schenectady, New York

GROUNDWATER DATA - VOCs

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: JULY 2013
Project Manager: J.K.P.	Reviewed By: J.H.	Designed By:	Drawn By: G.R.B.
Scale: AS SHOWN	Project No: 18631-50	Report No: 014	Drawing No: figure 2.2

18631-50(014)GN-WA002 FEB 21/2014

GT-9	10/16/01	04/02/02	10/02/09	12/22/09	12/9/11	NYSDEC CRITERIA
Metals						
Antimony	4.4	-	NS	NS	NS	3
Beryllium	-	-	NS	NS	NS	3
Lead	-	-	NS	NS	NS	25
Manganese	-	1,280	NS	NS	NS	300
Iron	-	877	NS	NS	NS	300
Sodium	-	39,400	NS	NS	NS	20,000
SVOCs						
Dieldrin	0.0056 J	-	-	NS	NS	0.004
Isophrone	-	-	-	NS	NS	50
4-Nitroaniline	-	-	-	NS	NS	5
Phenol	-	-	-	NS	NS	1
2,4-Dimethylphenol	-	3.1 J	-	NS	NS	1

VRI-3	10/16/01	04/02/02	9/30/09	10/12/11	12/5/11	NYSDEC CRITERIA
Metals						
Iron	1,470	4,220	NS	-	NS	300

GT-4	10/17/01	04/02/02	10/01/09	NYSDEC CRITERIA
Metals				
Iron	302	-	NS	300
Manganese	-	-	NS	300
Sodium	47,900	21,900	NS	20,000

GT-15	10/18/01	04/04/02	10/01/09	10/11/11	12/6/11	NYSDEC CRITERIA
Metals						
Iron	-	-	NS	NS	NS	300
Sodium	24,600	24,900 J	NS	NS	NS	20,000

GT-16	10/17/01	04/04/02	10/01/09	10/11/11	12/5/11	NYSDEC CRITERIA
Metals						
Chromium	99.6	-	NS	NS	NS	50
Iron	1,300	-	NS	NS	NS	300
Sodium	58,900	42,100 J	NS	NS	NS	20,000

GT-14	10/16/01	04/02/02	10/02/09	NYSDEC CRITERIA
Metals				
Iron	4,710	655	NS	300
Lead	-	-	NS	25
Magnesium	-	-	NS	35,000
Manganese	-	-	NS	300
SVOCs				
Phenol	-	-	-/-	1

VRI-4	10/16/01	04/02/02	9/30/09	NYSDEC CRITERIA
Metals				
Iron	5,990	10,600	NS	300
Manganese	384	814	NS	300

VRI-5	11/29/01	04/04/02	10/6/09	12/6/11	NYSDEC CRITERIA
Metals					
Arsenic	54.1	-	NS	NS	25
Barium	1,110	-	NS	NS	1,000
Chromium	112	-	NS	NS	50
Copper	202	-	NS	NS	200
Iron	130,000	5,340 J	NS	NS	300
Lead	57.3	-	NS	NS	25
Magnesium	114,000	-	NS	NS	35,000
Manganese	3,270	-	NS	NS	300
Nickel	110	-	NS	NS	100
Sodium	29,200	-	NS	NS	20,000

GT-7	10/18/01	04/04/02	10/02/09	10/11/11	12/5/11	NYSDEC CRITERIA
Metals						
Beryllium	-	-	NS	NS	NS	3
Iron	5,170	313J	NS	NS	NS	300
Lead	-	-	NS	NS	NS	25
Manganese	2,920	-	NS	NS	NS	300
Sodium	114,000	58,800J	NS	NS	NS	20,000
SVOCs						
2-methylphenol	1.3 J	-	-	NS	NS	1
Naphthalene	75	-	-	NS	NS	10

VRI-2	10/18/01	04/02/02	10/06/09	NYSDEC CRITERIA
Metals				
Thallium	11	-	NS	0,5

VRI-6	10/18/01	04/04/02	10/2/09	NYSDEC CRITERIA
Metals				
Iron	6,640	NS	NS	300
Sodium	77,600	NS	NS	20,000

VRI-1	10/18/01	04/02/02	10/05/09	12/22/09	10/12/11	12/7/11	NYSDEC CRITERIA
Metals							
Iron	336	-	NS	NS	NS	NS	300
Manganese	-	538/525	NS	NS	NS	NS	300
PESTICIDES							
Deildrin	0.0051 J	-	NS	NS	NS	NS	0.004

VRI-7	10/18/01	04/03/02	10/5/09	10/11/11	12/5/11	NYSDEC CRITERIA
Metals						
Iron	-	555	NS	NS	NS	300
Magnesium	-	45,600	NS	NS	NS	35,000
Sodium	192,000	291,000	NS	NS	NS	20,000

GT-13	10/16/01	04/02/02	10/06/09	10/12/11	12/7/11	NYSDEC CRITERIA
Metals						
Iron	-	-	NS	NS	NS	300
Manganese	839	-	NS	NS	NS	300
Mercury	-	-	NS	NS	NS	0.7
Sodium	277,000	29,800	NS	NS	NS	20,000
SVOCs						
2,4-Dimethylphenol	-	-	-	NS	NS	1
Naphthalene	-	-	-	NS	NS	10

GT-10	10/17/01	04/03/02	10/05/09	10/11/11	12/6/11	NYSDEC CRITERIA
Metals						
Iron	1,060	-	NS	NS	NS	300

GT-2R	10/16/01	04/03/02	10/02/09	NYSDEC CRITERIA
Metals				
Iron	12,500	-	NS	300
Manganese	481	-	NS	300
Sodium	308,000	587,000	NS	20,000

GT-1	10/17/01	04/03/02	09/30/09	NYSDEC CRITERIA
Metals				
Iron	-	-	NS	300
Manganese	-	-	NS	300
Sodium	100,000/105,000	201,000	NS	20,000
PCBs				
Aroclor 1242	2.5/3.7	-	NS	0.09
SVOCs				
Phenol	-	-	-	1

GT-12	10/17/01	04/02/02	10/06/09	NYSDEC CRITERIA
Metals				
Iron	327	-	NS	300
Lead	-	-	NS	25
Manganese	-	-	NS	300
Sodium	31,700	28,800	NS	20,000

GT-3	10/17/01	04/04/02	10/06/09	NYSDEC CRITERIA
Metals				
Antimony	-	NS	NS	3
Arsenic	-	NS	NS	25
Beryllium	-	NS	NS	3
Chromium	-	NS	NS	50
Iron	3,380	NS	NS	300
Lead	-	NS	NS	25
Magnesium	-	NS	NS	35,000
Manganese	-	NS	NS	300
Sodium	58,300	NS	NS	20,000

SMW-2	10/17/01	04/03/02	9/30/09	NYSDEC CRITERIA
Metals				
Chromium	133	212	NS	50
Iron	1,640	2,000	NS	300
Sodium	55,400	52,500	NS	20,000

SMW-1	10/17/01	04/03/02	9/30/09	NYSDEC CRITERIA
Metals				
Sodium	94,100	77,700	NS	20,000

GT-5	10/17/01	04/03/02	9/30/09	NYSDEC CRITERIA
Metals				
Antimony	4.7	-	NS	3
Sodium	56,800	37,800	NS	20,000
Iron	-	-	NS	300

GT-8	10/17/01	04/03/02	9/29/09	10/12/11	12/7/11	NYSDEC CRITERIA
Metals						
Barium	-	-	NS	NS	NS	1,000
Beryllium	-	-	NS	NS	NS	3
Chromium	-	-	NS	NS	NS	50
Iron	32,400	1,520	NS	NS	NS	300
Lead	-	-	NS	NS	NS	25
Manganese	761	-	NS	NS	NS	300
SVOCs						
Bis(2ethylhexyl)phalate	NS	NS	NS	NS	NS	5

VRI-8	10/17/01	04/03/02	NYSDEC CRITERIA
Metals			
Iron	-	388	300
Manganese	-	5,290	300
Sodium	42,400	203,000	20,000
SVOCs			
Naphthalene	-	130	10

LEGEND

- VRI-1 GROUNDWATER MONITORING WELL
- SMH MANHOLE
- CB CATCH BASIN
- SITE BOUNDARY
- CHAIN LINK FENCE

J ESTIMATED VALUE

ND NOT DETECTED AT ASSOCIATED CONCENTRATION

NA NOT ANALYZED

NS NOT SAMPLED

LOCATION ID — SAMPLE DATE — NYSDEC GROUNDWATER CLASS GA CRITERIA EXCEEDANCES (µg/L)

VRI-4	10/16/01	NYSDEC CRITERIA
Metals		
Iron	5,990	300
Manganese	-	300

PARAMETER — CONCENTRATION (µg/L) — NO EXCEEDANCE OF CRITERIA/NOT ANALYZED

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

Approved

VRI-RIVERVIEW FACILITY
Schenectady, New York

GROUNDWATER DATA - SVOCs, METALS, AND OTHER PARAMETERS ANALYTICAL RESULTS

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: JULY 2013
Project Manager: J.K.P.	Reviewed By: J.H.	Designed By:	Drawn By: G.R.B.
Scale: AS SHOWN	Project No: 18631-50	Report No: 014	Drawing No: figure 2.3

18631-50(014)GN-WA003 FEB 21/2014

0 75 150ft

LEGEND

- VRI-1 GROUNDWATER MONITORING WELL
- SMH MANHOLE
- CB CATCH BASIN
- SITE BOUNDARY
- CHAIN LINK FENCE
- MONITORING WELL TO BE SAMPLED FOR VOCs AND NON-STANDARD VOCs
- APPROXIMATE AREA OF IMPACTED GROUNDWATER
- PROPOSED ISCO INJECTION WELL

figure 2.4

ROD SELECTED REMEDY
VRI-RIVERVIEW FACILITY
Schenectady, New York

18631-50(014)GN-WA004 FEB 21/2014

0 50 150ft

SEE INSET

INSET
1" =20'

LEGEND

- VRI-1 GROUNDWATER MONITORING WELL
- SMH MANHOLE
- CB CATCH BASIN
- SITE BOUNDARY
- CHAIN LINK FENCE
- MONITORING WELL TO BE SAMPLED FOR VOCs AND NON-STANDARD VOCs
- APPROXIMATE AREA OF IMPACTED GROUNDWATER
- PROPOSED ISCO INJECTION WELL

figure 4.1

ISCO INJECTION WELL LAYOUT
VRI-RIVERVIEW FACILITY
Schenectady, New York

18631-50(014)GN-WA006 FEB 21/2014

ISCO INJECTION WELL DETAIL - (6 REQUIRED)

N.T.S.

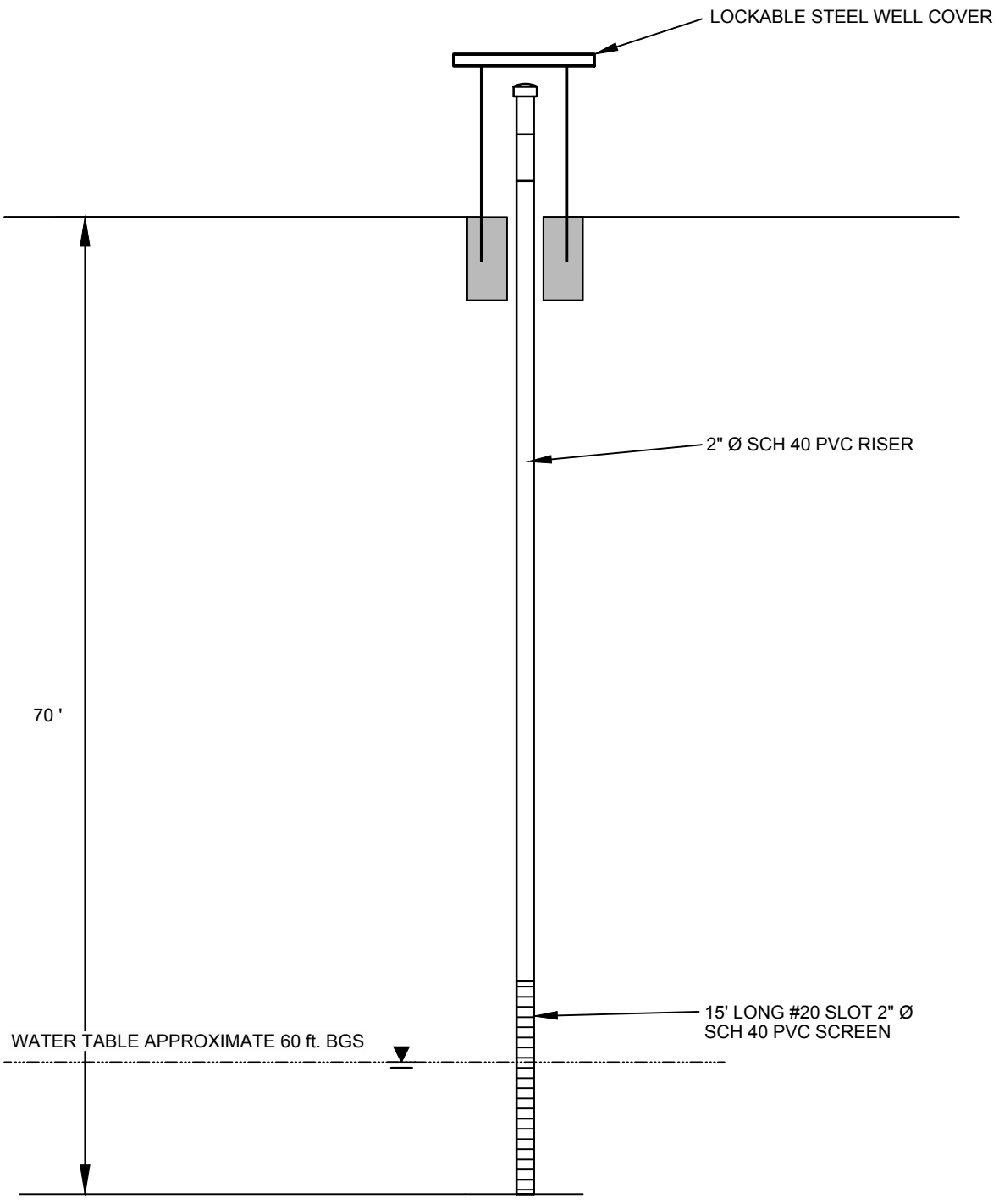


figure 4.2

ISCO INJECTION WELL DESIGN
VRI-RIVERVIEW FACILITY
Schenectady, New York

18631-50(014)GN-WA007 FEB 21/2014

TASK DESCRIPTION	DURATION (MONTHS)																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1) NYSDEC APPROVAL OF RD/RA WORK PLAN	*																										
2) OBTAINING UIC PERMIT FOR ISCO INJECTION	—	—																									
3) IMPLEMENTATION																											
i) Install Injection Wells			—																								
ii) ISCO Injections				*						*																	
4) STATUS REPORTS					*	*	*	*	*	*						*				*							*
5) GROUNDWATER MONITORING FIRST 2 YEARS (ANNUAL MONITORING FOR YEARS 3-5)			—					—						—				—						—			

figure 9.1

PROJECT SCHEDULE
VRI-RIVERVIEW FACILITY
Schenectady, New York

TABLE 4.1

GROUNDWATER SAMPLING PLAN
VRI SITE
SCHENECTADY, NEW YORK

Monitoring Well Location	*Monitoring -Years 1 and 2*					*Annual Monitoring - Years 3, 4, and 5*		
	Round 1-Initial Monitoring Before Injection	*Round 2*	*Round 3*	*Round 4*	*Round 5*			
VRI-1	√	√	√	√	√	√	√	√
VRI-2	√	√	√	√	√	√	√	√
GT9	√	√	√	√	√	√	√	√
VRI-3				√	√	√	√	√
VRI-4				√	√	√	√	√
VRI-9				√	√	√	√	√
GT14				√	√	√	√	√
GT15				√	√	√	√	√
GT16				√	√	√	√	√
GT7				√	√	√	√	√
6 Perimeter Injection Wells		√	√	√	√	√	√	√
1 Injection Well Beside Monitoring Well VRI-1	√	√	√	√	√	√	√	√

Notes:

- Monitoring schedule is presented on Figure 9.1

Appendix A

Health and Safety Plan

SITE-SPECIFIC HEALTH AND SAFETY PLAN

Prepared on behalf of:
GE Corporate Environmental Programs

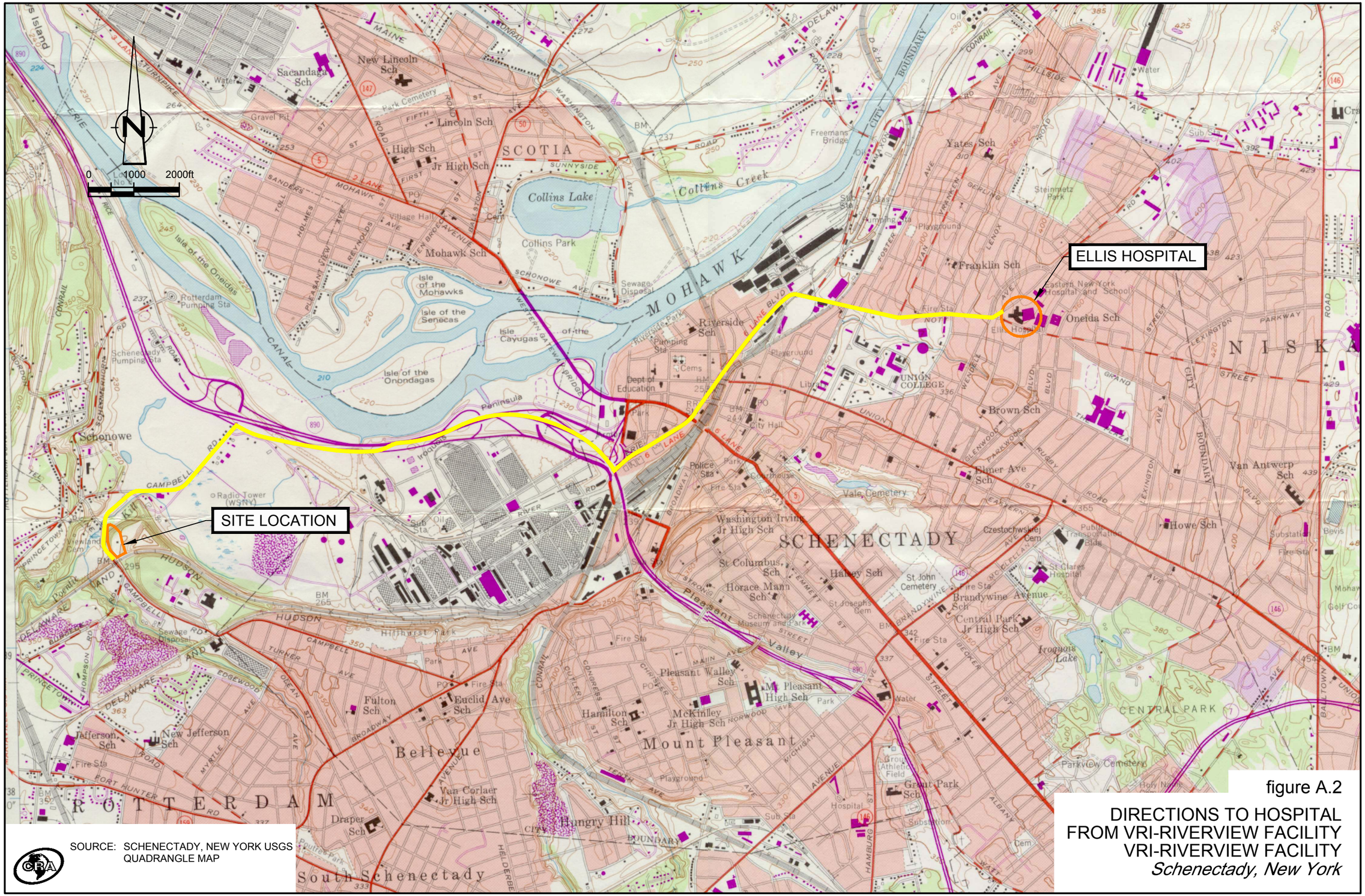
For the:
Von Roll USA, Inc. Facility
Schenectady, New York

FEBRUARY 2014
REF. NO. 018631 (14)

EMERGENCY CONTACT SHEET AND HOSPITAL ROUTE MAP
VON ROLL USA, INC. SITE

EMERGENCY INFORMATION		
Contact	**Phone Number**	**Hospital Directions**
Local Police	**911**	Directions: SEE ATTACHED MAP AND DIRECTIONS
Fire Department	**911**	
Ambulance	**911**	
Local Hospital: Ellis Hospital Address: 1101 Nott St., Schenectady, NY, 12308-2489	**518-243-4000**	Driving Time: Driving Distance:
National Poison Center	**800-222-1222**	
Project Manager Jamie Puskas Work: Cell:	 519-884-0510 519-572-9444	CRA – Incident Reporting Hotline Please call CRA at **(866) 529-4886,** and John Uruskyj (GE) at (518) 862-2717 or (518) 527-2943 and provide: • Name and location of caller • Description of incident • Name of any injured persons • Description of injuries • Phone number for return call
Site Supervisor Brian Pickert Work: Cell:	 - - 518-248-1970	
CRA Regional S&H Manager Craig Gebhardt Work: Cell:	 716-297-6150 716-609-0169	
Site Contact Kathy Doherty Work:	 518-344-7142	
Client Contact John Uruskyj Work: Cell:	 518-862-2717 518-527-2943	
Other Contact (Name) Work: Cell:	 	
Person to verify hospital route (Name)	**Signature**	

* Hospital Route must be field validated before site work commences.



SOURCE: SCHENECTADY, NEW YORK USGS QUADRANGLE MAP

figure A.2

DIRECTIONS TO HOSPITAL
FROM VRI-RIVERVIEW FACILITY
VRI-RIVERVIEW FACILITY
Schenectady, New York

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES
(Following Text)

LIST OF TABLES
(Following Text)

LIST OF ATTACHMENTS

HEALTH AND SAFETY PLAN
Signature Page

Site Name: Von Roll USA, Inc.

Location Address: 1 W Campbell Rd., Schenectady, NY 12306

Reference No.: 018631 CRA Office: Waterloo - Rankin

Anticipated Start Date: _____ Anticipated Project Duration: _____

Prepared By (Signature): _____ Date: _____

Project Manager (Signature): _____ Date: _____

Reviewed By (Signature:) Craig Liebhardt Date: 7/31/13

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this site-specific health and safety plan (HASP) is to provide specific guidelines and establish procedures for the protection of personnel performing the activities described in Section 2.0 Site Operations. The information in this HASP has been developed in accordance with applicable standards and is, to the extent possible, based on information available to date. The HASP is also a living document, in that it must continually evolve as site conditions and knowledge of the site work activities develop.

A vital element of CRA's Safety and Health Policies and Procedures is the implementation of a site-specific HASP for field activities. The HASP, as applicable to this project, includes the following measures:

- Communicate the contents of this HASP to site personnel.
- Eliminate unsafe conditions. Efforts must be initiated to identify conditions that can contribute to an incident and to remove exposure to these conditions.
- Utilize the STAR (Stop, Think, Act, and Review) process before beginning any activity/task/job, after an incident, and/or during any unusual circumstances. Stop the activities to think about the task, analyze the task hazards and determine methods to reduce risk, and review the results with affected personnel.
- Revise or develop Job Safety Analysis (JSA) forms for activities. Supervisors and affected personnel are responsible for JSA development. A blank JSA form has been included in Attachment B of this HASP.
- Complete behavioral-based safety observations via the use of the Safe Task Evaluation Process (STEP).
- Reduce unsafe acts. Personnel shall make a conscious effort to work safely. A high degree of safety awareness must be maintained so that safety factors become an integral part of the task. Supervisory personnel shall ensure that personnel committing unsafe acts are held accountable via counseling, mentoring, and, if necessary, reprimand.
- Inspect frequently. Regular documented safety inspections of the work site, materials, and equipment by qualified persons ensure early detection of unsafe conditions. Safety and health deficiencies shall be corrected as soon as possible or project activities shall be suspended. Documentation of daily inspections and corrective actions should be kept with the project files.

1.2 STOP WORK AUTHORITY

All CRA employees are empowered and expected to stop the work of co-workers, subcontractors, client employees, or other contractors if any person's safety or the environment are at risk. No repercussions will result from this action. Reporting of unsafe conditions/acts and/or Stop Work Authority shall be documented using the Unsafe Condition/Acts and SWA form located in Attachment A.

The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated shall result in the removal of site personnel from that area and re-evaluation of the hazard and the levels of protection.

1.3 PERSONNEL REQUIREMENTS

All personnel conducting activities on site must conduct their activities in compliance with all applicable Safety and Health legislation throughout North America to include, but not limited to, the Occupational Safety and Health Administration (OSHA) 29 CFR 1910, 29 CFR 1926, and CRA's policies and procedures. **Project personnel must also be familiar with the procedures and requirements of this HASP**. In the event of conflicting safety procedures/requirements, personnel must implement those safety practices affording the highest level of safety and protection.

1.4 PROJECT MANAGEMENT AND SAFETY RESPONSIBILITIES

Project Manager – CRA– Jamie Puskas

The CRA Project Manager (PM) shall be responsible for the overall implementation of the HASP, and for ensuring that all safety and health (S&H) responsibilities are carried out in conjunction with this project. This shall include, but is not limited to, review and approval of the HASP, ensuring that the STEP forms are completed properly, qualifying and directing subcontractors relative to S&H performance, coordinating all S&H submittals, and consultation with the Site Supervisor (SS) regarding appropriate changes to the HASP. The PM will also ensure that the appropriate resources are provided to support the project with respect to all operations.

Site Supervisor – CRA– Brian Pickert

The Site Supervisor (SS) is the person who, under the supervision of the project manager, shall be responsible for the communication of site requirements to site project personnel and subcontractors, and is responsible for carrying out the safety and health responsibilities by ensuring:

1. Conduct a daily Tailgate Safety meeting that communicates the site-specific hazards for the operations that day, and what proactive measure will minimize the hazards. Each meeting must be documented on the Tailgate Safety Meeting Form to include all topics covered, and the signatures of those in attendance.
2. All necessary cleanup and maintenance of safety equipment is conducted by project personnel.
3. Emergency phone numbers and services, including hospital and clinic locations, are verified.
4. Site personnel are implementing the STAR process before initiating activities.
5. JSA forms are developed and revised accordingly.
6. Forms attached to the HASP are completed, filed, and submitted correctly, including daily tailgate meetings and completion of daily inspection checklists.
7. A pre-entry briefing is conducted and documented, and serves to familiarize on-site personnel with the procedures, requirements, and provisions of the HASP.

Other duties include overall implementation of the HASP and ensuring that all safety and health responsibilities are carried out in conjunction with the project. This shall include, but is not limited to, review and approval of the HASP, communication of site requirements to subcontractor personnel, and consultation with the client/site representative regarding appropriate changes to the HASP.

The SS is also responsible for enforcing safe work practices for project employees. The SS watches for ill effects on any crew member, especially those symptoms caused by cold/heat stress or chemical exposure. The SS oversees the safety of visitors who enter the site. The SS maintains communication with the client/site representative(s).

Other specific duties of the SS include:

- Ordering the immediate shutdown and/or stop work of site activities in the case of a medical emergency, unsafe condition, or unsafe practice

- Providing the safety equipment, personal protective equipment (PPE), and other items necessary for employees
- Enforcing the use of required safety equipment, PPE, and other items necessary for employee or community safety
- Conducting job site inspections as a part of quality assurance for safety and health
- Reporting safety and health concerns to site and/or project management as necessary

Regional Safety & Health Manager - CRA – Craig Gebhardt

The Regional Safety & Health Manager (RSHM) is a full-time CRA employee who is trained as a safety and health professional, and serves in a consulting role to the PM and SS regarding potential safety and health issues.

Employee Safety Responsibility

CRA employees are responsible for their own safety as well as the safety of those around them. CRA employees shall use any equipment provided in a safe and responsible manner, as directed by their supervisor.

Employees are directed to take the following actions when appropriate:

- Suspend any operations that may cause an imminent health hazard to employees, subcontractors, or others.
- Utilize the STAR process before initiating work.
- Assist in the development and revision of JSA forms that are appropriate to their current scope of work.
- Prepare, submit, and review behavior-based safety observations using the STEP form. The STEP form is to be used in conjunction with the appropriate JSA to identify positive aspects of task performance as well as to identify any deficiencies associated with the observed task.
- Inspect tools and other equipment before each use or as manufacturer and/or OSHA dictates.
- Correct job site hazards when possible without endangering life or health.
- Report safety and health concerns to the SS, PM, or RSHM.

Subcontractors. CRA subcontractors are responsible for the implementation of their own HASP and agree to comply with its contents. In the event of conflicting safety procedures or requirements, personnel must implement those safety practices that

afford the highest level of safety and protection. In addition, non-compliance with safety and health policies and procedures may subject the subcontractor to disciplinary action up to and including termination of their contract with CRA. Subcontractors will be required to attend an initial site orientation and subsequent safety meetings.

Equipment Operators. All equipment operators are responsible for the safe operation of heavy equipment. Operators are responsible for inspecting their equipment on a daily basis to ensure safe performance. Brakes, hydraulic lines, backup alarms, and fire extinguishers must be inspected routinely throughout the project. Equipment will be taken out of service if an unsafe condition occurs. Documentation of daily inspections is required.

Authorized Visitors. Authorized visitors, as approved by the client**,** shall be provided with all known information with respect to the site operations and hazards as applicable to the purpose of their visit.

1.5 SITE HASP AMENDMENTS

Any change to the scope of work must be evaluated for its impact on the overall health and safety of the project and associated personnel. A minor change is one that adjusts already documented hazards within the HASP and does not expose site personnel to chemicals above exposure limits, such as the introduction of a new JSA, or PPE that does not involve a change in respiratory protection. Minor amendments must be communicated to key personnel and documented on the Site Health and Safety Plan Minor Amendment Form located in Attachment A.

Significant changes to the scope of work require a rewrite and review/approval of the HASP.

1.6 TRAINING AND MEDICAL SURVEILLANCE REQUIREMENTS

All individuals performing the field activities outlined in this HASP must have completed a training course of at least 40 hours meeting the requirements of 29 CFR §1926.65(e) for safety and health at hazardous waste operations. If the course was completed more than 12 months before the date of work, completion of an 8-hour refresher course on health and safety at hazardous waste operations is required.

In addition, each CRA employee and each employee of CRA's Subcontractors must receive Von Roll USA Contractor Training before being allowed to work at the Riverview Facility.

1.6.1 MEDICAL SURVEILLANCE

CRA has implemented a medical monitoring program in accordance with 29 CFR §1926.65(f). The CRA program is designed to monitor and reduce health risks to employees potentially exposed to hazardous materials and to provide baseline medical data for each employee involved in work activities. It is also designed to determine the employee's ability to wear PPE such as chemical-resistant clothing and respirators.

Medical examinations are administered on a pre-employment and annual basis and as warranted by symptoms of exposure or specialized activities. The examining physician is required to make a report to CRA of any medical condition that would increase the employee's risk when wearing a respirator or other PPE. CRA maintains personnel medical records as required by 29 CFR §1926.65(f), 29 CFR §1910.1020, and 29 CFR §1910.134 as applicable.

1.6.2 SITE-SPECIFIC TRAINING AND SAFETY AND HEALTH PLAN REVIEW

An initial site-specific training session or briefing shall be conducted by the PM or SS prior to commencement of work activities. During this initial training session, employees shall be instructed on the following topics:

- Personnel responsibilities
- Content and implementation of the HASP
- Site hazards and controls
- Site-specific hazardous procedures (e.g., chemical injections etc.)
- Training requirements
- PPE requirements
- Emergency information, including local emergency response team phone numbers, route to nearest hospital, incident reporting procedures, and emergency response procedures
- Instruction in the completion of required inspections and forms

- Location of safety equipment, such as portable eyewash, first aid kit, fire extinguishers, etc.

The various components of the project HASP will be presented, followed by an opportunity to ask questions to ensure that each attendee understands the HASP. Personnel will not be permitted to enter or work in potentially contaminated areas of the site until they have completed the site-specific training session. Personnel successfully completing the training session shall sign the HASP Training Acknowledgement Form, which is presented in Attachment A.

In addition to the initial site briefing conducted at the commencement of the project, supplemental brief safety meetings shall be conducted by the SS to discuss potential safety and health hazards associated with upcoming tasks and necessary precautions to be taken.

1.6.3 SAFETY MEETINGS

"Tailgate" safety meetings will take place each day prior to beginning the day's work. All site personnel will attend these safety meetings conducted by the SS. The safety meetings will cover specific safety and health issues, including the appropriate JSAs, site activities, changes in site conditions, and a review of topics covered in the site-specific pre-entry briefing. The safety meetings will be documented each day with written sign-in sheets containing a list of topics discussed. To assist with the compliance of documentation of the Tailgate safety meetings, there are two formats available. For meetings attended by more than four people, please use the Tailgate Safety Meeting Form-Large Group daily format, which requires one page for each Tailgate safety meeting conducted. If there are four or less people at the site, please use the Tailgate Safety Meeting Form-Small Group multiple-day format, which provides room to document three Tailgate safety meetings on one page. The two Tailgate Safety Meeting Forms (Large Group and Small Group) are located in Attachment A.

2.0 SITE OPERATIONS

2.1 SITE HISTORY/BACKGROUND

The Riverview Facility is located off the north side of West Campbell Road in the Town of Rotterdam near the border of the City of Schenectady. The property consists of approximately 22 acres. The active Facility area is fenced as shown on the attached Figure A.1. The Facility is bounded on the north by a steep embankment and the Delaware and Hudson (D&H) Railroad, the D&H Railroad and Rotterdam Square Mall to the west, Campbell Road and the Town of Rotterdam publicly owned treatment works (POTW) and Campbell Plastics to the south, and residential areas to the east.

The Riverview Facility is situated on a high, flat plateau about 80 feet above the Mohawk River Valley. The ground surface drops off quickly to the north-northeast toward the Mohawk River and more gently to the west and south. Soils underlying the site are composed primarily of medium to fine grained silty sand and are characterized as deep, coarse textured and well drained.

A broad line of insulating materials and composites for electrical insulating systems are produced at the Riverview Facility. The liquids manufacturing line at the Facility involves production of alkyd and polyester resins and formulation of epoxies, phenolic and acrylate resin solutions in reactors. The Facility also produces solid tapes that are composed of various substrates such as polyester-glass, paper, mica, and polyester. The tapes are laminated with varnishes including polyester, epoxy, acrylate, latex, and silicone. Following lamination, the tapes are cured in ovens, slit to correct widths, and packaged.

Large quantities of liquid and solid raw materials, products and intermediates are stored at the Facility. Under Resource Conservation and Recovery Act (RCRA), the Facility is currently operating as a less than 90-day storage facility for hazardous wastes generated on site. Hazardous wastes are stored in tote tanks and 55-gallon drums in building RV-42 and are hauled by an outside contractor to a hazardous waste disposal facility.

Prior to GE purchasing the Facility in the early 1940s, the property was occupied by a harness racing track and also used for agricultural purposes. GE purchased the property in 1942 and constructed radar development and testing facilities. GE operated the Facility as a radar development plant until GE Insulating Materials group moved into the Riverview Facility and began operating in 1959 or 1960. In March 1988, GE sold the Facility and it was renamed Insulating Materials Incorporated (IMI). Following the

purchase of the Facility, IMI continued to produce electrical insulation products and the operations generally remained consistent with GE operations. The Facility was subsequently purchased by Von Roll USA, Inc. in 1995.

2.2 SCOPE OF WORK

This HASP covers the specific site activities that will be conducted by CRA personnel and their subcontractors. These activities are as follows:

- Mobilization of personnel, materials, and equipment to and from the site
- Injection well development
- Groundwater sampling
- In-Situ Chemical Oxidation (ISCO) injection
- Decontamination of personnel and equipment

If site operations are altered or if additional tasks are assigned, an addendum to this HASP shall be developed to address the specific hazards associated with these changes.

3.0 HAZARD EVALUATION

This section identifies and evaluates the potential chemical, physical, and biological hazards that may be encountered during the completion of this project. These hazards and the anticipated initial exposure levels are based on client data, historical data, etc.

Specific activity JSA forms (located in Attachment B) have been developed to address the hazards associated with the site operations outlined in Section 2.0. New JSAs will be developed on an as-necessary basis if a JSA for that specific task is not available in the HASP. Additionally, current JSAs will be modified and customized in the field to ensure that the task-specific requirements are addressed each time the task is performed.

3.1 CHEMICAL HAZARDS

The chemical hazards associated with conducting site operations include the potential exposure to on-site contaminants encountered during field activities such as sampling activities, products used in decontamination of equipment, and support products such as fuel. The potential routes of exposure from these products during normal use may occur through inhalation of vapors and dusts, or direct contact or absorption with the materials. The chemical hazards of concern that may be encountered during the tasks identified in the project's scope of work include VOCs and SVOCs. A listing of the contaminants of concern is found in Table A.1, which includes exposure limits, signs and symptoms of exposure, chemical properties, and physical characteristics.

3.1.1 CHEMICAL HAZARD CONTROLS

Exposure to potential on-site contaminants/chemicals, such as those listed in Table A.1 and chemical-containing products that are brought to the Site [see Attachment C Material Safety Data Sheets (MSDSs)], shall be controlled by:

- Monitoring air concentrations with appropriate equipment in the breathing zone
- Revising JSAs to list chemical hazards and associated hazard controls on a task-specific basis
- Using PPE/respiratory protection, as appropriate, in areas known to have concentrations above the specified action level for each contaminant
- Reviewing MSDSs for the chemicals being handled

3.1.2 SKIN CONTACT AND ABSORPTION CONTAMINANTS

Skin contact with chemicals may be controlled by use of the proper PPE and good housekeeping procedures. The proper PPE (e.g., Tyvek®, gloves) as described in Section 4.0 shall be worn for all activities where contact with potentially harmful media or materials is anticipated. Utilize manufacturer data on permeation and degradation to minimize skin contact potential (see Section 4.2.1 for additional information).

3.1.3 HAZARD COMMUNICATION

Personnel required to handle or use hazardous materials as part of their job duties will be trained and educated in accordance with the Hazard Communication standard as applicable. The training shall include instruction on the safe use and handling procedures of hazardous materials, how to read and access MSDSs, and the proper labeling requirements.

The appropriate MSDS for the chemicals in use at the site will be maintained by and available for project personnel throughout the course of the project. A copy of all MSDSs is provided in Attachment C.

3.1.4 FLAMMABLE AND COMBUSTIBLE LIQUIDS

The storage, dispensing, and handling of flammable and combustible liquids must be in accordance with industry standards such as National Fire Protection Agency (NFPA) guidelines. The specific flammable or combustible liquids used at the site may include gasoline, diesel, kerosene, oils, and solvents.

Flammable and combustible liquids are classified according to flash point. This is the temperature at which the liquid gives off sufficient vapors to readily ignite. Flammable liquids have flash points below 100°F (37.8°C). Combustible liquids have flash points above 100°F (37.8°C) and below 200°F (93.3°C).

Storage

Many flammables can ignite at temperatures at or below room temperature. They are far more dangerous than combustibles when they are heated. As a result, these products must be handled very carefully. At normal temperatures, these liquids can release vapors that are explosive and hazardous to employee health. Exposure to heat can cause some of these liquids to break down into acids, corrosives, or toxic gases. For this

reason, flammable and combustible liquids should be stored in cool, well ventilated areas away from any source of ignition. Always consult the MSDS of the product for specific information.

Flammable and combustible liquids must be stored in designated areas. Such areas must be isolated from equipment and work activity that may produce flames, sparks, heat, or any form of ignition, including smoking. The most practical method is the use of one or more approved (commercially available) flammable/combustible liquid storage cabinets.

General Requirements

- Keep containers of flammable/combustible liquids closed when not in use.
- Keep flammable/combustible liquids in designated areas.
- Do not allow use of unapproved containers for transfer or storage. Use only approved safety cans (5-gallon maximum) with a spring closing lid and spout cover, designated to safely relieve internal pressure when exposed to heat or fire.
- Use only approved self-closing spigots, faucets, and manual pumps when drawing flammable/combustible liquids from larger containers/barrels.
- Use only approved metal waste cans with lids for disposal of shop towels/oily rags.
- Observe all signs indicating "No Smoking," "No Flames", and "No Ignition".

Transferring Flammable/Combustible Liquids

- This seemingly routine task can be hazardous if certain precautions are not followed. Grounding and bonding must be observed at all times to prevent the accumulation of static electricity when transferring containers/barrels one to another.
- Drums should be grounded to a grounding rod using a #4 copper conductor.
- Bonding is necessary between conductive containers (e.g., a barrel and a 5-gallon container).

3.2 PHYSICAL HAZARDS

Physical hazards that may be present during project work include: noise, vehicle traffic, material handling, heavy lifting, electrical or stored energy, use of hand and power tools, slip/trip/hit/fall injuries, heat/cold stress, biological hazards, other potential adverse weather conditions, working alone, and aggressive or menacing behavior. In

addition, personnel must be aware that the protective equipment worn may limit dexterity and visibility and may increase the difficulty of performing some tasks.

3.2.1 NOISE

Project activities that include working in close proximity to power tools that generate noise levels exceeding the decibel range of 85 dBA, will require the use of hearing protection with a Noise Reduction Rating (NRR) of at least 20. Hearing protection (earplugs/muffs) will be available to personnel and visitors requiring entry into these areas.

When it is difficult to hear a coworker at normal conversation distance, the noise level is approaching or exceeding 85 dBA, and hearing protection is necessary. All site personnel who may be exposed to high noise levels will participate in CRA's Hearing Conservation Program.

3.2.2 VEHICLE TRAFFIC AND CONTROL

The following safety measures are to be taken by CRA personnel that have the potential to be exposed to vehicle traffic:

- A high visibility safety garment meeting ANSI Class II requirements is to be worn at all times
- Employees will work using the "buddy system"
- Cones and other visible markers will be used to demarcate a safe work zone around the active work zone(s)
- Appropriate signage will be posted as necessary, to inform roadway/parking lot users of any additional control measures necessary to protect the public and CRA employees

3.2.3 MATERIAL HANDLING AND STORAGE

Material handling and storage practices to be conducted at the project site include manual lifting of materials and possibly the use of hoisting and rigging equipment. As a rule, use mechanical means for lifting heavy loads whenever possible.

General Storage Practices

The basic safety requirement for storage areas is that the storage of materials and supplies shall not create a hazard. Additional general storage area practices include the following:

- Bags, containers, bundles, etc. stored in tiers shall be stacked, blocked, interlocked, and limited in height so that they are stable and secure against sliding or collapse.
- All stacked materials, cargo, etc. shall be examined for sharp edges, protrusions, signs of damage, or other factors likely to cause injury to persons handling these objects. Defects should be corrected as they are detected.
- Storage areas shall be kept free from accumulation of materials that constitute hazards from tripping, fire, explosion, or pest harborage.
- Storage areas shall have provisions to minimize manual lifting and carrying. Aisles and passageways shall provide for the movement of mechanical lifting and conveyance devices.
- Stored materials shall not block or obstruct access to emergency exits, fire extinguishers, alarm boxes, first aid equipment, lights, electrical control panels, or other control boxes.
- "NO SMOKING" signs shall be conspicuously posted, as needed, in areas where combustible or flammable materials are stored and handled.

Cylindrical materials such as pipes and poles shall be stored in racks or stacked on the ground and blocked.

Special Precautions for Hazardous or Incompatible Materials Storage

Generally, materials are considered hazardous if they are ignitable, corrosive, reactive, or toxic. Manufacturers and suppliers of these materials must provide the recipient with MSDSs, which describe their hazardous characteristics and give instructions for their safe handling and storage.

Many hazardous materials are incompatible, which means they form mixtures that may have hazardous characteristics not described on the individual MSDSs. The following special precautions shall be followed regarding the storage of hazardous materials:

- Based on the information available on the MSDSs, incompatible materials shall be kept in separate storage areas

- Warning signs shall be conspicuously posted, as needed, in areas where hazardous materials are stored

3.2.4 MANUAL LIFTING

Proper lifting takes the hazard out of moving heavy objects. Below are some items that should be considered prior to a lift.

- Establish that you can lift the load safely; if the load is in excess of 50 pounds, you are required to ask for assistance
- Use a mechanical lifting device if available
- Inspect route to be traveled, confirming sufficient clearance
- Look for any obstructions or spills
- Inspect the object to determine how it should be grasped
- Look for any sharp edges, slivers, or other things that may cause personal injury
- Do not move any object that will obstruct your field of vision when transporting the load

When lifting objects, use the following proper lifting techniques:

- Feet must be parted, with one foot alongside the object being lifted and one foot behind. When the feet are comfortably spread, a more stable lift can occur and the rear foot is in a better position for the upward thrust of the lift.
- Use the squat position and keep the back straight - but remember that straight does not mean vertical. A straight back keeps the spine, back muscles, and organs of the body in correct alignment, and minimizes the compression of the guts that can cause a hernia.
- Grip is one of the most important elements of correct lifting. The fingers and the hand are extended around the object, using the full palm. Fingers have very little power, so use the strength of your entire hand.
- The load must be drawn close, and the arms and elbows must be tucked into the side of the body. Holding the arms away from the body increases the strain on the arms and elbows. Keeping the arms tucked in helps keep the body weight centered.

The body must be positioned so that the weight of the body is centered over the feet. This provides a more powerful line of thrust and also ensures better balance. Start the

lift with a thrust of the rear foot. Do not twist your back while lifting or moving heavy objects.

3.2.5 HAND AND POWER TOOLS

Hand Tools

- Hand tools must meet the manufacturer's safety standards
- Hand tools must not be altered in any way
- At a minimum, eye protection must be used when working with hand tools
- Wrenches (including adjustable, pipe, end, and socket wrenches) must not be used when jaws are sprung to the point that slippage occurs
- Impact tools (such as drift pins, wedges, and chisels) must be kept free of mushroom heads
- Wooden handles must be free of splinters or cracks and secured tightly to the tool
- Any damaged or defective tools must be immediately removed from service and tagged for destruction

Power Tools

- All power tools must be inspected regularly and used in accordance with the manufacturer's instructions and the tool's capabilities
- Electric tools must not be used in areas subject to fire or explosion hazards, unless they are approved for that purpose
- Portable electric tools must be connected to a Ground Fault Circuit Interrupter (GFCI) when working in wet areas
- Proper eye protection must be used when working with power tools
- Personnel must be trained in the proper use of each specific tool
- Any damaged or defective power tools must be immediately tagged and removed from service

3.2.6 CONTROL OF HAZARDOUS ENERGY

Hazardous energy sources may be encountered during the servicing and maintenance of equipment such as pumps, in which the unexpected energization or startup of the equipment could cause injury to project personnel.

The minimum performance requirements to control hazardous energy require that employers develop and implement an energy control program. The elements of an energy control program are as follows:

- Lockout/tagout
- Employee protection
- Energy control procedures
- Protective materials and hardware
- Periodic inspections
- Training and communication
- Energy isolation
- Employee notification

Project personnel who are required to conduct operations and maintenance activities that will require the isolation of an energy hazard through the use of a lockout/tagout device shall follow the written energy control procedures for that operation.

Employee Training

Employees authorized to attach and remove lockout/tagout devices shall be provided with initial training regarding the safe application, usage, and removal of such devices. Each authorized employee will receive training in the recognition of applicable hazardous energy sources, the type and magnitude of the associated energy, and the methods necessary for energy isolation and control.

All authorized employees will be provided with refresher training annually or at more frequent intervals whenever the following conditions apply:

- A job assignment change
- A change in machinery or equipment, or a process change that presents new hazards
- A change in the energy control procedures
- Possible deficiencies in the employee's understanding of the following
    - The hazards associated with the energy that controls the machinery or equipment in the employee's work area
    - Application and removal procedures for lockout/tagout devices

Employees who work in areas where lockout/tagout procedures are used shall receive initial and annual refresher training in the purpose and use of lockout/tagout devices and principles behind their use.

3.2.7 COMPRESSED GAS CYLINDERS

Compressed gases present several hazards. The cylinder must be properly labeled, identifying the hazardous properties of the gas, such as toxicity, flammability, or the presence of an oxidizer and a MSDS must be supplied by the manufacturer. In addition to the gas hazards, compressed gas cylinders pose other hazards simply because they contain gas under pressure.

Regardless of the properties of the gas, any gas under pressure can explode if the cylinder is improperly stored or handled. Improperly releasing the gas from a compressed gas cylinder is extremely dangerous. A sudden release of the gas can cause a cylinder to become a missile-like projectile, destroying everything in its path. Cylinders have been known to penetrate concrete-block walls. To prevent such a dangerous situation, there are several general procedures to follow for the safe storage and handling of a compressed gas cylinder:

- Store cylinders in an area specifically designated for that purpose. This area must protect the cylinders from being struck by another object. The area must be well-ventilated, away from sources of heat, and at least 20 feet away from highly combustible materials. Oxidizers must be stored at least 20 feet away from flammable gases.
- Cylinders must not be dropped or allowed to fall. Chain and rack them in an upright position during use and storage. When transporting cylinders, they must be secured from falling.
- When moving a cylinder, even for a short distance, all the valves must be closed, the regulator removed, and the valve cap installed. Never use the valve cap to lift a cylinder. If you are using a crane or some other lifting device to move a cylinder, use a cradle or boat designed for that purpose. Never use a sling or a magnet to move a cylinder.
- Never permit cylinders to contact live electrical equipment or grounding cables.
- Cylinders must be protected from the sun's direct rays, especially in high-temperature climates. Cylinders must also be protected from ice and snow accumulation.

- Before the gas is used, install the proper pressure-reducing regulator on the valve. After installation, verify the regulator is working, all gauges are operating correctly, and all connections are tight to ensure that there are no leaks. When you are ready to use the gas, open the valve with your hands. Never use a wrench or other tool. If you cannot open it with your hands, do not use it.

3.2.8 SLIP/TRIP/HIT/FALL

Slip/trip/hit/fall injuries are the most frequent of all injuries to workers. They occur for a wide variety of reasons, but can be minimized by the following prudent practices:

- Spot check the work area to identify hazards
- Establish and utilize a pathway free of slip and trip hazards
- Beware of trip hazards such as wet floors, slippery floors, and uneven surfaces or terrain
- Carry only loads you can see over
- Keep work areas clean and free of clutter, especially in storage rooms and walkways
- Communicate hazards to on-site personnel
- Secure all loose clothing and ties, and remove jewelry while around machinery.
- Report and/or remove hazards
- Keep a safe buffer zone between workers using equipment and tools

3.2.9 HEAT STRESS

Recognition and Symptoms

Temperature stress is one of the most common illnesses faced by project personnel when working in elevated temperatures and/or humidity. Acclimatization and frequent rest periods must be established for conducting activities where temperature stress may occur. Below are listed signs and symptoms of heat stress. Personnel should follow appropriate guidelines if any personnel exhibit these symptoms:

- **Heat Rash**: Redness of skin. Frequent rest and change of clothing.
- **Heat Cramps**: Painful muscle spasms in hands, feet, and/or abdomen. Administer lightly salted water by mouth, unless there are medical restrictions.

- **Heat Exhaustion**: Clammy, moist, pale skin, along with dizziness, nausea, rapid pulse, fainting. Remove to cooler area and administer fluids.
- **Heat Stroke**: Hot dry skin; red, spotted, or bluish; high body temperature of 104°F; mental confusion; loss of consciousness; convulsions or coma. Immediately cool victim by immersion in cool water. Wrap with wet sheet and sponge with cool liquid while fanning, treat for shock. **DO NOT DELAY TREATMENT. COOL BODY WHILE AWAITING AMBULANCE.**

Work Practices

The following procedures will be carried out to reduce heat stress:

- Heat stress monitoring
- Acclimatization
- Work/rest regimes (schedule of breaks) - mandatory breaks scheduled in summer months or during high risk activities for heat stress
- Heat stress safety personal protective equipment (cool-vests, bandanas, etc.)
- Cool potable water available
- Use of buddy system

Acclimatization

The level of heat stress at which excessive heat strain will result depends on the heat tolerance capabilities of the worker. Each worker has an upper limit for heat stress, beyond which the resulting heat strain can cause the worker to become a heat casualty. In most workers, appropriate repeated exposure to elevated heat stress causes a series of physiologic adaptations called acclimatization, whereby the body becomes more efficient in coping with the heat stress. Work/rest regimes should be planned as a component of project preparation and discussed during the daily tailgate safety meetings.

Worker Information and Training

All new and current employees who work in areas where there is a reasonable likelihood of heat injury or illness should be kept informed through continuing education programs (e.g., hazards, effects, preventative measures, drug/alcohol interaction).

3.2.10 SUN EXPOSURE

Overexposure to sunlight is a common concern when field activities occur during warm weather conditions. Overexposure can occur on clear, sunny days as well as on overcast and cloudy days. Ultraviolet (UV) rays from the sun can cause skin damage or sunburn, but can also result in vision problems, allergic reactions, and other skin concerns. Two types of UV rays are emitted from the sun: UVA and UVB rays.

UVB rays cause sunburn, skin cancer, and premature aging of the skin. UVB rays stimulate tanning but are also linked to other problems such as impaired vision, skin rashes, and some allergic and other reactions to certain drugs. Extra care should be taken if activities are to be conducted on or near water. Sunlight reflected off the surface of the water is intensified resulting in accelerated effects. The following steps should be taken to protect against overexposure to sunlight:

- **Always Use Sunscreen**: Apply a broad spectrum sunscreen with Sun Protection Factor (SPF) of at least 15 or higher liberally on exposed skin. Reapply every 2 hours or more. Even waterproof sunscreen can come off when you towel off or sweat.
- **Cover Up**: Wearing tightly woven, loose-fitting, and full-length clothing is a good way to protect your skin from UV rays.
- **Wear a Hat**: A hat with a wide brim offers good sun protection to your eyes, ears, face, and the back of your neck – areas particularly prone to overexposure to the sun.
- **Wear Sunglasses That Block 99 to 100 Percent of UV Radiation**: Sunglasses that provide 99 to 100 percent UVA and UVB protection will greatly reduce sun exposure that can lead to cataracts and other eye damage. Check the label when buying sunglasses.
- **Seek Shade**: Shade is a good source of protection, but keep in mind that shade structures (e.g., trees, umbrellas, canopies) do not offer complete sun protection.
- **Limit Time in the Midday Sun**: The sun's rays are strongest between 10 a.m. and 4 p.m. Whenever possible, limit exposure to the sun during these hours.

3.2.11 COLD STRESS

Cold stress is similar to heat stress, in that it is caused by a number of interacting factors including environmental conditions, clothing, and workload, as well as the physical and conditioning characteristics of the individual. Fatal exposures to cold have been reported in employees failing to escape from low environmental air temperatures or from immersion in low temperature water. Hypothermia, a condition in which the

body's deep core temperature falls significantly below 98.6°F (37°C), can be life threatening. A drop in core temperature to 95°F (35°C) or lower must be prevented.

Air temperature is not sufficient to determine the cold hazard of the work environment. The wind chill must be considered as it contributes to the effective temperature and insulating capabilities of clothing. The equivalent chill temperature should be used when estimating the combined cooling affect of wind and low air temperatures on exposed skin or when determining clothing insulation requirements to maintain the body's core temperature.

The body's physiologic defense against cold includes constriction of the blood vessels, inhibition of the sweat glands to prevent loss of heat via evaporation, glucose production, and involuntary shivering to produce heat by rapid muscle contraction.

The frequency of incidents increases with cold temperature exposures as the body's nerve impulses slow down, individuals react sluggishly, and numb extremities make for increased clumsiness. Additional safety hazards include ice, snow blindness, reflections from snow, and possible skin burns from contact with cold metal.

Pain in the extremities may be the first early warning of danger to cold stress. During exposure to cold, maximum severe shivering develops when the body temperature has fallen to 95°F (35°C). This must be taken as a sign of danger to the employees on site, and cold exposures should be immediately terminated for any employee when severe shivering becomes evident. Useful physical or mental work is limited when severe shivering occurs.

Predisposing Factors for Cold Stress

Certain predisposing factors make an individual more susceptible to cold stress. The project team members are responsible for informing the SHO/SS to monitor an individual, if necessary, or use other means of preventing/reducing the individual's likelihood of experiencing a cold related illness or disorder.

Predisposing factors that will increase an individual's susceptibility to cold stress are listed below:

- **Dehydration:** The use of diuretics and/or alcohol, or diarrhea can cause dehydration. Dehydration reduces blood circulation to the extremities.

- **Fatigue During Physical Activity:** Exhaustion reduces the body's ability to constrict blood vessels. This results in the blood circulation occurring closer to the surface of the skin and the rapid loss of body heat.
- **Age:** Some older and very young individuals may have an impaired ability to sense cold.
- **Poor Circulation:** Vasoconstriction of peripheral vessels reduces blood flow to the skin surface.
- **Heavy Work Load:** Heavy workloads generate metabolic heat and make an individual perspire even in extremely cold environments. If perspiration is absorbed by the individual's clothing and is in contact with the skin, cooling of the body will occur.
- **Use of PPE:** PPE usage that traps sweat inside the PPE may increase an individual's susceptibility to cold stress.
- **Lack of Acclimatization:** Acclimatization, the gradual introduction of workers into a cold environment, allows the body to physiologically adjust to cold working conditions.
- **History of Cold Injury:** Previous injury from cold exposures may result in increased cold sensitivity.

Prevention of Cold Stress

A variety of measures can be implemented to prevent or reduce the likelihood of employees developing cold related ailments and disorders. These include acclimatization, fluid and electrolyte replenishment, eating a well-balanced diet, wearing warm clothing, the provision of shelter from the cold, thermal insulation of metal surfaces, adjusting work schedules, and employee education.

- **Acclimatization:** Acclimatization is the gradual introduction of workers into the cold environment to allow their bodies to physiologically adjust to cold working conditions. However, the physiological changes are usually minor and require repeated uncomfortably cold exposures to induce them.
- **Fluid and Electrolyte Replenishment:** Cold, dry air can cause employees to lose significant amounts of water through the skin and lungs. Dehydration affects the flow of blood to the extremities and increases the risk of cold injury. Warm, sweet, caffeine-free, non-alcoholic drinks and soup are good sources to replenish body fluids.

- **Eating a Well-Balanced Diet:** Restricted diets including low salt diets can deprive the body of elements needed to withstand cold stress. Eat high-energy foods throughout the day.
- **Warm Clothing:** Maintaining air space between the body and outer layers of clothing is beneficial in order to retain body heat. However, the insulating effect provided by such air spaces is lost when the skin or clothing is wet.
- **Work/Rest Regimes:** Schedule work during the warmest part of the day, if possible. Rotate personnel and adjust the work/rest schedule to enable employees to recover from the effects of cold stress.

The parts of the body most important to keep warm are the feet, hands, head, and face. As much as 40 percent of body heat can be lost when the head is exposed.

3.2.12 ADVERSE WEATHER CONDITIONS

The SS shall decide on the continuation or discontinuation of work based on current and pending weather conditions. Electrical storms, heavy rains, hurricanes, tornado warnings, and sustained strong winds (approximately 40 mph) are examples of conditions that would call for the discontinuation of work and evacuation of site.

In addition, no work with elevated super structures (e.g., drilling, crane operations) will be permitted during any type of electrical storm or during wind events that have wind speeds exceeding 40 mph.

3.2.13 AGGRESSIVE OR MENACING BEHAVIOR

When confronted by an individual whose behavior becomes aggressive or menacing, staff should remain as calm as possible. Avoid arguing with or physically confronting the individual. Attempt to distance yourself from the individual. Advise others in the area to leave the scene and request police assistance by having someone call 911. Use the team approach. A staff member who is physically unable to break away from an attacker should shout for help.

The use of physical force is justified when a person believes that such force is necessary to protect himself or herself against the use or imminent use of unlawful physical force by another person. The use of physical force is also justified in the defense of another party, such as a co-worker, who is being subjected to unlawful physical force. Staff

members can use any technique of legal self-defense in order to halt or distract an attacker until law officers arrive on the scene.

Should an aggressor only be interested in the taking or damaging of property, do not interfere. Obtain a description of the individual to provide to local authorities, including height, weight, race, sex, clothing, accent, unusual markings such as tattoos, facial piercings, scars, hair color, and weapon, if any.

File an Incident Report with your immediate supervisor who will forward same accordingly.

3.3 BIOLOGICAL HAZARDS

CRA employees conduct numerous project activities that may encounter biological hazards, including bloodborne pathogens, insects, spiders, rodents, and snakes. This section identifies precautions to be taken if these hazards are encountered.

3.3.1 VEGETATION OVERGROWTH

Overgrown weeds, bushes, trees, grass, and other vegetation are fire and safety hazards. A number of hidden hazards may not be immediately recognized due to the overgrowth of vegetation in areas where field activities may occur, including discarded junk, litter, and debris. Construction materials such as boards, nails, concrete, and other debris may be hidden beneath tall grass, weeds, and bushes. Other hazards may include steep slopes, potholes, trenches, soft spots, dips, etc., all dangerously concealed from the view of the individual walking or operating motorized equipment in the area. Additionally, biological hazards such as snakes, ticks, chiggers, and mosquitoes may be present, as they breed in overgrowth conditions.

Here are some simple actions you can take:

- Assess the work area and determine if the area requires vegetation clearance. Consider that overgrowth extending above the lowest level of motorized equipment (i.e., bumper or fender) or 6 inches above your ankle has hidden hazards that you will not be able to readily identify.
- Determine if the area is safe to walk or whether you need motorized equipment. Consider the limitations of the equipment.

- Identify slip, trip, and fall hazards and remove from the general work area. Remember to give adequate clearance so that the items being removed do not pose future hazards.
- Adequately protect yourself against the hazards by wearing boots that protect the ankles, wearing long pants, and using insecticides.
- Consider the limitations of manual or mechanical equipment for the clearance of overgrowth, particularly the safety hazards when using sling blades, machetes, weed eaters, bush hogs, or other brush removing equipment.

Before taking any action, determine whether there any ecological issues that would affect or prevent the removal of overgrowth in protected areas such as wetlands, wildlife habitats, or sanctuaries for endangered and/or protected species.

3.3.2 POISONOUS PLANTS

Common **poison ivy** grows as a small plant, a vine, and a shrub. Poison ivy occurs in every state. The leaves always consist of three glossy leaflets. The plants are potent sensitizers and can cause a mild to severe allergic reaction, referred to as "contact dermatitis." ***These plants are found in the U.S. and Canada.***

Dermatitis, in Rhus-sensitive persons, may result from contact with the milky sap found in the roots, stems, leaves, and fruit, and may be carried by contacted animals, equipment, or apparel.

The best form of prevention is to avoid contact. Wearing long sleeves, gloves, and disposable clothing, such as Tyvek, is recommended in high-risk areas to avoid exposure from contaminated apparel. Barrier creams and cleaners are also recommended.

3.3.3 INSECTS

Ticks

Ticks are blood feeding external parasites of mammals, birds, and reptiles throughout the world. Some human diseases of current interest in the United States caused by tick-borne pathogens include Lyme disease, ehrlichiosis, babesiosis, Rocky Mountain spotted fever, tularemia, and tick-borne relapsing fever. Lyme disease is caused by a bacterial parasite called spirochete and is spread by infected ticks that live in and near

wooded areas, tall grass, and brush. The ticks that cause the disease in the Northeast and Midwest are often no bigger than a poppy seed or a comma in newsprint. The peak months for human infection are June through October. Many other tick-borne diseases, such as Rocky Mountain spotted fever, can be carried by a variety of ticks. The prevention and treatment of these diseases are similar to those of Lyme disease.

Prevention

Preventative measures include wearing light-colored clothing, keeping clothing buttoned, tucking pant legs in socks, and keeping shirttails tucked in. Periodic checks for ticks should be made during the day, and especially at night. Hair should also be checked by parting it and combing through it to make sure that no ticks have attached to the scalp. Also, check clothing when it is first removed, before ticks have a chance to crawl off. A shower or bath should be taken as soon as possible after leaving the site for the day.

The most common repellent recommended for ticks is N,N-dimethyl-m-toluamide, or DEET. It is important to follow the manufacturer's instructions found on the container with all insecticides, especially those containing DEET.

In general, DEET insect repellent should only be applied to clothing, not directly on the skin. Do not apply to sunburns, cuts, or abrasions. Use soap and water to remove DEET once indoors. However, the DEET user is required to read the insect repellant label and/or MSDS for safe use requirements. If ticks are not responding to DEET or other safety methods, then the PM and RSHM are to be notified and additional safety controls may be utilized.

Removal

The best way to remove a tick is removal by tweezers. If tweezers are not available, cover your fingers (tissue paper) while grasping the tick. It is important to grasp the tick as close as possible to the site of attachment and use a firm steady pull to remove it. When removing the tick, be certain to remove all the mouth parts from your skin so as not to cause irritation or infection. Wash hands immediately after with soap and water, and apply antiseptic to the area where tick was removed. Get medical attention if necessary.

Symptoms of Lyme Disease

The first symptoms of Lyme disease usually appear from 2 days to a few weeks after a person is bitten by an infected tick. Symptoms usually consist of a ring-like red rash on

the skin where the tick attached, and is often bulls eye-like with red on the outside and clear in the center. The rash may be warm, itchy, tender, and/or "doughy" and appears in only 60 to 80 percent of infected persons. An infected person also has flu-like symptoms of fever, fatigue, chills, headaches, a stiff neck, and muscle aches and pains (especially knees). Rashes may be found some distance away from original rash. Symptoms often disappear after a few weeks.

Bees, Wasps, and Yellow Jackets

Stinging insects are members of the order Hymenoptera of the class Insecta. There are two major subgroups: aphids (honeybees and bumblebees) and vespids (wasps, yellow jackets, and hornets). Aphids are docile and usually do not sting unless provoked. The stinger of the honeybee has multiple barbs, which usually detach after a sting. Vespids have few barbs and can inflict multiple stings.

Types of stinging insects that might be encountered on this project site may include:

- Carpenter bees
- Bumblebees
- Honeybees
- Mud dauber wasps
- Cicada killer wasps
- Paper wasps
- Giant hornets
- Yellow jackets

Symptoms

If you are stung, three types of reactions are possible: a normal, a toxic, or an allergic reaction.

- **Normal Reaction**: Only lasts a few hours and consists of pain, redness, swelling, itching, and warmth near the sting area
- **Toxic Reaction**: Will last for several days, results from multiple stings, and may cause cramps, headaches, fever, and drowsiness
- **Allergic Reaction:** Can cause hives, itching, swelling, tightness in the chest area, and a possibility of breathing difficulties, dizziness, unconsciousness, and cardiac arrest.

The stingers of many Hymenoptera may remain in the skin and should be removed as quickly as possible without concern for the method of removal. An ice cube placed over the sting will reduce pain. Persons with known hypersensitivity to such stings should carry a kit containing epinephrine in a prefilled syringe. Antihistamines may help decrease hives and angioedema. Persons who have severe symptoms of anaphylaxis,

have positive venom skin test results, and are at risk for subsequent stings should receive immunotherapy regardless of age or time since anaphylaxis.

Precautions

The following precautions can help you avoid stings. Try to wear light colored clothing and shy away from dark or floral prints. Avoid wearing perfumes, hairsprays, colognes, and scented deodorants while working outside. If eating outside, keep all food and drinks covered; sweet foods and strong scents attract stinging insects as well. Never swat or swing at the insect; it is best to wait for it to leave, softly blow it away, or gently brush it aside. Seek medical attention when the reaction to a sting includes swelling, itching, dizziness, or shortness of breath.

If physical control measures are not effective, use a pesticide that will have a minimal impact on both you and the environment.

Mosquitoes

Mosquitoes are common pests that can be found in any state and any work environment where warm, humid conditions exist. Mosquitoes can pass along diseases such as West Nile virus and malaria. Several different methods can be used to control adult mosquito populations: repellants such as DEET, mosquito traps, foggers, and vegetation and water management. ***Mosquitoes are found from the tropics to the Arctic Circle and from lowlands to the peaks of high mountains***.

3.3.4 VENOMOUS SPIDERS

Black Widow

Black Widow spiders are not usually deadly (especially to adults) and only the female is venomous. The female spider is shiny black, usually with a reddish hourglass shape on the underside of her spherical abdomen. Her body is about 1.5 inches long, while the adult male's is approximately half that. The spider's span ranges from 1 to 3 inches. The adult males are harmless, have longer legs, and usually have yellow and red bands and spots over their back, while the young black widows are colored orange and white. The bite of a black widow is often not painful and may go unnoticed. However, the venom injected by the spider's bite can cause severe reactions in certain individuals.

Symptoms

Symptoms include abdominal pain, profuse sweating, swelling of the eyelids, pains to muscles or the soles of the feet, salivation and dry-mouth (alternating), and paralysis of the diaphragm. If a person is bitten, they should seek immediate medical attention. Clean the area of the bite with soap and water. Apply a cool compress to the bite location. Keep effected limb elevated to about heart level. Additional information can be obtained from the Poison Center (1-800-222-1222). ***Black widows are found throughout the tropics, U.S., and Canada.***

3.3.5 THREATENING DOGS

If you are approached by a frightened or menacing dog:

- Do not attempt to run and don't turn your back
- Stay quiet, and remember to breathe
- Be still, with arms at sides or folded over chest with hands in fists
- Slowly walk away sideways
- Don't stare a dog in the eyes, as this will be interpreted as a threat
- Avoid eye contact
- If you have a jacket, you could wrap it around your arm and should he snap, take the bite harmlessly

3.3.6 RODENTS

Rodentia: (rats, mice, beavers, squirrels, guinea pigs, capybaras, coypu)

Rodents, or Rodentia, are the most abundant order of mammals. There are hundreds of species of rats; the most common are the black and brown rat.

Rats and mice often become a serious problem in cold winter months when they seek food and warmth inside buildings. They may suddenly appear in large numbers when excavation work disturbs their in-ground nesting locations or their food source is changed.

There are six major problems caused by rats and mice:

1. They eat food and contaminate it with urine and excrement.
2. They gnaw into materials such as paper, books, wood, or upholstery, which they use as nest material. They also gnaw plastic, cinder blocks, soft metals such as lead and aluminum, and wiring, which may cause a fire hazard.
3. Rats occasionally bite people and may kill small animals.
4. They, or the parasites they carry (such as fleas, mites, and worms), spread many diseases such as salmonella, trichinosis, rat bite fever, hantavirus, Weil's disease, and the bubonic plague.
5. Rats can damage ornamental plants by burrowing among the roots or feeding on new growth or twigs. They also eat some garden vegetables, such as corn and squash.
6. Rats and mice are socially unacceptable. These rodents have been a problem for centuries, chiefly because they have an incredible ability to survive and are so difficult to eliminate. In addition, they are extremely compatible with human behavior and needs.

3.3.7 SNAKES

Snakes may be found in any region of the country. While many snakes encountered are not venomous, a few are, so all snakes should be given a wide berth. Of the 7,000 venomous snakebites reported each year, only about 15 prove to be fatal, so your chances of survival are extremely high. The usual snake encounter is one in which they see you before you see them, and they slither away from you quickly, startling you. If you see a snake, back away from it slowly and do not touch it. If you or someone you know are bitten, try to see and remember the color and shape of the snake, which can help with treatment of the snakebite.

Venomous snakes include the coral snake and pit vipers, such as the cottonmouth (water moccasin), copperhead, and rattlesnake. The venom of pit vipers is primarily *hematoxic* because it acts upon the victim's blood system. This venom breaks down blood cells and blood vessels and affects heart action. Bite victims experience severe burning pain, localized swelling and discoloration for the first 3 to 30 minutes, followed by nausea, vomiting, occasional diarrhea, and usually shock.

Preventing Snakebites

The best ways to prevent snakebites are to watch where you step, put your hands, or sit down. Poisonous snakes live on or near the ground and often like rocks, woodpiles, and other spots that offer both a place to sun and a place to hide. Most bites occur in and around the ankle. About 99 percent of all bites occur below the knee, except when someone accidentally picks up or falls on the snake.

Watching where you step and wearing boots in tall grass can prevent most snakebites. Snake chaps can also help protect against snakebites.

Signals that indicate a poisonous snakebite include:

- One or two distinct puncture wounds, which may or may not bleed - the exception is the coral snake, whose teeth leave a semicircular mark
- Severe pain and burning at the wound site immediately after or within 4 hours of the incident
- Swelling and discoloration at the wound site immediately after or within 4 hours of the incident

Emergency First Aid for Poisonous Snakebite

Although it is important to obtain medical aid immediately, emergency first aid can slow the spread of poison from the bite. Remain calm and avoid unnecessary movement, especially if someone is with you. The rate of venom distribution throughout your body will be slower if you are still and quiet. *Do not* use home remedies, and *do not* drink alcoholic beverages.

To care for a bite from a pit viper, such as a rattlesnake, copperhead, or cottonmouth, follow these steps:

- Call 9-1-1 or the local emergency number
- Wash the wound
- Keep the injured area still and lower than the heart; if possible, carry a person who must be taken to a medical facility or have him or her walk slowly
- Do not apply ice
- Do not cut the wound
- Do not apply suction

- Do not apply a tourniquet
- Do not use electric shock, such as from a car battery

3.3.8 BLOODBORNE PATHOGENS

Hepatitis and other communicable diseases are largely transmitted through exposure to bodily fluids containing the hepatitis virus, which could be found on refuse encountered in subsurface investigations. This includes activities occurring at landfills, sewage treatment facilities, sewers, topical spreading of treated waste and medical wastes (e.g., contaminated needles and syringes). Individuals performing tasks for these types of project should consult with their physicians and be properly vaccinated. The primary method of transmission depends on the prevalence of the disease in a given area.

Hepatitis A is a liver disease caused by the hepatitis A virus. Hepatitis A can affect anyone and can occur in situations ranging from isolated cases of disease to widespread epidemics.

Hepatitis B is a serious disease caused by a virus that attacks the liver. The virus, which is called hepatitis B virus (HBV), can cause lifelong infection, cirrhosis (scarring) of the liver, liver cancer, liver failure, and death.

Hepatitis C is a liver disease caused by the hepatitis C virus (HCV), which is found in the blood of persons who have the disease. HCV is spread by contact with the blood of an infected person.

Hepatitis D is a liver disease caused by the hepatitis D virus (HDV), a defective virus that needs the hepatitis B virus to exist. HDV is found in the blood of persons infected with the virus.

Hepatitis E is a liver disease caused by the hepatitis E virus (HEV) and is transmitted in much the same way as hepatitis A virus. Hepatitis E, however, does not often occur in North America.

Prevention

Preventative measures include wearing appropriate PPE: leather work gloves, a long sleeved shirt, and safety footwear. Several vaccines have been developed for the prevention of hepatitis B and C virus infection. Vaccines rely on the use of one of the viral proteins (hepatitis B surface antigen or HBsAg). The vaccine was originally

prepared from plasma obtained from patients who had long-standing hepatitis B virus infection. However, currently these are more often made using recombinant technology, though plasma-derived vaccines continue to be used; the two types of vaccines are equally effective and safe.

4.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

4.1 GENERAL

This section shall cover the applicable personal protective equipment (PPE) requirements, which shall include eye, face, hand, head, foot, and respiratory protection.

The purpose of PPE is to shield or isolate individuals from the chemical and physical hazards that may be encountered during work activities.

4.2 TYPES OF PERSONAL PROTECTIVE EQUIPMENT (PPE)

The type of PPE required for a project will vary based on the level of protection required to protect the employee from physical, chemical, biological, and thermal hazards.

4.2.1 TYPES OF PROTECTIVE MATERIAL

Protective clothing is constructed of a variety of different materials for protection against exposure to specific chemicals. No universal protective material exists. All will decompose, be permeated, or otherwise fail to protect under certain circumstances.

Fortunately, most manufacturers list guidelines for the use of their products. These guidelines usually concern gloves or coveralls and generally only measure rate of degradation (failure to maintain structure). It should be noted that a protective material may not necessarily degrade but may allow a particular chemical to permeate its surface. For this reason, guidelines must be used with caution. When permeation tables are available, they should be used in conjunction with degradation tables.

In order to obtain optimum usage from PPE, the following procedures are to be followed by all site personnel using PPE:

- When using disposable coveralls, don a clean, new garment after each rest break or at the beginning of each shift
- Inspect all clothing, gloves, and boots both prior to and during use for:
  - Imperfect seams
  - Non-uniform coatings

  - Tears
  - Poorly functioning closures
- Inspect reusable garments, boots, and gloves both prior to and during use for:
  - Visible signs of chemical permeation
  - Swelling
  - Discoloration
  - Stiffness
  - Brittleness
  - Cracks
  - Any sign of puncture
  - Any sign of abrasion

Reusable gloves, boots, or coveralls exhibiting any of the characteristics listed above will be discarded. PPE used in areas known or suspected to exhibit elevated concentrations of chemicals will not be reused.

If an individual experiences a failure or other alteration of PPE that may affect its protective ability, that person is to leave the work area immediately. The PM or the SS must be notified and, after reviewing the situation, is to determine the effect of the failure on the continuation of ongoing operations. If the PM or the SS determines that the failure affects the safety of workers, the work site, or the surrounding environment, workers are to be evacuated until corrective actions have been taken. The SS will not allow re-entry until the equipment has been repaired or replaced and the cause of the failure has been identified.

4.3 RESPIRATORY PROTECTION

Respiratory protection may be worn by personnel during project activities. Personnel required to work in these areas will wear a air-purifying respirator, follow the procedures and guidelines as described below, and follow CRA's Respiratory Protection Program.

All personnel required to use this equipment shall first be instructed in how to properly fit a respirator to achieve the required face-piece-to-face seal for respiratory protective

purposes. The presence of beards, sideburns, eyeglasses, and the absence of upper or lower dentures could affect this face seal.

The air-purifying respirator cartridges selected for use during project work at this site are a combination filter that will provide protection against organic vapors and particulates. These cartridges have the ability to protect against the known contaminant concentrations.

All cartridges will be changed prior to breakthrough or at a minimum daily. Changes will also be made when personnel begin to experience increased inhalation resistance or breakthrough of a chemical warning property.

4.3.1 RESPIRATOR CLEANING

Respiratory equipment and other non-disposable equipment will be fully decontaminated and then placed in a clean storage area. Respirator decontamination will be conducted at a minimum once daily. Face pieces will be disassembled, the cartridges thrown away, and all other parts placed in a cleansing solution. After an appropriate amount of time in the solution, the parts will be removed and re-seated with tap water.

Face pieces will be allowed to air dry before being placed in sanitized bags and stored in a clean area.

4.4 LEVELS OF PROTECTION

The level of PPE will be categorized as Level C, D or Modified D, based upon the degree of protection required. The following is a brief summary of the three levels that may be used at this Facility. The need to exercise caution in the performance of work is made more acute due to restrictions in mobility, peripheral vision, and communications caused by the PPE.

Level C. The concentration(s) and type(s) of airborne substance(s) is known and the criteria for using air purifying respirators are met. The following constitute Level C PPE:

- NIOSH approved, full-face or half-face, air-purifying respirators with organic vapor cartridges and P100 particulate filters; the cartridges may be used for a maximum of 6 hours
- Chemical-resistant clothing (overalls, chemical-splash suit, disposable chemical-resistant overalls)
- Coveralls (optional)
- Gloves, outer, chemical-resistant
- Gloves, inner, chemical-resistant, nitrile
- Boots, outer, chemical-resistant, with steel toe and shank
- Chemical resistant boot covers (optional)
- Hard hat when working around overhead hazards or heavy equipment
- Face shield when not wearing a full-face respirator

Modified Level D. The concentration(s) and type(s) of airborne substance(s) is known and the criteria for not using air purifying respirators are met. A level of skin protection above Level D is required. Full Modified Level D PPE is necessary when extensive contact with contaminated materials is anticipated, such as drilling. The following constitute Modified Level D equipment:

- Level D PPE plus coveralls, Tyvek® overgarment or an apron
- Nitrile gloves
- Hearing protection when working in noise hazardous areas
- Cut resistant gloves when working with metal objects, drums, soil samples which contain glass fragments or other potentially sharp materials
- Boots or shoes, chemical-resistant, steel toe and shank
- Chemical-resistant boot covers (optional)
- Safety glasses, chemical splash goggles or face shield (a face shield is required for decontamination activities using pressure washing or steam or while handling drums that contain liquid)
- Hard hat when working around overhead hazards or heavy equipment

Level D. A work uniform affording minimal protection, used for nuisance contamination only. The following constitute Level D PPE:

- Coveralls or work clothes
- Cut resistant gloves when working with metal objects, drums, soil samples with glass fragments or other potentially sharp materials
- Boots or shoes, chemical-resistant, steel toe and shank
- Hearing protection when working in noise hazardous areas
- Chemical-resistant boot covers (optional)
- Safety glasses or chemical splash goggles and an optional face shield
- Hard hat when working around overhead hazards or heavy equipment

The level of protection must correspond to the level of hazard known or suspected in the specific work area. PPE has been selected with specific considerations to the hazards associated with site activities. The specific PPE to be used for each activity is outlined in each JSA form, which are located in Attachment B.

- All PPE will be disposed of and/or decontaminated at the conclusion of each workday as described below. Decontamination procedures will follow the concept of decontaminating the most contaminated PPE first.
- All disposable equipment shall be removed before meal breaks and at the conclusion of the workday, and replaced with new equipment prior to commencing work.
- Eating, drinking, chewing gum or tobacco, and smoking are prohibited while working in areas where the potential for chemical and/or explosive hazards may be present. Personnel must wash thoroughly before initiating any of the aforementioned activities.

4.4.1 REASSESSMENT OF PROTECTION LEVELS

Protection levels provided by PPE selection shall be upgraded or downgraded based upon a change in site conditions or the review of the results of air monitoring or the initial exposure assessment-monitoring program, if one was conducted.

When a significant change occurs, the hazards shall be reassessed. Some indicators of the need for reassessment are:

- Commencement of a new work phase
- Change in job tasks during a work phase
- Change of season/weather
- Temperature extremes or individual medical considerations limit the effectiveness of PPE
- Chemicals other than those expected to be encountered are identified
- Change in ambient levels of chemicals
- Change in work scope, which affects the degree of contact with areas of potentially elevated chemical presence

All proposed changes to protection levels and PPE requirements will be reviewed and approved prior to their implementation by the SS.

5.0 AIR MONITORING PROGRAM

Inhalation hazards are caused from the intake of vapors and contaminated dust. Air monitoring shall be performed while intrusive activities are taking place to detect the presence and relative level of those air contaminants that are inhalation hazards. The purpose of air monitoring is to identify and quantify airborne contaminants in order to determine the level of worker protection needed. Initial screening for identification is often qualitative, but the determination of its concentration (quantification) must await subsequent testing.

All instruments will be calibrated on a daily basis in accordance with the manufacturer's guidelines. Records of all calibrations and real-time measurements will be kept in a bound field logbook or documented via air monitoring and calibration log sheets.

When air monitoring is required, the workers breathing zone(s) will be monitored and the results recorded. Additionally, area samples at the following locations will be taken daily. Record time, location, and results of monitoring and actions taken based on the readings:

- Upwind of work areas to establish background concentrations
- In support zone to check for contamination or migration of emissions
- Along decontamination line to check that decontamination workers are properly protected and on-site workers are not removing protective equipment in a contaminated area
- Downwind of work area to track any contaminants/emissions leaving the site

The data collected throughout the monitoring effort shall be used to determine the appropriate levels of protection. Action levels for upgrading or downgrading of PPE have been established and Table A.2 presents the action levels for the on-site Air Monitoring Program.

5.1 EXPOSURE MONITORING

Air monitoring equipment to be used during site activities shall consist of:

- Photoionization detector (PID)

5.1.1 PHOTOIONIZATION DETECTORS

Exposure to volatile organic compounds (VOCs) shall be monitored with a photoionization detector (PID) with a 11.7 eV lamp. The PID has the ability to detect organic vapor concentrations from 1 part per million (ppm) to 2,000 ppm. All PID monitoring shall be conducted in the breathing zone.

5.1.2 MONITORING FREQUENCY

Monitoring will be conducted continuously during ground intrusive activities or during any activity where airborne hazards (e.g., organic vapors) may be present. The monitoring equipment listed per work activity relates to the initial level of protection. The monitoring frequency may be decreased if the work areas and activities are unchanging, the result of the first hour of monitoring indicate contaminant concentrations are non-detect, and no differing conditions are observed.

Monitoring results will be legibly documented each work day. They will note project name/number, date, time, serial number, date of last calibration, name of person performing calibration, name of person performing monitoring, monitor location within the site, and monitoring results. Daily documentation will be kept with the SS and included in the project file.

5.1.3 SAFETY AND HEALTH ACTION LEVELS

An action level is a point at which increased protection or cessation of activities is required due to the concentration of contaminants in the work area. All activities shall be initiated in either Modified Level D or Level C. The appropriate actions are to be taken at designated action levels. The initial action level(s) for site work can be located in Table A.2.

In addition to the action level, an upgrade to Level C is required if:

- Any symptoms occur, as described in Section 3.0
- Requested by an individual performing the task
- Any irritation to eye, nose, throat, or skin occurs

A work stoppage and evacuation (cease and desist) at the specific work area is required if levels in the breathing zone exceed the protection factor of the respirator.

6.0 COMMUNITY AIR MONITORING PLAN

This Community Air Monitoring Plan will be implemented during all ground intrusive activities at the Site. Real-time air monitoring for volatile organic compounds (VOCs) and respirable dust levels will be performed at the perimeter of the EZ.

Fence line and/or property line air monitoring locations will be selected based on the work zone location, wind direction, and proximity of potential receptors.

The frequency and locations to provide representative air monitoring will be evaluated on a day-to-day basis by the SS/SSO and adjusted for the weather conditions and the locations of remedial work.

Community air monitoring will be conducted in accordance with the following:

i) VOCs will be monitored continuously at the downwind perimeter of the EZ. Readings will be recorded at 15-minute intervals or sooner if an action level has been exceeded. If total VOC levels exceed 5 ppm above background, work activities will be halted and monitoring continued under the provisions of the Vapor Emission Response Plan (see Section 6.3). All monitoring readings will be recorded and available for review; and

ii) A fugitive dust suppression and particulate monitoring program will be conducted in accordance with the procedures presented in Section 6.4.

6.1 STEP 1 VAPOR EMISSION MONITORING

If the ambient air concentrations of VOCs exceeds 5 ppm above background at the downwind perimeter of the EZ, then a check of the downwind Site perimeter will be made to verify that the level is less than 5 ppm. Activities will be halted and monitoring at the downwind perimeter of the Site will be continued if levels at the downwind perimeter are greater than 5 ppm. If the VOC level decreases below 5 ppm above background at the downwind perimeter of the Site, work activities can resume.

If the VOC level is above 25 ppm at the downwind perimeter of the EZ, air monitoring at 200 feet downwind of the Site perimeter or half the distance to the nearest residential or commercial structure, whichever is less, will be performed to ensure that vapor emission does not impact the nearest residential or commercial structure at levels exceeding those specified in the Step 2 Vapor Emission Monitoring section (Section 6.3).

6.2 STEP 2 VAPOR EMISSION MONITORING

If any VOC levels greater than 5 ppm over background are identified 200 feet downwind from the work area or half the distance to the nearest residential or commercial property, whichever is less, then the air quality will be monitored within 20 feet of the perimeter of the nearest residential or commercial structure (20 Foot Zone).

If efforts to abate the emission source are unsuccessful, and if any of the VOC levels persist at 5 ppm above background or greater for more than 30 minutes in the 20 Foot Zone, then the Vapor Emission Response Plan (see Section 6.3) will automatically be placed into effect.

Additionally, the Vapor Emission Response Plan will be immediately placed into effect if VOC levels are greater than 10 ppm above background at the 20 Foot Zone for any one time.

6.3 VAPOR EMISSION RESPONSE PLAN

Upon activation, the following activities will be undertaken:

i) All New York State Department of Environmental Conservation (NYSDEC) contacts, Client contacts and CRA contacts will be notified so that evacuation procedures may begin and/or the Emergency Response Plan will go into effect.

ii) Frequent air monitoring will be conducted at 30 minute intervals within the 20-Foot Zone. If two successive readings below action levels are measured, air monitoring may be halted or modified by the SS/SSO.

6.4 FUGITIVE DUST SUPPRESSION AND PARTICULATE MONITORING PROGRAM

The following fugitive dust suppression and particulate monitoring program will be employed at the Site during ground invasive activities or during other activities which may potentially create an airborne hazard:

i) Reasonable fugitive dust suppression techniques will be employed during all Site activities which may generate fugitive dust.

ii) Particulate monitoring will be employed during ground invasive activities or activities which may generate fugitive dust.

iii) Particulate monitoring will be performed using a real-time particulate monitor that is capable of monitoring particulate matter less than 10 microns in size. Particulate levels will be monitored at the downwind side of the EZ. Readings will be based on the 15-minute average concentrations.

iv) Particulate monitoring will be performed by a trained technician who fully understands the operation of the monitoring equipment and the necessary calibration procedures. The technician will be responsible for keeping the air monitoring log book which will contain records of equipment calibration and all air monitoring readings.

v) The action level will be set at 150 micrograms per cubic meter ($\mu g/m^3$) based on a 15 minute average. If particulate levels are detected in excess of 150 $\mu g/m^3$, the upwind background level will be measured immediately using the same portable monitor. If the working Site particulate measurement is greater than 100 $\mu g/m^3$ above the background level, additional dust suppression techniques will be implemented to reduce the generation of fugitive dust and corrective actions will be taken to protect project personnel and reduce the potential for chemical migration. Corrective measures may include increasing the level of personal protection and implementing additional dust suppression techniques. These may include:

   a) Wetting equipment and work areas

   b) Immediately covering work areas or materials upon completion

vi) If dust is observed leaving the working Site, additional dust suppression techniques will be employed.

vii) If the dust suppression techniques being utilized at the Site do not lower particulates to an acceptable level (below 150 μg/m3) work will be suspended until appropriate corrective measures are approved to remedy the situation.

While project activities are ongoing, work other than RD/RA activities may impact dust levels. If dust levels at the fence line exceed 150 $\mu g/m^3$ while work other than remedial construction is underway, then dust readings will be obtained at the downwind boundary of the remedial work area to determine if the remedial work is contributing to the fence line measured dust levels.

If it is apparent that the source of dust that exceeds 150 $\mu g/m^3$ is due to work other than the RD/RA activities, then NYSDEC will be notified of this occurrence and project activities will continue without implementing dust control measures.

7.0 SITE CONTROL

The purpose of site control is to minimize potential contamination of workers and protect the public from hazards found on site. Site control is especially important in emergency situations.

7.1 EXCLUSION ZONE (EZ)

The EZ consists of the specific work area of suspected contamination or area where project personnel may come into contact with the safety and health hazards that are present at the Site. All employees entering the EZ must use the required PPE, and must have the appropriate training and medical clearance for hazardous waste work. The EZ is the defined area where there is a possible respiratory and/or contact health hazard. The location of each EZ will be identified by cones, caution tape, or other appropriate means.

7.2 CONTAMINATION REDUCTION ZONE (CRZ)

The CRZ or transition area will be established to perform decontamination of personnel and equipment. All personnel entering or leaving the EZ will pass through this area to prevent any cross-contamination. Tools, equipment, and machinery will be decontaminated in a specific location. The decontamination of all personnel will be performed on Site at an existing decontamination wash pad or adjacent to the EZ. Personal protective outer garments and respiratory protection will be removed in the CRZ and prepared for cleaning or disposal. This zone is the only appropriate corridor between the EZ and the support zone (SZ).

7.3 SUPPORT ZONE (SZ)

The SZ is a clean area outside of the CRZ located to prevent employee exposure to hazardous substances, a windsock will be equipped in this area to help determine if there could be any exposure due to change in wind direction. Eating and drinking will be permitted in the support area only after proper decontamination. Smoking is not prohibited on Site. The SZ also provides an area for the storage of equipment and supplies.

7.4 COMMUNICATION

Each member of the project team will be able to communicate with other team members at all times. Communications will be by way of an air horn, walkie-talkie, telephone, or hand signals.

The primary means for external communication are telephones and radio. Telephones are located at the Riverview Facility. If telephone lines are not available at a site, all team members should:

- Know the location of the nearest telephone
- Have the necessary telephone numbers readily available

(Note: The authorized use of cellular phones must be cleared by the client prior to entering site.)

Understanding of the following standard hand signals will be mandatory for all employees, regardless of other means of communication:

- Hand gripping throat — Cannot breathe
- Hands on top of head — Need assistance
- Thumbs up — OK, I'm all right, I understand
- Thumbs down — No, negative
- Gripping partner's wrist, or gripping both of your own hands on wrist (if partner is out of reach) – Leave area immediately

7.5 BUDDY SYSTEM

7.5.1 RESPONSIBILITIES

A buddy system shall be implemented when conducting intrusive activities on this site. This buddy shall be able to:

- Provide his or her partner with assistance
- Observe his or her partner for signs of chemical exposure or temperature stress
- Periodically check the integrity of his or her partner's protective clothing
- Notify emergency personnel if emergency help is needed

7.6 SITE SECURITY

Site security is necessary to prevent the exposure of unauthorized, unprotected people to site hazards and to avoid interference with safe working procedures. Security shall be maintained outside of the actual work area(s) so as to prevent unauthorized entry into the work area(s). Members of the general public are to be protected from site hazards.

7.7 DECONTAMINATION

The SS is responsible for ensuring that all personnel and pieces of equipment coming off site are properly decontaminated according to the procedures outlined below. Documentation of decontamination must be made in the field log notebook and will become part of the permanent project file.

7.7.1 PERSONNEL AND EQUIPMENT DECONTAMINATION PROCEDURES

All PPE will be disposed of and/or decontaminated at the conclusion of each workday as described below. Decontamination procedures will follow the concept of decontaminating the most contaminated PPE first.

All disposable equipment shall be removed before meal breaks and at the conclusion of the workday, and will be replaced with new equipment prior to commencing work.

Procedures for decontamination must be followed to prevent the spread of contamination and to eliminate the potential for chemical exposure:

- **Personnel:** Decontamination will be initiated prior to exiting the contaminated work area and completed in the Contamination Reduction Zone.
- **Modified Level D**: First, remove outer protective wear. Remove gloves and properly dispose in designated waste container. Wash hands and face.
- **Level C**: Wash and rinse outer gloves, boots and suit, and remove; remove respirator; dispose of cartridges; wash respirator; and remove inner gloves and dispose. Wash hands and face. Handle all clothing inside out when possible.

- **Equipment:** All equipment must be decontaminated with Alconox/Liquinox solution or discarded upon exit from the contaminated area in a well-ventilated area. A temporary decontamination pad with a low-volume high-pressure washer will be set up on site during project operations. All decontamination materials will be drummed for subsequent disposal.

7.8 ADDITIONAL CONTROL PROCEDURES

7.8.1 EATING AND DRINKING

Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited in the work area.

7.8.2 HAND WASHING

Hands and face must be thoroughly washed before eating, drinking and leaving the Site.

7.8.3 IMPACTED SURFACES

Contact with potentially impacted surfaces should be avoided whenever possible. Workers should minimize walking through puddles, mud, or other discolored surfaces; kneeling on ground; and leaning, sitting, or placing equipment on drums, containers, vehicles, or the ground.

8.0 EMERGENCY PROCEDURES

8.1 ON-SITE EMERGENCIES

Emergencies can range from minor to serious conditions. Various procedures for responding to site emergencies are listed in this section. The PM or SS is responsible for contacting local emergency services, if necessary, for specific emergency situations. Various individual site characteristics will determine preliminary action to ensure that these entry procedures are successfully implemented in the event of an emergency. The project team will address necessary facility/client emergency protocols to ensure compatibility between this document and facility/client programs and expectations.

An Emergency Information Sheet containing the hospital location, directions, government agency phone numbers, emergency phone numbers, and a map with directions to the hospital is presented on Figure A2.

8.2 INCIDENT, INJURY, AND ILLNESS REPORTING AND INVESTIGATION

Any work-related incident, injury, illness, exposure, or property loss must be reported to your supervisor, the SS, and **within 1 hour** through the CRA Incident Reporting Hotline. The client contact must also be notified **within 1 hour** of any work-related incident, injury, illness, exposure, or property loss. Motor vehicle accidents must also be reported through this system. CRA's Incident Reporting Form, located in Attachment A, must also be filled out and provided to the SS. The report must be filed for the following circumstances:

- Incident, injury, illness, or exposure of an employee
- Injury of a subcontractor
- Damage, loss, or theft of property
- Any motor vehicle accident, regardless of fault, which involves a company vehicle, rental vehicle, or personal vehicle while the employee is acting in the course of employment

Occupational incidents resulting in employee injury or illness will be investigated by the SS. This investigation will focus on determining the cause of the incident and modifying future work activities to eliminate the hazard.

Near Loss

A Near Loss means any undesired event or incident that under slightly different circumstances could have resulted in personal injury, illness, environmental release, or loss. Only a fortunate break in the chain of events prevented an injury, fatality or damage. Although human error is commonly an initiating event, a faulty process or system invariably permits or compounds the harm, and should be the focus of improvement. CRA's Near Loss Report Form, located in Attachment A, must also be filled out and provided to the SS.

All employees have the right and obligation to report unsafe work conditions, previously unrecognized safety hazards, or safety violations of others. If you wish to make such a report, it may be made orally to your supervisor or other member of management, or you may submit your concern in writing, either signed or anonymously.

8.3 EMERGENCY EQUIPMENT/FIRST AID

Safety equipment will be available for use by site personnel, located within 30 feet of the work area(s), and maintained at the site. The safety equipment may include, but is not limited to, the following:

- First Aid kit (size is dependant upon the number of personnel on-site):

  Contents: Each first aid kit shall contain, as a minimum (ANSI 308.1-2003):

1	Absorbent Compress (32 square inches, no side less than 4 inches)
16	Adhesive Bandages (1 inch x 3 inches)
1	Adhesive Tape (roll, 3/8 inch x 5 yards)
10	Individual Antiseptic (0.5 g)
6	Burn Treatments (Antibiotic) (each 1/32 oz.)
2 pair	Medical Exam Gloves (not to be reused)
4	Sterile Pads (3 inches x 3 inches)
1	Triangular Bandage

This list shall be placed in each first aid kit for the purposes of inspection and restocking.

- Automated External Defibrillators (AEDs) are optional first aid response equipment for conditions related to heart stoppage. If a unit is on site, designated personnel

must be trained in the specific AED unit in addition to First Aid and CPR certification, conduct monthly inspections, and contact listed AED Unit coordinator.

- Emergency eyewash bottles and/or an eyewash station lasting 15 minutes.
- Emergency alarms as a means to alert all personnel instantaneously for an emergency.
- Fire extinguisher (at a minimum, a 2A/10BC will be on site).

8.4 EMERGENCY PROCEDURES FOR CONTAMINATED PERSONNEL

Whenever possible, personnel should be decontaminated in the contamination reduction zone before administering first aid, without causing further harm to the patient.

- **Skin Contact:** Remove contaminated clothing, wash immediately with water, and use soap, if available.
- **Inhalation:** Remove victim from contaminated atmosphere. Remove any respiratory protection equipment. Initiate artificial respiration, if necessary. Transport to the hospital.
- **Ingestion:** Remove from contaminated atmosphere. Do not induce vomiting if victim is unconscious. Never induce vomiting when acids, alkalis, or petroleum products are suspected. Transport to the hospital, if necessary.

Any person transporting an injured/exposed person to a clinic or hospital for treatment should take with them directions to the hospital and a listing of the contaminants of concern to which they may have been exposed.

Any vehicle used to transport contaminated personnel will be cleaned or decontaminated, as necessary.

8.5 SITE EVACUATION

In the event of an emergency situation such as fire, explosion, or significant release of toxic gases, project personnel in the field will be notified through established communications to evacuate the area. In the event of an emergency, CRA personnel will gather at their primary mustering point for a head count. The SS will determine a primary and secondary muster point to be used as an assembly area in the event of an emergency. The secondary muster point will be located at least 90 degrees from the

primary. These locations will be communicated to the work crew(s) during the site-specific training prior to commencement of work activities, weekly thereafter, and prior to the advent of potentially threatening weather. Muster points will be identified in the Emergency Information Sheet and may be indicated on the map.

8.6 SPILL AND RELEASE CONTINGENCIES

If a spill has occurred, the first step is personal safety, then controlling the spread of contamination, if possible. CRA personnel will immediately contact site management to inform them of the spill and activate emergency spill procedures.

General Spill Response Procedures

- Shut off all equipment
- Evacuate immediate area of spill
- Notify the SS
- Coordinate agency reporting with the Project Manager
- Determine PPE level required to approach the spill
- Don the correct PPE and prepare to make entry to apply spill containment and control procedures
- VOC's will be monitored and verified to be less than 1 ppm in workers breather zone prior to entry
- After obtaining the proper spill response tools (shovels, booms and pads, absorbent socks, etc.) and PPE, personnel will attempt to contain the spill so that it does not discharge to surface water
- Locate and abate source of spill
- Absorb or otherwise clean up the spill and containerize the material, absorbent and affected soils
- Clean and decontaminate the affected area(s)
- Conduct investigation and complete an Incident Report

8.6.1 CHEMICAL SPILL PROCEDURE

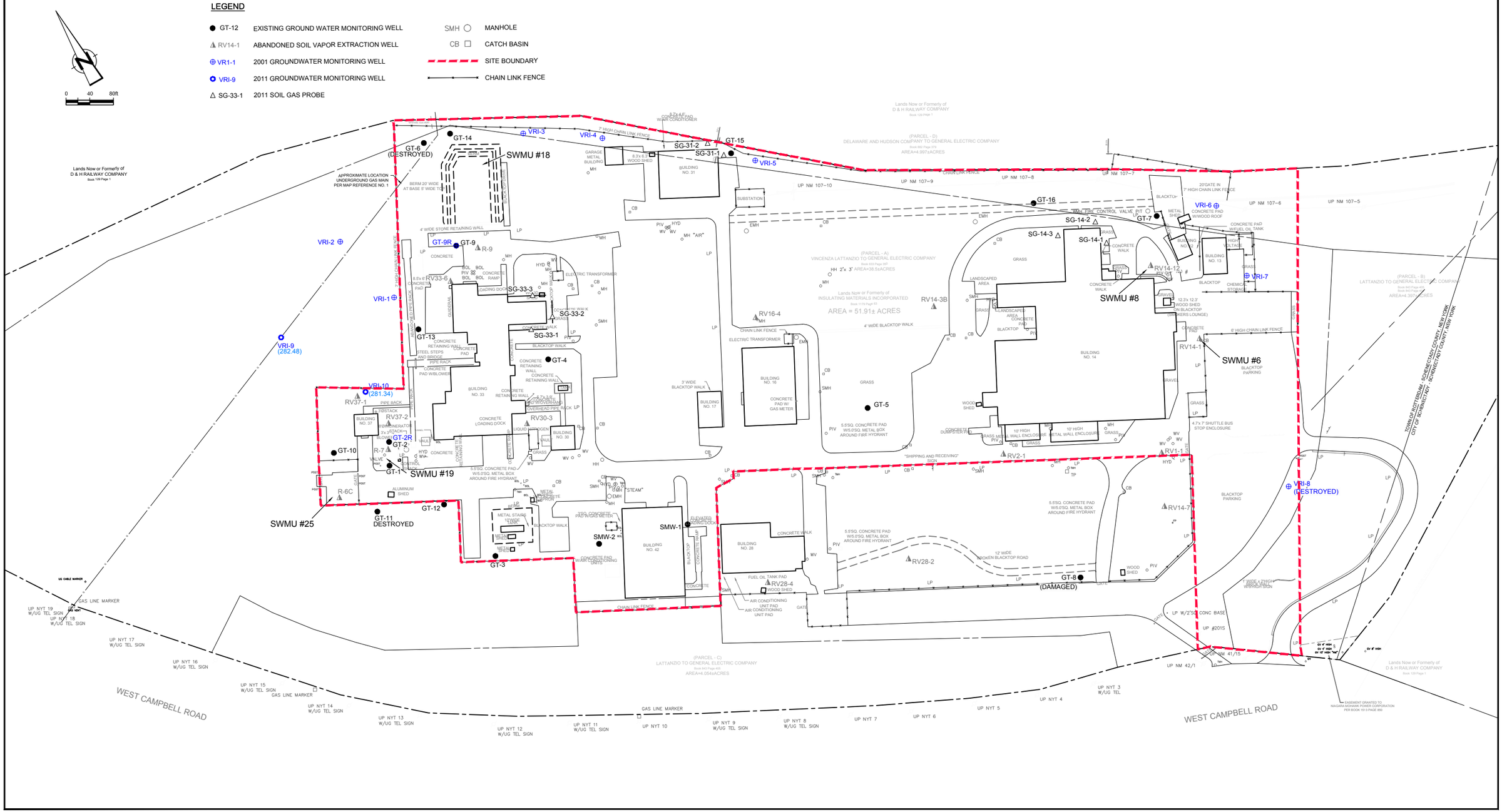
The emergency spill procedure for a spill of the sodium hydroxide solution or the sodium persulfate solution is listed below:

- Determine the appropriate PPE level required to approach the spill
- After obtaining the proper spill response tools (shovels, booms and pads, absorbent socks etc.) and PPE, personnel will attempt to contain the spill so that it does not enter any conveyance (sewer, drainage, ditch etc.) that eventually discharges to surface waters
- Absorb the spill using an absorbent (sand, vermiculite, fuller's earth)
- Collect the waste and put it in plastic bags for disposal later
- Wash any ground exposed to the spill with a neutralizing solution (water)

9.0 RECORDKEEPING

The SS shall establish and maintain records of all necessary and prudent monitoring activities as described below:

- Name and job classification of the employees involved on specific tasks
- Air monitoring/sampling results and instrument calibration logs
- Records of training acknowledgment forms (site-specific training, toolbox meetings, etc.)
- Documentation of site inspections, results of inspections, and corrective actions implemented
- Emergency reports describing any incidents or accidents



SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

Approved

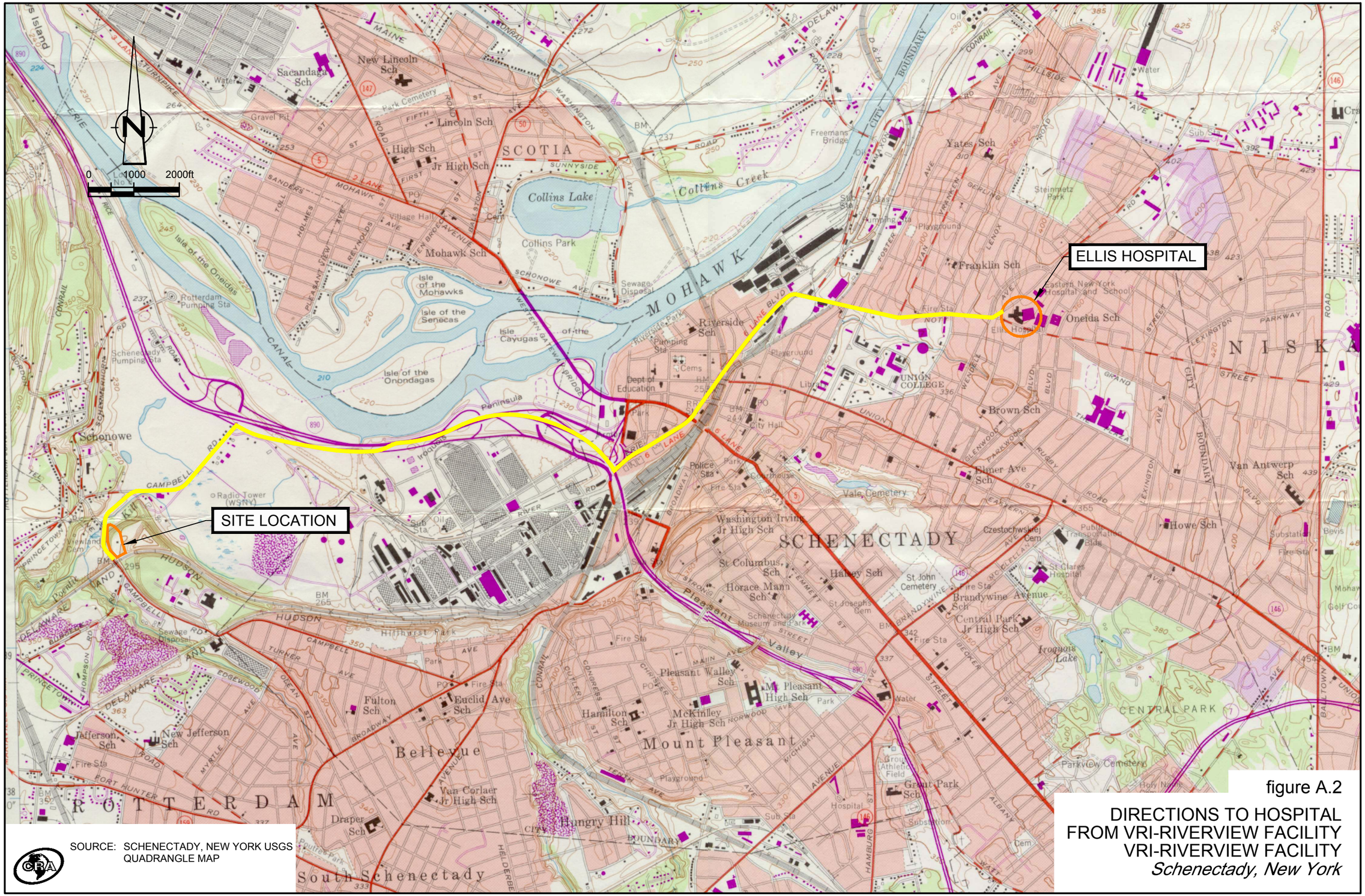
VRI-RIVERVIEW FACILITY
Schenectady, New York

SITE MAP

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: JULY 2013
Project Manager: J.K.P.	Reviewed By: J.H.	Designed By:	Drawn By: G.R.B.
Scale: AS SHOWN	Project No: 18631-50	Report No: 007	Drawing No: figure A.1

18631-50(007)GN-WA001 FEB 3/2014



SOURCE: SCHENECTADY, NEW YORK USGS QUADRANGLE MAP

figure A.2

DIRECTIONS TO HOSPITAL
FROM VRI-RIVERVIEW FACILITY
VRI-RIVERVIEW FACILITY
Schenectady, New York

TABLE 1

PROPERTIES OF POTENTIAL SITE CONTAMINANTS

Chemical Name (Synonyms)	Concentration at Site	Exposure Limits	Routes Of Entry	Symptoms/Health Effects	Chemical Properties	Physical Characteristics
2-Methylphenol 2-Cresol O-Cresylic Acid CAS-95-48-7	1.3 ug/L	TLV: 5 ppm [skin] PEL: 5 ppm [skin] STEL: NE IDLH: 250 ppm	Inhalation Skin Contact Eye Contact Ingestion	ACUTE: The substance is corrosive to the eyes, the skin and the respiratory tract. Corrosive on ingestion. Inhalation of vapor or aerosol may cause lung oedema (see Notes). The substance may cause effects on the central nervous system depression, respiratory failure and tissue lesions. Exposure at high levels may results in lowering of consciousness and death. CHRONIC: Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the cardiovascular system and central nervous system.	(FP) 178°F (VP) 0.29 mm (IP) 8.93eV (UEL) NE (LEL) 1.4%	Colorless crystals, with characteristic odor. Turns dark on exposure to air and light. Reacts violently with strong oxidants
Polychlorinated Biphenyls PCB (42%) Chlorodiphenyl (42% chlorine) Aroclor 1242 CAS-53469-21-9	3.7 ug/L	TLV: 0.001 mg/m3 [skin] PEL: 1 mg/m3 [skin] STEL: NE IDLH: 5 mg/m3	Inhalation Absorption (skin) Ingestion	ACUTE: Eye irritation. CHRONIC: Dermatitis, chloracne, liver damage.	(FP) NA (VP) 0.001 mm (IP) NE (UEL) NA (LEL) NA	Colorless to light colored viscous liquid with a mild hydrocarbon odor.
Benzene Benzol CAS-71-43-2	38 ug/L	TLV: 0.5 ppm [skin] PEL: 1 ppm STEL: 2.5 ppm IDLH: 500 ppm	Inhalation Absorption (skin) Ingestion	ACUTE: Irritation to eyes, skin, respiratory tract; dizziness; headache; nausea; staggered gait; fatigue, abdominal pain. CHRONIC: Defatting of the skin, may have effects on bone marrow and immune system, decrease in blood cells. Carcinogenic to humans.	(FP) 12°F (VP) 75 mm (IP) 9.24 eV (UEL) 7.8% (LEL) 1.2%	Colorless to light-yellow liquid with an aromatic odor. Solid below 42°F.
Carbon tetrachloride Carbon chloride Tetrachloromethane Tetrachlorocarbon CAS-56-23-5	46 ug/L	TLV: 2 ppm [skin] PEL: 10 ppm STEL: 10 ppm IDLH: 200 ppm	Inhalation Ingestion Skin contact Absorption Eye contact	ACUTE: Irritation of the eyes and skin. Nausea, dizziness. May affect liver, kidneys and CNS, resulting in unconsciousness. CHRONIC: Dermatitis. May cause damage to kidneys. Possible human carcinogen.	(FP) NE (VP) 91 mm (IP) 11.47 eV (UEL) NE (LEL) NE	Colorless liquid with a characteristic ether-like odor.
Chloroform Methane trichloride Trichloromethane CAS-67-66-3	2.1 ug/L	TLV: 10 ppm PEL: 50 ppm (C) STEL: NE IDLH: 500 ppm	Inhalation Ingestion Skin contact Absorption Eye contact	ACUTE: Irritation of the eyes and skin. Dizziness, headache, nausea and confusion. CHRONIC: Enlarged liver. Possible human carcinogen.	(FP) NE (VP) 160 mm (IP) 11.42 eV (UEL) NE (LEL) NE	Colorless liquid with a pleasant odor.

Notes:

FP	FP - Flash Point	PEL	PEL - OSHA Permissible Exposure Limit
IDLH	IDLH - Immediately Dangerous to Life ord Health	STEL	STEL - Short Term Exposure Limit
IP	IP - Ionization Potential	TLV	TLV - ACGIH Threshold Limit Value
NE	NE - Not Established (Information Not Available)	VP	VP - Vapor Pressure
NA	NA - Not Applicable	C	C - Ceiling Exposure Limit
CNS	CNS - Central Nervous System	[skin]	[skin] - potential for dermal absorption
PNS	PNS - Peripheral Nervous System	mm	mm - milimeters Hg (mercury)
ppm	ppm - parts per million	eV	eV - electrovolts
mg/m3	mg/m3 - miligrams per cubic meter		

TABLE 1

PROPERTIES OF POTENTIAL SITE CONTAMINANTS

Chemical Name (Synonyms)	Concentration at Site	Exposure Limits	Routes Of Entry	Symptoms/Health Effects	Chemical Properties	Physical Characteristics
Dibutyl phthalate DBP Dibutyl-1,2-benzene-dicarboxylate Di-n-butyl phthalate CAS-84-74-2	2.9 ug/L	TLV: 5 mg/m3 PEL: 5 mg/m3 STEL: NE IDLH: 4000 mg/m3	Inhalation Ingestion Skin contact Eye contact	ACUTE: Irritation eyes, skin, nose, throat; drowsiness; nausea, vomiting; pulmonary edema. CHRONIC: liver, kidney injury; sterility; [potential occupational carcinogen]	(FP) 315°F (VP) 0.00007mm (IP) NE (UEL) NE (LEL) 456°F: 0.5%	Colorless to faint-yellow, oily liquid with a slight, aromatic odor. Class IIIB Combustible Liquid: Fl.P. at or above 200°F.
Ethylbenzene Ethylbenzol EB CAS-100-41-4	4.4 ug/L	TLV: 100 ppm PEL: 100 ppm STEL: 125 ppm IDLH: 800 ppm	Inhalation Ingestion Skin contact Eye contact	ACUTE: Causes irritation of the eyes, skin, mucous membranes, and respiratory tract. Effects on CNS. CHRONIC: Defatting of the skin, narcosis, and coma.	(FP) 55°F (VP) 7 mm (IP) 8.76 eV (UEL) 6.7% (LEL) 0.8%	Colorless liquid with an aromatic odor.
Naphthalene Naphthalin Coal tar White tar CAS-91-20-3	75 ug/L	TLV: 10 ppm PEL: 10 ppm STEL: 15 ppm IDLH: 250 ppm	Inhalation Ingestion Skin contact Absorption Eye contact	ACUTE: Levels above 10 ppm may cause: Inhalation - Headache, nausea, excessive sweating and vomiting; Skin - May cause irritation and if hypersensitive to naphthalene then severe irritation may occur; Eyes - Irritation. Direct contact may cause blurring vision and damage to the cornea; Ingestion - Nausea, vomiting, abdominal pain, bladder irritation, and brown or black coloration of urine. CHRONIC: Clouding of the eyes. Chronic skin problems in cases of hypersensitivity. Liver and kidney damage.	(FP) 174°F (VP) 0.08 mm (IP) 8.12 eV (UEL) 5.9% (LEL) 0.9%	Colorless to brown solid with an odor of mothballs. Sometimes found as a crystalline white solid. Shipped as a molten solid.
Phenol Hydroxybenzene Carbolic acid CAS-108-95-2	0.011 ug/L	TLV: 5 ppm [skin] PEL: 5 ppm [skin] STEL: NE IDLH: 250 ppm	Inhalation Absorption Ingestion	ACUTE: CORROSIVE to eyes, skin and respiratory tract. May cause lung edema, affects CNS, heart, and kidneys, resulting in convulsions, coma, cardiac disorders and respiratory failure. CHRONIC: Dermatitis. May damage liver and kidneys.	(FP) 175°F (VP) 0.4 mm (IP) 8.50 eV (UEL) 8.6% (LEL) 1.8%	Colorless to yellow or light pink, crystalline solid with a sweet, acrid odor.

Notes:

FP	FP - Flash Point	PEL	PEL - OSHA Permissible Exposure Limit
IDLH	IDLH - Immediately Dangerous to Life ord Health	STEL	STEL - Short Term Exposure Limit
IP	IP - Ionization Potential	TLV	TLV - ACGIH Threshold Limit Value
NE	NE - Not Established (Information Not Available)	VP	VP - Vapor Pressure
NA	NA - Not Applicable	C	C - Ceiling Exposure Limit
CNS	CNS - Central Nervous System	[skin]	[skin] - potential for dermal absorption
PNS	PNS - Peripheral Nervous System	mm	mm - milimeters Hg (mercury)
ppm	ppm - parts per million	eV	eV - electrovolts
mg/m3	mg/m3 - miligrams per cubic meter		

TABLE 1

PROPERTIES OF POTENTIAL SITE CONTAMINANTS

Chemical Name (Synonyms)	Concentration at Site	Exposure Limits	Routes Of Entry	Symptoms/Health Effects	Chemical Properties	Physical Characteristics
Trichloroethene TCE Trichloroethylene Ethylene trichloride CAS-79-01-6	19 ug/L	TLV: 10ppm PEL: 100ppm STEL: 25ppm IDLH: 1,000 ppm	Inhalation Ingestion Absorption	ACUTE: Irritation to eyes and skin. Ingestion may cause chemical pneumonitis. Affects CNS. Unconsciousness due to exposure. CHRONIC: Dermatitis. Affects CNS, loss of memory. May damage liver and kidneys. Probable human carcinogen.	(FP) NE (VP) 58 mm (IP) 9.45 eV (UEL) 10.5% @ 77°F (LEL) 8.0% @ 77°F	Colorless liquid with a chloroform-like odor. Sometimes dyed blue.
Toluene Methylbenzene Toluol CAS-108-88-3	82 ug/L	TLV: 20 ppm [skin] PEL: 200 ppm STEL: NE IDLH: 500 ppm	Inhalation Ingestion Absorption	ACUTE: Irritation to eyes and respiratory tract. Ingestion may cause chemical pneumonitis. Affects CNS. Unconsciousness and cardiac dysrhythmia at high level exposures. CHRONIC: Defatting of the skin. Affects CNS. Enhanced hearing damage.	(FP) 40°F (VP) 21 mm (IP) 8.82 eV (UEL) 7.1% (LEL) 1.1%	Colorless liquid with a sweet, pungent, benzene-like odor.
Xylene (o;m;p isomers) CAS-106-42-3	670 ug/L	TLV: 100 ppm PEL: 100 ppm STEL: 150 ppm IDLH: 900 ppm	Inhalation Absorption Ingestion	ACUTE: Irritation to eyes and respiratory tract. Ingestion may cause chemical pneumonitis. Affects CNS. CHRONIC: Defatting of the skin, lung damage resulting in chronic bronchitis. Affects CNS and blood.	(FP) 90/82/81°F (IP) 7/9/9 mm (IP) 8.56eV (UEL) 6.7% (LEL) 0.9%	Colorless liquid with an aromatic odor. (p-isomer solid <56°F).

Notes:

FP	FP - Flash Point	PEL	PEL - OSHA Permissible Exposure Limit
IDLH	IDLH - Immediately Dangerous to Life ord Health	STEL	STEL - Short Term Exposure Limit
IP	IP - Ionization Potential	TLV	TLV - ACGIH Threshold Limit Value
NE	NE - Not Established (Information Not Available)	VP	VP - Vapor Pressure
NA	NA - Not Applicable	C	C - Ceiling Exposure Limit
CNS	CNS - Central Nervous System	[skin]	[skin] - potential for dermal absorption
PNS	PNS - Peripheral Nervous System	mm	mm - milimeters Hg (mercury)
ppm	ppm - parts per million	eV	eV - electrovolts
mg/m3	mg/m3 - miligrams per cubic meter		

TABLE 2

ON-SITE AIR MONITORING PROGRAM ACTION LEVELS
HEALTH AND SAFETY PLAN
VON ROLL USA, INC. FACILITY
SCHENECTADY, NEW YORK

Monitoring Device	*Action Level*	*Action*
Photoionization Detector (PID)		
11.7 eV lamp	< 1.0 ppm or Background	Full-Face Respirator Available
	≥ 1.0 ppm and ≤ 50 ppm	Full-face air purifying respirator Level C PPE MSA GME P100 Cartridge
	>50 ppm and < 500 ppm	Supplied air respirator Level B PPE. Implement additional engineering controls
	≥ 500 ppm	Shut down activities. Notify SS. Implement additional engineering controls

If CRA is unable to identify/quantify the contaminants, supplied air will be required when the PID reading is greater than background, as the contaminant will be unknown and NIOSH, OSHA, and the manufacturer's use requirements for Level C (air purifying respirators) will not be met. If PID readings subside, workers can downgrade as necessary. CRA will upgrade to supplied air and attempt to obtain additional information for possible chemicals present in CRA's work area. The Owner will need to provide/obtain additional information as to the identity of the contaminant(s) in order to permit the use of Modified D and/or Level C.

Notes:

SS Safety Supervisor
PPE Personnel Protective Equipment
ppm parts per million

ATTACHMENT A

FORMS

TAILGATE SAFETY MEETING FORM
LARGE GROUP FORMAT - SINGLE DAY
VON ROLL USA, INC.
SCHENECTADY, NEW YORK

Date: _____ Time: _____ Presenter: _____

Safety topics/items discussed:

_____

_____

_____

_____

Site personnel in attendance:

Print Name	Signature	Company

TAILGATE SAFETY MEETING FORM
SMALL GROUP FORMAT - MULTIPLE DAYS
VON ROLL USA, INC.
SCHENECTADY, NEW YORK

Date: _____ Time: _____ Presenter: _____

Safety topics/items discussed:

_____
_____
_____

Site personnel in attendance:

Print Name	Signature	Company

Date: _____ Time: _____ Presenter: _____

Safety topics/items discussed:

_____
_____
_____

Print Name	Signature	Company

Date: _____ Time: _____ Presenter: _____

Safety topics/items discussed:

_____
_____
_____

Print Name	Signature	Company

UNSAFE ACTS/UNSAFE CONDITIONS/ STOP WORK AUTHORITY (SWA) REPORT

Reported By:		Employee's Office:	
To: CRA RSHM –		Date:	Time:
Employee Supervisor:		Employee Principal:	
Project Related:	☐ No ☐ Yes If yes, Name of Client:		
Client Contact:		Project No (if applicable):	

Re: (check all that apply) ☐ **Unsafe Act** ☐ **Unsafe Condition** ☐ **Stop Work Authority (SWA)**
Location: (check one) ☐ Driving ☐ Field ☐ Office

Date Reported to Supervisor/PM:		Date Corrected:	
Time Reported to Supervisor/PM:		Time Corrected:	

Describe the unsafe act, unsafe condition, or SWA Situation:

List corrective action(s) implemented:

Did the corrective action(s) mitigate the unsafe act/unsafe condition?

For SMART Administrators Use Only:

CRA Category:

- ☐ **PPE** - Personal Protective Equipment
- ☐ **BP** - Body Positioning
- ☐ **WE** – Work Environment
- ☐ **OP** – Operating Procedures
- ☐ **TE** – Tools and Equipment
- ☐ **CU** – Computer Usage
- ☐ **PD** – Pre-Driving
- ☐ **OPP** – Operating Procedures – Parking

Chevron Category:

- ☐ **A –** Person or People
- ☐ **B –** Equipment
- ☐ **C –** Environmental
- ☐ **D –** Procedures/ Processes/ JSA-review/revise
- ☐ **E –** Visitors

Causative Factor:

- ☐ 1. Insufficient training for task
- ☐ 2. Hurrying to complete the task
- ☐ 3. Easier if proper process not followed
- ☐ 4. Took shortcuts without prior incident
- ☐ 5. Incomplete or no procedures
- ☐ 6. Procedures not known or enforced
- ☐ 7. Improper PPE
- ☐ 8. Improper tools
- ☐ 9. Improper workplace layout
- ☐ 10. Exposure to conditions

Energy Source:

- ☐ **G –** Gravity
- ☐ **M –** Motion
- ☐ **ME –** Mechanical
- ☐ **E –** Electrical
- ☐ **P –** Pressure
- ☐ **T –** Temperature
- ☐ **C –** Chemical
- ☐ **B –** Biological
- ☐ **R –** Radiation
- ☐ **S –** Sound

Are additional actions required? ☒ No ☐ Yes If yes, what? _____

CONESTOGA-ROVERS & ASSOCIATES (CRA) INCIDENT REPORTING FORM

CRA Inc and Ltd – Incidents must be called into Incident Hot Line: 1-866-529-4886
CRA Europe – Incidents must be called into the Head Office during working hours (0115 965 6700) and to the CRA Europe Incident Hotline afterhours (0773 076 2845)

Instructions: For Personal Injuries, Occupational Illnesses, and Property Damage, complete Sections 1 and 2. For Vehicle Accidents, Complete Sections 1, 2, and 4. **Initial report must be submitted within 24 hours.**

Report Status (insert date)					
	Initial Report	**Update Report**	**Final Report**	**Verification/Validation**	**Report Input into SMART Database**

SECTION 1

A. Employee Identification ☐ **CRA Employee** ☐ **Temporary Employee** ☐ **Subcontractor**				
Employee No.	Last Name	First Name	Middle Name/Initial	☐ Male ☐ Female
Area Code ( ) Telephone Number	Employee Home Address (Street, City, State/Province/County, Postal/Zip Code)			
Date of Hire Month Day Year	Position/Title	Supervisor	Employee's Company/Home Office Location	

B. General Information			
Where did the Incident occur and which country? ☐ Office ☐ Project Site ☐ Other _____ ☐ Canada ☐ United States ☐ UK		Type of incident (Check all that apply) ☐ Employee Injury/Illness ☐ Vehicle Accident ☐ Property Damage Only	
Address of Incident (City, State/Providence/County, Postal/Zip Code)		Specific Location of incident (e.g., where on site)	
Date and Hour of Incident Month Day Year a.m. p.m.	Date and Hour Reported to Employer Month Day Year a.m. p.m.	Date and Hour Last Worked Month Day Year a.m. p.m.	Time Employee Began Work a.m. p.m.
Normal Work Hours From:. To:	Witnesses? ☐ Yes ☐ No	Witness Name and Telephone Number	

C. Project Information (Project Related Incident Only) Project Related? ☐ Yes ☐ No				
Project #	Project Name	Project Manager	Site Telephone Number ( )	Project Manager Cell Number ( )
Client Name	Was the Client Advised of the Incident? ☐ Yes ☐ No	Name of Person Contacted	Date and Time Contacted	

SECTION 2

A. Details of the Incident
1. What job/task was being performed when the incident occurred? (Example: collecting groundwater samples).
2. Provide a detailed description of the employee's specific activities at the time of the incident. Include details of equipment/materials being used, including the size and weight of objects being handled, and weather conditions at time of the incident. If necessary, attach additional pages to the report.
3. For injuries, identify the specific part of body injured, and specify left or right side. For illnesses, identify and describe the affected area/body part.
4. Identify the object or substance that directly injured the employee and how. Include size, weight, and shape of object, quantity of substance, etc.
5. Identify property damaged and how it was damaged (include owner of property, nature and source of damage, and model and serial number, if appropriate).

B. Health Care/Medical Treatment	
Employee received health care? ☐ Yes ☐ No	Identify the type of health care provided and where it was performed. **(Check all that apply).** ☐ First Aid ☐ Medical treatment other than first aid (sutures, etc.) ☐ Hospitalized ☐ Clinic ☐ Hospital emergency room ☐ On location by self or CRA employee) ☐ On site by EMT
Name of Health Care Provider, Physician Name, Phone Number, Address (Street, City, Province/State/County, and Postal/Zip Code)	

SECTION 2 (continued)

C. Incident Investigation
☐ **5 Why Root Cause Analysis Investigation [Non-OSHA Recordable, <$5,000/£3,000 damage]**
☐ **Tap Root Cause Analysis [OSHA Recordable, and/or >$5,000/£3,000 damages]**

HASP prepared? ☐ Yes ☐ No ☐ N/A Submit a PDF of HASP and relevant JSA(s)/Risk Assessment to Investigation Team. If yes, was the HASP on site? ☐ Yes ☐ No	Did the safety plan identify and provide safety procedures for the specific tasks the employee was conducting when injured? ☐ Yes ☐ No If no, why not? (Explain) _____ Did the employee utilize the STAR process before initiating the task? ☐ Yes ☐ No If no, why not? (Explain) _____ Was the employee drug & alcohol tested post incident? ☐ Yes ☐ No

5-Why Root Cause: Incident Statement	Additional information: Attach photos, witness statement(s), affected employee statement, accident diagrams, as applicable, to the end of this document.
1. Why did "above" happen?	
2. Why did "1" happen?	
3. Why did "2" happen?	
4. Why did "3" happen?	
	See *Corrective Actions/Verification and Validation* Section (Page 4)
5. Why did "4" happen?	
6. Why did "5" happen?	

D. Accountability

Initial Report Date Month Day Year	Initial Report Prepared by: (please print)	Initial Report Prepared by: (signature)
Investigation Team	Company	Position/Title
Final Report Date Month Day Year	Final Report Prepared by: (please print)	Final Report Prepared by: (signature)

E. Stewardship

Will an Incident Summary be Prepared? ☐ Yes ☐ No By:	Disciplinary Action Taken? ☐ Yes ☐ No	
Quality Review By:	Date:	Findings:

CRA Inc & Ltd - Fax Completed Form to CRA's Incident Reporting Fax: (832) 485-5259
CRA Europe – Email Completed Form to the RSHM
Send Original to CRA's Incident Reporting Department, Houston, Texas

SECTION 3

A. Agency Reporting and Recording Information (To be completed by the Regional Safety and Health Manager)			
CANADA			
Provincial Regulatory Agency Reporting Required? ☐ Yes ☐ Not required	Employee Injury Information (Injury met the following criteria): ☐ First Aid ☐ Medical Treatment ☐ Critical Injury ☐ Modified Duty ☐ Lost Time Injury If medical treatment, what?		
Joint Safety and Health Committee Notified? ☐ Yes ☐ No	Total days of modified duty If exceeds 7 days, report to WSIB	Total days of lost time (if any)	Date employee returned to work Month Day Year
UNITED STATES			
OSHA Recordable Injury? ☐ Yes ☐ No OSHA Recordable.pdf	Employee Injury Information (Injury met the following OSHA 300 Log criteria) ☐ First Aid ☐ Medical Treatment ☐ Restricted Duty ☐Lost Time Injury If medical treatment, what?		
Total days of restricted duty:	Total days of lost time (if any)		Date employee returned to work Month Day Year
UNITED KINGDOM			
RIDDOR Reportable Injury? ☐ Yes ☐ No RIDDOR.pdf	Employee Injury Information (Injury met the following criteria): ☐ First Aid ☐ Medical Treatment ☐ Restricted Duty ☐Lost Time Injury If medical treatment, what? (HSE RIDDOR reporting: http://www.hse.gov.uk/riddor/report.htm)		
Total days of restricted duty:	Total days of lost time (if any)		Date employee returned to work Month Day Year

VEHICLE ACCIDENT SECTION

(Complete this Section for all Vehicle Accidents)

SECTION 4

A. Vehicle CRA Employee was Operating ☐ Personal ☐ CRA-Owned ☐ Rental - Rental Company:

License Plate No.	State/Province/County	Police Department City	State/Province/County
Vehicle Year/Make/Model	Odometer Reading at Time of Accident	Police Report Number	Weather Conditions

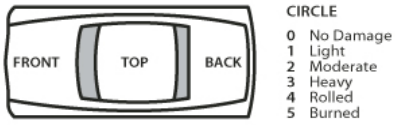
Name of Person Operating Vehicle

Address

City State/Province/County Postal/Zip Code

Telephone: Area Code ( )

"X" IN AREA OF VEHICLE DAMAGE



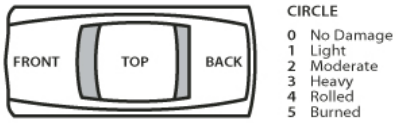
Description of Vehicle Damage:

B. Other Vehicles Involved

Name of Owner	Address	City/State/Prov./County/Postal/Zip	Area Code and Telephone Number ( )
Operator's Name (if different from above)	Address	City/State/Prov./County/Postal/Zip	Area Code and Telephone Number ( )

Year/Make/Model	Description of Property Damage:
Insurance Co. Name & Telephone	
License Plate No./State/Province	

"x" IN AREA OF VEHICLE DAMAGE



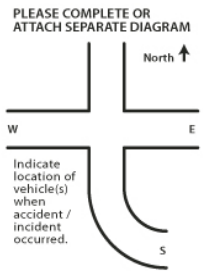
C. Injured Persons

Name	Address Street, City, State/Prov./County/Postal/Zip Code	Phone Number	Nature of Injury	Indicate if Injured was a Vehicle Driver/ Passenger, CRA Employee, Other, or Pedestrian
1.				
2.				
3.				

D. Witnesses

Name	Address Street, City, State/Prov./County/Postal/Zip Code	Area Code and Telephone Number
1.		( )
2.		( )

E. Description of Accident



Was Ticket Issued? Reason:

☐ Other Operator

☐ CRA Operator

Report Date Month Day Year	Report Prepared by: (please print)	Report Prepared by: (signature)

Note: If Additional Space is Required to Complete this Report, Use Separate Sheet of Paper and Attach.

CRA Inc & Ltd - Fax Completed Form to CRA's Incident Reporting Fax: (832) 485-5259
CRA Europe – Email Completed Form to the RSHM
Send Original to CRA's Incident Reporting Department, Houston, Texas

INCIDENT REPORT
CORRECTIVE ACTIONS/VERIFICATION AND VALIDATION

Safety Means Awareness Responsibility Teamwork

Causative Factors and Corrective Actions						Verification (Did we do what we said we would do?) and Validation (Is it working?)		
Item No.	CF	Corrective Actions (Must match Causative Factor)	Responsible Party	Date Due	Date Completed	Verified By/ Validated By	Date	Details
						Verified By:		
						Validated By:		
						Verified By:		
						Validated By:		
						Verified By:		
						Validated By:		
						Verified By:		
						Validated By:		

CRA 10 CAUSATIVE FACTORS

Personal Factors		Company Factors		External Factors	
1	Insufficient training for task	5	Incomplete or no procedures	10	Exposure to conditions
2	Hurrying to complete the task	6	Procedures not known or enforced		
3	Easier if proper process not followed	7	Improper PPE		
4	Took shortcuts without prior incident	8	Improper tools		
		9	Improper workplace layout		

NL

CONESTOGA-ROVERS & ASSOCIATES (CRA) NEAR LOSS REPORTING FORM

CRA Inc and Ltd – A Significant Near Loss must be called into Incident Hot Line: 1-866-529-4886
CRA Europe – Incidents must be called into the Head Office during working hours (0115 965 6700) and to the CRA Europe Incident Hotline afterhours (0773 076 2845)

CRA SMART PROGRAM
Safety Means Awareness Responsibility Teamwork

Instructions:
1) *Employee completes the Near Loss Report and submits to Supervisor.*
2) *Supervisor reviews and makes other comments.*
3) *Employee discusses Near Loss with Project Manager.*
4) *Submit to Regional Safety & Health Manager*

Report Status (insert date)	Initial Report	Update Report	Final Report	Verification/Validation	Report Input into SMART Database

SECTION 1

A. Employee Identification ☐ **CRA Employee** ☐ **Temporary Employee** ☐ **Subcontractor**

Employee No.	Last Name	First Name	Employee's Company - if Subcontractor
Date of Hire	**Position/Title**	**Supervisor**	**Home Office Location - if CRA Employee**

B. General Information

Where did the Near Loss occur?
☐ Office ☐ Project Site ☐ Other _____
☐ Canada ☐ United States ☐ UK

Type of Near Loss (Check all that apply)
☐ Employee Injury/Illness ☐ Vehicle Accident ☐ Property Damage ☐ Environmental

Address of Near Loss (City, State/Province/County, Postal/Zip Code)

Specific Location of Near Loss (e.g., where on site)

Date and Hour of Near Loss		Date and Hour Reported to CRA		Time Employee Began Work
Month Day Year	a.m. p.m.	Month Day Year	a.m. p.m.	a.m. p.m.

Witnesses?
☐ Yes ☐ No

Witness Name and Telephone Number

C. Project Information (Project Related Near Loss Only): Project Related: ( ) Yes ( ) No

Project #	Project Name	CRA Project Manager	Client	Client Contact

Was the Client Advised of the Near Loss?	Name:	Date and Time
☐ Yes ☐ No ☐ N/A		Month Day Year Time

SECTION 2

A Details of the Near Loss

1. What job/task was being performed when the Near Loss occurred? (Example: collecting groundwater samples).

2. Provide a detailed description of the employee's specific activities at the time of the Near Loss. Include details of equipment/materials being used, including the size and weights of objects being handled, and weather conditions at time of the Near Loss. If necessary, attach additional pages to the report.

B. Near Loss Investigation

Conduct a 5-Why Root Cause Analysis Investigation. In addition, if there was the potential for a significant injury or loss, report the Near Loss to the Incident Hot Line (this will determine if a Tap Root Cause Analysis is necessary).

HASP prepared?
☐ Yes ☐ No ☐ N/A
Submit a PDF of HASP to Investigation Team.
If yes, was the HASP on site?
☐ Yes ☐ No

Did the safety plan identify and provide safety procedures for the specific tasks being performed when the Near Loss occurred?
☐ Yes ☐ No If no, why not? (Explain) _____
Did the employee utilize the STAR process before initiating the task?
☐ Yes ☐ No If no, why not? (Explain) _____

SECTION 2 (continued)

5-Why Root Cause:	Additional information: Attach photos, witness statement(s), affected employee statement, as applicable, to the end of this document.
1. Why did "above" happen?	
2. Why did "1" happen?	
3. Why did "2" happen?	
4. Why did "3" happen?	
5. Why did "4" happen?	See Section 3 Below: Corrective Actions/ Verification and Validation
6. Why did "5" happen?	

C. Accountability

Initial Report Date Month Day Year	Initial Report Prepared by: (please print)	Initial Report Prepared by: (signature)
Investigation Team	Company	Position/Title
Final Report Date Month Day Year	Final Report Prepared by: (please print)	Final Report Prepared by: (signature)

D. Stewardship

Will a Near Loss Summary be Prepared? ☐ Yes ☐ No If yes, by:

Quality Review By:	Date:	Findings:

SECTION 3

Corrective Action					Validation & Verification		
CF	**Corrective Actions (Must match Causative Factor)**	**Responsible Party**	**Due Date**	**Date Completed**	**Verified By/ Validated By**	**Date**	**Details**
					Verified By		
					Validated By		
					Verified By		
					Validated By		
					Verified By		
					Validated By		

CRA 10 CAUSATIVE FACTORS (CF)

PERSONAL FACTORS		COMPANY FACTORS		EXTERNAL FACTORS	
1	Insufficient training for task	5	Incomplete or no procedures	10	Exposure to conditions
2	Hurrying to complete the task	6	Procedures not known or enforced		
3	Easier if proper process not followed	7	Improper PPE		
4	Took shortcuts without prior incident	8	Improper tools		
		9	Improper workplace layout		

CRA SAFETY COORDINATION REVIEW

SECTION A - JOB SCOPE

	Pre-Job Meeting/Prep HASP	Completed by:
	On-Site Orientation Meeting	
	End of Job Evaluation	
	Tailgate Safety Meeting Planning Tool	
	Site Audit	

Date: _____ Project Name:_____ Project Number: _____

Project Location: _____

Project Description _____

CRA Project Team

PM:_____ Site Supervisor: _____ SHO: _____

Technician(s): _____ Others:_____

CLIENT INFORMATION

Company Name: _____
Address: _____
Primary Contact: _____
Phone: _____ Cell: _____ Fax: _____

SUBCONTRACTOR INFORMATION

Company Name: _____
Address: _____
Primary Contact: _____
Phone: _____ Cell: _____ Fax: _____
additional subcontractors listed on last page

SECTION B - PROJECT SAFETY COORDINATION

1.1 High Risk Activities

Confirm activities to be conducted during project	Resource	Yes	No
Working at or above 6 feet (fall protection)	PM		
Aerial lift	PM		
Heavy equipment	PM		
Drilling	PM		
Excavation	PM		
Lock-Out Tag-Out permit(s) required	PM		
Hot work	PM		
Hot work permit(s) required	PM		
Confined space entry	PM		
Confined space entry permit required	PM		
Subsurface activities	PM		
ATV, Snowmobile, 4 wheeler	PM		
Access agreements in-hand and signed by property owner	PM		
Permit requirements communicated to affected employees	PM		

CRA SAFETY COORDINATION REVIEW

1.2	**Guiding Principals**				
	(All items identified, verified and discussed)	**Resource**	**Yes**	**No**	
	Safety Commitment	SMART			
	Injury Free Operation (IFO)	SMART			
	Stop Work Authority	SMART			
	Lessons Learned	SMART			
	Any unresolved safety concerns or issues	SS			

1.3	**Personnel Requirements**				
	(All items identified, verified and discussed)	**Resource**	**Yes**	**No**	**N/A**
	Site personnel trained to execute the Scope of Work	PM			
	Verification of all personnel's training certifications	PM			
	Potential for language barrier issues for this project	PM			
	Potential technical understanding barriers for this project	PM			
	Number of SSE(s) on site concurrent with CRA/client policy	PM			
	Short Service Employee(s) identification	PM			
	Mentor assignment for each SSE(s)	PM			
	Employees trained to use the tools/equipment	PM			
	Verification of all personnel's:				
	- Medical clearance & respirator fit test (as required)	Safety Admin			
	- Alcohol & drug clearance	Safety Admin			
	Daily personnel evaluation if they are fit to function and working safely	SS			
	Safety Health Officer required for the site	PM			

1.4	**Behavior Based Safety - SMART Tools**				
	(All items identified, verified and discussed)	**Resource**	**Yes**	**No**	**N/A**
	STAR/Loss Prevention Self Assessment (LPSAs)	SMART			
	Near loss/incident reporting procedure	SMART			
	STEP/LPO	SMART			
	At-risk behaviors and observation trends	SMART			

1.5	**HASP Development & Review**				
	(All items identified, verified and discussed)	**Resource**	**Yes**	**No**	**N/A**
	Site-specific Health & Safety Plan developed	HASP			
	Site-specific Health & Safety Plan approval by CRA safety professional	HASP			
	System to modify the Health & Safety Plan in the field (i.e., "dirty JSA/JLA")	HASP			

1.6	**JSA/JLA**				
	(All items identified, verified and discussed)	**Resource**	**Yes**	**No**	**N/A**
	On-site hazard assessment	PM			
	JSA/JLAs available for all tasks including those performed by subcontractors	HASP			
	Requirement to have JSA/JLAs modified in the field daily (i.e., "dirty JSA/JL	SS			
	MSDSs obtained, reviewed, and hazards incorporated into JSA/JLAs	HASP			

CRA SAFETY COORDINATION REVIEW

1.7	**PPE**				
	(All items identified, verified and discussed)	**Resource**	**Yes**	**No**	**N/A**
	Confirm task-specific PPE per JSA/JLAs	HASP			
	System to inspect PPE before start of work	SS			
1.8	**Site Emergency Response**				
	(All items identified, verified and discussed)	**Resource**	**Yes**	**No**	**N/A**
	First-aid requirements	HASP			
	Minimum - one first-aid trained person on-site	HASP			
	First-aid equipment within 50 feet of risk	HASP			
	Eye wash/shower within 50 feet of risk	HASP			
	Spill response equipment inspected and available within 50 feet of risk	HASP			
	Emergency Action Plan (EAP) - specific personnel identified for key incident command roles - discussed role responsibilities and actions with all site personnel, mustering/meeting location set	HASP			
	Site emergency evacuation alarm confirmed	SS			
	EAP drill schedule	HASP			
	Nearest hospital confirmation	HASP			
	Nearest hardwired telephone confirmation	Site Drawing			
	Emergency shut-off switch/valve locations confirmation	Site Drawing			
	Emergency contact confirmation - coordinate with facility and client	HASP			
1.9	**Utility Locates**				
	(All items identified, verified and discussed)	**Resource**	**Yes**	**No**	**N/A**
	CRA and/or client-specific Subsurface Utility Clearance Protocol reviewed and adhered to	PM			
	QSF-019 Property Access Form completed	PM			
	Client-specific requirements communicated to all affected employees	PM			
	One-call responses verified	PM			
1.10	**Traffic Control Program**				
	(All items identified, verified and discussed)	**Resource**	**Yes**	**No**	**N/A**
	Temporary Traffic Control Plan (TTCP) required	PM			
	TTCP provided	PM			
	TTCP approval by the client, if required	PM			
1.11	**Site Control**				
	(All items identified, verified and discussed)	**Resource**	**Yes**	**No**	**N/A**
	Have the following areas been considered for site control:				
	Fencing, barricades or other identifiers	SS			
	Signage to control pedestrian traffic	SS			
	Safety perimeter around equipment and work zone	SS			
	Swing radius barricades and/or signage struck-by (crush zones) reviewed and controlled.	SS			
1.12	**Equipment**				
	(All items identified, verified and discussed)	**Resource**	**Yes**	**No**	**N/A**
	Proper lifting/transport of heavy objects (drums, augers)	SS			
	Equipment inspected and documented where required	SS			
	GFCI used and tested	SS			

CRA SAFETY COORDINATION REVIEW

1.13	**Weather**				
	(All items identified, verified and discussed)	**Resource**	**Yes**	**No**	**N/A**
	Weather condition changes discussed - how to handle during work	HASP			
	Weather monitoring- who is responsible	HASP			
	Weather related hazards (heat/cold accommodations)	HASP			
	Hold time after lightning and thunder	SS			
1.14	**Crew Commitment**				
	(All items identified, verified and discussed)	**Resource**	**Yes**	**No**	**N/A**
	Crew is aware of Safety Commitment that they are making	TBD			
1.15	**Materials**				
	(All items identified, verified and discussed)	**Resource**	**Yes**	**No**	**N/A**
	MSDSs availability for all HAZCOM/WHMIS regulated materials on the job site	HASP			
	Affected employees aware of special handling instructions for hazardous materials	HASP			
	Hazardous materials stored appropriately	HASP			
	Plan for dealing with leftover and/or waste materials	WP			
1.16	**Sub-Contractors**				
	(All items identified, verified and discussed)	**Resource**	**Yes**	**No**	**N/A**
	Approval through the QSF 12, 22, 30, 31	PM			
	CRA Safety Coordination Review Form completed with the subcontractor as applicable	PM			
1.17	**Documentation**				
	All required QS Forms are available and attached to the project file	PM	**Yes**	**No**	**N/A**
	- QSF-12	PM			
	- QSF-13	PM			
	- QSF-16	PM			
	- QSF-19	PM			
	- QSF-22	PM			
	- QSF-30/31	PM			
	- Meeting attendance sign in sheets	PM			
	Daily Tailgate sign in sheets	PM			
	Permits/air monitoring records	PM			
	STEP observation form	PM			
	Equipment inspection forms	PM			
	Client specific forms	PM			

CRA SAFETY COORDINATION REVIEW

SECTION C - ACTION ITEMS		
Action Items:	Responsible	Due Date

HASP Health and Safety Plan
PM Project Manager
SS Site Supervisor
SHO Safety & Health Officer

SUBCONTRACTOR INFORMATION
Company Name: _____
Address: _____
Primary Contact: _____
Phone: _____ Cell: _____ FAX: _____

SUBCONTRACTOR INFORMATION
Company Name: _____
Address: _____
Primary Contact: _____
Phone: _____ Cell: _____ FAX: _____

Copies of the forms for Pre-Job Meeting and On-Site Orientation shall be maintained in the Project File

FIELD SAFE TASK EVALUATION PROCESS (F-STEP)

Report Status: (insert date)	Initial Report	Updated Report	Final Report	Verification/Validation	Report Input to SMART Database

Observer's Name	Date:	Time:
Client:	Project Name:	
Observer's Office:	Site Location:	
Observer's Supervisor:	Project No. (If applicable):	
Subcontractor: ☐ Yes ☐ No	Subcontractor Company Name:	

Feedback Conducted By:	Date:
Observee's Supervisor:	Time:

Check Task Being Observed (if not listed here, go to columns at right)		If checking this column, write in the specific task	
☐ Air Knifing	☐ Mob/Demob	☐ Agricultural Services	
☐ Clearing	☐ Project Oversight	☐ Construction	
☐ Demolition	☐ Soil Sampling	☐ Landfill	
☐ Drilling	☐ Stack Testing	☐ Office Operations	
☐ Electrical Work	☐ Surveys & Audits	☐ O&M	
☐ Excavation	☐ Traffic Control	☐ Pipeline	
☐ General Site Cleaning	☐ UST Removal	☐ Refinery	
☐ Heavy Equipment Operations	☐ Water Sampling	☐ Treatment Plants	
☐ IH Sampling	☐ Well Management	☐ Other	
☐ Manual Lifting			

Give a brief description of task being performed and your surroundings

Observer's Positive Comments

1.

2.

3.

Feedback Session Conclusion:
If NO Questionable Items: Brief Recap of Positive Actions/Comments
If Questionable Items: Brief Recap of Positive Actions/Comments AND Why the Questionable Item(s) Occurred

FIELD SAFE TASK EVALUATION PROCESS (F-STEP)

PERSONAL PROTECTIVE EQUIPMENT	Meets Work Standards	???	N/A	Evaluation Comments
1. Hearing Protection (e.g., Ear Plugs)			☐	
2. Head Protection (e.g., Hard Hat)			☐	
3. Eye Protection (e.g., Safety Glasses/Goggles)			☐	
4. Hand Protection (e.g., Gloves)			☐	
5. Foot Protection (e.g., Steel-toe Boots)			☐	
6. Respiratory Protection			☐	
7. Fall Protection (e.g., lanyard/harness)			☐	
8. High Visibility Clothing (e.g., Work Vest)			☐	
9. First Aid Kit/Fire Extinguisher			☐	
10. Other (be specific)			☐	
BODY POSITION	**Meets Work Standards**	**???**	**N/A**	**Evaluation Comments**
11. Proper Body Positioning When Exerting Force (Lifting/Pushing/Pulling)			☐	
12. Pinch Points/Moving Equipment - Hands/Body Placement			☐	
13. 3-Points of Contact			☐	
14. Other (be specific)			☐	
WORK ENVIRONMENT	**Meets Work Standards**	**???**	**N/A**	**Evaluation Comments**
15. Work/Walk Surface Clear (Free And Clear Pathway)			☐	
16. Housekeeping/Equipment Storage			☐	
17. Controlled Work Zone (e.g., Warning Devices, Barricades, Cones, Flags)			☐	
18. Emergency Stop/Safety Switches			☐	
19. Materials Labeled Correctly			☐	
20. Storage/Disposal of Waste			☐	
21. Other (be specific)			☐	
OPERATING PROCEDURES	**Meets Work Standards**	**???**	**N/A**	**Evaluation Comments**
22. STAR Performed/Job Planning			☐	
23. Stop Work Authority Process – understood and considered			☐	
24. JSA/JLA/Risk Assessment Reviewed and Followed			☐	
25. Daily Site Inspection			☐	
26. High Risk Task Specific (Hot Work, Confined Space, LOTO, Excavation/ Trenching)			☐	
27. Inspect Work Zone for Hazards			☐	
28. Coordinate/Communicate with Site Rep and/or others on site			☐	
29. Spotters used appropriately			☐	
30. Underground/Overhead Utilities Identified			☐	
31. Other (be specific)			☐	
TOOLS/EQUIPMENT	**Meets Work Standards**	**???**	**N/A**	**Evaluation Comments**
32. Hand/Power Tool - Selection, Condition, and Use			☐	
33. Field/Test Equipment - Selection, Condition, and Use			☐	
34. Heavy Equipment - Selection, Condition, and Use			☐	
35. Other (be specific)			☐	
Observation Total Occurrences				
% Observations to Meet Work Standards				
Item Specific to Work Task	**Meets Work Standards**	**???**		**Evaluation Comments**
Insert Task/JSA/SOP Step				
Insert Task/JSA/SOP Step				
Insert Task/JSA/SOP Step				

FIELD SAFE TASK EVALUATION PROCESS (F-STEP)

Causative Factors and Corrective Actions						Verification (Did we do what we said we would do?) and Validation (Is it working?)		
Item No.	CF	Corrective Actions (Must match Causative Factor)	Responsible Party	Date Due	Date Completed	Verified By/ Validated By	Date	Details
						Verified By:		
						Validated By:		
						Verified By:		
						Validated By:		
						Verified By:		
						Validated By:		
						Verified By:		
						Validated By:		

CRA 10 CAUSATIVE FACTORS

Personal Factors		Company Factors		External Factors	
1	Insufficient training for task	5	Incomplete or no procedures	10	Exposure to conditions
2	Hurrying to complete the task	6	Procedures not known or enforced		
3	Easier if proper process not followed	7	Improper PPE		
4	Took shortcuts without prior incident	8	Improper tools		
		9	Improper workplace layout		

PROPERTY ACCESS/UTILITY CLEARANCE DATA SHEET

(QSF-019)

PROJECT NAME: _____ PROJECT NUMBER: _____

CRA REPRESENTATIVE: _____

CLIENT: _____ CLIENT REPRESENTATIVE: _____ PHONE: _____

ON-SITE PROPERTY ACCESS APPROVAL _____ (OWNER OR AUTHORIZED AGENT SIGNATURE)

OFF-SITE PROPERTY ACCESS APPROVAL (if applicable) _____ (OWNER OR AUTHORIZED AGENT SIGNATURE)

UTILITY CLEARANCE APPROVAL _____ (OWNER OR AUTHORIZED AGENT SIGNATURE)

CONTRACTOR VERIFICATION APPROVAL _____ (OWNER OR AUTHORIZED AGENT SIGNATURE)

UTILITIES (INDICATE THAT LOCATION/UTILITY PRESENCE WAS CHECKED) *												
Borehole/ Excavation Location	Date (m/d/y)	Telephone	Water	Storm Sewer	Sanitary Sewer	Process Sewer	Gas	Electrical	Cable	Overhead Utilities	Other	Comments/Warnings

Additional Comments:

_____

_____

_____

* Note as appropriate, Contractor, Client or Owner, or Agent to sign, indicating no utilities are at the selected borehole/excavation locations.

THIS COMPLETED FORM IS A QUALITY RECORD

SITE HEALTH AND SAFETY PLAN MINOR AMENDMENT FORM

Amendment #

Site Name/Project ID

JSA Title

Date

Type of Amendment

Reason for Amendment

Alternate or Additional Safeguard Procedures

Required changes in PPE

Project Manager Notified ☐

RSHM Notified ☐

Client PM Notified (if necessary) ☐

Site Safety and Health Officer

Date

Note: To be used for changes such as MSDS additives, JSA changes, and equipment changes.

This original form must remain on site and a copy placed in the project file. Any changes to the original HASP must be discussed with all affected site personnel prior to commencing work.

ATTACHMENT B

JOB SAFETY ANALYSIS FORMS

JOB SAFETY ANALYSIS (JSA)

Driving

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g., site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each workday. **Stop, Think, Act, Review (STAR)** must be used prior to any activity. All personnel must possess the appropriate training prior to initiating scheduled tasks. Also consider weather conditions. CRA personnel have the authority and responsibility to use **Stop Work Authority (SWA).**

Date Issued/Revised:	July 29, 2013	**JSA Type:**	Driving
Work Type:	Environmental	**Client:**	GE Corporate Environmental Programs
Work Activity:	Travel to/from site with company/rental/personal vehicles without trailers or equipment		
Work Site:	1 W Campbell Rd, Schenectady, NY 12306		
Key Equipment:	Vehicle, valid driver's license		
Task-specific Training:	Defensive Driving;		

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (see job steps for task-specific requirements)					
☐ Reflective Vest	☐ Goggles	☐ Gloves*	**Supplied Air**	**APR**	
☐ Hard Hat	☐ Face Shield*	☐ Coveralls*	☐ SCBA	☐ Full Face APR	☐ Particulate ☐ Organic Vapor
☐ Lifeline/Harness*	☐ Hearing Protection*	☐ PPE Clothing*	☐ Airline Respirator (attach description)	☐ Half Mask APR	☐ Particulate/Organic Vapor Combined
☐ Safety Glasses	☐ Safety-toed Boots				☐ Acid Gas
☐ Other*			☐ Other*	☐ Other*	
ADDITIONAL PPE (*provide specific type(s) or descriptions of this item below)					

Reviewed By Name	Signature	Position/Title	Modified By	Project Development Team	Position/Title	Date
				Chris Muirhead	Junior Scientist	July 29, 2013
				Craig Gebhardt	RSHM	July 29. 2013
				Jamie Puskas	Project Manager	July 29, 2013

JOB SAFETY ANALYSIS (JSA)

Driving

Job Steps[1]	Task Activity	Potential Hazard(s)[2]	Corrective Measure(s)[3]	Person Responsible
1	Discuss STAR and SWA	• Site personnel not aware of STAR and SWA	• Project team (CRA) discusses importance of and documentation procedures for SWA during pre-job safety meeting • Discuss route, concerns, and alternate routes with passenger and drivers of other vehicles • Use SWA to stop any work that is unsafe • Ensure proper vehicle selected for travel (use a truck if going to construction site or area with rough conditions that would damage a small vehicle?)	Driver and passenger
2	Check weather	• Unexpected storm • Fog; rain; snow; lightening/thunder • Heat/cold stress	• Check local weather forecast • Discuss weather issues and precautions to take while driving and on site during the pre-job safety meeting • If weather conditions (e.g., fog, rain, snow, etc.) impair the ability/vision of the driver, exit at nearest safe location and assess the situation • While on site, at first sign of lightening/thunder utilize SWA and assess weather conditions • In extreme temperatures, ensure all personnel have proper clothing, hydration, and heat/cold protection (e.g., canopy, fan, glove warmers)	Driver or Passenger
3	Complete CRA Daily Operator Vehicle Checklist	• Damaged vehicle lights, tires, windows, mirrors, horn • Inadequate vehicle documents and/or safety items	• Check for fluid leaks under vehicle • Test operation of headlights, front/rear turn signals, backup lights, brake lights, and emergency flashers • Visually check the pressure/wear of tires • Ensure the vehicle has a properly inflated spare tire and associated tools to install • Assure windshield and window glass is clean and free from obstructions • Assure all fluids are topped off (e.g., windshield wiper fluid) and scheduled routine maintenance has occurred (e.g., oil changes). • Test the windshield wipers and horn • Verify vehicle registration, insurance card, and inspection sticker is present and valid • If the vehicle contains a first aid kit, fire extinguisher, and road hazard kit, verify that all items with expiration dates are current and that fire extinguisher has had documented monthly check • Do not use vehicle if any safety device is found not functioning	Driver or Passenger
4	Check and adjust seat, steering wheel, headrest, and mirrors	• Back/body strain • Blind spot • Impaired vision	• Adjust seat, headrest, and steering wheel height so body is fully supported/comfortable and pedals are within easy reach • Ensure mirrors are properly adjusted	Driver or Passenger
5	Fasten seat belt(s) and ensure passengers' seat belts are fastened	• Serious injury, ejection, or death from collision and/or traffic citation	• Verify driver and passenger(s) seat belts are in good condition and properly latched	Driver or Passenger
6	Ensure vehicle doors are locked	• Serious injury, ejection, or death from collision • Unwanted intrusion • Lost equipment	• Manually lock all doors to vehicle prior to starting the vehicle	Driver

JOB SAFETY ANALYSIS (JSA)

Driving

Job Steps[1]	Task Activity	Potential Hazard(s)[2]	Corrective Measure(s)[3]	Person Responsible
7	Start engine and check gauges and warning lights	• Vehicle breakdown	• Verify sufficient fuel and other hazard lamps (e.g., battery, oil, and temperature) are not lit	Driver
8	Driving – Use defensive driving techniques and stay alert	• Arriving late • Collision • Blind spots of other vehicles • Injury or death to occupants or other parties	• Acknowledge and comply with all traffic regulations, laws, and ordinances • Do not use two-way communicating devices or perform other distracting activities while vehicle is in motion • Constantly scan intersections, move eyes, check mirrors, and assess traffic lights (fresh vs. stale) • Recognize other vehicle's blind spots and minimize time spent within these zones • Maintain safety cushion around vehicle (front, sides, and rear) and 4-second following distance (add an extra second for each hazardous condition, triple following distance in poor weather conditions) • Signal well in advance before changing lanes or turning • Utilize all driving defensive techniques	Driver
9	Arrive at site	• Pedestrian injury • Collision	• Maintain awareness of pedestrian/vehicular traffic when entering site and traveling to work zone	Driver
10	Park vehicle – assign a spotter if necessary (when in doubt use a spotter)	• Pedestrian injury • Collision • Property damage	• Maintain awareness of pedestrian/vehicular traffic • Park vehicle in pull-through parking space or facing the exit • Use caution and mirrors/spotter when backing vehicle • Set parking brake	Driver
11	Demobilization – conduct a vehicle walk-around inspection paying particular attention to path(s) of travel	• Collision • Injury or death to occupants or other parties	• Perform perimeter vehicle check • Maintain awareness of pedestrian/vehicular traffic when exiting site • Utilize defensive driving techniques • Complete post-departure checklist and report vehicle problems to company vehicle maintenance manager or rental car agency	Driver or Passenger
12	Report maintenance or mechanical problems upon returning vehicle	• Conditions worsen leading to mechanical failure resulting in collision and injury	• Report vehicle problems immediately to company representative or rental car agency • Schedule and/or perform repairs as soon as possible	Driver

(1) Each Job or Task consists of a set of steps. Be sure to list all the steps in the sequence that they are performed. Specify the equipment or other details to set the basis for the potential (associated) hazards.

(2) A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress/ergonomics/lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught".

(3) Aligning with the Job Steps, Task Activity Description, and Potential Hazard columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable, and quantified terms. Avoid subjective general statements such as "be careful" or "use as appropriate".

JOB SAFETY ANALYSIS (JSA)

Decontamination of Sampling Equipment and Personnel (PPE Level D)

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g., site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each workday. **Stop, Think, Act, Review (STAR)** must be used prior to any activity. All personnel must possess the appropriate training prior to initiating scheduled tasks. Also consider weather conditions. CRA personnel have the authority and responsibility to use **Stop Work Authority (SWA).**

Date Issued/Revised:	July 29, 2013	**JSA Type:**	Decontamination
Work Type:	Environmental	**Client:**	GE Corporate Environmental Programs
Work Activity:	Decontamination of sampling equipment and personnel (PPE Level D)		
Work Site:	1 W Campbell Rd., Schenectady, NY 12306		
Key Equipment:	Alconox/Liquinox, methanol, brushes, pails		
Task-specific Training:	Decontamination/Site Control; Quality Control/Sampling Plan; 40-hour HAZWOPER; 8-hour HAZWOPER refresher; HAZCOM; PPE		

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (see job steps for task-specific requirements)					
☒ Reflective Vest	☐ Goggles	☒ Gloves*	**Supplied Air**	**APR**	
☒ Hard Hat	☐ Face Shield*	☐ Coveralls*	☐ SCBA	☐ Full Face APR	☐ Particulate ☐ Organic Vapor
☐ Lifeline/Harness*	☐ Hearing Protection*	☐ PPE Clothing*	☐ Airline Respirator (attach description)	☐ Half Mask APR	☐ Particulate/Organic Vapor Combined
☒ Safety Glasses	☒ Safety-toed Boots				☐ Acid Gas
☐ Other*			☐ Other*	☐ Other*	
ADDITIONAL PPE (*provide specific type(s) or descriptions of this item below)					
Nitrile gloves to be worn when decontaminating reusable equipment					

Reviewed By			**Modified By**	**Project Development Team**		
Name	**Signature**	**Position/Title**			**Position/Title**	**Date**
				Chris Muirhead	Junior Scientist	July 29, 2013
				Craig Gebhardt	RSHM	July 29, 2013
				Jamie Puskas	Project Manager	July 29, 2013

JOB SAFETY ANALYSIS (JSA)

Decontamination of Sampling Equipment and Personnel (PPE Level D)

Safety Means Awareness Responsibility Teamwork

Job Steps[1]	Task Activity	Potential Hazard(s)[2]	Corrective Measure(s)[3]	Person Responsible
1	Discuss STAR and SWA	• Site personnel not aware of STAR and SWA	• Project team (CRA) discusses importance of and documentation procedures for SWA during pre-job safety meeting • Use SWA to stop any work that is unsafe	Sampling personnel
2	Decontamination of sampling equipment (including pumps, bailers, tubing, etc.)	• Contaminant exposure • Pinch points • Slip/trip/hit/fall hazards • Lifting hazards • Back injury • Manual material handling	• Set up decon station to capture any spills to avoid cross-contamination and manage wastes • Wear appropriate PPE • Scrub equipment clean then rinse and verify it is clean and free of contamination • Avoid putting hands in or near pinch points • Maintain good housekeeping and be aware of surroundings • Size up the load; if the object is too large or odd shaped OR is in excess of 50 pounds (23 kg) then assistance (mechanical means, such as a dolly, cart, or a buddy lift) will be required • Lift with the legs (bend at the knees and use the leg muscles) to protect the lower back and keep lower back in a neutral position • Refer to the HASP for additional lifting techniques	Sampling personnel
3	Decontamination of personnel	• Contaminant exposure • Slip/trip/hit/fall hazards	• Refer to the HASP for specific procedures but in general start with most contaminated article and remove until inner gloves are the last item left • Dispose of used PPE in accordance with site requirements • Wash hands and face before eating, drinking, or using tobacco products • Take care when removing PPE (boots, gloves, etc.); sit down to remove/change boots as necessary	Sampling personnel
4	Management of waste derived from decontamination activities	• Contaminant exposure • Lifting hazards • Back injury • Manual material handling	• Containerize decon waste (e.g., water, used PPE) as required • Properly dispose of decon fluids (e.g., sediments) • Refer to step 1 and the HASP for additional lifting information	Sampling personnel

(1) Each Job or Task consists of a set of steps. Be sure to list all the steps in the sequence that they are performed. Specify the equipment or other details to set the basis for the potential (associated) hazards.

(2) A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress/ergonomics/lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught".

(3) Aligning with the Job Steps, Task Activity Description, and Potential Hazard columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable, and quantified terms. Avoid subjective general statements such as "be careful" or "use as appropriate".

JOB SAFETY ANALYSIS (JSA)

Groundwater Sampling (Peristaltic Pump)

Safety Means Awareness Responsibility Teamwork

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g., site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each workday. **Stop, Think, Act, Review (STAR)** must be used prior to any activity. All personnel must possess the appropriate training prior to initiating scheduled tasks. Also consider weather conditions. CRA personnel have the authority and responsibility to use **Stop Work Authority (SWA).**

Date Issued/Revised:	July 29, 2013	**JSA Type:**	Groundwater Sampling
Work Type:	Environmental	**Client:**	GE Corporate Environmental Programs
Work Activity:	Groundwater sampling		
Work Site:	1 W Campbell Rd., Schenectady, NY 12306		
Key Equipment:	Bailer or peristaltic pump (select one or both – address in task activity and hazards); photoionization detector; safety cones/barricades		
Task-specific Training:	Electrical Safety (if using pump), Groundwater Sampling Procedures – reference HASP for additional site/client safety training requirements; 40-Hour HAZWOPER; 8-Hour Refresher; PPE; HAZCOM		

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (see job steps for task-specific requirements)

☒ Reflective Vest	☐ Goggles	☒ Gloves*	**Supplied Air**	**APR**	
☒ Hard Hat	☐ Face Shield*	☐ Coveralls*	☐ SCBA	☐ Full Face APR	☐ Particulate ☐ Organic Vapor
☐ Lifeline/Harness*	☒ Hearing Protection*	☐ PPE Clothing*	☐ Airline Respirator (attach description)	☐ Half Mask APR	☐ Particulate/Organic Vapor Combined
☒ Safety Glasses	☒ Safety-toed Boots				☐ Acid Gas
☒ Other* Sunscreen and Insect Repellant			☐ Other*	☐ Other*	

ADDITIONAL PPE (*provide specific type(s) or descriptions of this item below)

Use Ndex nitrile gloves when handling wet sampling containers; use abrasion/cut-resistant gloves for other tasks; use hearing protection as necessary based on site conditions.

Reviewed By Name	Signature	Position/Title	Modified By	Project Development Team	Position/Title	Date
				Chris Muirhead	Junior Scientist	July 29, 2013
				Craig Gebhardt	RSHM	July 29, 2013
				Jamie Puskas	Project Manager	July 29, 2013

JOB SAFETY ANALYSIS (JSA)

Groundwater Sampling (Peristaltic Pump)

Job Steps[1]	Task Activity	Potential Hazard(s)[2]	Corrective Measure(s)[3]	Person Responsible
1	Discuss STAR and SWA	• Site personnel not aware of STAR and SWA	• Project team (CRA) discusses importance of and documentation procedures for SWA during pre-job safety meeting • Use SWA to stop any work that is unsafe	Sampling Technician
2	Inspect/calibrate sampling equipment	• Loss due to malfunctioning equipment	• Check all equipment to ensure it is in proper working order and has been calibrated to CRA and manufacturer's standards, and document	Sampling Technician
3	Establish work zone at monitoring well location	• Traffic • Pinch points • Lifting hazards • Back injury • Manual material handling	• Maintain awareness of on-site traffic patterns and walking paths; setup barricades • Reduce travel distance when there is a need to carry/lift materials • Make sure grip is adequate; wear leather/cotton gloves when setting up barricades • Size up the load; if the object is too large or odd shaped OR is in excess of 50 pounds (23 kg) then assistance (mechanical or a buddy lift) will be required • Lift with the legs (bend at the knees and use the leg muscles) to protect the lower back and keep lower back in a neutral position • Avoid one-handed carrying if possible; maintain awareness of footing	Sampling Technician
4	Open monitoring well cover(s)	• Pinch points • Hand injury • Biological hazards	• Avoid placing hands in pinch points • Wear proper PPE (gloves) for task and use the proper tool(s) when opening well covers (open face wrench/socket wrench) • Inspect for other hazards that may affect the hands (hypodermic needles, etc.) • Heightened awareness of wasps, ants, bees, spiders, and poison plants	Sampling Technician
5	Measure water levels	• Contaminant exposure • Cross contamination	• Wear proper PPE (Ndex nitrile gloves) • use PID to monitor air quality • Decon probe and measuring tape following gauging of well	Sampling Technician
6	Develop/purge monitoring well location (select one or both – peristaltic pump or bailer – hazards will be contingent upon method)	• Slip/trip/fall hazards • Cuts • Pinch points • Electrical (AC or DC) • Back and shoulder strain	• Maintain housekeeping; be aware of ground conditions • Use PPE and proper tools • Keep hands away from pinch points • Inspect wiring, clamps, cables, etc.; avoid arcing • Stretch affected muscles (triceps, back, neck, and shoulder) prior to/during/after activity • Avoid repetitive motions and overhead lifts; use proper lifting techniques and neutral postures and take breaks	Sampling Technician
7	Collect groundwater sample utilizing bailer or peristaltic pump	• Chemical exposure • Cuts from container breaking • Sample misidentification	• Wear proper PPE • Inspect bottles for signs of breakage/damage; do not use suspect containers • Close glass bottles carefully – avoid cross threading lid and bottle • Ensure sample id numbers match sample location/site plan • Check sample labels for accuracy prior to placing in container	Sampling Technician
8	Close monitoring well cover	• Traffic • Hand injury • Pinch points	• Maintain awareness of on-site traffic patterns; verify barricades are still in place • Wear appropriate gloves and use proper tool(s) • Avoid placing hands in pinch points	Sampling Technician

JOB SAFETY ANALYSIS (JSA)

Groundwater Sampling (Peristaltic Pump)

Safety Means Awareness Responsibility Teamwork

Job Steps[1]	Task Activity	Potential Hazard(s)[2]	Corrective Measure(s)[3]	Person Responsible
9	Pack samples in container (i.e., cooler)	• Bottle breakage • Chemical exposure • Lifting hazards • Back injury • Manual material handling • Lost time due to sampling error	• Pack glass containers in bubble wrap or equivalent protection • Wear appropriate PPE (Ndex nitrile gloves) • Refer to step 2 and the HASP for additional lifting techniques/information • Ensure samples are packed/labeled/shipped correctly – double check	Sampling Technician
10	Manage any investigative derived waste (IDW)	• Chemical exposure • Pinch points • Slip/trip/fall hazards • Lifting hazards • Back injury • Manual material handling • Mislabeling waste	• Wear appropriate PPE (Ndex gloves) and work gloves • Avoid pinch points • Use proper PPE • Inspect for proper housekeeping; clean up work area • Refer to step 2 and the HASP for additional lifting techniques/information • Label IDW appropriately (generator, contact number, identification of contents, and site location); specify type of contents; arrange for disposal	Sampling Technician and Project Manager

(1) Each Job or Task consists of a set of steps. Be sure to list all the steps in the sequence that they are performed. Specify the equipment or other details to set the basis for the potential (associated) hazards.

(2) A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress/ergonomics/lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught".

(3) Aligning with the Job Steps, Task Activity Description, and Potential Hazard columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable, and quantified terms. Avoid subjective general statements such as "be careful" or "use as appropriate".

JOB SAFETY ANALYSIS (JSA)

Monitoring Well Sampling with Bladder Pump

Safety Means Awareness Responsibility Teamwork

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g., site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each workday. **Stop, Think, Act, Review (STAR)** must be used prior to any activity. All personnel must possess the appropriate training prior to initiating scheduled tasks. Also consider weather conditions. CRA personnel have the authority and responsibility to use **Stop Work Authority (SWA).**

Date Issued/Revised:	July 29, 2013	**JSA Type:**	O&M
Work Type:	Environmental	**Client:**	GE Corporate Environmental Programs
Work Activity:	Monitoring well sampling/gauging		
Work Site:	1 W Campbell Rd., Schenectady, NY 12306		
Key Equipment:	Bladder pump, nitrogen, flow through cell, water level meter, nitrogen air regulator and air hose.		
Task-specific Training:	Water level meter, pumps, sample collection, sample packaging and shipping. 40-Hour HAZWOPER; 8-Hour HAZWOPER Refresher; PPE; HAZCOM		

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (see job steps for task-specific requirements)					
☐ Reflective Vest	☐ Goggles	☒ Gloves*	**Supplied Air**	**APR**	
☒ Hard Hat	☐ Face Shield*	☒ Coveralls*	☐ SCBA	☐ Full Face APR	☐ Particulate ☐ Organic Vapor
☐ Lifeline/Harness*	☐ Hearing Protection*	☒ PPE Clothing*	☐ Airline Respirator (attach description)	☐ Half Mask APR	☐ Particulate/Organic Vapor Combined
☒ Safety Glasses	☒ Safety-toed Boots				☐ Acid Gas
☒ Other* Insect repellant with DEET, sun screen			☐ Other*	☐ Other*	
ADDITIONAL PPE (*provide specific type(s) or descriptions of this item below)					
Nitrile gloves					

Reviewed By Name	Signature	Position/Title	Modified By	Project Development Team	Position/Title	Date
				Chris Muirhead	Junior Scientist	July 29, 2013
				Craig Gebhardt	RSHM	July 29, 2013
				Jamie Puskas	Project Manager	July 29, 2013

JOB SAFETY ANALYSIS (JSA)

Monitoring Well Sampling with Bladder Pump

Job Steps[1]	Task Activity	Potential Hazard(s)[2]	Corrective Measure(s)[3]	Person Responsible
1	Discuss STAR and SWA	• Site personnel not aware of STAR and SWA	• Project team (CRA) discusses importance of and documentation procedures for SWA during pre-job safety meeting • Use SWA to stop any work that is unsafe	
2	Coordinate site access	• Delays or added work	• Notify Station Manager of schedule • Notify other required personnel if applicable (city, regulators, private property owners, etc.)	Project Manager
3	Mobilize with proper equipment/supplies for sampling	• Delay or improper/unsafe performance of work due to improper equipment on site • Cross-contamination of wells	• Review work plan to determine equipment/supply needs • Make sure all sampling/gauging equipment is decontaminated • Bring ice for sample storage • Review the HASP and gather necessary PPE	Sampling Technician
4	Notify other personnel on site	• Unknown traffic or other work hazards • Lack of communication between all interested parties • Biological hazards (spiders, snakes, chiggers, ticks, bees, etc.)	• Meet with station attendant or other site personnel and explain planned activities • Inspect area for potential biological hazards. Chigger habitat (high grass, thick brush, especially in summer). If chiggers are suspected, take the following precautions: tuck in pant legs, apply insect repellant containing minimum of 25% DEET to boots, pant legs, and outer clothing generally. After potential exposure in chigger infested area, use proper hygiene practices and shower as soon as practicable (i.e., as soon as arriving home). Wash clothes prior to wearing again.	Sampling Technician
5	Determine sampling order	• Cross-contamination of samples and wells due to incomplete decontamination of sampling equipment	• Review prior analytical results and set sampling order from lowest to highest concentration wells	Sampling Technician
6	Perform STAR and tailgate safety meeting upon arrival at site	• Consider worst-case scenario (including weather conditions)	• Review HASP with co-workers • Highlight aspects identified by HASP and, if necessary, add to HASP • Get signature of all co-workers on HASP	Sampling Technician
7	Set up exclusion zone(s)	• Injury or exposure to public or other on-site personnel • Slip/trip/fall hazards	• Implement exclusion zone setup instructions of the HASP (barricades, caution tape, cones, etc.) • Set up work area free of trip hazards	Sampling Technician
8	Gauge water levels and product thickness (where applicable) in wells	• Back strain • Inhalation or dermal exposure to chemical hazards	• Don any additional PPE and initiate air quality monitoring in accordance with the HASP • Maintain safe distance from well head • Bend at knees, not waist	Sampling Technician

JOB SAFETY ANALYSIS (JSA)

Monitoring Well Sampling with Bladder Pump

Job Steps[1]	Task Activity	Potential Hazard(s)[2]	Corrective Measure(s)[3]	Person Responsible
9	Purge well(s) and collect purge water	• Cross-contamination • Lifting hazards • Back injury • Manual material handling • Inhalation or dermal exposure to chemicals • Slip/trip/fall hazards • Spilling contaminated water • Nitrogen tanks	• Decontaminate purging equipment between each sampling location • Reduce travel distance when there is a need to carry/lift materials • Make sure grip is adequate; wear leather/cotton gloves • Size up the load; if the object is too large or odd shaped OR is in excess of 50 pounds (23 kg) then assistance (mechanical or a buddy lift) will be required • Lift with the legs (bend at the knees and use the leg muscles) to protect the lower back and keep lower back in a neutral position • Avoid one-handed carrying if possible; maintain awareness of footing • Use PPE and monitoring in accordance with the HASP • Keep work area clear of tripping or slipping hazards • Store purge water in appropriate containers • Transport and store nitrogen tanks in accordance with DOT regulatory requirements • Inspect all air lines and fittings prior to pressurizing hoses • Release pressure slowly when disconnecting air lines • Do not open nitrogen cylinder in confined area and use adequate ventilation	Sampling Technician
10	Collect samples in accordance with sampling plan	• Cross-contamination • Lifting hazards • Back injury • Manual material handling • Inhalation or dermal exposure to chemical hazards • Slip/trip/fall hazards • Improper labeling or storage • Injury due to acid burn (unsealed or leaking sample bottle) • Injury from broken sample bottle (cuts or acid burn)	• Use PPE in accordance with the HASP • Use PPE whenever handling or labeling samples • Decontaminate sampling equipment between each well (unless disposable) • Refer to step 9 and the HASP for additional lifting methods • Label samples in accordance with sampling plan • Keep samples stored in proper containers, at correct temperature, and away from work area • Wear nitrile gloves when handling bottles • Handle bottles carefully	Sampling Technician
11	Dispose or store purge water on site	• Lifting hazards • Back injury • Manual material handling • Exposure to chemicals • If disposing through on-site treatment system, damage or injury from improper use of equipment • Improper storage or disposal	• Use proper equipment to transport water (pumps, drum dollies, etc.) • Refer to step 9 and the HASP for additional lifting methods • Where PPE in accordance with the HASP • Review any necessary instructions for use of on-site treatment systems • Label storage containers properly and locate in isolated area away from traffic and other site functions • Coordinate off-site disposal (where applicable)	Sampling Technician
12	Clean site/demobilize	• Traffic • Nuisance or safety hazard left on site • Back strain	• Use buddy system as necessary to remove traffic control • Leave site clean of refuse and debris • Notify station personnel of departure, and note any purge water left on site • Exercise caution when lifting coolers out of the trunk of a car; use the buddy system if justified	Sampling Technician

JOB SAFETY ANALYSIS (JSA)

Monitoring Well Sampling with Bladder Pump

Job Steps[1]	Task Activity	Potential Hazard(s)[2]	Corrective Measure(s)[3]	Person Responsible
13	Package and deliver samples to lab	• Bottle breakage • Improper temperature • Exceeding hold times • Improper completion of Chain of Custody (COC)	• Pack samples in ice, use bubble wrap/bags for sample bottles • Use standard COC forms and labels • Submit samples to lab as soon as possible (no more than 3 days, but check sampling plan for any special requirements such as rush turnaround or special hold time restrictions)	Sampling Technician

(1) Each Job or Task consists of a set of steps. Be sure to list all the steps in the sequence that they are performed. Specify the equipment or other details to set the basis for the potential (associated) hazards.

(2) A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress/ergonomics/lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught".

(3) Aligning with the Job Steps, Task Activity Description, and Potential Hazard columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable, and quantified terms. Avoid subjective general statements such as "be careful" or "use as appropriate".

JOB SAFETY ANALYSIS (JSA)

Mobilization/Demobilization

Safety Means Awareness Responsibility Teamwork

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g., site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each workday. **Stop, Think, Act, Review (STAR)** must be used prior to any activity. All personnel must possess the appropriate training prior to initiating scheduled tasks. Also consider weather conditions. CRA personnel have the authority and responsibility to use **Stop Work Authority (SWA).**

Date Issued/Revised:	July 29, 2013	**JSA Type:**	Mobilization/Demobilization
Work Type:	Environmental	**Client:**	GE Corporate Environmental Programs
Work Activity:			
Work Site:	1 W Campbell Rd., Schenectady NY, 12306		
Key Equipment:			
Task-specific Training:	40-Hour HAZWOPER; 8-Hour HAZWOPER Refresher; HAZCOM; PPE		

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (see job steps for task-specific requirements)					
☐ Reflective Vest	☐ Goggles	☒ Gloves*	**Supplied Air**	**APR**	
☐ Hard Hat	☐ Face Shield*	☐ Coveralls*	☐ SCBA	☐ Full Face APR	☐ Particulate ☐ Organic Vapor
☐ Lifeline/Harness*	☐ Hearing Protection*	☐ PPE Clothing*	☐ Airline Respirator (attach description)	☐ Half Mask APR	☐ Particulate/Organic Vapor Combined
☐ Safety Glasses	☒ Safety-toed Boots				☐ Acid Gas
☐ Other*			☐ Other*	☐ Other*	
ADDITIONAL PPE (*provide specific type(s) or descriptions of this item below)					

Reviewed By Name	Signature	Position/Title	Modified By	Project Development Team	Position/Title	Date
				Chris Muirhead	Junior Scientist	July 29, 2013
				Craig Gebhardt	RSHM	July 29, 2013
				Jamie Puskas	Project Manager	July 29, 2013

JOB SAFETY ANALYSIS (JSA)

Mobilization/Demobilization

Job Steps[1]	Task Activity	Potential Hazard(s)[2]	Corrective Measure(s)[3]	Person Responsible
1	Discuss STAR and SWA	• Site personnel not aware of STAR and SWA	• Project team (CRA) discusses importance of and documentation procedures for SWA during pre-job safety meeting • Use SWA to stop any work that is unsafe	Site Personnel
2	Check weather	• Unexpected storm • Fog, rain, snow; lightening/thunder • Heat/cold stress	• Check local weather forecast • If adverse weather conditions are likely, prepare a contingency plan for lodging, etc. with project manager • Discuss weather issues and precautions to take while driving and on site during the pre-job safety meeting • If weather conditions (e.g., fog, rain, snow, etc.) impair the ability/vision of the driver, exit at nearest safe location and assess the situation • While on site, at first sign of lightening/thunder utilize SWA and assess weather conditions • In extreme temperatures, ensure all personnel have proper clothing, hydration, and heat/cold protection (e.g., canopy, fan, glove warmers)	Site Personnel
3	Load equipment into vehicle	• Lifting hazards • Manual material handling • Back injury • Cuts • Pinch points • Hand/foot injury • Forgotten or damaged equipment	• Reduce travel distance when there is a need to carry/lift materials • Make sure grip is adequate; wear leather/cotton gloves • Size up the load; if the object is too large or odd shaped OR is in excess of 50 pounds (23 kg) then assistance (mechanical or a buddy lift) will be required • Lift with the legs (bend at the knees and use the leg muscles) to protect the lower back and keep lower back in a neutral position • Avoid one-handed carrying if possible; maintain awareness of footing • Avoid placing hands/fingers in pinch point locations • Wear safety-toed boots • Verify requested equipment against warehouse form • Load equipment in an organized manner to prevent shifting during transport or use cargo netting	Site Personnel
4	Complete CRA Daily Operator Vehicle Checklist	• Damaged vehicle lights, tires, windows, mirrors, horn • Inadequate vehicle documents and/or safety items	• Check for fluid leaks under vehicle • Test operation of headlights, front/rear turn signals, backup lights, brake lights, and emergency flashers • Visually check the pressure/wear of tires • Ensure the vehicle has a spare tire • Assure windshield and window glass is clean and free from obstructions • Test the windshield wipers and horn • Verify vehicle registration, insurance card, and inspection sticker is present and valid • Ensure the vehicle contains a first aid kit, fire extinguisher, and road hazard kit • Check immediate vehicle perimeter and initial path of travel for obstructions	Site Personnel
5	Check and adjust seat, steering wheel, headrest, and mirrors	• Back/body strain • Blind spot • Impaired vision	• Adjust seat, headrest, and steering wheel height so body is fully supported/comfortable and pedals are within easy reach • Ensure mirrors are properly adjusted	Site Personnel
6	Fasten seat belt(s) and ensure passenger(s) seat belts are fastened	• Serious injury, ejection, or death from collision and/or traffic citation	• Verify driver and passenger(s) seat belts are in good condition and properly latched	Site Personnel

JOB SAFETY ANALYSIS (JSA)

Mobilization/Demobilization

Job Steps[1]	Task Activity	Potential Hazard(s)[2]	Corrective Measure(s)[3]	Person Responsible
7	Ensure vehicle doors are locked	• Serious injury, ejection, or death from collision • Unwanted intrusion • Lost equipment	• Manually lock all doors to vehicle	Site Personnel
8	Start engine and check gauges and warning lights	• Vehicle breakdown	• Verify sufficient fuel and other hazard lamps (e.g., battery, oil, and temperature) are not lit	Site Personnel
9	Mobilize to site	• Arriving late • Collision • Injury or death to occupants or other parties	• Do not use cell phones or perform other distracting activities while vehicle is in motion • Constantly scan intersections, move eyes, check mirrors, and assess traffic lights (fresh vs. stale) • Maintain safety cushion around vehicle (front, sides, and rear) and 4-second following distance • Utilize all driving defensive techniques	Site Personnel
10	Arrive at site	• Pedestrian injury • Collision	• Maintain awareness of pedestrian/vehicular traffic when entering site and traveling to work zone	Site Personnel
11	Park vehicle	• Pedestrian injury • Collision • Property damage	• Maintain awareness of pedestrian/vehicular traffic • Park vehicle in pull-through parking space or facing the exit • Use caution and mirrors when backing vehicle • Use a spotter if necessary	Site Personnel
12	Demobilization	• Collision • Injury or death to occupants or other parties	• Check immediate vehicle perimeter and initial path of travel for obstructions • Maintain awareness of pedestrian/vehicular traffic when exiting site • Utilize defensive driving techniques • Complete post-departure checklist and report vehicle problems to company vehicle maintenance manager or rental car agency	Site Personnel

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(2) A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress/ergonomics/lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught".

(3) Aligning with the Job Steps, Task Activity Description, and Potential Hazard columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable, and quantified terms. Avoid subjective general statements such as "be careful" or "use as appropriate".

JOB SAFETY ANALYSIS (JSA)

Well Maintenance/Inspection

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g., site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each workday. **Stop, Think, Act, Review (STAR)** must be used prior to any activity. All personnel must possess the appropriate training prior to initiating scheduled tasks. Also consider weather conditions. CRA personnel have the authority and responsibility to use **Stop Work Authority (SWA).**

Date Issued/Revised:	July 29, 2013	**JSA Type:**	O&M
Work Type:	Environmental	**Client:**	GE Corporate Environmental Programs
Work Activity:	Well maintenance/inspection		
Work Site:	1 W Campbell Rd., Schenectady NY, 12306		
Key Equipment:			
Task-specific Training:	40-Hour HAZWOPER; LPS training (as applicable); 8-Hour HAZWOPER Refresher; HAZCOM; PPE		

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (see job steps for task-specific requirements)

☒ Reflective Vest	☒ Goggles	☒ Gloves*	**Supplied Air**	**APR**	
☒ Hard Hat	☐ Face Shield*	☐ Coveralls*	☐ SCBA	☐ Full Face APR	☐ Particulate ☐ Organic Vapor
☐ Lifeline/Harness*	☒ Hearing Protection*	☐ PPE Clothing*	☐ Airline Respirator (attach description)	☐ Half Mask APR	☐ Particulate/Organic Vapor Combined
☒ Safety Glasses	☒ Safety-toed Boots				☐ Acid Gas
☐ Other*			☐ Other*	☐ Other*	

ADDITIONAL PPE (*provide specific type(s) or descriptions of this item below)

Minimum Level D PPE; type of gloves dependent on job-specific requirements. Additional PPE may be required in the Health and Safety Plan (HASP).
Also refer to the HASP for required traffic control, air monitoring, and emergency procedures.

Reviewed By Name	Signature	Position/Title	Modified By	Project Development Team	Position/Title	Date
				Chris Muirhead	Junior Scientist	July 29, 2013
				Craig Gebhardt	RSHM	July 29, 2013
				Jamie Puskas	Project Manager	July 29, 2013

JOB SAFETY ANALYSIS (JSA)

Well Maintenance/Inspection

Job Steps[1]	Task Activity	Potential Hazard(s)[2]	Corrective Measure(s)[3]	Person Responsible
1	Discuss STAR and SWA	• Site personnel not aware of STAR and SWA	• Project team (CRA) discusses importance of and documentation procedures for SWA during pre-job safety meeting • Use SWA to stop any work that is unsafe	Site Personnel
2	Coordinate site access	• Delays or added work	• Notify site personnel of schedule • Notify other required personnel if applicable (city, regulators, private property owners, etc.)	Site Personnel
3	Mobilize with proper equipment/supplies	• Delay or improper/unsafe performance of work due to improper equipment on site • Chemical exposure • Lifting hazards • Manual material handling • Back injury	• Review work plan to determine equipment/supply needs • Make sure all equipment is decontaminated • Review the HASP and gather necessary PPE • Reduce travel distance when there is a need to carry/lift materials • Make sure grip is adequate; wear leather/cotton gloves • Size up the load; if the object is too large or odd shaped OR is in excess of 50 pounds (23 kg) then assistance (mechanical or a buddy lift) will be required • Lift with the legs (bend at the knees and use the leg muscles) to protect the lower back and keep lower back in a neutral position • Avoid one-handed carrying if possible; maintain awareness of footing	Site Personnel
4	Notify other personnel on site	• Unknown traffic or other work hazards • Lack of communication between all interested parties	• Meet with site superintendent or other site personnel and explain planned activities • Meet with all affected/interested parties and discuss work hazards	Site Personnel
5	Perform STAR upon arrival at site	• Consider worst-case scenario (including weather conditions)	• Review site-specific procedures • Highlight aspects identified by STAR and, if necessary, add to HASP • Have all co-workers sign the HASP	Site Personnel
6	Set up necessary traffic control	• Accident during placement or as a result of improper traffic control equipment placement • Lifting hazards • Manual material handling • Back injury	• Use buddy system for placing traffic control • Refer to step 2 and HASP for additional lifting methods/information • Reference traffic control plan section of the HASP (may include specific requirements based on encroachment permit)	Site Personnel
7	Set up exclusion zone(s)	• Injury or exposure to public or other on-site personnel • Slip and fall hazards to workers	• Implement exclusion zone setup instructions of the HASP (barricades, caution tape, cones, etc.) • Set up work area free of trip hazards	Site Personnel
8	Open well vaults, pull pumps for inspection, reset pumps	• Lifting hazards • Manual material handling • Back injury • Exposure to contaminants • Insect or animal bites • Chemical exposure by pump contents • Pressurized air or electrical hazard	• Identify site-specific hazards using the STAR process and 'dirty' the JSA • Refer to step 2 and HASP for additional lifting methods/information • Wear appropriate PPE • Have first aid kit available • Use tool to open well box • Practice zero energy procedures/lockout	Site Personnel
9	Clean site/demobilize	• Traffic • Nuisance or safety hazard left on site	• Use buddy system as necessary to remove traffic control • Leave site clean of refuse and debris • Notify site personnel of departure, and note any refuse left on site	Site Personnel

(1) Each Job or Task consists of a set of steps. Be sure to list all the steps in the sequence that they are performed. Specify the equipment or other details to set the basis for the potential (associated) hazards.

(2) A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress/ergonomics/lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught".

(3) Aligning with the Job Steps, Task Activity Description, and Potential Hazard columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable, and quantified terms. Avoid subjective general statements such as "be careful" or "use as appropriate".

JOB SAFETY ANALYSIS (JSA)

Sodium Persulfate Storage, Preparation, NaOH Activation, and Injection Activities

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g., site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each workday. **Stop, Think, Act, Review (STAR)** must be used prior to any activity. All personnel must possess the appropriate training prior to initiating scheduled tasks. Also consider weather conditions. CRA personnel have the authority and responsibility to use **Stop Work Authority (SWA).**

Date Issued/Revised:	July 29, 2013	**JSA Type:**	Remediation
Work Type:	Environmental or Remediation	**Client:**	GE Corporate Environmental Programs
Work Activity:	Storage, preparation, and injection of sodium persulfate ($Na_2 S_2O_8$) solution		
Work Site:	1 W Campbell Rd, Schenectady, NY 12306		
Key Equipment:	Storage pad/mixing pad; mixing equipment, pumps		
Task-specific Training:	40-Hour HAZWOPER/8 Hour refresher training; Supervisor shall have First Aid and CPR Training; HAZCOM (MSDS $Na_2O_8S_2$ and NaOH); Mixing Solution Properly; PPE; working around equipment		

MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT (see job steps for task-specific requirements)

☒ Reflective Vest	☒ Goggles	☒ Gloves*	**Supplied Air**	**APR**	
☒ Hard Hat	☒ Face Shield*	☒ Coveralls*	☐ SCBA	☐ Full Face APR	☐ Particulate ☐ Organic Vapor
☐ Lifeline/Harness*	☒ Hearing Protection*	☒ PPE Clothing*	☐ Airline Respirator (attach description)	☐ Half Mask APR	☐ Particulate/Organic Vapor Combined
☒ Safety Glasses	☒ Safety-toed Boots				☐ Acid Gas
☒ Other* Gloves according to task			☐ Other*	☐ Other*	

ADDITIONAL PPE (*provide specific type(s) or descriptions of this item below)

Minimum Level D PPE; type of gloves dependent on job-specific requirements. Additional PPE may be required in the Health and Safety Plan (HASP).
Also refer to the HASP for required traffic control, air monitoring, and emergency procedures. Tyvek coveralls; rubber apron, rubber boots, chemical-resistant gloves.

Reviewed By Name	Signature	Position/Title	Modified By	Project Development Team	Position/Title	Date
				Chris Muirhead	Junior Scientist	July 29, 2013
				Craig Gebhardt	RSHM	July 29, 2013
				Jamie Puskas	Project Manager	July 29, 2013

JOB SAFETY ANALYSIS (JSA)

Sodium Persulfate Storage, Preparation, NaOH Activation, and Injection Activities

Job Steps[1]	Task Activity	Potential Hazard(s)[2]	Corrective Measure(s)[3]	Person Responsible
1	Discuss STAR and SWA	• Site personnel not aware of STAR and SWA	• Project team (CRA) discusses importance of and documentation procedures for SWA during pre-job safety meeting • Use SWA to stop any work that is unsafe	Site Personnel
2	Storage of sodium persulfate	• Slip/trip/fall hazards when placing chemical in temporary storage boxes or other lined storage pads	• Inspect work areas before access for obstructions, moisture, and clear pathways • Pick up chemical totes with forklift and position them for storage • Keep dry chemical containers closed when not in use • Keep a large quantity of sand available for fire suppression and emergency decontamination • Do not use water to suppress fire • Initiate in Level D with leather gloves • In case of accidental opening: OHSA PEL = 5 mg/m^3	Site Personnel
		• Heavy lifting	• Lift no more than one bag of oxidizer and keep it close to your body • Carry with two hands in front of you to avoid back stress, or get assistance • Lift bag to carrying position using heavy lifting techniques, keeping back vertical and straight, lifting with leg muscles as opposed to back muscles	Site Personnel
		• Incompatibility with other chemicals	• Keep valve on tote tightly closed when not opened for mixing • Store in cool, dry, ventilated location away from greases, oils, heat, or ignition sources • Do not store in close proximity to water, acids, organics • Do not store on or near wood, metal salts, peroxides, or reducing agents	Site Personnel
		• Release to environment and human exposure	• Solution preparation area can be lined with plastic sheeting to prevent spillage onto ground surface • When handling liquid chemical, wear nitrile gloves, Tyvek overalls, and full-face shield • After being mixed into solution, close container and revert to Modified Level D for all work involving the $Na_2O_8S_2$ solution • Have neutralizing solution (water) on hand in sufficient quantity for managing splashes to clothing or ground surface and equipment • Keep unauthorized or un-needed persons out of chemical mixing area if possible and keep all containers of prepared liquid persulfate solution closed/covered at all times • Modified Level D with full-face splash shields and rubber aprons and boots	Site Personnel
3	Preparation of solution from chemical and decontamination of equipment, personnel, and soil	• Slip/trip/fall hazards when placing bags of chemical in temporary storage boxes or other lined storage pads	• Inspect work areas before access for obstructions, moisture, and clear pathways • Pick up chemical totes with forklift and position them for storage • Keep dry chemical containers closed when not in use • Initiate in Level D with leather gloves • In case of accidental opening: OHSA PEL = 5 mg/m^3	Site Personnel

JOB SAFETY ANALYSIS (JSA)

Sodium Persulfate Storage, Preparation, NaOH Activation, and Injection Activities

Job Steps[1]	Task Activity	Potential Hazard(s)[2]	Corrective Measure(s)[3]	Person Responsible
		• Heavy lifting	• Lift no more than one bag of oxidizer and keep it close to your body • Carry with two hands in front of you to avoid back stress, or get assistance • Lift bags to carrying position using heavy-lift techniques, keeping back vertical and straight, lifting with leg muscles as opposed to back muscles	Site Personnel
		• Incompatibility with other chemicals	• Keep valve on tote tightly closed when not opened for mixing • Store in cool, dry, ventilated location away from greases, oils, heat, or ignition sources • Do not store in close proximity to water, acids, organics • Do not store on or near wood, metal salts, peroxides, or reducing agents	Site Personnel
		• Release to environment and human exposure	• Solution preparation area can be lined with plastic sheeting to prevent spillage onto soil • When handling liquid chemical, wear nitrile gloves, Tyvek overalls, and full-face shield • After being mixed into solution, close container and revert to Modified Level D for all work involving the $Na_2O_8S_2$solution • Have neutralizing solution (water) on hand in sufficient quantity for managing splashes to clothing or ground surface and equipment • Keep unauthorized or un-needed persons out of chemical mixing area if possible and keep all containers of prepared liquid persulfate solution closed/covered at all times • Modified Level D with full-face splash shields and rubber aprons and boots	Site Personnel
4	Activation with Sodium Hydroxide (NaOH)	• Incompatibility with other chemicals	• Avoid contact with water, acids, aluminum, zinc, magnesium, flammable liquids, and organic halogens • Do not add water to concentrated sodium hydroxide – always add sodium hydroxide to water during dilution	Site Personnel
		• Release to environment and human exposure	• Large volumes should be stored within secondary containment • When handling liquid chemical, wear natural rubber gloves, Tyvek overalls, rubber or vinyl apron, safety glasses and full-face shield • After being mixed into solution, close container and revert to Modified Level D for all work involving the $Na_2O_8S_2$solution • Have neutralizing solution (water) on hand in sufficient quantity for managing splashes to clothing or ground surface and equipment • Keep unauthorized or un-needed persons out of chemical mixing area if possible and keep all containers of prepared liquid persulfate solution closed/covered at all times • Modified Level D with full-face splash shields and rubber aprons and boots	Site Personnel
		• Solidification of Sodium Hydroxide solution	• 50% solution of Sodium Hydroxide solidifies at 54 degrees F • 30% solution of Sodium Hydroxide solidifies at 36 degrees F • 25% solution of Sodium Hydroxide solidifies at 14 degrees F • 10% solution of Sodium Hydroxide solidifies at 10 degrees F	Site Personnel

JOB SAFETY ANALYSIS (JSA)

Sodium Persulfate Storage, Preparation, NaOH Activation, and Injection Activities

Job Steps[1]	Task Activity	Potential Hazard(s)[2]	Corrective Measure(s)[3]	Person Responsible
5	Injection of solution into subsurface	• Pressurized line rupture, spillage • Disconnection drips and associated releases	• All personnel within proximity) of pumps, lines, should wear appropriate PPE, rubber aprons and boots, and nitrile gloves and be aware of leak or splash potential • Depressurize and bleed lines to buckets before disconnecting any fittings • Watch for emanation of liquid from other boreholes, creek banks, and monitoring wells in the area during injection • Stop injection if excessive pressure is experienced or releases are evident, or if any other unusual condition is observed • Inspect all fittings and lines from solution batch tank to drill-string probe prior to use • Modified Level D with full-face splash shields and rubber aprons and boots • Be cognizant to not allow solutions to sit deadheaded in lines, pumps, or in ball valves where pressure can rupture the container. • Rinse all lines, pumps, etc. with water after chemical contact.	Site Personnel

(1) Each Job or Task consists of a set of steps. Be sure to list all the steps in the sequence that they are performed. Specify the equipment or other details to set the basis for the potential (associated) hazards.

(2) A hazard is a potential danger. What can go wrong? How can someone get hurt? Consider, but do not limit, the analysis to: **Contact** - victim is struck by or strikes an object; **Caught** - victim is caught on, caught in or caught between objects; **Fall** - victim falls to ground or lower level (includes slips and trips); **Exertion** - excessive strain or stress/ergonomics/lifting techniques; **Exposure** - inhalation/skin hazards. Specify the hazards and do not limit the description to a single word such as "Caught".

(3) Aligning with the Job Steps, Task Activity Description, and Potential Hazard columns, describe what actions or procedures are necessary to eliminate or minimize the hazards. Be clear, concise and specific. Use objective, observable, and quantified terms. Avoid subjective general statements such as "be careful" or "use as appropriate".

JOB SAFETY ANALYSIS (JSA)

Sodium Persulfate Storage, Preparation, NaOH Activation, and Injection Activities

The information contained in this JLA has been reviewed with me and I understand the duties I am responsible for.

_____/___/____	_____/___/____	_____/___/____
_____/___/____	_____/___/____	_____/___/____
_____/___/____	_____/___/____	_____/___/____
_____/___/____	_____/___/____	_____/___/____
_____/___/____	_____/___/____	_____/___/____

ATTACHMENT C

MATERIAL SAFETY DATA SHEETS

ALCONOX MSDS

Section 1: PRODUCT INFORMATION

Chemical family: Detergent.

Product name: Alconox

Manufacturer: Alconox, Inc.
30 Glenn St.
Suite 309
White Plains, NY 10603.

Manufacturer emergency phone number: 800-255-3924.
813-248-0585 (outside of the United States).

Supplier: Same as manufacturer.

TDG classification: Not regulated.

WHMIS classification: D2B

DSL status: The supplier has certified that all substances in this product appear on the domestic substances list.

Supplier MSDS date: 2005/03/09

Section 2: HAZARDOUS INGREDIENTS

C.A.S.	CONCENTRATION %	Ingredient Name	T.L.V.	LD/50	LC/50
25155-30-0	10-30	SODIUM DODECYLBENZENESULFONATE	NOT AVAILABLE	438 MG/KG RAT ORAL 1330 MG/KG MOUSE ORAL	NOT AVAILABLE
497-19-8	7-13	SODIUM CARBONATE	NOT AVAILABLE	4090 MG/KG RAT ORAL 6600 MG/KG MOUSE ORAL	2300 MG/M3/2H RAT INHALATION 1200 MG/M3/2H MOUSE INHALATION
7722-88-5	10-30	TETRASODIUM PYROPHOSPHATE	5 MG/M3	4000 MG/KG RAT ORAL 2980 MG/KG MOUSE ORAL	NOT AVAILABLE

7758-29-4	10-30	SODIUM PHOSPHATE	NOT AVAILABLE	3120 MG/KG RAT ORAL 3100 MG/KG MOUSE ORAL >4640 MG/KG RABBIT DERMAL	NOT AVAILABLE

Section 2A: ADDITIONAL INGREDIENT INFORMATION

Note: (supplier).
CAS# 497-19-8: LD50 4020 mg/kg - rat oral.
CAS# 7758-29-4: LD50 3100 mg/kg - rat oral.

Section 3: PHYSICAL DATA

Physical state: Solid

Appearance & odor: Almost odourless.
White granular powder.

Odor threshold (ppm): Not available.

Vapour pressure (mmHg): Not applicable.

Vapour density (air=1): Not applicable.

By weight: Not available.

Evaporation rate (butyl acetate = 1): Not applicable.

Boiling point (°C): Not applicable.

Freezing point (°C): Not applicable.

pH: (1% aqueous solution).
9.5

Specific gravity @ 20 °C: (water = 1).
0.85 - 1.10

Solubility in water (%): 100 - > 10% w/w

Coefficient of water\oil dist.: Not available.

VOC: None

Section 4: FIRE & EXPLOSION DATA

Flammability: Not flammable.

Conditions of flammability: Surrounding fire.

Extinguishing media: Carbon dioxide, dry chemical, foam.
Water
Water fog.

Special procedures: Self-contained breathing apparatus required.
Firefighters should wear the usual protective gear.

Auto-ignition temperature:	Not available.
Flash point (°C), method:	None
Lower flammability limit (% vol):	Not applicable.
Upper flammability limit (% vol):	Not applicable.
Explosion Data	
Sensitivity to static discharge:	Not available.
Sensitivity to mechanical impact:	Not applicable.
Hazardous combustion products:	Oxides of carbon (COx). Hydrocarbons.
Explosive power:	None

Section 5: REACTIVITY DATA

Chemical stability:	Stable under normal conditions.
Conditions of instability:	None known.
Hazardous polymerization:	Will not occur.
Incompatible substances:	Strong acids. Strong oxidizers.
Hazardous decomposition products:	See hazardous combustion products.

Section 6: TOXICOLOGICAL PROPERTIES

Route of entry:	Skin contact, eye contact, inhalation and ingestion.
Effects of acute exposure	
Eye contact:	May cause irritation.
Skin contact:	Prolonged contact may cause irritation.
Inhalation:	Airborne particles may cause irritation.
Ingestion:	May cause vomiting and diarrhea. May cause abdominal pain. May cause gastric distress.
Effects of chronic exposure:	Contains an ingredient which may be corrosive.
LD50 of product, species & route:	> 5000 mg/kg rat oral.
LC50 of product, species & route:	Not available for mixture, see the ingredients section.
Exposure limit of material:	Not available for mixture, see the ingredients section.
Sensitization to product:	Not available.
Carcinogenic effects:	Not listed as a carcinogen.

Reproductive effects:	Not available.
Teratogenicity:	Not available.
Mutagenicity:	Not available.
Synergistic materials:	Not available.
Medical conditions aggravated by exposure:	Not available.

Section 7: PREVENTATIVE MEASURES

Precautionary Measures

Gloves/Type:

Neoprene or rubber gloves.

Respiratory/Type:

If exposure limit is exceeded, wear a NIOSH approved respirator.

Eye/Type:

Safety glasses with side-shields.

Footwear/Type:	Safety shoes per local regulations.
Clothing/Type:	As required to prevent skin contact.
Other/Type:	Eye wash facility should be in close proximity. Emergency shower should be in close proximity.
Ventilation requirements:	Local exhaust at points of emission.
Leak/Spill:	Contain the spill. Recover uncontaminated material for re-use. Wear appropriate protective equipment. Contaminated material should be swept or shoveled into appropriate waste container for disposal.
Waste disposal:	In accordance with municipal, provincial and federal regulations.
Handling procedures and equipment:	Protect against physical damage. Avoid breathing dust. Wash thoroughly after handling. Keep out of reach of children. Avoid contact with skin, eyes and clothing. Launder contaminated clothing prior to reuse.
Storage requirements:	Keep containers closed when not in use. Store away from strong acids or oxidizers. Store in a cool, dry and well ventilated area.
TDG classification:	Not regulated.
Special shipping information:	Not regulated.

Section 8: FIRST AID MEASURES

Skin contact: Remove contaminated clothing.
Wash thoroughly with soap and water.
Seek medical attention if irritation persists.

Eye contact: Check for and remove contact lenses.
Flush eyes with clear, running water for 15 minutes while holding eyelids open: if irritation persists, consult a physician.

Inhalation: Remove victim to fresh air.
Seek medical attention if symptoms persist.

Ingestion: Dilute with two glasses of water.
Never give anything by mouth to an unconscious person.
Do not induce vomiting, seek immediate medical attention.

Additional information: The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. This company shall not be held liable for any inaccuracies.

Section 9: ADDITIONAL INFORMATION

General note: This material safety data sheet was prepared from information obtained from various sources, including product suppliers and the Canadian Center for Occupational Health and Safety.

Precision Gas Products Inc.

2455 Cawthra Road, Unit 21 Mississauga, Ontario L5A 3P1
Tel: (905)-949-2626/1-888-730-8196 Fax: (905)-949-2688
Emergency Contact: Chemtrec (800) 424-9300

Isobutylene in Air
0.0001% to 0.9%

MATERIAL SAFETY DATA SHEET

Identification

Revision Date 01-01-06

Products Name: ISOBUTYLENE IN AIR 0.0001% TO 0.9%
CAS Number: N/A
Chemical Family: Gas Mixture
Chemical formula: C4H8 in Air
MSDS identification Code/ Number: MSDS 113

Composition/ Information on Ingredients

Ingredient Name		Concentration Percent by Weight
ISOBUTYLENE CAS Number: 115-11-7		0.0001 to 0.9
AIR CAS Number: 25635-88-5	None	99.1 to 99.999

Exposure Limits
Simple Asphyxiant – Maintain oxygen levels above 19.5%

Hazard Identification

No data given

First Aid Measures

Eyes
Never introduce oil or ointment into the eyes without medical advice! In case of freezing or cryogenic "burns" by rapidly evaporating liquid, do not wash the eyes with hot or even tepid water! Remove victim from the source of contamination. Open eyelids wide to allow liquid to evaporate. If pain is present, refer the victim to an ophthalmologist for further treatment and follow-up. If the victim cannot tolerate light, protect eyes with a light bandage or handkerchief.

Skin
Remove contaminated clothing and flush affected area with cold water and soap. *Do not use hot water.* A physician should see the patient promptly if the cryogenic "burn" has resulted in blistering of the skin or deep tissue freezing or if frostbite has occurred. Treat the "burn" in a similar manner as a thermal burn.

Ingestion
Keep victim calm and warm. Notify physician and inform of nature of material, the state of the victim and any observed signs or symptoms.
Conscious persons should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be moved to an uncontaminated area, and if breathing has stopped, administer artificial resuscitation and supplemental oxygen. Further treatment should be symptomatic and supportive.

Fire Fighting Measures

Flammable Properties

Flash Point: Gas

Lower Explosive Limit (%): 1.8 (Isobutylene)
Upper Explosive Limit (%): 9.6 (Isobutylene)

- Fire and Explosion Hazards: Isobutylene is heavier than air and may travel a considerable distance to an ignition source. Isobutylene is a flammable gas! Keep away from open flame and other sources of ignition. Do not allow smoking in storage area or when handling.
- Extinguishing Media: Water, carbon dioxide, dry chemical
- Fire Fighting Instructions: If possible, stop flow of gas mixture. Use water spray to cool surrounding containers. If fire is extinguished and flow of gas is continued, increase ventilation to prevent a buildup of flammable/explosive atmosphere. Extinguish sources of ignition.

Accidental Release Measures

Evacuate all personnel from affected areas. Use appropriate protective equipment. If leak is in user's equipment, be certain to purge piping with an inert gas prior to attempting repairs. If leak is in container or container valve, contact CHEMTREC location for emergency assistance.

Handling and Storage

- **Handling and Storage Precautions**

Use only in well – ventilated areas. Valve protection caps must remain in place unless container is secured with valve outlet piped to use point. Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Use a pressure-reducing regulator when connecting cylinder to lower pressure (<3000 psig) piping or systems. Do not heat cylinder by any means to increase the discharge rate of product from the cylinder. Use a check valve or trap in the discharge line to prevent hazardous backflow into the system.

Protect cylinders from physical damage. Store in cool, dry, well – ventilated area of noncombustible construction away from heavily trafficked areas and emergency exits. Do not allow the temperature where cylinders are stored to exceed i30°F (54°C). Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Use a "first in, first out" inventory system to prevent full cylinders being stored for excessive periods of time. For additional recommendations consult Compressed Gas Association Pamphlet P-1. Post "NO SMOKING" signs in the storage area or use area.

Never carry a compressed gas cylinder or a container of a gas in cryogenic liquid form in an enclosed space such as a car trunk, van or station wagon. A leak can result in a fire, asphyxiation or toxic exposure.

Exposure Controls/Personal Protection

Engineering Controls: Use local exhaust to prevent accumulation. Use general ventilation to prevent buildup of flammable concentrations. May use hood with forced ventilation when handling small quantities. If product is handled routinely where the potential for leaks exists, all electrical equipment must be rated for use in potentially flammable atmospheres. Consult the National Electrical code for details.

Eye/Face Protection: Safety goggles or glasses.

Skin Protection: Plastic or rubber gloves.

Respiratory Protection: Positive pressure air lines with mask or self-contained breathing apparatus should be available for emergency use. A chemical cartridge respirator with organic vapor cartridges may be used for low concentrations when adequate oxygen is present, however product does not have adequate warning properties.

Other/General Protection: Safety shoes, safety shower, eyewash.

Physical & Chemical Properties

Appearance: A colorless gas.
Odor: Unpleasant odor similar to that of burning coal.

Basic Physical Properties
Solubility (H20): Insoluble
Present Volatiles: 100

Material Safety Data Sheet
Methanol

ACC# 14280

Section 1 - Chemical Product and Company Identification

MSDS Name: Methanol
Catalog Numbers: AC167830000, AC167830025, AC167835000, AC176840000, AC176840010, AC176840025, AC176840250, AC176845000, AC177150000, AC177150010, AC177150025, AC177150050, AC177150051, AC177150250, AC177150251, AC268280000, AC268280010, AC268280025, AC325740000, AC325740010, AC325740025, AC326630000, AC326630010, AC326630025, AC326950000, AC326950010, AC326951000, AC326952500, AC327900000, AC327900010, AC364390000, AC364390010, AC364391000, AC413770000, AC413770040, AC413775000, AC423950000, AC423950010, AC423950040, AC423950200, AC423955000, AC610090040, AC610200040, AC610400010, AC61040019, AC61040019, AC61040050, AC61040050, AC610401000, AC61040115, AC61040115, AC61040200, AC610981000, AC611070040, AC615130025, S75162, S75163, S75959, S75965, S75965A, S75965HPLC, S93301, S93301A, S93302, S93302A, 19123467, A408-1, A408-4, A408-4LC, A408SK-4, A411-20, A411-4, A412-1, A412-20, A412-200, A412-200LC, A412-4, A412-4LC, A412-500, A412200001, A412CU-1300, A412FB-200, A412FB115, A412FB19, A412FB50, A412J500, A412P-4, A412P-4LC, A412POP19, A412POPB-200, A412RB-200, A412RB-50, A412RB115, A412RS-200, A412RS115, A412RS19, A412RS28, A412RS50, A412SK-4, A412SS-115, A412SS-200, A412SS-50, A413-20, A413-200, A413-4, A413-500, A433F-1GAL, A433P-1GAL, A433P-4, A433P1GAL, A433S-20, A433S-200, A433S-4, A434-20, A450-4, A452-1, A452-212, A452-4, A452-4LC, A452J1, A452N1-19, A452N2-19, A452POP-200, A452POP50, A452RS-115, A452RS-19, A452RS-200, A452RS-28, A452RS-50, A452SK-1, A452SK-4, A452SS-115, A452SS-19, A452SS-200, A452SS-28, A452SS-50, A453-1, A453-1LC, A453-4, A453-500, A453J1, A454-1, A454-4, A454-4LC, A454J1, A454RS-115, A454RS-200, A454RS-28, A454SS-19, A454SS-200, A454SS-28, A454SS-50, A455-1, A455RS19, A456-1, A456-4, A457-4, A4574LC, A935-4, A935RB-200, A935RB200, A947-4, A947-4LC, A947POP-200, A947POP200, A947RS-115, A947RS-200, A947RS-28, A947SS-115, A947SS-200, A947SS-28, A947SS-50, BP1105-1, BP1105-4, BP1105SS19, BP1105SS28, BP2618100, HC400 1GAL, NC9105104, NC9134255, NC9173853, NC9283877, NC9360649, NC9386568, NC9419923, NC9433033, NC9433739, NC9541632, NC9942270, NC9964975, SC95-1, SW2-1, TIA947-4, TIA947P-200, TIA947P-200L
Synonyms: Carbinol; Methyl alcohol; Methyl hydroxide; Monohydroxymethane; Wood alcohol; Wood naptha; Wood spirits; Columbian spirits; Methanol.
Company Identification:

Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410

For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
67-56-1	Methanol	> 99	200-659-6

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: APHA: 10 max clear liquid. Flash Point: 12 deg C.
Danger! Poison! May be fatal or cause blindness if swallowed. Vapor harmful. **Flammable liquid and vapor.** Harmful if swallowed, inhaled, or absorbed through the skin. Causes eye, skin, and respiratory tract irritation. May cause central nervous system depression. Cannot be made non-poisonous.
Target Organs: Eyes, nervous system, optic nerve.

Potential Health Effects
Eye: May cause painful sensitization to light. Methanol is a mild to moderate eye irritant. Inhalation, ingestion or skin absorption of methanol can cause significant disturbances in vision, including blindness.
Skin: Causes moderate skin irritation. May be absorbed through the skin in harmful amounts. Prolonged and/or repeated contact may cause defatting of the skin and dermatitis. Methanol can be absorbed through the skin, producing systemic effects that include visual disturbances.
Ingestion: May be fatal or cause blindness if swallowed. Aspiration hazard. Cannot be made non-poisonous. May cause gastrointestinal irritation with nausea, vomiting and diarrhea. May cause systemic toxicity with acidosis. May cause central nervous system depression, characterized by excitement, followed by headache, dizziness, drowsiness, and nausea. Advanced stages may cause collapse, unconsciousness, coma and possible death due to respiratory failure. May cause cardiopulmonary system effects.
Inhalation: Methanol is toxic and can very readily form extremely high vapor concentrations at room temperature. Inhalation is the most common route of occupational exposure. At first, methanol causes CNS depression with nausea, headache, vomiting, dizziness and incoordination. A time period with no obvious symptoms follows (typically 8-24 hrs). This latent period is followed by metabolic acidosis and severe visual effects which may include reduced reactivity and/or increased sensitivity to light, blurred, doubl and/or snowy vision, and blindness. Depending on the severity of exposure and the promptness of treatment, survivors may recover completely or may have permanent blindness, vision disturbances and/or nervous system effects.
Chronic: Prolonged or repeated skin contact may cause dermatitis. Chronic exposure may cause effects similar to those of acute exposure. Methanol is only very slowly eliminated from the body. Because of this slow elimination, methanol should be regarded as a cumulative poison. Though a single exposure may cause no effect, daily exposures may result in the accumulation of a harmful amount. Methanol has produced fetotoxicity in rats and teratogenicity in mice exposed by inhalation to high concentrations that did not produce significant maternal toxicity.

Section 4 - First Aid Measures

Eyes: In case of contact, immediately flush eyes with plenty of water for a t least 15 minutes. Get medical aid.
Skin: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid immediately. Wash clothing before reuse.
Ingestion: Potential for aspiration if swallowed. Get medical aid immediately. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If vomiting occurs naturally, have victim lean forward.
Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician: Effects may be delayed.
Antidote: Ethanol may inhibit methanol metabolism.

Section 5 - Fire Fighting Measures

General Information: Ethanol may inhibit methanol metabolism. As in any fire, wear a self-

contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Use water spray to keep fire-exposed containers cool. Water may be ineffective. Material is lighter than water and a fire may be spread by the use of water. Vapors are heavier than air and may travel to a source of ignition and flash back. Vapors can spread along the ground and collect in low or confined areas.
Extinguishing Media: For small fires, use dry chemical, carbon dioxide, water spray or alcohol-resistant foam. Water may be ineffective. For large fires, use water spray, fog or alcohol-resistant foam. Do NOT use straight streams of water.
Flash Point: 12 deg C (53.60 deg F)
Autoignition Temperature: 455 deg C (851.00 deg F)
Explosion Limits, Lower:6.0 vol %
Upper: 31.00 vol %
NFPA Rating: (estimated) Health: 1; Flammability: 3; Instability: 0

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Use water spray to disperse the gas/vapor. Remove all sources of ignition. Absorb spill using an absorbent, non-combustible material such as earth, sand, or vermiculite. Do not use combustible materials such as sawdust. Use a spark-proof tool. Provide ventilation. A vapor suppressing foam may be used to reduce vapors. Water spray may reduce vapor but may not prevent ignition in closed spaces.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Ground and bond containers when transferring material. Use spark-proof tools and explosion proof equipment. Avoid contact with eyes, skin, and clothing. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Keep container tightly closed. Do not ingest or inhale. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames. Use only with adequate ventilation. Keep away from heat, sparks and flame. Avoid use in confined spaces.
Storage: Keep away from heat, sparks, and flame. Keep away from sources of ignition. Store in a cool, dry, well-ventilated area away from incompatible substances. Flammables-area. Keep containers tightly closed.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Use explosion-proof ventilation equipment. Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Methanol	200 ppm TWA; 250 ppm STEL; Skin - potential significant contribution to overall exposure by the cutaneous r oute	200 ppm TWA; 260 mg/m3 TWA 6000 ppm IDLH	200 ppm TWA; 260 mg/m3 TWA

OSHA Vacated PELs: Methanol: 200 ppm TWA; 260 mg/m3 TWA

Personal Protective Equipment
Eyes: Wear chemical splash goggles.
Skin: Wear appropriate protective gloves to prevent skin exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant respirator use.

Section 9 - Physical and Chemical Properties

Physical State: Clear liquid
Appearance: clear, colorless - APHA: 10 max
Odor: alcohol-like - weak odor
pH: Not available.
Vapor Pressure: 128 mm Hg @ 20 deg C
Vapor Density: 1.11 (Air=1)
Evaporation Rate:5.2 (Ether=1)
Viscosity: 0.55 cP 20 deg C
Boiling Point: 64.7 deg C @ 760 mmHg
Freezing/Melting Point:-98 deg C
Decomposition Temperature: Not available.
Solubility: miscible
Specific Gravity/Density:.7910 g/cm3 @ 20°C
Molecular Formula:CH4O
Molecular Weight:32.04

Section 10 - Stability and Reactivity

Chemical Stability: Stable under normal temperatures and pressures.
Conditions to Avoid: High temperatures, ignition sources, confined spaces.
Incompatibilities with Other Materials: Oxidizing agents, reducing agents, acids, alkali metals, potassium, sodium, metals as powders (e.g. hafnium, raney nickel), acid anhydrides, acid chlorides, powdered aluminum, powdered magnesium.
Hazardous Decomposition Products: Carbon monoxide, irritating and toxic fumes and gases, carbon dioxide, formaldehyde.
Hazardous Polymerization: Will not occur.

Section 11 - Toxicological Information

RTECS#:
CAS# 67-56-1: PC1400000
LD50/LC50:
CAS# 67-56-1:
Draize test, rabbit, eye: 40 mg Moderate;
Draize test, rabbit, eye: 100 mg/24H Moderate;
Draize test, rabbit, skin: 20 mg/24H Moderate;
Inhalation, rabbit: LC50 = 81000 mg/m3/14H;
Inhalation, rat: LC50 = 64000 ppm/4H;
Oral, mouse: LD50 = 7300 mg/kg;
Oral, rabbit: LD50 = 14200 mg/kg;
Oral, rat: LD50 = 5600 mg/kg;
Skin, rabbit: LD50 = 15800 mg/kg;

Human LDLo Oral: 143 mg/kg; Human LDLo Oral: 428 mg/kg; Human TCLo Inhalation; 300 ppm caused visual field changes & headache; Monkey LDLo Skin: 393 mg/kg. Methanol is significantly less toxic to most experimental animals than humans, because most animal species metabolize methanol differently. Non-primate species do not ordinarily show symptoms of metabolic acidosis or the visual effects which have been observed in primates and humans.
Carcinogenicity:
CAS# 67-56-1: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

Epidemiology: No information found
Teratogenicity: There is no human information available. Methanol is considered to be a potential developmental hazard based on animal data. In animal experiments, methanol has caused fetotoxic or teratogenic effects without maternal toxicity.
Reproductive Effects: See actual entry in RTECS for complete information.
Mutagenicity: See actual entry in RTECS for complete information.
Neurotoxicity: ACGIH cites neuropathy, vision and CNS under TLV basis.
Other Studies:

Section 12 - Ecological Information

Ecotoxicity: Fish: Fathead Minnow: 29.4 g/L; 96 Hr; LC50 (unspecified)Fish: Goldfish: 250 ppm; 11 Hr; resulted in deathFish: Rainbow trout: 8000 mg/L; 48 Hr; LC50 (unspecified)Fish: Rainbow trout: LC50 = 13-68 mg/L; 96 Hr.; 12 degrees CFish: Fathead Minnow: LC50 = 29400 mg/L; 96 Hr.; 25 degrees C, pH 7.63Fish: Rainbow trout: LC50 = 8000 mg/L; 48 Hr.; UnspecifiedBacteria: Phytobacterium phosphoreum: EC50 = 51,000-320,000 mg/L; 30 minutes; Microtox test No data available.
Environmental: Dangerous to aquatic life in high concentrations. Aquatic toxicity rating: TLm 96>1000 ppm. May be dangerous if it enters water intakes. Methyl alcohol is expected to biodegrade in soil and water very rapidly. This product will show high soil mobility and will be degraded from the ambient atmosphere by the reaction with photochemically produced hyroxyl radicals with an estimated half-life of 17.8 days. Bioconcentration factor for fish (golden ide) < 10. Based on a log Kow of -0.77, the BCF value for methanol can be estimated to be 0.2.
Physical: No information available.
Other: No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series:
CAS# 67-56-1: waste number U154 (Ignitable waste).

Section 14 - Transport Information

	US DOT	Canada TDG
Shipping Name:	METHANOL	METHANOL
Hazard Class:	3	3
UN Number:	UN1230	UN1230
Packing Group:	II	II
Additional Info:		FLASHPOINT 11 C

Section 15 - Regulatory Information

US FEDERAL

TSCA
CAS# 67-56-1 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
CERCLA Hazardous Substances and corresponding RQs
CAS# 67-56-1: 5000 lb final RQ; 2270 kg final RQ
SARA Section 302 Extremely Hazardous Substances
None of the chemicals in this product have a TPQ.
SARA Codes
CAS # 67-56-1: immediate, fire.
Section 313
This material contains Methanol (CAS# 67-56-1, > 99%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.
Clean Air Act:
CAS# 67-56-1 is listed as a hazardous air pollutant (HAP).
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.
OSHA:
None of the chemicals in this product are considered highly hazardous by OSHA.
STATE
CAS# 67-56-1 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

California Prop 65

California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives
Hazard Symbols:
T F
Risk Phrases:
R 11 Highly flammable.
R 23/24/25 Toxic by inhalation, in contact with skin and if swallowed.
R 39/23/24/25 Toxic : danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.

Safety Phrases:
S 16 Keep away from sources of ignition - No smoking.
S 36/37 Wear suitable protective clothing and gloves.
S 45 In case of accident or if you feel unwell, seek medical advice

immediately (show the label where possible).
S 7 Keep container tightly closed.

WGK (Water Danger/Protection)
CAS# 67-56-1: 1

Canada - DSL/NDSL
CAS# 67-56-1 is listed on Canada's DSL List.

Canada - WHMIS
This product has a WHMIS classification of B2, D1B, D2B.
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.

Canadian Ingredient Disclosure List
CAS# 67-56-1 is listed on the Canadian Ingredient Disclosure List.

Section 16 - Additional Information

MSDS Creation Date: 7/21/1999
Revision #14 Date: 9/05/2006

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

ISO9001:2000 Certified

Material Safety Data Sheet
Sodium hydroxide solutions, 1-50%

Section 1 - Chemical Product and Company Identification

MSDS Name:
Sodium hydroxide solutions, 1-50%

Catalog Numbers:
LC23950, LC24000, LC24040, LC24060, LC24070, LC24075, LC24078, LC24085, LC24090, LC24095, LC24100, LC24110, LC24115, LC24120, LC24140, LC24150, LC24200, LC24220, LC24230, LC24250, LC24270, LC24275, LC24280, LC24300, LC24305, LC24307, LC24310, LC24320, LC24330, LC24350, LC24380, LC24400, LC24420, LC24430, LC24450, LC24455, LC24460, LC24500, LC24523, LC24525

Synonyms:
Caustic Soda, Soda Lye, Sodium Hydrate

Company Identification:
LabChem, Inc.
200 William Pitt Way
Pittsburgh, PA 15238

Company Phone Number:
(412) 826-5230

Emergency Phone Number:
(800) 424-9300

CHEMTREC Phone Number:
(800) 424-9300

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name:	Percent
7732-18-5	Water	balance
1310-73-2	Sodium hydroxide	0.04-50

Section 3 - Hazards Identification

Emergency Overview

Appearance: *Clear, colorless solution*

Caution! *Corrosive. Causes burns by all exposure routes.*

Target Organs: *Eyes, skin, mucous membranes*

Potential Health Effects

Eye:
Causes eye burns. May cause chemical conjunctivitis and corneal damage.

Skin:
Causes skin burns. May cause deep, penetrating ulcers of the skin. May cause skin rash (in milder cases), and cold and clammy skin with cyanosis or pale color.

Ingestion:
Causes gastrointestinal tract burns. Causes severe pain, nausea, vomiting, diarrhea, and shock.

Inhalation:
Irritation may lead to chemical pneumonitis and pulmonary edema. Causes severe irritation of upper respiratory tract with coughing, burns, breathing difficulty, and possible coma.

Chronic:
Prolonged or repeated skin contact may cause dermatitis.

Section 4 - First Aid Measures

Eyes:
Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids until chemical is gone. Get medical aid at once.

Skin:
Get medical aid at once. Immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Remove contaminated clothing to reduce further exposure.

Ingestion:
Do NOT induce vomiting. Give conscious victim 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid at once.

Inhalation:
Move victim to fresh air immediately. Give artificial respiration if necessary. If breathing is difficult, give oxygen. Get medical aid.

Notes to Physician:
Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information:
As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Use water spray to keep fire-exposed containers cool. Use water with caution and in flooding amounts. Vapors may be heavier than air. They can spread along the ground and collect in low or confined areas. Contact with metals may evolve flammable hydrogen gas. Containers may explode when heated. Non-combustible, substance itself does not burn but may decompose upon heating to produce irritating, corrosive and/or toxic fumes.

Extinguishing Media:
Do NOT get water inside containers. For small fires, use dry chemical, carbon dioxide, or water spray. For large fires, use dry chemical, carbon dioxide, alcohol-resistant foam, or water spray. Cool containers with flooding quantities of water until well after fire is out.

Autoignition Temperature:
Not applicable.

Flash Point:
Not applicable.

NFPA Rating:
CAS# 7732-18-5: Health- 0, Flammability- 0, Instability- 0
CAS# 1310-73-2: Health- 3, Flammability- 0, Instability- 1

Explosion Limits:
Lower: No information Upper: No information

Section 6 - Accidental Release Measures

General Information:

Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:

Absorb spills with absorbent (vermiculite, sand, fuller's earth) and place in plastic bags for later disposal.

Section 7 - Handling and Storage

Handling:

Wash thoroughly after handling. Use with adequate ventilation. Do not get in eyes, on skin, or on clothing. Do not ingest or inhale. Do not breathe spray or mist.

Storage:

Store in a cool, dry, well-ventilated area away from incompatible substances. Keep away from strong acids. Keep away from metals. Keep away from flammable liquids. Keep away from organic halogens.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls:

Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.

Exposure Limits:

Chemical Name:	ACGIH	NIOSH	OSHA
Water	None of the components are on this list.	None of the components are on this list.	None of the components are on this list.
Sodium hydroxide	2 mg/m3 Ceiling	10 mg/m3 IDLH	2 mg/m3 TWA

OSHA Vacated PELs:

None listed

Personal Protective Equipment

Eyes:

Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133.

Skin:

Wear appropriate gloves to prevent skin exposure.

Clothing:

Wear appropriate protective clothing to prevent skin exposure.

Respirators:

Follow the OSHA respirator regulations found in 29CFR 1910.134. Always use a NIOSH-approved respirator when necessary.

Material Safety Data Sheet
Sodium hydroxide solutions, 1-50%

Section 9 - Physical and Chemical Properties

Physical State:	Liquid
Color:	Clear
Odor:	Not available.
pH:	Alkaline
Vapor Pressure:	3 mm Hg @ 37°C
Vapor Density:	>1.0
Evaporation Rate:	No information found.
Viscosity:	>1 (ether=1)
Boiling Point:	100-142°C
Freezing/Melting Point:	0-10.6°C
Decomposition Temperature:	No information found.
Solubility in water:	Soluble
Specific Gravity/Density:	1.0-1.5
Molecular Formula:	NaOH
Molecular Weight:	40.00

Section 10 - Stability and Reactivity

Chemical Stability:
Stable.

Conditions to Avoid:
Incompatible materials, extreme temperatures..

Incompatibilities with Other Materials:
Metals, acids, aluminum, nitro compounds, zinc, tin, halogenated hydrocarbons, nitromethane, flammable liquids.

Hazardous Decomposition Products:
Toxic fumes of sodium oxide.

Hazardous Polymerization:
Has not been reported.

Section 11 - Toxicological Information

RTECS:
CAS# 7732-18-5: ZC0110000.
CAS# 1310-73-2: WB4900000.

LD50/LC50:
CAS# 7732-18-5:
Oral, rat: LD50 = >90 mL/kg.
CAS# 1310-73-2:
Draize test, rabbit, eye: 400 ug Mild;
Draize test, rabbit, eye: 1% Severe;
Draize test, rabbit, eye: 50 ug/24H Severe;

Carcinogenicity:
CAS# 7732-18-5: Not listed as a carcinogen by ACGIH, IARC, NIOSH, NTP, OSHA, or CA Prop 65.
CAS# 1310-73-2: Not listed as a carcinogen by ACGIH, IARC, NIOSH, NTP, OSHA, or CA Prop 65.

Epidemiology:
No information found.
Teratogenicity:
No information found.
Reproductive:
No information found.
Mutagenicity:
No information found.
Neurotoxicity:
No information found.

Section 12 - Ecological Information

No information found.

Section 13 - Disposal Considerations

Dispose of in accordance with Federal, State, and local regulations.

Section 14 - Transport Information

	US DOT		
	< 0.5%	Between 0.5% and 2.0%	> 2.0%
Shipping Name:	Not regulated.	Sodium hydroxide solution	Sodium hydroxide solution
Hazard Class:		8	8
UN Number:		UN1824	UN1824
Packing Group:		PG III	PG II

Section 15 - Regulatory Information

US Federal

TSCA:
CAS# 7732-18-5 is listed on the TSCA Inventory.
CAS# 1310-73-2 is listed on the TSCA Inventory.
SARA Reportable Quantities (RQ):
CAS# 1310-73-2: final RQ = 1000 pounds (454 kg)
CERCLA/SARA Section 313:
None of the components are on this list.
OSHA - Highly Hazardous:
None of the components are on this list.

US State

State Right to Know:
Sodium hydroxide can be found on the following state Right-to-Know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

California Regulations:
None.

European/International Regulations

Canadian DSL/NDSL:
CAS# 7732-18-5 is listed on Canada's DSL List.
CAS# 1310-73-2 is listed on Canada's DSL List.

Canada Ingredient Disclosure List:
CAS# 7732-18-5 is not listed on Canada's Ingredient Disclosure List.
CAS# 1310-73-2 is listed on Canada's Ingredient Disclosure List.

Section 16 - Other Information

MSDS Creation Date: July 6, 1998
Revision Date: September 16, 2009

Information in this MSDS is from available published sources and is believed to be accurate. No warranty, express or implied, is made and LabChem Inc. assumes no liability resulting from the use of this MSDS. The user must determine suitability of this information for his application.

Material Safety Data Sheet
Sodium persulfate

MSDS# 88474

Section 1 - Chemical Product and Company Identification

MSDS Name:	Sodium persulfate
Catalog Numbers:	AC202020000, AC202020250, 20202-0010, 20202-0050, 20202-5000, BP2637-1, O6114-1, O6114-500
Synonyms:	Sodium peroxydisulfate; Disodium peroxodisulphate.
Company Identification:	Fisher Scientific One Reagent Lane Fair Lawn, NJ 07410
For information in the US, call:	201-796-7100
Emergency Number US:	201-796-7100
CHEMTREC Phone Number, US:	800-424-9300

Section 2 - Composition, Information on Ingredients

CAS#:	7775-27-1
Chemical Name:	Sodium persulfate
%:	>98
EINECS#:	231-892-1

Hazard Symbols: XN O

Risk Phrases: 22 42/43 8

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Danger! Strong oxidizer. Contact with other material may cause a fire. Hygroscopic (absorbs moisture from the air). May be harmful if swallowed. May cause allergic respiratory and skin reaction. Causes eye, skin, and respiratory tract irritation. Target Organs: Respiratory system, eyes, skin.

Potential Health Effects

Eye:	Causes eye irritation.
Skin:	Causes skin irritation. May cause skin sensitization, an allergic reaction, which becomes evident upon re-exposure to this material.
Ingestion:	May cause irritation of the digestive tract. May be harmful if swallowed.
Inhalation:	Causes respiratory tract irritation. May cause asthmatic attacks due to allergic sensitization of the respiratory tract.
Chronic:	Repeated or prolonged exposure may cause allergic reactions in sensitive individuals.

Section 4 - First Aid Measures

Eyes:	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical aid.
Skin:	In case of contact, immediately flush skin with soap and plenty of water. Remove contaminated clothing and shoes. Get medical aid if symptoms occur. Wash clothing before reuse.
Ingestion:	If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical aid.
	If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.

Inhalation: Get medical aid.

Notes to Physician:

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Strong oxidizer. Contact with other material may cause fire. Use water with caution and in flooding amounts. Decomposes at high temperatures, resulting in toxic and corrosive products.

Extinguishing Media: Deluge with water. Do not use carbon dioxide or other gas filled fire extinguishers; they will have no effect.

Autoignition Temperature: Not applicable.

Flash Point: Not applicable.

Explosion Limits: Lower: Not available

Explosion Limits: Upper: Not available

NFPA Rating: ; instability: OX

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks: Vacuum or sweep up material and place into a suitable disposal container. Avoid generating dusty conditions. Provide ventilation. Keep combustibles (wood, paper, oil, etc.,) away from spilled material.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Minimize dust generation and accumulation. Avoid contact with eyes, skin, and clothing. Keep container tightly closed. Keep from contact with clothing and other combustible materials. Do not breathe dust. Use only with adequate ventilation. Inform laundry personnel of contaminant's hazards. Do not take working clothes home.

Storage: Do not store near combustible materials. Keep container closed when not in use. Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances. Keep away from acids. Store protected from moisture. Avoid storage on wood floors.

Section 8 - Exposure Controls, Personal Protection

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Sodium persulfate	0.1 mg/m3 TWA (as Persulfate) (listed under Persulfates, inorganic, n.o.s.).	none listed	none listed

OSHA Vacated PELs: Sodium persulfate: None listed

Engineering Controls:

Use process enclosure, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits. Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower.

Exposure Limits

Personal Protective Equipment

Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin: Wear appropriate protective gloves to prevent skin exposure.

Clothing: Wear appropriate protective clothing to prevent skin exposure.

Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a

Respirators: NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Section 9 - Physical and Chemical Properties

Physical State:	Crystalline powder
Color:	white
Odor:	odorless
pH:	5-7 (1% soln)
Vapor Pressure:	Not available
Vapor Density:	Not available
Evaporation Rate:	Not available
Viscosity:	Not available
Boiling Point:	Not available
Freezing/Melting Point:	100 deg C (212.00°F)
Decomposition Temperature:	
Solubility in water:	Soluble
Specific Gravity/Density:	2.6
Molecular Formula:	Na2S2O8
Molecular Weight:	238.09

Section 10 - Stability and Reactivity

Chemical Stability:	Stable under normal temperatures and pressures.
Conditions to Avoid:	Dust generation, moisture, excess heat.
Incompatibilities with Other Materials	Strong reducing agents, acids, strong bases, alcohols, finely powdered metals, organic materials, halides, combustible materials.
Hazardous Decomposition Products	Oxides of sulfur, oxygen.
Hazardous Polymerization	Will not occur.

Section 11 - Toxicological Information

RTECS#:	CAS# 7775-27-1: SE0525000
LD50/LC50:	RTECS: Not available.
Carcinogenicity:	Sodium persulfate - Not listed as a carcinogen by ACGIH, IARC, NTP, or CA Prop 65.
Epidemiology:	The occurrence of frequent skin rashes, causing both irritant dermatitis & hypersensitivity reactions, was found in workers producing ammonium & potassium persulfates. The rashes were reduced by the use of protective clothing & gloves & improved dustremoval from the workplace air. Others reported asthma in hairdressers that was induced by exposure to persulfates.
Teratogenicity:	No information found
Reproductive:	No information found
Neurotoxicity:	No information found
Mutagenicity:	No information found
Other:	Not available

Section 12 - Ecological Information

Ecotoxicity:
Fish: Bluegill/Sunfish: 771mg/L; 96-hour; (FMC Study I92-1250)
Daphnia: Daphnia: 133mg/L; 48-hour; (FMC Study I92-1252)

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification. RCRA P-Series: None listed. RCRA U-Series: None listed.

Section 14 - Transport Information

US DOT
Shipping Name: SODIUM PERSULFATE
Hazard Class: 5.1

UN Number: UN1505
Packing Group: III
Canada TDG
Shipping Name: SODIUM PERSULFATE
Hazard Class: 5.1
UN Number: UN1505
Packing Group: III

Section 15 - Regulatory Information

US Federal

TSCA

CAS# 7775-27-1 is listed on the TSCA Inventory.

Health & Safety Reporting List	None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules	None of the chemicals in this product are under a Chemical Test Rule.
Section 12b	None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule	None of the chemicals in this material have a SNUR under TSCA.
CERCLA Hazardous Substances and corresponding RQs	None of the chemicals in this material have an RQ.
SARA Section 302 Extremely Hazardous Substances	None of the chemicals in this product have a TPQ.
SARA Codes	CAS # 7775-27-1: acute, chronic, flammable.
Section 313	No chemicals are reportable under Section 313.
Clean Air Act:	This material does not contain any hazardous air pollutants. This material does not contain any Class 1 Ozone depletors. This material does not contain any Class 2 Ozone depletors.
Clean Water Act:	None of the chemicals in this product are listed as Hazardous Substances under the CWA. None of the chemicals in this product are listed as Priority Pollutants under the CWA. None of the chemicals in this product are listed as Toxic Pollutants under the CWA.
OSHA:	
STATE	Sodium persulfate can be found on the following state right to know lists: New Jersey.
California Prop 65	
California No Significant Risk Level:	None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols: XN O

Risk Phrases:

R 22 Harmful if swallowed.

R 42/43 May cause sensitization by inhalation and skin contact.

R 8 Contact with combustible material may cause fire.

Safety Phrases:

S 8 Keep container dry.

S 17 Keep away from combustible material.

S 26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

WGK (Water Danger/Protection)

CAS# 7775-27-1: 1

Canada

CAS# 7775-27-1 is listed on Canada's DSL List

Canadian WHMIS Classifications: C, D2A, D2B

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.

CAS# 7775-27-1 is not listed on Canada's Ingredient Disclosure List.

Section 16 - Other Information

MSDS Creation Date: 12/12/1997

Revision #6 Date 6/29/2007

Appendix B

Quality Assurance Project Plan

Table of Contents

Table of Contents

List of Tables
(Following Text)

List of Attachments

Section 1.0 Introduction

This Quality Assurance Project Plan (QAPP) is Site-specific and has been prepared for the Remedial Design/Remedial Action (RD/RA) for the Von Roll USA, Inc. (VRI) Site, located north of West Campbell Road in the Town of Rotterdam, Schenectady County, New York.

The objectives of this QAPP are to provide data and documentation for the development and implementation of final plans and specifications for implementing the remedial alternative set forth in the New York State Department of Environmental Conservation (NYSDEC) March 2013 Record of Decision (ROD). This QAPP provides comprehensive information regarding the project personnel responsibilities, and sets forth specific procedures to be used during the analysis of soil and water samples.

Section 2.0 Project Background

A detailed description of the history and background information for the Site is presented in the RD/RA Work Plan, February 2014.

2.1 General

This QAPP provides quality assurance/quality control (QA/QC) criteria for work efforts associated with sample analyses of groundwater and soil. Methods for sample analyses have been selected to provide results which characterize the samples, such that the sampling objectives can be met.

Section 3.0 Project Organization and Responsibility

A brief description of the duties of the key project personnel is presented below.

<u>Project Manager – Jamie Puskas</u>

i) Provides day-to-day project management

ii) Provides managerial guidance to the QA/QC Officer - Sampling and Analytical Activities

iii) Prepares and reviews reports

iv) Conducts preliminary chemical data interpretation and assessment

v) Responsible for overall project completion in accordance with the approved design

QA/QC Officer - Sampling and Analytical Activities – Susan Scrocchi (see Attachment A for CV)

i) Determines laboratory data corrective action
ii) Performs analytical data validation and assessment
iii) Reviews laboratory QA/QC
iv) Assists in preparation and review of final report
v) Provides Oversees and reviews laboratory activities
vi) technical representation for analytical activities
vii) Provides managerial and technical guidance to the Field Sampling Supervisor

Field Sampling Supervisor - Brian Pickert

i) Provides immediate supervision of all on-Site activities
ii) Provides field management of sample collection and field QA/QC
iii) Provides technical representation for field activities
iv) Is responsible for maintenance of the field equipment

Laboratory - Project Manager, Analytical Contractor

i) Ensures resources of laboratory are available on an as-required basis
ii) Coordinates laboratory analyses
iii) Supervises laboratory's in-house Chain of Custody
iv) Schedules analyses of samples
v) Oversees review of data
vi) Oversees preparation of analytical reports
vii) Approves final analytical reports

Laboratory - QA/QC Officer, Analytical Contractor

i) Overviews laboratory QA/QC
ii) Overviews QA/QC documentation
iii) Conducts detailed data review
iv) Decides laboratory corrective actions, if required
v) Provides technical representation for laboratory QA/QC procedures

Laboratory - Sample Custodian - Analytical Contractor

i) Receives and inspects the sample containers

ii) Records the condition of the sample containers

iii) Signs appropriate documents

iv) Verifies Chain of Custody and their correctness

v) Notifies laboratory Project Manager and laboratory QA/QC Officer of sample receipt and inspection

vi) Assigns a unique laboratory identification number correlated to the field sample identification number, and enters each into the sample receiving log

vii) Initiates transfer of samples to the appropriate lab sections with assistance from the laboratory project manager

viii) Controls and monitors access to and storage of samples and extracts

The analytical laboratory selected to perform the environmental analyses will be performed by a New York State Department of Health (NYSDOH) approved laboratory. The laboratory will be certified under the National Environmental Laboratory Approval Program (NELAP) and the NYSDOH Environmental Laboratory Accreditation Program (ELAP) Contract Laboratory Protocol (CLP) Tier.

Section 4.0 Project Objectives

4.1 Quality Assurance Objectives for Measurement Data

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

Quality assurance measures for this project will begin with sample containers. Sample containers for waters will be purchased from a certified manufacturer and will be precleaned (I-Chem Series 200 or equivalent).

4.2 Laboratory Quality Assurance

The following subsections define the QA goals required to meet the Data Quality Objectives (DQOs) of the project.

4.2.1 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. Analytical methods and targeted detection limits listed have been specified to meet the groundwater quality standards.

A summary of the targeted detection limits is provided in Table B.4.2. It should be noted that these limits are targeted detection limits only; limits are highly matrix dependent and may not always be achieved.

The method accuracy (percent recovery) will be determined by spiking selected samples (matrix spikes) with the method recommended spiking compounds. Accuracy will be reported as the percent recovery of the spiking compound(s) and will compare with the criteria given in the appropriate methods, as identified in Section 7.0.

The method(s) precision (reproducibility between duplicate analyses) will be determined based on the duplicate analysis of matrix spike samples for organic parameters and duplicate sample analyses for inorganic parameters. Precision will be reported as Relative Percent Differences (RPDs) between duplicate analyses; acceptance criteria will be as specified in the appropriate methods identified in Section 7.0.

4.2.2 Completeness, Representativeness and Comparability

A completeness requirement of 90 percent will be targeted for the program (see Section 13.1.3 for definition of completeness).

The quantity of samples to be collected has been estimated in an effort to effectively represent the population being studied. A summary of the sampling and analysis programs is presented in Table B.4.1.

Section 5.0 Sampling Procedures

The sample collection procedures are described in the RD/RA Field Sampling Plan, February 2014.

The sample container, preservation, shipping, and packaging requirements are identified in Table B.5.1 and Section 6.3.

Section 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. Recordkeeping documentation will include use of the following:

i) Field logbooks (bound with numbered pages) to document sampling activities in the field

ii) Labels to identify individual samples

iii) Chain of Custody record sheet to document analyses to be performed

iv) Laboratory sample custody logbook

6.1 Field Logbook

The field team may use bound notebooks, sample collection logs, or electronic journals to record daily logs, sampling events, and field observations. Regardless of the media, entries should be dated and signed (or initialed) by the person making the entry. Entries on paper should be made with waterproof ink. The type of information to be recorded in the field includes:

i) Date

ii) Time

iii) Field calibrations performed during the sampling

iv) Location and Sample ID

v) Pertinent health and safety concerns

vi) Up/downgradient or clean/contaminated designation

vii) Physical condition of well

viii) Depth of well (both installed and measured)

ix) Weather conditions (temperature, cloud cover, humidity, wind, etc.)

x) Sample crew and/or Agency names

xi) Work progress

xii) Measuring point elevation

xiii) Depth to water

xiv) Purge volume

xv) Purge time (start/stop)

xvi) Recharge time

xvii) Time of sample collection

xviii) Important field observations regarding purge or sample water or conditions related to sample integrity

xix) QA/QC samples

xx) Name of laboratory(ies) performing analysis

xxi) Delays

xxii) Comments (e.g., unusual situations, well damage, departure from established QA/QC field procedures, instrument problems, accidents, etc.)

6.2 Sample Numbering

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

Example:	GW-081007 – AA – LLL - XXX
Where:	GW - Designates sample type (GW=Groundwater) (S=Soil) (SE=Sediment)
081007:	Date of collection (mm/dd/yy)
AA:	Sampler initials
LLL:	Location ID
XXX:	Unique sample number

QC samples will also be numbered with a unique well ID, with the exception of matrix spikes and matrix spike duplicates.

Sample labels shall be affixed to each sample container (not the caps). The labels shall be completed in waterproof ink. All labels (except weatherproof labels) should be taped to the sample containers with clear package sealing tape. The labels will include the following information:

i) Sample number/identification code

ii) Name/initials of sampler

iii) Date and time of sample collection

iv) Site name

v) Project number

vi) Required analysis

vii) Type of preservation (if applicable)

6.3 Chain of Custody Records

Chain of Custody forms will be completed for all samples collected during the program.

The Chain of Custody form will document the transfer of sample containers. Custody seals will be placed on each cooler. The cooler will then be sealed with packing tape. Sample container labels will include sample number, place of collection and date and time of collection. All samples will be refrigerated using wet ice at 4°C (±2°C) and delivered to the analytical laboratory within 24 to 48 hours of collection. All samples will be delivered to the laboratory by commercial courier or Contractor personnel. All samples will be stored at 4°C (±2°C) at the laboratory.

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.

Each sample cooler being shipped to the laboratory will contain a Chain of Custody form. The Chain of Custody form will consist of two originals which will be distributed as follows:

i) The shipper will maintain one original while the other will be enclosed in a waterproof envelop within the cooler with the samples

ii) The cooler will then be sealed properly for shipment

iii) The laboratory, upon receiving the samples, will complete the original and make copies

iv) The laboratory will maintain a copy for their records

v) One copy will be returned to the Laboratory QA/QC Officer upon receipt of the samples by the laboratory

vi) The laboratory original will be returned to the Data Management Consultant with the data deliverables package

6.4 Sample Documentation in the Laboratory

Upon receipt of the cooler at the laboratory, the shipping cooler and the custody seal will be inspected by the 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 Laboratory Project Manager and Laboratory QA/QC Officer before samples are processed.

Each sample or group of samples shipped to the laboratory for analysis will be given a unique identification number. The Sample Custodian will record the client name, number of samples and date of receipt of samples in the Sample Control Logbook. Samples removed from storage for analyses will be documented in the Sample Control Logbook.

The laboratory will be responsible for maintaining analytical logbooks and laboratory data as well as a sample (on hand) inventory for submittal to Glenn Springs Holdings, Inc. (GSHI) 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 GSHI will advise the laboratory regarding the need for additional storage.

6.5 Storage of Samples

After the Sample Custodian has completed the Chain of Custody forms and the incoming sample log, the Chain of Custody will be checked to ensure that all samples are stored in the appropriate locations. All samples will be stored within an access controlled custody room and will be maintained at 4°C (±2°C) until all analytical work is complete.

Section 7.0 Analytical Procedures for Chemical Analyses

Samples collected for laboratory chemical analyses will be analyzed for the parameters listed in Tables B.4.2 and B.4.3, using the methods cited in Table B.4.1. These methods have been selected to meet the DQOs for each sampling activity.

Data deliverables for this program will include final results for the investigative samples and corresponding QC parameters as specified in Section 9.2.

All sample results will be calculated using external standards with the exception of the samples analyzed by gas chromatograph/mass spectrometer (GC/MS); these methods employ the use of internal standards or isotopic dilution for analyte quantitation. The specific procedures for target analyte quantitation are detailed in the appropriate analytical methods.

Section 8.0 Calibration Procedures and Frequency

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 the activities associated with QA monitoring and repairs program will be recorded. These records will be checked during periodic equipment review and internal and external QA/QC audits.

8.1 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 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. All method-specified calibration criteria must be met prior to sample analyses. All calibrations must be performed using either average response factors or first-order linear regression (with a correlation coefficient requirement of $\geq$0.995). Higher order fits will not be allowed.

8.2 High Resolution Gas Chromatography/High Resolution Mass Spectrometry (HRGC/HRMS)

All calibration and quantitation will be in accordance with the cited method.

8.3 Gas Chromatography (GC)

Quantification of samples that are analyzed by GC/MS with element selective detectors shall 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 must be met prior to sample analyses. All calibrations must be performed using either average response factors or first-order linear regression (with a correlation coefficient requirement of $\geq$0.995). Higher order fits will not be allowed.

8.4 Instrumentation for Inorganic Analyses

Inductively coupled argon plasma (ICAP) instrumentation, including inductively coupled plasma/mass spectrometer (ICP/MS), will be calibrated using a minimum of a blank and one standard. Mercury and cyanide instrumentation will be calibrated using a blank and a minimum of three calibration standards (four for mercury), with a correlation coefficient requirement of $\geq$0.995. All remaining method-specified calibration procedures will be performed and acceptance criteria will be met prior to sample analyses.

Section 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/QC Officer. The Laboratory QA/QC 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 relevant 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:

i) Raw data produced and checked by the responsible analysts is turned over for independent review by another analyst

ii) The area supervisor reviews the data for attainment of quality control criteria presented in the referenced analytical methods

iii) Upon completion of all reviews and acceptance of the raw data by the laboratory operations manager, a computerized report will be generated and sent to the Laboratory QA/QC Officer

iv) The Laboratory QA/QC Officer will complete a thorough inspection of all reports

v) The Laboratory QA/QC Officer and area supervisor will decide whether any sample reanalysis is required

vi) Upon acceptance of the preliminary reports by the Laboratory QA/QC Officer, final reports will be generated and signed by the Laboratory Project Manager

Validation of the analytical data will be performed by the QA/QC Officer - Sampling and Analytical Activities. The data validation will be performed in accordance with the following documents: "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review", United States Environmental Protection Agency (USEPA) 540/R-99/008, October 1999; and "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review", USEPA 540-R-04-004, October 2004.

Assessment of analytical data will include the following checks:

1. Ensure that the data package is complete
2. Check all holding times against the requirements in Table B.5.1
3. Check all QC data fall within the required limits and specifications
4. Confirm that the proper methods were utilized
5. Compare raw data to summary sheets
6. Confirm the proper data qualifiers were used

The results of the data verification/validation will be provided in a Data Usability Summary Report (DUSR) that is provided to CRA's Project Manager and included in the final investigation report.

Raw 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.

9.2 Laboratory Reporting, Data, Presentation and Final Report

Reporting and deliverables for the volatile organic analyses shall include, but not be limited to, all items listed in Table B.9.1.
All sample data and corresponding QA/QC data as specified in the analytical methods, shall be maintained accessible either in hard copy or on magnetic tape or disk (computer data files).

The laboratory will submit one copy of the final analytical report within 14 calendar days of receipt of the final sample included in the sample delivery group (SDG). An electronic copy of the results and QC in EQuIS format will also be required with the hard copy.

9.3 Document Control System

A document control system ensures that all documents are accounted for when the project is complete.

A project number will be assigned to the project. This number will appear on sample identification tags, logbooks, data sheets, control charts, project memos and analytical reports, document control logs, corrective action forms and logs, QA plans, and other project analytical records.

9.4 QC Check Points and Data Flow

The following specific QC check points will be common to all metals, GC, and GC/MS analyses. They are presented with the decision points.

Chemist - bench level checks:

- Systems check: sensitivity, linearity, and reproducibility within specified limits
- Duplicate analyses within control limits
- Matrix spike results within control limits
- Surrogate spike results within control limits (organics only)
- Calculation/data reduction checks: calculations cross-checked, any discrepancies between forms and results evident, results tabulated sequentially on the correct forms

Laboratory Project Manager:

- Systems operating within limits
- Data transcription correct
- Data complete
- Data acceptable

Sample Control:

- Samples returned to sample control following analysis

Laboratory QA/QC Officer:

- QA objectives met;
- QC checks are completed; and
- Final data and report package is complete.

Section 10.0 Internal Quality Control Checks and Frequency

10.1 QC for Laboratory Analyses

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

10.1.1 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.

10.1.2 Matrix Spike/Matrix Spike Duplicate (MS/MSD)/ Analyses

An MS/MSD sample will be analyzed for organic parameters and a duplicate and MS will be analyzed for inorganic parameters at a minimum frequency of one per analytical batch. Acceptable criteria and analytes that will be used for MS are identified in the methods. Where method specified limits were not available, general control limits were used. Percent spike recoveries will be used to evaluate analytical accuracy while percent relative standard deviation or the RPD between duplicate analyses will be used to assess analytical precision.

10.1.3 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 must fall within the control limits specified in the methods. If surrogate recoveries are excessively low (<10 percent), the laboratory will contact the QA/QC Officer-Sampling and Analytical Activities for further instructions. Dilution of samples to bring the analyte concentration into the linear range of calibration may dilute the surrogates out of the quantification 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 QC for Field Sampling

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.

10.2.1 Field (Rinse) Blanks

When well-dedicated equipment is not used and/or on the first sampling event in which non-certified clean equipment is used, field blanks will be used during the sampling programs to detect contamination introduced through sample collection procedures and equipment, external field conditions, sample transport, sample container preparation, sample storage, and/or the analytical process.

10.2.2 Trip Blanks

Trip blanks for volatile analyses will be prepared by the laboratory using analyte-free water and submitted with the sample collection containers. Trip blanks will be kept unopened in the field with sample bottles. Two trip blanks will be transported to the laboratory on a daily basis with each batch of aqueous volatile samples. The laboratory will analyze trip blanks as samples.

10.2.3 Field Duplicate Samples

Field duplicate samples will be collected and used to assess the aggregate precision of sampling techniques and laboratory analysis. For every 20 investigative samples, a field duplicate sample will be collected using standard sampling procedures. This duplicate will be packed and shipped to the laboratory for analysis.

Section 11.0 Performance and System Audits

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.

The QA/QC Officer-Sampling and Analytical Activities 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 all systems are operational, during the program, or after completion of the program. Such audits typically involve a comparison of the activities given in the 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 QA/QC Officer-Sampling and Analytical Activities 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.

Section 12.0 Preventative Maintenance

This section applies to both field and laboratory equipment. Specific preventive maintenance procedures for field equipment will be consistent with the manufacturer's guidelines. Specific preventive maintenance protocols for laboratory equipment will be consistent with the contract laboratory's Standard Operating Procedures (SOPs).

All 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.

Routine maintenance of the instruments will be performed as per manufacturers' recommendations. The Laboratory Project Manager is responsible for the preventive maintenance of the instruments.

Section 13.0 Specific Routine Procedures Uses 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 analyses. Precision as percent relative difference will be calculated as follows for values significantly greater than the associated detection limit:

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

- D_1 = matrix spike recovery
- D_2 = matrix spike duplicate spike recovery

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

Precision = Original result - duplicate result <CRDL[1]

[1] CRDL - Contract Required Detection Limit.

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

In some cases, MS and/or MSD recoveries may not be available due to elevated levels of the spiked analyte in the investigative sample. In such cases, accuracy will be assessed based on surrogate spike recoveries and/or laboratory control samples.

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 must contain all QC check analyses verifying precision and accuracy for the analytical protocol. In addition, all 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:

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

13.1.4 Outliers

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.

Section 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 actions system will be:

i) Checking the predetermined limits for data acceptability beyond which corrective action is required

ii) Identifying and defining problems

iii) Assigning responsibility for investigating the problem

iv) Investigating and determining the cause of the problem

v) Determination of a corrective action to eliminate the problem (this may include reanalysis or resampling and analyses)

vi) Assigning and accepting responsibility for implementing the corrective action

vii) Implementing the corrective action and evaluating the effectiveness

viii) Verifying that the corrective action has eliminated the problem

ix) Documenting the corrective action taken

For each measurement system, the laboratory QA/QC Officer will be responsible for initiating the corrective action and the Laboratory Project Manager will be responsible for implementing the corrective action.

Section 15.0 Quality Assurance Reports

Final reports will contain a discussion on QA/QC summarizing the quality of the data collected and/or used as appropriate for each phase of the project. The Project Manager who has responsibility for these summaries, will rely on written reports/memoranda documenting the data assessment activities, performance and systems audits and footnotes identifying qualifications to the data, if any.

Each summary of sampling activities will include a tabulation of the data including:

i) Field blank and field duplicate sample results

ii) Maps showing well locations

iii) An explanation of any sampling conditions or quality assurance problems and their effect on data quality

A DUSR will be prepared by the QA/QC Officer - Sampling and Analytical Activities following receipt of all analytical data. These reports will include discussions of the following and their effects on the quality of the data reported:

i) Sample holding times

ii) Laboratory/reagent blank data

iii) Surrogate spike, MS and MSD data

iv) Field QA/QC data

v) Pertinent instrument performance per method protocols

vi) Audit results (if performed)

In addition, the DUSR will summarize all QA problems, and give a general assessment of QA results versus control criteria for such parameters as accuracy, precision, etc.

The QA reports will be forwarded to the Project Manager.

TABLE B4.1

SAMPLING AND ANALYSIS SUMMARY
QUALITY ASSURANCE PROJECT PLAN
VRI SITE
TOWN OF SCHENECTADY, NEW YORK

Sample Matrix	*Analytical Parameters*	*Analytical Method 1*	*Investigative Samples*	*Field Duplicates*	*Field Blanks*	*Trip Blanks*	*MS/MSD*
Groundwater	TCL Volatiles plus selected volatiles *	SW-846 8260	TBD	1/20	1/Day	1/Day	1/20
	TCLP VOCs	SW-846 1311/8260	TBD	1/20	1/Day	1/Day	1/20
Soil	TCL Volatiles plus selected volatiles *	SW-846 8260	TBD	1/20	1/Day	1/Day	1/20
	TCLP VOCs	SW-846 1311/8260	TBD	1/20	1/Day	1/Day	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.

TCL Target Compound List.

- Not applicable.

* Selected volatiles: 1,2,3-trichloropropane, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, and n-propylbenzene

TABLE B4.2

ORGANIC COMPOUND LIST AND PRACTICAL QUANTITATION LIMIT (PQL)
QUALITY ASSURANCE PROJECT PLAN
VRI SITE
TOWN OF SCHENECTADY, NEW YORK

		Quantitation limits	
	CAS Number	*Water (µg/L)*	*Soil/Sediment (µg/Kg)*
TCL Volatiles plus selected volatiles			
1,1,1-Trichloroethane	71-55-6	1.0	10
1,1,2,2-Tetrachloroethane	79-34-5	1.0	10
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1.0	10
1,1,2-Trichloroethane	79-00-5	1.0	10
1,1-Dichloroethane	75-34-3	1.0	10
1,1-Dichloroethylene	75-35-4	1.0	10
1,2,3-Trichloropropane	96-18-4	1.0	10
1,2,4-Trichlorobenzene	120-82-1	1.0	10
1,2,4-Trimethylbenzene	95-63-6	1.0	10
1,2-Dibromo-3-chloropropane	96-12-8	1.0	10
1,2-Dibromoethane	106-93-4	1.0	10
1,2-Dichloroethane	107-06-2	1.0	10
1,2-Dichloropropane	78-87-5	1.0	10
1,3,5-Trimethylbenzene	108-67-8	1.0	10
2-Butanone	78-93-3	5.0	10
2-Hexanone	591-78-6	5.0	10
4-Methyl-2-pentanone	108-10-1	5.0	10
Acetone	67-64-1	5.0	10
Benzene	71-43-2	1.0	10
Bromodichloromethane	75-27-4	1.0	10
Bromoform	75-25-2	1.0	10
Bromomethane	74-83-9	1.0	10
Carbon disulfide	75-15-0	1.0	10
Carbon tetrachloride	56-23-5	1.0	10
Chlorobenzene	108-90-7	1.0	10
Chloroethane	75-00-3	1.0	10
Chloroform	67-66-3	1.0	10
Chloromethane	74-87-3	1.0	10
cis-1,2-Dichloroethene	156-59-2	1.0	10
cis-1,3-Dichloropropene	10061-01-5	1.0	10
Cyclohexane	110-82-7	1.0	10
Dibromochloromethane	124-48-1	1.0	10
Dichlorodifluoromethane	75-71-8	1.0	10
Ethylbenzene	100-41-4	1.0	10
Isopropylbenzene	98-82-8	1.0	10
m-Dichlorobenzene	541-73-1	1.0	10
Methyl Acetate	79-20-9	1.0	10
Methyl tert-Butyl Ether	1634-04-4	1.0	10
Methylcyclohexane	108-87-2	1.0	10
Methylene chloride	75-09-2	1.0	10
n-Propylbenzene	103-65-1	1.0	10
o-Dichlorobenzene	95-50-1	1.0	10
p-Dichlorobenzene	106-46-7	1.0	10
Styrene	100-42-5	1.0	10
Tetrachloroethylene	127-18-4	1.0	10
Toluene	108-88-3	1.0	10
trans-1,2-Dichloroethylene	156-60-5	1.0	10
trans-1,3-Dichloropropene	10061-02-6	1.0	10
Trichloroethylene	79-01-6	1.0	10
Trichlorofluoromethane	75-69-4	1.0	10
Vinyl chloride	75-01-4	1.0	10
Xylene(total)	1330-20-7	3.0	10

Notes:

TCL Target Compound List

TABLE B4.3

WASTE CHARACTERIZATION AND REGULATORY LIMITS
QUALITY ASSURANCE PROJECT PLAN
VRI SITE
TOWN OF SCHENECTADY, NEW YORK

TCLP Volatiles	***Regulatory Limits***	***Units***
Vinyl chloride	0.2	mg/L
1,1-Dichloroethene	0.7	mg/L
Chloroform	6.0	mg/L
1,2-Dichloroethane	0.5	mg/L
2-Butanone	200	mg/L
Carbon Tetrachloride	0.5	mg/L
Trichloroethene	0.5	mg/L
Benzene	0.5	mg/L
Tetrachloroethene	0.7	mg/L
Chlorobenzene	100	mg/L

Notes:

TCLP Toxicity Characterization Leaching Procedure

TABLE B5.1

SAMPLE CONTAINER, PRESERVATION, AND HOLDING TIME PERIODS
REMEDIAL DESIGN/REMEDIAL ACTION
VRI SITE
TOWN OF SCHENECTADY, NEW YORK

Analyses	*Sample Containers*	*Preservation*	*Maximum Holding Time*	*Notes*
Groundwater				
VOCs	Three 40 mL glass vials Teflon-lined septum	Cool 4°C pH<2 HCl	10 days from receipt to analysis	Fill completely with no head space
TCLP VOCS	Three 40 mL glass vials Teflon-lined septum	Cool 4°C	7 days from collection to leaching 7 days from leaching to analysis	Fill completely with no head space
Soil				
VOCs	3 Terracores (or equiv) 1-2oz jar (for dry wt)	Cool 4°C	48 hrs from collection to preservation 10 days from receipt to analysis	Fill per directions
TCLP VOCS	1-2oz jar	Cool 4°C	7 days from collection to leaching 7 days from leaching to analysis	Fill completely with no head space

Notes:

- Not applicable.
TCLP Toxicity Characteristic Leaching Procedure.
VOC Volatile Organic Compounds.

TABLE B9.1

LABORATORY REPORTING DELIVERABLES - FULL
REMEDIAL DESIGN/REMEDIAL ACTION
VRI SITE
TOWN OF SCHENECTADY, 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. Data (including all raw data and CLP-like summary forms)
   1. samples
   2. laboratory duplicates [(2)]
   3. method blanks
   4. spikes, spike duplicates [(2) (3)]
   5. surrogate recoveries [(2)]
   6. internal standard recoveries
   7. calibration
   8. any other applicable quality control (QC) data (e.g., serial dilution)
   9. 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. standard preparation logs
   5. 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.

(4) Tentatively Identified Compounds (TICs).

Attachment A

Curriculum Vitae For QA/QC Officer

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

Appendix C

Field Sampling Plan

Table of Contents

List of Attachments

Section 1.0 Introduction

This appendix presents the Field Sampling Plan (FSP) for the Remedial Design/ Remedial Action (RD/RA) Work Plan for the Von Roll USA, Inc. (VRI) Site located north of West Campbell Road in the Town of Rotterdam, Schenectady County, New York (Site). This report outlines the protocols which will be followed during the following activities:

- Sampling of groundwater monitoring wells
- Equipment cleaning
- Waste handling

Section 2.0 General Sampling Protocols

The following general sampling procedures will be conducted for all sampling activities presented in this FSP.

1) Prior to sampling at each location, all sampling instruments and equipment will be cleaned in accordance with the protocols presented in Section 4.0.
2) Disposable gloves will be worn by samplers and changed between sampling points. Additional glove changes will be undertaken as necessary.
3) All sampling generated wastes such as gloves, tyveks, etc., will be collected and consolidated with the waste material for proper disposal.
4) Samples will be labeled noting the location and/or interval, analysis required, preservative added, date, time, and sampler's initials. A hardcover bound field book will be maintained to record all samples and sampling events. Details regarding recordkeeping and labeling are presented in the QAPP (Appendix B).
5) Sample containers will be packed loosely in laboratory-supplied coolers to allow for placement of cushioning materials (i.e., vermiculite) between bottles to prevent breakage.
6) Following packing of the sample cooler, the completed chain-of-custody (see Section 5.0) will be placed in a watertight plastic bag and attached to the inside of the cooler lid.
7) A signed custody seal will be placed across the cooler closure and the cooler will then be sealed with packing tape. The packing tape will not completely cover the seal.
8) Samples will be handled and shipped in accordance with the protocols described in the QAPP.
9) All samples will be delivered to the laboratory via an overnight courier.
10) At the laboratory, all samples will be stored at 4°C (±2°C).

Section 3.0 Monitoring Well Sampling

3.1 Water Level Measurements

Water level measurements will be taken prior to well development, purging, and sampling.

Prior to measuring water levels, a survey mark will be placed on the riser pipe for use as a measuring point and the elevation of this measuring point will be surveyed to an accuracy of 0.01 feet.

The water levels will be obtained by measuring the distance from the top of the well riser to the top of the water column using an electronic water level meter. Measurements will be obtained to ±0.01-foot accuracy.

Water level measurements taken for the determination of groundwater flow direction and hydraulic gradient will be measured within a 24-hour period for all wells. Water levels will be allowed to stabilize for a minimum of 24 hours after well construction and development, prior to measurement. Recovery may take longer for low yield wells.

Water level measuring equipment that comes in contact with well water will be cleaned in accordance with Section 4.0 to ensure that cross-contamination does not occur.

3.2 Monitoring Well Purging and Groundwater Sampling

Groundwater sampling will be conducted using low-flow purge and sampling methods as described in EPA/540/S-95/504, dated April 1996 (see Attachment C-1 to this Appendix). 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.

All monitoring wells will be sampled, and groundwater samples will be analyzed for TCL VOCs and Non-Standard VOCs using Method 8260.

Section 4.0 Sampling Equipment Cleaning

Prior to mobilization of the drill rig it shall be thoroughly cleaned to remove oil, grease, mud, and other foreign matter. Subsequently, before initiating drilling at each borehole, samplers, drill steel, and associated equipment will be cleaned to prevent cross-contamination from the previous drilling location. All cleaning will be conducted at the on-Site decontamination pad. Cleaning will be accomplished by flushing and wiping the components to remove all visible sediments followed by

thorough high pressure water wash. Special attention will be given to the threaded sections of the drill rods and the soil samples.

Reusable sampling equipment will be cleaned between sampling events 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.

Section 5.0 Chain of Custody

Samples will remain under the control of the sampling personnel in the field until relinquished to the delivery firm or directly to the laboratory. Chain-of-custody documents will be completed for each cooler. The original and two copies will be placed within the cooler. The fourth copy will be retained by the sampler. In addition, Field Sampling Data Sheets and a sample log of samples collected and shipped off Site will be maintained on Site. A sample chain-of-custody is presented in Attachment C-2.

Section 6.0 Waste Handling

All soil cuttings and purge/development water brought to the surface will be collected in 55-gallon DOT-approved drums and transferred to an on-Site interim drum staging area. Any borehole fluid will also be contained, collected, and transferred to an on-Site 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.

Attachment C-1

Low-Flow (Minimum Drawdown)
Groundwater Sampling Procedures EPA/540/S-95/504, April 1996

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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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-water 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 mentioned 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.

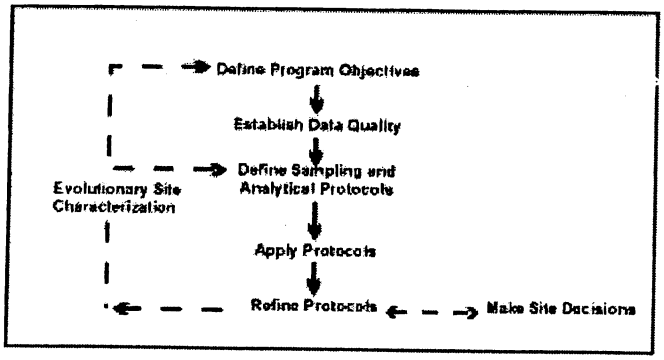

Figure 1. Evolutionary Site Characterization Model

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. Dependent 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 <u>any</u> 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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VIII. References

Backhus, D,A., J.N. Ryan, D.M. Groher, J.K. McFarlane, and P.M. Gschwend. 1993. Sampling Colloids and Colloid-Associated Contaminants in Ground Water. *Ground Water*, 31(3):466-479.

Barcelona, M.J., J.A. Helfrich, E.E. Garske, and J.P. Gibb. 1984. A laboratory evaluation of groundwater sampling mechanisms. *Ground Water Monitoring Review*, 4(2):32-41.

Barcelona, M.J. and J.A. Helfrich. 1986. Well construction and purging effects on ground-water samples. *Environ. Sci. Technol.*, 20(11):1179-1184.

Barcelona, M.J., H.A. Wehrmann, and M.D. Varljen. 1994. Reproducible well purging procedures and VOC stabilization criteria for ground-water sampling. *Ground Water*, 32(1):12-22.

Buddemeier, R.W. and J.R. Hunt. 1988. Transport of Colloidal Contaminants in Ground Water: Radionuclide Migration at the Nevada Test Site. *Applied Geochemistry*, 3: 535-548.

Danielsson, L.G. 1982. On the Use of Filters for Distinguishing Between Dissolved and Particulate Fractions in Natural Waters. *Water Research*, 16:179.

Enfield, C.G. and G. Bengtsson. 1988. Macromolecular Transport of Hydrophobic Contaminants in Aqueous Environments. *Ground Water*, 26(1): 64-70.

Gschwend, P.M. and M.D. Reynolds. 1987. Monodisperse Ferrous Phosphate Colloids in an Anoxic Groundwater Plume, *J. of Contaminant Hydrol.*, 1: 309-327.

Herzog, B., J. Pennino, and G. Nielsen. 1991. Ground-Water Sampling. In **Practical Handbook of Ground-Water Monitoring** (D.M. Nielsen, ed.). Lewis Publ., Chelsea, MI, pp. 449-499.

Horowitz, A.J., K.A. Elrick, and M.R. Colberg. 1992. The effect of membrane filtration artifacts on dissolved trace element concentrations. *Water Res.*, 26(6):753-763.

Laxen, D.P.H. and I.M. Chandler. 1982. Comparison of Filtration Techniques for Size Distribution in Freshwaters. *Analytical Chemistry*, 54(8):1350.

McCarthy, J.F. and J.M. Zachara. 1989. Subsurface Transport of Contaminants, *Environ. Sci. Technol.*, 5(23):496-502.

McCarthy, J.F. and C. Degueldre. 1993. Sampling and Characterization of Colloids and Ground Water for Studying Their Role in Contaminant Transport. In: Environmental Particles (J. Buffle and H.P. van Leeuwen, eds.), Lewis Publ., Chelsea, MI, pp. 247-315.

Parker, L.V. 1994. The Effects of Ground Water Sampling Devices on Water Quality: A Literature Review. *Ground Water Monitoring and Remediation*, 14(2):130-141.

Penrose, W.R., W.L. Polzer, E.H. Essington, D.M. Nelson, and K.A. Orlandini. 1990. Mobility of Plutonium and Americium through a Shallow Aquifer in a Semiarid Region, *Environ. Sci. Technol.*, 24:228-234.

Puls, R.W. and M.J. Barcelona. 1989. Filtration of Ground Water Samples for Metals Analyses. *Hazardous Waste and Hazardous Materials*, 6(4):385-393.

Puls, R.W., J.H. Eychaner, and R.M. Powell. 1990. Colloidal-Facilitated Transport of Inorganic Contaminants in Ground Water: Part I. Sampling Considerations. EPA/600/M-90/023, NTIS PB 91-168419.

Puls, R.W. 1990. Colloidal Considerations in Groundwater Sampling and Contaminant Transport Predictions. *Nuclear Safety*, 31(1):58-65.

Puls, R.W. and R.M. Powell. 1992. Acquisition of Representative Ground Water Quality Samples for Metals. *Ground Water Monitoring Review*, 12(3):167-176.

Puls, R.W., D.A. Clark, B.Bledsoe, R.M. Powell, and C.J. Paul. 1992. Metals in Ground Water: Sampling Artifacts and Reproducibility. *Hazardous Waste and Hazardous Materials*, 9(2): 149-162.

Puls, R.W. and C.J. Paul. 1995. Low-Flow Purging and Sampling of Ground-Water Monitoring Wells with Dedicated Systems. *Ground Water Monitoring and Remediation*, 15(1):116-123.

Ryan, J.N. and P.M. Gschwend. 1990. Colloid Mobilization in Two Atlantic Coastal Plain Aquifers. *Water Resour. Res.*, 26: 307-322.

Thurnblad, T. 1994. Ground Water Sampling Guidance: Development of Sampling Plans, Sampling Protocols, and Sampling Reports. Minnesota Pollution Control Agency.

U. S. EPA. 1992. RCRA Ground-Water Monitoring: Draft Technical Guidance. Office of Solid Waste, Washington, DC EPA/530/R-93/001, NTIS PB 93-139350.

U. S. EPA. 1995. Ground Water Sampling Workshop – A Workshop Summary, Dallas, TX, November 30 - December 2, 1993. EPA/600/R-94/205, NTIS PB 95-193249, 126 pp.

U. S. EPA. 1982. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA SW-846. Office of Solid Waste and Emergency Response, Washington, D.C.

Attachment C-2

Field Forms

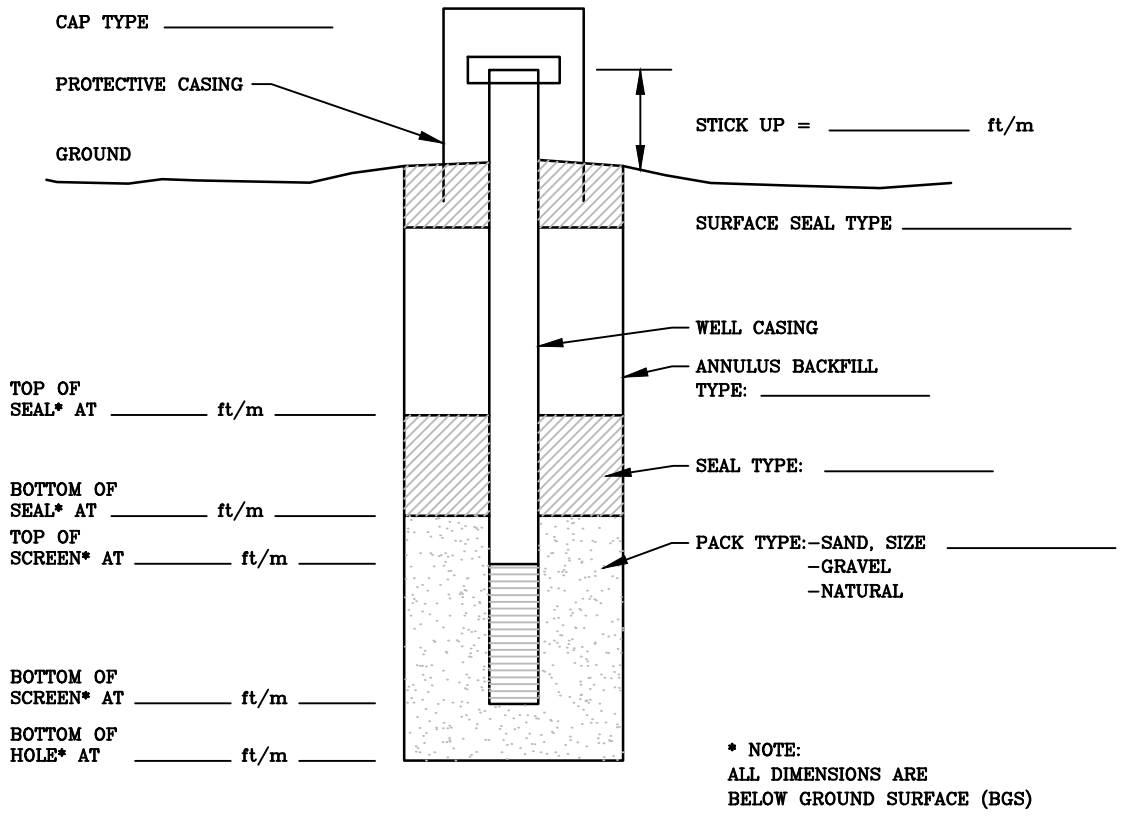
OVERBURDEN INSTRUMENTATION LOG

PROJECT NAME _____ HOLE DESIGNATION _____

PROJECT NUMBER _____ DATE COMPLETED _____

CLIENT _____ DRILLING METHOD _____

LOCATION _____ CRA SUPERVISOR _____



SCREEN TYPE: ☐ continuous slot ☐ perforated ☐ louvre ☐ other: _____

SCREEN MATERIAL: ☐ stainless steel ☐ plastic ☐ other: _____

SCREEN LENGTH: _____ ft/m SCREEN DIAMETER: _____ in/cm SCREEN SLOT SIZE: _____

WELL CASING MATERIAL: _____ WELL CASING DIAMETER: _____ in/cm

HOLE DIAMETER: _____

DEVELOPMENT: METHOD: _____ DURATION: _____

CRA

WELL DEVELOPMENT AND STABILIZATION FORM

PROJECT NAME: _____ **PROJECT NO.:** _____

DATE OF WELL DEVELOPMENT: _____

DEVELOPMENT CREW MEMBERS: _____

PURGING METHOD: _____

SAMPLE NO.: _____

SAMPLE TIME: _____

WELL INFORMATION

WELL NUMBER: _____

WELL TYPE (diameter/material) _____

MEASURING POINT ELEVATION: _____

STATIC WATER DEPTH: _____ **ELEVATION:** _____

BOTTOM DEPTH: _____ **ELEVATION:** _____

WATER COLUMN LENGTH: _____

SCREENED INTERVAL: _____

WELL VOLUME:

Note: For 1-inch diameter well: 1 foot = 0.04 US gallons
1 meter = 0.5 liters
For 2-inch diameter well: 1 foot = 0.16 US gallons
1 meter = 2 liters
For 4-inch diameter well: 1 foot = 0.70 US gallons
1 meter = 8.2 liters

UNITS	*1*	*2*	*3*	*4*	*5*	*TOTAL/ AVERAGE*
VOLUME PURGED (volume/total volume):						
FIELD pH:						
FIELD TEMPERATURE:						
FIELD CONDUCTIVITY:						
CLARITY/TURBIDITY VALUES:						
COLOR:						
ODOR:						
COMMENTS:						

COPIES TO: _____

SAMPLE COLLECTION DATA SHEET - GROUNDWATER SAMPLING PROGRAM

PROJECT NAME _____ PROJECT NO. _____

SAMPLING CREW MEMBERS _____ SUPERVISOR _____

DATE OF SAMPLE COLLECTION _____

[Note: For 2" dia. well, 1 ft. = 0.14 gal (imp) or 0.16 gal (us)]

Sample I.D. Number	Well Number	Measuring Point Elev. (ft. AMSL)	Bottom Depth (ft. btoc)	Water Depth (ft. btoc)	Water Elevation (ft. AMSL)	Well Volume (gallons)	Bailer Volume No. Bails	Volume Purged (gallons)	Field pH	Field Temp.	Field Cond.	Time	Sample Description & Analysis

Additional Comments: _____

Copies to: _____

CRA

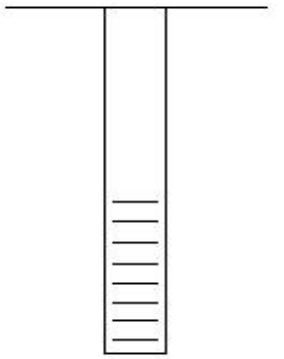
MONITORING WELL RECORD FOR LOW-FLOW PURGING

Project Data:

Project Name: _____ Date: _____

Ref. No.: _____ Personnel: _____

_____



Monitoring Well Data:

Well No.: _____

Vapour PID (ppm): _____ Saturated Screen Length (m/ft): _____

Measurement Point: _____ Depth to Pump Intake (m/ft)[1]: _____

Constructed Well Depth (m/ft): _____ Well Diameter, D (cm/in): _____

Measured Well Depth (m/ft): _____ Well Screen Volume, V_s (L)[2]: _____

Depth of Sediment (m/ft): _____ Initial Depth to Water (m/ft): _____

Time	*Pumping Rate (mL/min)*	*Depth to Water (m/ft)*	*Drawdown from Initial Water Level (3)* (m/ft)	*Temperature °C*	*Conductivity (mS/cm)*	*Turbidity NTU*	*DO (mg/L)*	*pH*	*ORP (mV)*	*Volume Purged, Vp (L)*	*No. of Well Screen Volumes Purged (4)*
			Precision Required (5):	*±3 %*	*±0.005 or 0.01 (6)*	*±10 %*	*±10 %*	*±0.1 Units*	*±10 mV*		

Notes:

(1) The pump intake will be placed at the well screen mid-point or at a minimum of 0.6 m (2 ft) above any sediment accumulated at the well bottom.

(2) The well screen volume will be based on a 1.52 metres (5-foot) screen length (L). For metric units, $V_s=\pi*(r^2)*L$ in mL, where r (r=D/2) and L are in cm. For Imperial units, $V_s=\pi*(r^2)*L*(2.54)^3$, where r and L are in inches

(3) The drawdown from the initial water level should not exceed 0.1 m (0.3 ft). The pumping rate should not exceed 600 mL/min.

(4) Purging will continue until stabilization is achieved or until 20 well screen volumes have been purged (unless purge water remains visually turbid and appears to be clearing, or unless stabilization parameters are varying slightly outside of the stabilization criteria and appear to be stabilizing), No. of Well Screen Volumes Purged= Vp/Vs.

(5) For conductivity, the average value of three readings <1 mS/cm ±0.005 mS/cm or where conductivity >1 mS/cm ±0.01 mS/cm.

Appendix D

Waste Management Plan

Table of Contents

Section 1.0 Waste Management Plan

1.1 Objectives and Scope of Work

The following sections describe procedures and protocols for handling waste materials generated during remediation. Potential types of wastes that may be generated include, but may not be limited to the following:

- Drill cuttings
- Construction materials/debris (e.g., pipe)
- Waste water including well development water
- Personal Protection Equipment

The following activities will be conducted as part of the Site remedial work:

- Drilling and installation of ISCO injection wells
- Collection and off-Site disposal of drill cuttings
- Mixing and injection of sodium persulfate into the groundwater

1.2 Site Preparation

Prior to commencement of construction activities temporary support facilities will be established at the Site including:

Equipment Decontamination Area

An equipment decontamination area will be constructed prior to initiating ground intrusive work. A low-volume, high-pressure washer will be located at the decontamination facility for equipment cleaning. Liquid waste water generated from decontamination activities shall be collected in drums and temporarily stored in the waste staging area prior to off-Site disposal.

Exclusion Zone

An exclusion zone (EZ) will be established around all areas where potentially impacted materials are to be handled or temporarily stored, and all areas where contaminated equipment or personnel travel. Work areas included within the EZ will be: drilling and ISCO injection area and the decontamination area.

Demarcation of the EZ perimeter will be made by means of temporary construction fencing and/or barrier rope and colored tape which will be fixed at regular intervals to T-bars driven into the ground. Access to the EZ will be provided from the decontamination facility only.

Contaminant Reduction Zone

The contaminant reduction zone (CRZ) will be located at the interface of the EZ and Clean Zone and will provide for the decontamination of vehicles/equipment that have contacted potentially contaminated materials prior to leaving the EZ, the decontamination of personnel and removal of PPE prior to entering the Clean Zone and for the physical segregation of the Clean Zone and EZ.

Clean Zone

The clean zone (CZ) is the portion of the Site defined as being the area outside the zone of significant air and waste contamination. The function of the CZ includes:

- Site entry for personnel, material and equipment
- Parking for personal vehicles
- the equipment compound

Site activities and controls shall be designed to prevent migration of contamination into the CZ from the EZ.

1.3 Wastewater and Liquids

All liquids contacting waste materials (wastewater) will be collected in drums and stored in the waste staging area prior to being disposed off Site at a licensed liquid waste disposal facility. Wastewaters are anticipated to include well development water, purge water and decontamination water. Wastewater waste characterization samples will be analyzed for metals, SVOCs, PCBs, VOCs, and RCRA characteristics.

1.4 Injection of Oxidant into Groundwater

Sodium persulfate will be brought to the Site in bulk containers and mixed with water to 25 percent solution. This will be performed in batches of approximately 400 gallons and the solution will be injected into the groundwater at the injection wells. The amount of sodium persulfate required for each round of injections will be determined in advance so that all the oxidant can be mixed and used. It is not anticipated that there will not be any residual bulk sodium persulfate requiring storage/disposal. The mixing tank and pumps will be cleaned with potable water and the residual water pumped into one or more of the injection wells.

1.5 Construction Materials/Debris/PPE

Clean construction waste (e.g., cut pieces of piping, wrappings, bags, etc.) will be placed in a separate roll off box and disposed off Site as a non-hazardous solid waste. Construction waste that has contacted potentially contaminated soils and used PPE will be placed in roll off containers along with the unsuitable excavated soils and drill cuttings and disposed off Site with that waste stream. Alternatively, if appropriate, the construction waste may be decontaminated and disposed off Site with the clean construction waste stream.

1.6 Drill Cuttings

All soil cuttings brought to the surface will be collected in 55-gallon DOT-approved drums and transferred to the interim drum staging area. Samples will be collected and analyzed for metals, SVOCs, PCBs, VOCs, TCLP metals, TCLP SVOCs, TCLP VOCs, and RCRA characteristics. The drill cutting will be either disposed off Site of in accordance with State and Federal regulations or spread on the ground surface in the vicinity of the well installations if acceptable to NYSDEC.