F I N A L

Site Characterization Investigation Work Plan, Essex-Hope Site in Jamestown, New York

Site Number 907015

Prepared for

Essex Specialty Products, Inc.

July 2016

ch2m

Professional Engineer Certification

I, Key Rosebrook, certify that I am currently a New York State registered professional engineer as defined in 6 New York Codes, Rules, and Regulations Part 375, and that this *Site Characterization Investigation Work Plan* was prepared in accordance with all applicable statutes and regulations, and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

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Acronyms and Abbreviations

µg/L	micrograms per liter
amsl	above mean sea level
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
bgs	below ground surface
BPU	Board of Public Utilities
CAMP	Community Air Monitoring Plan
CBTEX	cumene, benzene, toluene, ethylbenzene, and xylene
CFR	Code of Federal Regulations
CH2M	CH2M HILL
CPM	Custom Production Manufacturing Inc.
DCE	dichloroethene
DER-10	Division of Environmental Remediation Technical Guidance for Site Investigation and Remediation
DNAPL	dense nonaqueous phase liquid
Dow	The Dow Chemical Company
DPT	direct-push technology
EPA	U.S. Environmental Protection Agency
Essex	Essex Specialty Products Inc.
gpd	gallons per day
gpm	gallons per minute
HPT	hydraulic profile tool
HSP	Health and Safety Plan
MIP	membrane interface probe
mL	milliliter
NFA	No Further Action
NR	not reported
NYCRR	New York Codes, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
PID	photoionization detector
PMP	Performance Monitoring Plan
ppb	parts per billion

ppm	parts per million
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RAO	remedial action objective
ROD	Record of Decision
SVE	soil vapor extraction
TBD	to be determined
TCE	trichloroethene
TOC	total organic carbon
URS	URS Corporation
UST	underground storage tank
VOC	volatile organic compound
WBZ	water-bearing zone

SECTION 1

Introduction

CH2M HILL (CH2M) prepared this work plan on behalf of Essex Specialty Products Inc. (Essex), to present proposed activities to supplement previous investigations for refining the conceptual site model and planning for future remedial activities at the Essex-Hope State Superfund site located at 125 Blackstone Avenue in Jamestown, New York (site; Figure 1). The site, presently owned by Custom Production Manufacturing Inc. (CPM), is listed under the New York Superfund Program (Site Number 907015) and managed by the New York State Department of Environmental Conservation (NYSDEC). A Record of Decision (ROD) was issued in 1994 requiring the implementation of remedial actions at the site (NYSDEC 1994). This work plan has been developed in general accordance with the NYSDEC's Division of Environmental Remediation Technical Guidance for Site Investigation and Remediation (DER-10), dated May 2010.

1.1 Purpose and Scope

The activities proposed within this work plan are being conducted to meet the following objectives:

- **Objective 1** – Assess vadose zone soil conditions in the former aboveground storage tank (AST) area, the eastern portion of the former underground storage tank (UST) area, and the north parking lot, and compare conditions to site remedial action objectives (RAOs). Soil conditions have not been recently assessed in these locations, thus progress toward achieving RAOs will be better quantified.
- **Objective 2** – Complete delineation of the shallow water-bearing zone (WBZ) cumene, benzene, toluene, ethylbenzene, and xylene (CBTEX) plume under the West Building and provide information on potential upgradient (offsite) contributions near the West Building. A 2013 investigation found elevated concentrations of CBTEX in shallow groundwater under the West Building, but the lateral extent of the plume was not completely delineated at that time (URS Corporation [URS] 2014a).
- **Objective 3** – Provide additional information on the offsite shallow WBZ trichloroethene (TCE) plume to the north and east of the site along Hopkins Avenue and provide a more robust monitoring well network for future monitoring. This area has been investigated previously using temporary groundwater grab samples and monitored at two shallow monitoring wells. The expanded network will enhance delineation.
- **Objective 4** – Improve the understanding of the hydraulic and geochemical characteristics of the aquifers and geotechnical characteristics of soil to assist in understanding alternative remedial options.
- **Objective 5** – Enhance the monitoring network in the deep WBZ to the north and east of Plant 5 to evaluate the effectiveness of the deep extraction well network in preventing the downgradient migration of a deep TCE and acetone plume. Two deep monitoring wells presently are monitored as sentinel wells.
- **Objective 6** – Improve the effectiveness of the deep groundwater extraction system. The goal of the deep groundwater extraction system is to recover contaminated groundwater and hydraulically control downgradient migration of the deep plume. Deep groundwater extraction well RW-6D, however, has experienced issues with excessive silt production that has affected operation of this well.
- **Objective 7** – Assess the deep groundwater conditions underneath and near the West Building to determine whether shallow CBTEX contamination has migrated to the deep WBZ and if

contamination has migrated onsite from offsite sources. Conditions in the deep WBZ in this area have not been previously investigated.

- **Objective 8** – Characterize the source area within the deep WBZ TCE plume. Groundwater sample results along the northern edge of the Plant 5 Building and to the north of Hopkins Avenue have contained elevated concentrations of TCE and its daughter products that suggest this area may contain the source of contamination. Refined characterization of the potential source area will be useful for evaluating potential remedial alternatives for the deep TCE and acetone plume.

In order to meet the aforementioned objectives, the following activities are proposed:

- **Install and Develop Monitoring Wells:** Install and develop up to eighteen 2-inch-diameter monitoring wells. Thirteen shallow monitoring wells will be installed to estimated depths of 15 feet below ground surface (bgs) and five deep monitoring wells will be installed to estimated depths of 40 feet bgs to satisfy Objectives 1, 2, 3, 5, and 7. Soil samples from select well installation locations will be submitted for analysis of geotechnical and/or contaminant concentration characteristics to satisfy Objectives 1 and 4.
- **Replace Recovery Well:** Install and develop a replacement recovery well at RW-6D to satisfy Objective 6. Before installation, an exploratory boring will be advanced to define grain size and geotechnical characteristics to design a well screen. Work will include disconnecting RW-6D from the groundwater treatment system and connecting the replacement recovery well to the system.
- **Conduct High-Resolution Characterization by Membrane Interface Probe (MIP):** Advance up to 10 soil borings using a direct-push technology (DPT) rig, with a MIP and hydraulic profile tool (HPT) to estimated depths of 45 feet bgs to satisfy Objectives 4 and 8. MIP tools will enable characterization of subsurface lithology and constituent distribution, while the HPT will enable characterization of the hydraulic characteristics of the aquifers.
- **Conduct DPT Sampling at 10 Locations:** Continuous soil sampling at 10 soil borings to depths ranging from 10 to 45 feet bgs to satisfy Objectives 1 and 8. Groundwater sampling at three of the DPT locations will be conducted to confirm MIP results.
- **Sample Groundwater:** Two rounds of groundwater samples will be collected from the new monitoring wells for chemical analysis to satisfy Objectives 2, 3, 5, and 7, with a portion of the wells to be analyzed for geochemical characteristics. In addition, select existing monitoring wells not in the Performance Monitoring Plan (PMP; URS 2014b) sampling program will be sampled, and select existing monitoring wells will be sampled for geochemical parameters to satisfy Objective 4 and develop an enhanced baseline of site conditions.

1.2 Project Organization and Responsibilities

The project roles and responsibilities are presented in Table 1.

Table 1. Project Organization and Responsibilities
Essex-Hope Site, Jamestown, New York

Staff/Subcontractor	Role	Responsibilities
Kyle Block/CH2M	Project Manager	Implement and execute the technical, quality, and administrative/ financial aspects of the project, including managing the project team Ensure the work is conducted in accordance with applicable plans and guidelines, including the project instructions and Health and Safety Plan (HSP) Communicate all technical, quality assurance (QA), and administrative matters to the client Document any deviations from the approved scope, budget, and schedule and communicating these to the client for approval
Key Rosebrook/CH2M	Professional Engineer	Provide technical direction and leadership for engineering aspects of project Ensure compliance with NYSDEC requirements
Fred Roche/CH2M	Junior Engineer/Field Team Leader	Provide CH2M field oversight of utility locator, driller, and MIP subcontractors Conduct field implementation of the work plan, including collecting and submitting samples to laboratory, soil logging, and reporting Site safety coordinator responsible for implementing the HSP
Dave Boehnker/CH2M	Senior Technical Consultant	Provide technical direction and leadership for hydrogeological aspects of project
Shane Lowe/CH2M	Project Chemist	Prepare the Quality Assurance Project Plan (QAPP) Validate data
New York Leak Detection	Third-Party Utility Locate	Conduct third-party utility locate of proposed drilling locations
Parratt Wolff Inc.	Driller	Conduct drilling and installing monitoring wells Collect soil and groundwater grab samples Develop wells Drill and install recovery well and connect to groundwater treatment system
Columbia Technologies	MIP/HPT	Operate MIP equipment and provide reporting on results
Alpha Analytical	Laboratory	Analyze soil and groundwater samples
TBD	Surveyor	Conduct survey of horizontal and vertical location of newly installed wells

TBD = to be determined

1.3 Work Plan Organization

This work plan is organized as follows:

- Section 1 – Introduction
- Section 2 – Site Background
- Section 3 – Investigation Scope of Work
- Section 4 – Quality Assurance Project Plan
- Section 5 – Other Planning Documents

- Section 6 – Reporting and Schedule
- Section 7 – References
- Appendix A – Quality Assurance Project Plan
- Appendix B – Health and Safety Plan

Tables 4, 5, and 6 and supporting materials such as figures and appendices are presented at the end of this work plan.

SECTION 2

Site Background

The 4.7-acre site is located at 125 Blackstone Avenue in Jamestown, New York (Figure 2). The site is in an industrialized area of the city that has seen various degrees of industrial use over the past 75 years. Contamination onsite is the result of historical practices conducted at the facility as discussed in a 1992 remedial investigation report[1] and summarized below.

2.1 Historical Operations

Historically, two distinct operations occupied the site: Jamestown Finishes at the southern portion of the site (along Blackstone Avenue) and Hope's Windows in the northern portion (along Hopkins Avenue). The site has been divided into five separate areas based on the site history and identified areas of contamination (Figure 2). These areas include:

- Plant 5 Building
- North Parking Lot
- West Building
- Former UST area
- Former AST area

Several spills in the early 1990s have been reported at the site, including a sump overflow resulting in a discharge to the roadside (Spill Number 9204735), a spill of 13 gallons of petroleum-based solvent (Spill Number 9201470), and a spill of 17 gallons of Almond Dip Organosol (Spill Number 9100810). All three spills were remediated and given a No Further Action (NFA) determination. Additionally, there is a spill report (Spill Number 9006906) regarding the initial site assessment conducted in 1990 by O'Brien & Gere for the site.

Additional details on the site history at each area are provided below.

2.1.1 Plant 5 Building and North Parking Lot

Hope's Windows previously occupied the northern portion of the site (along Hopkins Avenue). This portion of the site is divided into the following two areas:

- Plant 5 Building
- North Parking Lot

The Plant 5 Building historically was used for the manufacture of window screens until the early 1970s, when manufacturing switched to production of aluminum windows (McFarlene 1991). The building also was used to store aluminum and to cut, punch, notch, weld, and assemble aluminum parts.

A TCE degreaser and paint primer tank were present in the southwestern corner of the building, but were both removed before Essex purchased the site in 1985 (Hallquist 1991). The TCE degreasing pit reportedly was cleaned and pumped to a sump in the North Parking Lot (west of the Plant 5 Building). The sump and surrounding soils were excavated in the mid-1990s as one of the ROD remedies (NYSDEC 1994).

Impacts to soil and groundwater have included polychlorinated biphenyls in soil in the North Parking Lot and TCE and its daughter products in soil, the shallow WBZ, and the deep WBZ under the North Parking

[1] Because CH2M has not obtained the main text of the remedial investigation reports, historical information for the site is relatively limited. CH2M requested these documents from NYSDEC, URS/AECOM, and Dow.

Lot and the Plant 5 Building. Both shallow and deep groundwater impacts have been detected offsite to the north, and shallow groundwater impacts extend offsite east along Hopkins Avenue.

After Essex purchased the Plant 5 Building in 1985, the building reportedly was used as a raw materials warehouse. The building has been used for light metals fabrication since CPM purchased the site in 2000. During a 2014 VI survey, numerous chemicals, including TCE, tetrachloroethene, petroleum distillates, methyl isobutyl ketone, toluene, methylene chloride, 1,1,1-trichloroethane, and acetone were observed stored at the facility (URS 2015).

2.1.2 West Building and Former AST and UST Areas

The southern portion of the site is divided into the following three areas:

- West Building
- Former AST area
- Former UST area

The West Building was built in the early 1900s and was subsequently expanded several times through the years. The building was used by a variety of owners/operators to produce paints, varnishes, and other industrial coatings under the name Jamestown Finishes or Jamestown Finishing Products (NYSDEC 1994). The former AST area was northwest of the West Building. Soil and the shallow WBZ in the West Building and former AST areas historically have been impacted by CBTEX and, to a lesser extent, TCE and daughter products cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride (NYSDEC 2015). To the east of the West Building is the former UST area, which formerly contained USTs with acetone, xylenes, and other solvents used in the production of coatings (NYSDEC 1992). Historical impacts in this area included CBTEX in soil and the shallow WBZ.

2.2 Geology and Hydrogeology

The site gently slopes to the northeast, with elevations range from 1,281 feet above mean sea level (amsl) in the southwestern portion of the site to 1,276 feet amsl at the Plant 5 Building.

Environmental investigations at the site have focused on two WBZs separated by a deposit of silty clay. The shallowest WBZ exists in shallow silty sands and gravels under unconfined (water table) conditions, with a typical depth to water of 7 to 11 feet bgs. The shallow silty sands and gravels generally extend from near the ground surface to about 10 to 15 feet bgs. Wells completed in this WBZ are generally appended with the letter S. The saturated thickness of this shallow WBZ is approximately 6 to 10 feet, and the average hydraulic conductivity is 9.1 feet per day (Dow Environmental 1995), with an average groundwater velocity ranging from 0.25 to 0.5 foot per day under non-pumping conditions, groundwater flow direction is to the east-northeast toward the Chadakoin River. Three extraction wells (RW-1S and RW-2S in the North Parking Lot area and RW-3S in the former AST area) are screened in the shallow WBZ and affect groundwater flow patterns in their vicinity.

The silty clay observed at most of the site serves as an aquitard separating the shallow WBZ from deeper groundwater. The silty clay is generally about 5 feet thick, but varies considerably and in some locations is absent. Because the silty clay is absent or thin in locations, this silty clay aquitard may be considered a leaky aquitard.

Beneath the silty clay, confined to semiconfined groundwater exists in the 25- to 35-foot-thick fine-grained sandy silts and silty sands. This groundwater is called the deep WBZ, but it also was previously referred to as the Lower Fine Sand WBZ. Wells completed in this zone are typically appended with the letter D. Under non-pumping conditions, groundwater flow direction is to the east-northeast toward the Chadakoin River. Two extraction wells are completed in the deep WBZ (RW-2D and RW-6D).

When pumping, these wells create a cone of depression in the deep WBZ under much of the site, and the cone extends to the north and east of the site.

Underlying the fine-grained sandy silts and silty sands is an approximately 30-foot-thick sequence of silts and clays to about 95 feet bgs. One well, MW-7DD, is screened in the deepest sand and gravel WBZ found at 95 to 100 feet bgs.

2.3 Population, Surrounding Land Use, and History

The site is located in a highly industrialized area with numerous metal working shops and other manufacturing facilities. To the north is a vacant field previously occupied by Hope's Windows Plant 6. To the east and northeast toward the Chadakoin River are several metalworking shops (H&H Metal Specialty, Johnson Machine, and Rollform) as well as several residences along Bigelow Street and Hopkins Avenue. Several manufacturing and commercial businesses are present to the south and southeast of the site, including Jamestown Metal Products, a glass business, plumbing supplies, and motor vehicle repair shop. To the west and southwest of the site are United Alloys, Hope's Architectural Products and Blackstone Advanced Technologies, respectively. The Chadakoin River (a Class C river) is located north of the site, although because of sweeping meander bends, the channel lies approximately 500 feet west of the site, 730 feet north of the site, and 500 feet north-northeast of the site.

2.4 Adjacent Property Spill Incidents

Reported spills at nearby industrial sites include:

- A sulfuric acid spill (Spill Number 9306084) at Hope's Architectural (84 Hopkins Avenue, west of the site) that was remediated and a No Further Action (NFA) issued in 1993.
- A gasoline release (Spill Number 9301932) observed at Jamestown Pipe and Supply at 132 Blackstone Avenue (south of the site, across Blackstone Street from the West Building) during a UST removal. Soil was excavated and an NFA issued in 1993.
- A report of an oil spill (Spill Number 9307513) in the Chadakoin River behind H&H Metal Specialty site. NYSDEC staff did not find oil in the creek.
- A cutting oil spill (Spill Number 9606157) from metal cuttings in onsite Luggers stored at Johnson Machine & Fibre Pro at 142 Hopkins Avenue, located adjacent to the site east of the Plant 5 Building. Contaminated soil was removed and NFA determined.
- Leaking USTs (Spill Number 9104026) were removed from Rollform at 181 Blackstone Avenue, located adjacent to the site east of the former UST area. Two USTs, with unknown contents, were removed in 1991 and contaminated soil was excavated. An NFA was issued in 1992.
- A 20-gallon diesel spill (Spill Number 0075264) from a truck hitting metal debris at Jamestown Metal Products at 178 Blackstone Avenue, located southeast of the site, diagonally adjacent to the former UST area. The spill was closed in 2000. There was also a spill reported (9000157) related to the removal of a paint thinner UST, a TCE UST, and a gasoline UST. Soil surrounding the gasoline UST (4 cubic yards) and the TCE UST (2 cubic yards) was removed.

2.5 Utilities and Groundwater Use

The Jamestown Board of Public Utilities (BPU) supplies water to the site and vicinity. The BPU supplies water to Jamestown from a network of wells more than 2 miles east of the site completed in the confined aquifers in the Cassadaga Creek and Conewango Creek drainages. Historical data indicate groundwater has been historically used in the vicinity of the site with 16 wells mapped near the site in a 1966 map (Crain 1966) as detailed in Table 2. The current use of the wells detailed within Table 2 are

unknown and many of them may no longer be active and according to a feasibility study report (O'Brien & Gere 1994), there were no user wells in the area and the area was supplied by the municipal water supply. Therefore, it is likely that the groundwater wells listed in Table 2 are no longer in use.

Table 2. Nearby Wells Identified in 1966
Essex-Hope Site, Jamestown, New York

Well #	Location from Site (feet)	Year Drilled	Depth (feet bgs)	Depth to Bedrock (feet bgs)	Use	Estimated Pumpage (gpd)	Note
210-915-1	2,000 ENE	1926	240	571	Commercial	NR	Artesian (yields 75 gpm)
210-915-2	2,000 ENE	1952	138	NR	Commercial	NR	Artesian (yields 50 gpm with 31 feet drawdown)
210-915-4	2,000 ENE	NR	125	NR	Domestic/ Commercial	250	
210-915-6	2,000 ESE	1952	72	NR	Commercial	300	
210-915-7	2,000 E	NR	100	30	Commercial	800	
210-915-8	2,000 ESE	1927	80	NR	Domestic	100	
210-915-9	2,000 ESE	NR	79	NR	Commercial	300	
210-915-10	2,000 ENE	NR	122	NR	Domestic	150	
210-915-11	500 NW	1955	104	NR	Domestic	100	Possibly Hope's Windows Plant 3 well

Source: Crain, 1966, Table 6
Wells 210-915-3, 210-915-14, 210-910-15, and 210-910-16 were presented on Inset 2 of Plate 2, but not included in Crain's Table 6.

E = east
ENE = east-northeast
ESE = east-southeast
NW = northwest
W = west
NE = northeast
NR = not reported
bgs = below ground surface
gpd = gallons per day
gpm =gallons per minute

No recently installed (2000 and more recent) water wells were identified within 1 mile of the site, according to an NYSDEC water well database (http://www.dec.ny.gov/lands/33317.html). Most historical wells in the immediate vicinity of the site appear to be drilled 70 to 140 feet bgs and encountered a thick sequence of silts and clays underlain by a lens of sand and gravel.

Utilities include sanitary sewer lines, storm sewers, water service lines, natural gas lines, and buried electrical lines (Figure 3). There are separate service lines for the West Building and the Plant 5 Building. Based on the reported depth of the sanitary sewer line in Hopkins Avenue (approximately 8 feet, likely beneath the water table), this utility corridor may influence constituent migration. An offsite TCE plume extends east-west roughly along Hopkins Avenue, roughly parallel to the sanitary sewer line. There is also subsurface piping associated with the extraction wells and groundwater treatment system and piping associated with the former soil vapor extraction (SVE) and air sparging systems in this area but these are expected to be above the water table.

2.6 Constituents of Interest

The primary constituents of interest in soil and groundwater at the site include:

- TCE and its daughter products cis-1,2-DCE and vinyl chloride
  - Historically detected in soil in the North Parking Lot area
  - Present primarily in the North Parking Lot area, underneath the Plant 5 Building, and offsite to the north and east in the shallow WBZ
  - Present under the Plant 5 Building and offsite to the north and east of the site in the deep WBZ
- Acetone
  - Present under and to the north of the Plant 5 Building in the deep WBZ
- CBTEX
  - Historically present in soil in the former UST area
  - Present in the former AST area, under the West Building, and in the former UST area in the shallow WBZ

2.7 Remedial Action Objectives

RAOs were presented in an ROD issued in 1994 (NYSDEC 1994). The remediation goals selected for the site included:

- Eliminate the potential for direct human or animal contact with contaminated soils
- Mitigate the impacts of contaminated groundwater to the environment
- Mitigate, to the extent practicable, migration of constituents from onsite areas to groundwater
- Provide for attainment of RAOs for groundwater and soil quality

Numeric RAOs are summarized in Table 3.

Table 3. 1994 Remedial Action Objectives
Essex-Hope Site, Jamestown, New York

Media	Parameter	1994 RAO
Soil	Total volatile organic compounds	10 ppm
	Each individual volatile organic compound	1 ppm
	Total semivolatile organic compounds	500 ppm
	Each Individual semivolatile organic compound	50 ppm
	Polychlorinated biphenyls	10 ppm
Groundwater	trans-1,2-Dichloroethene	5 ppb
	Trichloroethene	5 ppb
	Vinyl chloride	5 ppb
	Ethylbenzene	5 ppb
	Toluene	5 ppb
	Xylene	5 ppb
	Polychlorinated biphenyls	0.1 ppb
	Other compounds	NYSDEC Ambient Groundwater Quality Standard*

ppm = parts per million
ppb – parts per billion
µg/L – micrograms per liter

* Current New York State Department of Environmental Conservation Ambient Groundwater Quality Standards for other compounds commonly found at the site include acetone – 50 µg/L; benzene – 1 µg/L; cis-1,2-dichloroethene – 5 µg/L; 2-butanone (MEK) – 50 µg/L; 1,1-dichloroethene – 5 µg/L; isopropylbenzene (cumene) – 5 µg/L

2.8 Remedial Actions

Numerous remedial actions have been undertaken at the site in response to the 1994 ROD (NYSDEC 1994). Remedial actions have included a pump and treat system that extracts and treats shallow and deep groundwater; soil excavation in the North Parking Lot; air sparging of shallow WBZ in the North Parking Lot, former AST, and former UST areas; and SVE of vadose zone soils in these same areas. Supplemental actions implemented include removing the USTs and adjacent soil, conducting a pilot test of zero-valent iron injections in the North Parking Lot, installing a subslab vapor mitigation system at an offsite residence, and implementing in-situ chemical oxidation injections in the shallow WBZ in the former UST area and the deep WBZ near the northeastern corner of the Plant 5 Building (VeruTEK Technologies 2010; URS 2012). Presently, three recovery wells are pumping from the shallow WBZ (RW-1S, RW-2S, and RW-3S) and two recovery wells are pumping from the deep WBZ (RW-2D and RW-6D). RW-6D has experienced issues with excessive silt production.

SECTION 3

Investigation Scope of Work

This section presents a detailed scope of work for addressing the data needs detailed in Section 1.1. Locations of the proposed field investigation activities are shown on Figure 4.

3.1 Field Investigation Activities

3.1.1 Utility Clearance

At each drilling location, a third-party utility survey will be completed. An area approximately 5-foot-square around each boring as shown on Figure 4 will be evaluated using non-intrusive geophysical utility locator technologies (e.g., magnetic, ground-penetrating radar, or similar) as necessary to identify, mark out, and locate underground utilities and other subsurface obstructions within the survey area. Utilities will be flagged and marked for review upon drill rig mobilization. CH2M personnel accompanying the utility locating contractor will take photographs of markings made and draw rough sketches in the field logbook of found subsurface utilities.

In addition to the private utility survey/mark out, Dig Safe Systems will be contacted at least 3 working days and not more than 10 working days before initial mobilization of drilling equipment to the site.

3.1.2 Monitoring Well Installation

A total of 18 monitoring wells will be installed on the site and at adjacent properties. Specifically, monitoring well installations include:

- Thirteen wells will be installed using hollow stem auger drilling techniques within the shallow WBZ (estimated 15 feet bgs). Each well will be constructed as a 2-inch-diameter, Schedule 40 polyvinyl chloride (PVC) monitoring well with a 5-foot 0.010-slot screen.
- Five monitoring wells will be installed within the deep WBZ using a combination of hollow stem auger and drive-and-wash techniques. Wells will be constructed as a 2-inch-diameter, Schedule 40-PVC monitoring well with a 10-foot 0.010 slot-screen. The proposed installation technique includes:
  - Hollow stem augers will be advanced at least 1 foot into the silty clay layer (approximately 16 feet bgs) and a temporary PVC casing will be placed within the augers.
  - Drive-and-wash methods will then be used to advance a 5-inch, flush-joint, temporary well casing to the target depth (40 feet bgs).
  - Well and well pack materials will be installed as the temporary casing is removed.
- If the borehole has been drilled to a depth greater than the well is to be set, the borehole will be backfilled with bentonite pellets to a depth approximately 1 foot below the intended well depth. The bentonite pellets will be allowed to hydrate for at least one hour prior to installing well. Approximately 1 foot of clean sand will be placed on top of the bentonite to return the borehole to the proper depth for well installation. At each monitoring well, the screen will be sand packed using 20/40 sieve size sand pack to a depth that corresponds to 2 feet above the top of the well screen. A 3-foot bentonite seal will be placed on top of the sand pack in the annulus of the borehole, and the remainder of the annulus will be cemented to the surface using Portland cement that contains up to 8 percent bentonite by weight. If all or a portion of the bentonite seal is above the water table, clean water will be added to hydrate the bentonite. A hydration period of at least 30 minutes will be required following installation of the bentonite seal. The cement-bentonite grout will be installed continuously in one operation from the bottom of the space to be grouted to the ground surface

through a tremie pipe. The top of the PVC riser will be cut to a maximum of 6-inches below grade. A lockable steel flush mount road box cover will be installed at each monitoring well with an expansion plug for the wellhead. The flush mount road box should be rated for construction vehicles and should be placed in a 2-foot by 2-foot concrete pad.

- At each boring location, continuous soil sampling using split spoon samplers will be conducted. Soil samples will be logged for the project record according to the Unified Soil Classification System. Each boring will describe at a minimum: percent recovery, soil type, color, moisture content, texture, grain size and shape, consistency, and visible evidence of impacts. Each 2-foot interval of sample will be screened on 6-inch intervals using the headspace technique for the presence of ionizable compounds in soil using a photoionization detector (PID) equipped with a 10.6-electron volt bulb using the steps outlined below.
- Three geotechnical samples per boring will be collected at three locations (MW-106D, MW-107S, and MW-113D) using a Shelby Tube and split spoon sampling techniques. Field observations and stratigraphy will determine the exact depths at which these samples will be collected. A shallow sand and gravel sample, a middle silty clay sample, and a deep fine sand sample will be collected at MW-106D and MW-113D, while a shallow sand and gravel sample at MW-107S will be collected. Geotechnical data will be used for evaluation of potential remedial alternatives. The geotechnical samples will be analyzed for the following:
  - Percent moisture (U.S. Environmental Protection Agency [EPA] 160.3/American Society for Testing and Materials [ASTM] D2216)
  - Grain size (ASTM D422)
  - Atterberg limits (ASTM D4318)
  - Bulk density (ASTM D7263)
  - pH (SW846-9045D)
  - Total organic carbon (TOC) (Lloyd Kahn method)
- Two vadose-zone soil samples will be collected at each of three locations (MW-115D, MW-114S, and MW-111D) using EnCore (or equivalent) samplers and analyzed for VOCs by EPA Method 8260C to compare soil conditions to RAOs.
- Additional vadose zone soil samples from other well installation locations may be submitted for chemical analysis based on headspace PID screening (greater than 1 part per million [ppm]) and/or visual observation of impacts. Soil exhibiting the highest PID reading at a location will be submitted for analysis for VOCs by EPA Method 8260C.
- Saturated or unsaturated soils indicating elevated VOC headspace concentrations during the PID analysis (greater than 100 ppm) and/or visible signs of NAPL such as staining, sheens, or a strong odor will be evaluated for dense nonaqueous phase liquid (DNAPL) presence using the Sudan IV dye tests and will be submitted for laboratory analysis for VOCs by EPA Method 8260C. The Sudan IV dye test will be performed as follows:
  - A colorless plastic 40- to 60-milliliter (mL) vial will be filled approximately halfway with the soil sample, with the remaining volume of the sample vial filled with distilled water.
  - A small quantity of Sudan IV dye in powder form will be added to the vial containing the soil and water (approximately 2 to 4 milligrams, equivalent to the amount that would rest on the edge of a toothpick).
  - The soil and water will be evaluated for reaction with the dye (change to bright red color). The jar will be closed and gently shaken approximately 10 to 20 seconds.

  - The contents in the closed jar will be examined for visible bright red-dyed liquid inside the jar.
  - A positive test result will be indicated by reaction between the dye and the sheen layer upon first addition of the Sudan IV, a bright red coating the inside of the vial, particularly above the water line, or red-dyed droplets within the soil (see example below).

- A minimum of 48 hours after installation, monitoring wells will be developed utilizing a whale pump with a surge block or similar to remove drilling fines and provide a better connection with the aquifer. Wells will be allowed to equilibrate at least 2 weeks before sampling.

Proposed new monitoring well locations are presented on Figure 4 and the proposed construction specifications are summarized in Table 4. Proposed analytical soil and geotechnical samples also are presented in Table 4.

3.1.3 Replacement of Recovery Well

Because of ongoing siltation issues, RW-6D will be replaced. Planned recovery well installation activities include:

- Advancing a test boring using hollow stem auger techniques to 47 feet bgs in advance of the recovery well installation to determine the position of the deep WBZ and to determine grain size distribution for the well screen design.
- Up to 10 samples will be collected from the deep WBZ (every 2 feet from 20 to 40 feet bgs) for grain size analysis (ASTM D422) with an additional three samples (one each from the shallow sand and gravel, a middle silty clay sample, and a deep fine sand) collected for percent moisture (EPA 160.3/ ASTM D2216), Atterberg limits (ASTM D4318), bulk density (ASTM D7263), pH (SW 846-9045D), and TOC (Lloyd Kahn method). The shallow sand and gravel and middle silty clay sample also will be analyzed for grain size by ASTM D422.
- One vadose zone soil sample also will be collected for analysis of VOCs by EPA Method 8260C.
- Additionally, if soil samples exhibit visible signs of NAPL such as staining, sheens, or a strong odor, soils will be evaluated for DNAPL presence using the Sudan IV dye tests using the procedures outlined within Section 3.1.2, and at least one soil sample from the affected depth will be submitted for VOC analysis by EPA Method 8260C.
- The test boring will be abandoned using bentonite chips or a slurry placed by a tremie pipe.
- The grain size data will be evaluated to design a custom screen with slot sizes appropriate for the formation materials. A 6-inch, PVC wire-wrapped custom well screen will be ordered, and the new recovery well will be installed using the following procedure:
  - A 10.25-inch (or larger) boring will be drilled to approximately 47 feet bgs using hollow stem auger techniques.
  - A 2-foot sump will be installed at the base of the borehole.
  - A 6-inch-diameter well will be constructed using Schedule 80 PVC riser and the custom-ordered well screen.
  - A sand filter pack, to be chosen based on the custom-screen design, will be installed to 2 feet above the top of the well screen.
  - A 3-foot bentonite pellet seal will be placed on top of the filter pack.
  - A cement-bentonite grout will be placed on top of the bentonite seal to the depth of the well vault.

  - The well vault will be a 24-inch-diameter, high-density polyethylene pipe, rated for construction vehicles and equipped with a round manhole cover, installed to at least 32 inches bgs.
  - An 8-inch-thick concrete pad (4 feet by 4 feet) and reinforced with rebar will be installed around the well vault.
- A pump will be installed in the recovery well and discharge piping connected to existing conduit from existing well RW-6D.
- The pump power cable and level control signal wiring will be connected to the existing RW-6D variable frequency drive controller.
- The recovery well will be developed using a combination of an undersized surge block equipped with soft disks to avoid damaging the well screen, or similar, combined with periodic over pumping until the well no longer produces silt and field parameters have stabilized. At least three well volumes will be removed. Well development water will be discharged to the onsite groundwater treatment system after being filtered.

3.1.4 Additional Soil and Grab Groundwater Sampling

Continuous soil sampling at 10 locations will be conducted using dual-tube DPT to assess site compliance with RAOs. Seven shallow borings will be advanced to depths of 10 feet bgs (DPT-01 through DPT-07), and an additional three deep borings (at three of the MIP locations) will be advanced to a depth of 45 feet bgs. At the three deep borings, groundwater grab samples also will be collected for confirmation of MIP results (see Section 3.1.5). DPT soil and groundwater sample locations to be co-located with MIP locations will be selected based on MIP results. A summary of proposed sample locations and analytes is presented in Table 5.

Borings will be advanced using a DPT rig equipped with dual-tube system. Soil cores will be collected continuously using a dual-tube (DT22) system with PVC liners with an integrated core catcher. Soil samples will be collected at two depths in the vadose zone at each of the seven shallow DPT borings for analysis of VOCs by EPA Method 8260C. Samples will be collected with EnCore (or equivalent) samplers.

Soil samples will be collected at three depths, likely in the deep WBZ, at the three deep DPT borings (co-located with MIP locations, offset by approximately 2 feet) for analysis of VOCs by EPA Method 8260C. Samples will be collected with EnCore (or equivalent) samplers, and sample depths will be selected based on MIP results. Up to two deep WBZ groundwater samples will be collected and analyzed for VOCs using EPA Method 8260C at each of the three deep DPT borings. Groundwater samples will be collected using a screen point sample (SP-22). The tool string will be advanced to the desired depth, and the SP-22 screen will be inserted inside the outer rod, at which point the outer rod will be retracted, exposing the SP-22 screen. Polyethylene tubing will be inserted into the casing or inner drive rod, and a peristaltic pump will be used to collect a groundwater grab sample. Once groundwater sampling is complete, the SP-22 screen will be retrieved and the DT-22 soil sampling equipment will be reinstalled. The data will be used to confirm MIP results. Depths of groundwater samples will be selected based on MIP results.

Any soil samples that exhibit visible signs of NAPL such as staining, sheens, or a strong odor will be evaluated for DNAPL presence using the Sudan IV dye tests. Quality control (QC) samples will be collected in accordance with Section 3.8 of the QAPP (Appendix A). DPT borings will be grouted to grade with bentonite or bentonite slurry following completion of sampling activities with the surface restored with like-materials. The proposed DPT locations are presented on Figure 4.

3.1.5 Membrane Interface Probe

An MIP is a tool for detecting and semiquantitatively characterizing the distribution of VOCs in the subsurface. The probe will be equipped with PID, flame ionization detector, electron capture device, and electrical conductivity sensors. Additionally, an HPT will be installed on the probe to continuously characterize the hydraulic conductivity of the subsurface. The data from the probe will be collected continuously while the MIP is being advanced. Details of the MIP investigations include:

- Twelve locations will be advanced for evaluation using MIP.
- Ten locations (MIP-001 through MIP-010) will be advanced to 45 feet bgs, and two locations (MIP-011 and MIP-012) will be evaluated to 15 feet bgs, or until refusal is reached, whichever is encountered first.
- The deep borings will evaluate the potential source area and assess aquifer hydraulic characteristics within the northern portion of the Plant 5 Building and north of the Plant 5 Building along Hopkins Avenue.
- The shallow borings along Bigelow Street will assess the hydraulic characteristics of the shallow WBZ to assist with remedial alternative evaluations.
- As discussed in Section 3.1.4, three of the MIP locations will have follow-up DPT borings to collect soil and groundwater samples to confirm the semiquantitative MIP results. QC samples will be submitted in accordance with Section 3.8 of the QAPP (Appendix A).
- Following MIP removal, MIP locations will be immediately filled by using a tremie pipe to place a 95% Portland/5% Bentonite to seal the hole to minimize the potential for constituent migration.

The proposed MIP locations are presented on Figure 4.

3.1.6 Survey

Following installation, a licensed surveyor will survey the completed soil borings and monitoring wells. The horizontal and vertical locations for the monitoring well ground surface, steel flush-mount lid, and top of PVC well riser will be surveyed.

3.1.7 Groundwater Sampling

Two rounds of groundwater sampling will be performed at all of the 18 newly installed monitoring wells and RW-6D-R. One round of groundwater sampling for VOCs will be conducted at four of the existing wells (MW-1, MW-4, MW-23D, and MW-30S) to supplement the annual performance monitoring groundwater sampling. In addition, geochemical samples will be collected at nine existing wells and seven new wells during one round of groundwater sampling (see Table 6).

The groundwater sampling detailed below is in additional to the annual performance monitoring groundwater sampling, although the events likely will be combined. Details on the proposed groundwater sampling include:

- Samples will be collected using a peristaltic pump and standard low-flow techniques (EPA, 1996).
- Before purging, water levels and total depths of the wells will be measured. For wells near the shallow CBTEX plume, an interface probe will be used to detect the presence and thickness of any measurable light nonaqueous phase liquid, as well as the water level.
- Polyethylene tubing will be lowered to the middle of the well screen.
- Purging flow rate will range between 0.2 and 0.5 liter per minute, with a goal of maintaining a stable water level.

- Throughout purging, the field parameters will be measured every 3 to 5 minutes and will be considered stabilized when measurements meet the following criteria for three consecutive measurements:
  - pH: within 0.1 pH units
  - Temperature: within 1 degree Celsius
  - Specific conductance: within 3 percent
  - Dissolved oxygen: within 10 percent
  - Turbidity: within 10 percent or as low as practicable given sampling conditions
  - Oxidation reduction potential: within 10 millivolts
- Samples will be collected at all wells for analysis of VOCs by EPA Method 8260C.

During one event (preferably in conjunction with the annual performance monitoring event), groundwater samples will be collected to characterize the geochemistry of both the shallow and deep WBZ throughout the site (at seven of the newly installed wells, three wells not in the PMP, and six wells in the PMP). The geochemical sampling will be performed to support monitored natural attenuation assessments and to potentially assess other remedial options. Samples will be analyzed for:

- Alkalinity by SM-2320B
- Dissolved iron and manganese by SW846-6020A
- Nitrate and nitrite by SM-4500NO3-F
- Sulfate by EPA 300.0 or SW846-9056
- Sulfide by SW846-9030B/9034
- Methane/ethane/ethene gas by RSK 175
- Chloride by EPA 300 or SW846-9056
- TOC by SM-5310C

The wells to be sampled and analyses conducted are presented in Table 6. QC samples will be submitted in accordance with Section 3.8 of the QAPP (Appendix A). Proposed groundwater sample locations are presented on Figure 4.

3.2 Waste Management Plan

The waste streams anticipated during this project are soil cuttings, well development and purge water, a mixture of soil cuttings and drilling fluid, decontamination water containing surfactants, and personal protective equipment. The general details of their management are discussed in the following subsections.

3.2.1 Waste Characterization and Classification

Waste generated from these activities will be characterized and classified in accordance with Title 40 Code of Federal Regulations (CFR) Part 262.11 and 6 New York Codes, Rules, and Regulations (NYCRR) 371. Waste will be managed and disposed of in accordance with the requirements of EPA, NYSDEC, and Essex-Hope. Based on generator knowledge, environmental media that contains the following constituents are classified as listed hazardous wastes and have the waste code listed below:

- Acetone – U002
- Methylbenzene – U220
- Dimethylbenzene – U239

If wastes are not listed wastes, a combination of generator knowledge and appropriate analytical sampling will be used to determine if the waste has hazardous characteristics. In this case, wastes will be sampled and analyzed for the toxicity characteristic compounds listed in 40 CFR 261.24, Table 1 using

appropriate SW846 methods. The toxicity characteristic leaching procedure (SW846-1311) will be performed when appropriate. The corrosive characteristic for liquids will be assessed using either field pH data or through laboratory analysis. In addition, liquid waste will be tested through laboratory analysis for the characteristic of ignitability. Based on generator knowledge, the non-liquid wastes that will be generated during this work are not ignitable. Wastes are assumed not to have the characteristic of reactivity; however, sampling may be conducted for cyanide and sulfide. Additional analysis may be required by disposal facilities.

If sampling is required, the approach will be determined based on site history, composition of the waste stream, process generating the waste stream, and types of containers in which the waste is collected. Samples will be collected such that the results are representative of each waste stream. In general, for each waste stream, samples will be taken at the following frequency:

- One sample per 500 tons of solid media will be collected for solids accumulated in bulk containers.
- One sample per bulk container will be collected for liquids accumulated in bulk containers.
- One sample per 10 drums of each distinct waste stream will be collected for liquids or solids accumulated in drums.

Site conditions may dictate deviations from these guidelines, which will be documented in the investigation report.

3.2.2 Waste Staging and Management

Given the high likelihood that wastes generated will be hazardous, waste containers will be managed in accordance with the substantive requirements of 6 NYCRR 373 and 40 CFR 265 Subpart I. 6 NYCRR 373-1.1(d)(iii)(a) prohibits staging more than 8,800 gallons of liquid waste in each storage area. Based on the configuration of the site, there is a single area, and assuming that each 55-gallon container would be filled with only 50 gallons or less of liquid waste, this translates to a limitation of 176 drums of liquid waste onsite at any time. There is not a similar limitation for solids. In accordance with 6 NYCRR 373-3.29(a)(2)(v), waste containers generated as part of a remedial action are exempt from the air emission standards for containers. Wastes generated will be removed from the site within 90 days of the day of generation. It is anticipated that well development and purge water will be disposed of using the existing, permitted onsite groundwater treatment system.

Drums and other small containers will be inspected before being placed in service. Any container that is not structurally sound or otherwise compatible with the waste will not be used. Drums will be arranged in rows of not more than two drums wide with 3 feet of space between rows. Each container will be provided with its own visible label. Containers will be kept closed except when adding or removing waste and will be disposed of with their contents.

Waste containers will be immediately labeled and dated appropriately at the same time that waste is first placed in the container. Hazardous waste will be labeled with the words “Hazardous Waste,” the accumulation start date, the generator contact information (name, address, and phone number), and the EPA generator identification number. The waste manifest number and other marking and labeling information required by 49 CFR will be added to the label before offsite shipment.

Waste accumulation areas including secondary containment structures will be inspected at least weekly for malfunctions, deterioration, discharges, and leaks that could result in a release. The inspection will be documented, and any deficiencies observed or noted during inspection will be corrected immediately.

3.2.3 Shipping Documentation, Transportation, and Disposal

Hazardous and nonhazardous wastes that are generated during the investigation will be disposed of in the United States at a treatment, storage, and disposal facility that is permitted under Resource

Conservation and Recovery Act Subtitles C or D, respectively. Alternatively, a wastewater treatment plant that is permitted under an Industrial Waste Discharge Permit with the Jamestown Board of Public Utilities may be used. In addition, given the close proximity to the Canadian border, wastes may be shipped to facilities in Canada that are properly permitted to accept such waste. Uncontaminated debris and trash will be disposed of at a local transfer station.

Wastes will be shipped on the appropriate manifests for their designation (Universal Hazardous Waste Manifest or Nonhazardous Waste Manifest). Transportation subcontractors must be appropriately licensed for the type of waste that they are transporting. The designated offsite facility will be responsible for providing a copy of the fully executed waste manifest and a certificate of treatment or disposal for each load of waste received. If a copy of the completed manifest is not received within 35 days, the transporter and disposal facility will be contacted to determine the whereabouts of the waste. If a copy is not received within 45 days, an exception report will be filed.

SECTION 4

Quality Assurance Project Plan

The QAPP is presented in Appendix A.

SECTION 5

Other Planning Documents

The documents listed in this section were prepared to define the technical approach, project data quality objectives, proposed field investigation activities and methodologies, personal assignments, planned reporting, and project milestones.

5.1 Community Air Monitoring Plan

The Community Air Monitoring Plan (CAMP) is limited because of the generally small scope. The CAMP was developed for use during intrusive field activities at the site to provide a measure of protection for the downwind community. During implementation of the work, methods for monitoring VOCs and particulates and, if necessary, controls to limit VOCs and/or particulates that will be implemented.

Using a handheld PID, VOCs will be monitored at the upwind and downwind perimeter of the immediate work area beginning at the start of each workday and intermittently throughout the day during intrusive activities. The following actions will be taken if the total VOC vapors at the downwind perimeter of the work area or exclusion zone meet the following concentrations:

- Exceeds 5 ppm above background for the 15-minute average, work activities will be temporarily halted and monitoring will continue. If the total organic vapor level readily decreases below 5 ppm over background, work activities can resume with continued monitoring.
- Persists at levels in excess of 5 ppm over background but less than 25 ppm, work activities will be halted, the source of vapors will be identified, corrective actions will be taken to abate emissions, and monitoring will continue.
- Is above 25 ppm, activities will be shut down, and corrective actions will be taken. Corrective actions could include temporarily suspending advancement into subsurface allowing time to passively vent, relocating the boring, and rapidly containerizing cuttings.

If action levels are exceeded, the NYSDEC project manager will be notified within 1 business day. The notification will include the results observed, mitigation actions and effectiveness of such actions, and any planned modifications to the work plan, if necessary to prevent a recurrence of the exceedance.

Readings will be recorded and be available for the NYSDEC and New York State Department of Health (NYSDOH) personnel to review.

5.2 Health and Safety Plan

A site-specific Health and Safety Plan (HSP) is included in Appendix B that identifies potential task-specific hazards and selects appropriate health and safety protective measures addressing accident prevention, personal protection, and emergency response procedures for the field activities.

SECTION 6

Reporting and Schedule

6.1 Schedule

Schedule milestones have been established based on the assumption that an approved work plan is in place by July 2016. Field activities will not proceed until NYSDEC approves the work plan. In the event of changes in availability of regulatory staff, project approach, or site conditions, a revised schedule will be provided to NYSDEC. The anticipated schedule milestones are as follows:

Date	Milestone
Early July 2016	Submit work plan to NYSDEC and NYSDOH for review
July 2016	Meet with NYSDEC and NYSDOH to go over work plan
July 2016	Obtain NYSDEC approval on work plan
August/September 2016	Mobilize for fieldwork
September 2016	Complete intrusive fieldwork
October 2016	Complete first groundwater sample event in conjunction with performance monitoring sampling
April 2017	Submit report as part of the annual PMP

6.2 Deliverables

CH2M will develop a report describing the chemical, geotechnical, and delineation activities data and results. The report will include a summary of the field activities performed and present boring logs and tables and a MIP report. The report will be submitted to NYSDEC and NYSDOH as an appendix to the PMP for 2016. Electronic data deliverables will be submitted to NSYDEC.

A meeting with NYSDEC will be set up to discuss the results and proposed path forward.

SECTION 7

References

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Tables

Table 4. Planned Well Installations and Soil Sampling

Essex-Hope Site, Jamestown, New York

Proposed Well Name	WBZ	Soil Analytical	Geotechnical						Rationale/Notes
		VOCs by 8260C	Grain Size (ASTM D422)	Percent Moisture	Atterberg Limits	Bulk Density	pH	TOC (Lloyd Kahn)	
RW-6D-R	Deep	**1**	12	3	3	3	3	3	Replace RW-6D with well that will not produce as much silt Assess vadose zone conditions near Plant 5 Building Collect shallow soil for full geotech Collect silty clay for full geotech Collect deep fine sand grain size samples every 2 ft from 20-22 to 38-40 for well screen design Collect 1 deep fine sand for full geotech Assess vadose zone conditions near Plant 5 Building
MW-101S	Shallow								Monitor shallow groundwater conditions near offsite TCE plume
MW-102S	Shallow								Monitor shallow groundwater conditions near offsite TCE plume
MW-103S	Shallow								Monitor shallow groundwater conditions near offsite TCE plume
MW-104S	Shallow								Monitor shallow groundwater offsite TCE plume
MW-105S	Shallow								Monitor shallow groundwater offsite TCE plume
MW-106S	Shallow								Monitor shallow groundwater offsite TCE plume
MW-106D	Deep		3	3	3	3	3	3	Monitor groundwater conditions downgradient of deep TCE/acetone plume Collect shallow sand and gravel for full geotech Collect silty clay for full geotech Collect deep fine sand for full geotech In area of potential shallow injections
MW-107S	Shallow		1	1	1	1	1	1	Monitor shallow groundwater offsite TCE plume Collect shallow sand and gravel for full geotech In area of potential downgradient shallow injection
MW-108S	Shallow								Monitor shallow groundwater offsite TCE plume
MW-109S	Shallow								Monitor shallow groundwater offsite TCE plume
MW-110D	Deep								Monitor groundwater conditions downgradient of deep TCE/acetone plume
MW-111D	Deep	2							Monitor deep WBZ at southeastern edge of deep TCE plume Assess vadose zone conditions in southern portion of north parking lot
MW-112S	Shallow								Monitor shallow CBTEX plume core
MW-113D	Deep		3	3	3	3	3	3	Assess deep WBZ conditions beneath shallow CBTEX plume Collect shallow sand and gravel for full geotech Collect silty clay for full geotech Collect deep fine sand for full geotech
MW-114S	Shallow	2							Delineate shallow CBTEX plume to west Assess vadose zone conditions under western portion of West Building
MW-115D	Deep	2							Assess deep WBZ conditions at former AST area Assess vadose zone conditions in former AST area
MW-116S	Shallow								Assess upgradient shallow groundwater conditions
MW-117S	Shallow								Assess upgradient shallow groundwater conditions

Notes:
Shallow wells will 2-inch-diameter Schedule 40 PVC wells with 5' 0.010-inch slot screens from approximately 10-15' bgs
Deep wells will be 2-inch-diameter Schedule 40 PVC wells with 10' 0.010-inch slot screen from approximately 30-40' bgs
RW-6D-R is an extraction well that will be constructed using 6-inch-diameter PVC and a custom-designed wire-wrapped screen.
Example Field Sample ID: MW-113D_dd-dd_YYYYMMDD
A Field Duplicate will be collected and analyzed for the same parameters as the parent sample at a frequency of 1 duplicate for every 10 samples
MS/MSD pairs will be analyzed at a frequency of 1 pair for every 20 samples (Add "MS" or "SD" to end of ID)
Soil samples submitted for VOC analysis will be collected from the vadose zone

Table 5. Planned DPT Soil and Groundwater Sampling

Essex-Hope Site, Jamestown, New York

Proposed Location Name	Depth (ft bgs)	Soil		Groundwater Analytical	Rationale/Notes
		Sudan IV Dye Test	VOCs by 8260C	VOCs by 8260C	
DPT-001	10		2		Assess vadose zone conditions in eastern former UST area
DPT-002	10		2		Assess vadose zone conditions in eastern former UST area
DPT-003	10		2		Assess vadose zone conditions in eastern former UST area
DPT-004	10		2		Assess vadose zone conditions in former AST area
DPT-005	10		2		Assess vadose zone conditions in north parking lot area
DPT-006	10		2		Assess vadose zone conditions in north parking lot area
DPT-007	10		2		Assess vadose zone conditions in north parking lot area
MIP-003*	45	3	3	2	Collect samples to confirm/quantify MIP results; depths and location to be selected based on MIP results
MIP-007*	45	3	3	2	Collect samples to confirm/quantify MIP results; depths and location to be selected based on MIP results
MIP-010*	45	3	3	2	Collect samples to confirm/quantify MIP results; depths and location to be selected based on MIP results

Notes:

*MIP locations for confirmation soil and groundwater sampling will be chosen based on MIP results

DPT-001 through DPT-007 soils will be collected from the vadose zone, above the water table

Example Field Sample ID: DPT-001_dd-dd_YYYYMMDD

A Field Duplicate will be collected and analyzed for the same parameters as the parent sample at a frequency of 1 duplicate for every 10 samples (Add "D" to end of ID)

MS/MSD pairs will be analyzed at a frequency of 1 pair for every 20 samples (Add "MS" or "SD" to end of ID)

Table 6. Planned Monitoring Well Groundwater Sampling

Essex-Hope Site, Jamestown, New York

					Event 1		Event 2		
					Groundwater Analytical		Groundwater Analytical		Rationale/Notes
Well Name	WBZ	New Well	Existing Well in PMP	Existing Well not in PMP	VOCs by 8260C	Geochemical	VOCs by 8260C	Geochemical	
MW-4	Shallow			X			X		Assess shallow groundwater conditions at upgradient well
MW-15D	Deep		X					X	Assess geochemical conditions in deep TCE plume core
MW-1	Shallow			X			X	X	Assess upgradient shallow geochemical conditions
MW-22D	Deep		X					X	Assess geochem of deep downgradient TCE plume
MW-23D	Deep			X			X	X	Assess upgradient deep geochemical conditions
MW-25S	Shallow		X					X	Assess geochem of shallow TCE plume core
MW-26S	Shallow		X					X	Assess geochem of downgradient BTEX plume near site boundary
MW-27S	Shallow		X					X	Assess geochem of downgradient BTEX plume near site boundary
MW-30S	Shallow			X			X	X	Assess geochem of CBTEX plume in core; Monitor groundwater conditions in area with highest CBTEX concentrations
MW-7D	Deep		X					X	Assess geochem of deep TCE plume core
RW-6D-R	Deep	X			X	X	X		Replace RW-6D; assess geochem of deep Acetone/TCE
MW-101S	Shallow	X			X		X		Monitor shallow groundwater conditions near offsite TCE plume
MW-102S	Shallow	X			X		X		Monitor shallow groundwater conditions near offsite TCE plume
MW-103S	Shallow	X			X		X		Monitor shallow groundwater conditions near offsite TCE plume
MW-104S	Shallow	X			X		X		Monitor shallow groundwater offsite TCE plume
MW-105S	Shallow	X			X		X		Monitor shallow groundwater offsite TCE plume
MW-106S	Shallow	X			X	X	X		Monitor shallow groundwater offsite TCE plume Assess geochem of shallow TCE plume core
MW-106D	Deep	X			X	X	X		Monitor groundwater conditions downgradient of deep TCE/acetone plume Assess geochem of downgradient TCE plume fringe
MW-107S	Shallow	X			X	X	X		Monitor shallow groundwater offsite TCE plume Assess geochem of shallow TCE plume core
MW-108S	Shallow	X			X		X		Monitor shallow groundwater offsite TCE plume
MW-109S	Shallow	X			X		X		Monitor shallow groundwater offsite TCE plume
MW-110D	Deep	X			X		X		Monitor groundwater conditions downgradient of deep TCE/acetone plume
MW-111D	Deep	X			X		X		Monitor deep WBZ at southeastern edge of deep TCE plume
MW-112S	Shallow	X			X	X	X		Assess geochem of shallow CBTEX Monitor shallow CBTEX plume core
MW-113D	Deep	X			X		X		Assess deep WBZ conditions beneath shallow CBTEX plume
MW-114S	Shallow	X			X		X		Delineate shallow CBTEX plume to west
MW-115D	Deep	X			X	X	X		Assess deep WBZ conditions at former AST area Assess upgradient deep geochem
MW-116S	Shallow	X			X	X	X		Assess upgradient shallow groundwater conditions Assess upgradient shallow geochem
MW-117S	Shallow	X			X		X		Assess upgradient shallow groundwater conditions

Notes:

Geochemical Constituents include: ORP, DO, pH, conductance, Temperature by field methods; alkalinity, dissolved iron, dissolved manganese, nitrate, nitrite, sulfate, sulfide, MEE (by RSK 175), chloride, TOC

Example Field Sample ID: MW-101S-YYYYMMDD

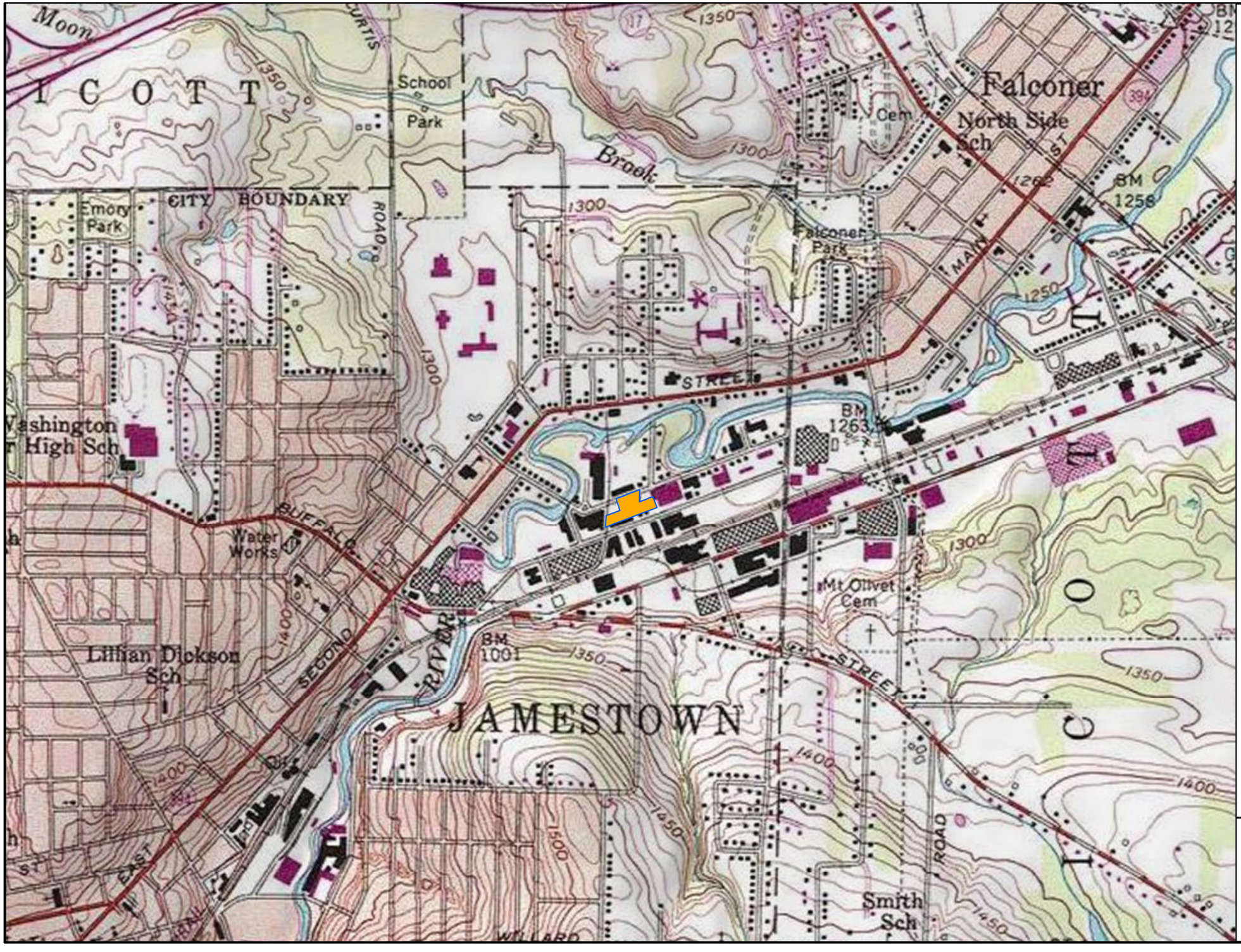
A Field Duplicate will be collected and analyzed for the same parameters as the parent sample at a frequency of 1 duplicate for every 10 samples (Add "D" to end of ID)

MS/MSD pairs will be analyzed at a frequency of 1 pair for every 20 samples (Add "MS" or "SD" to end of ID)

Wells in the PMP will be sampled for VOCs as part of the annual performance monitoring sampling

Figures

C:\Work\Boston\Jamestown\Mapfiles\CSM\Jamestown_CSM_Fig03-01_Topo.mxd mcotterb 11/10/2015



Legend

Approximate Area of Jamestown Site

N

0 1,000 2,000 Feet

1 inch = 1,000 feet

FIGURE 1
TOPOGRAPHIC SETTING
2016 EVALUATION WORK PLAN
JAMESTOWN, NEW YORK

ch2m

C:\Work\Boston\Jamestown\Mapfiles\CSM\Jamestown_CSM_Fig01-01_SiteAreas.mxd mcotterb 10/16/2015

Legend

- Approximate Site Boundary
- Parcel Boundary

N

0 60 120 Feet

1 inch = 60 feet

FIGURE 2
ESSEX/HOPE SITE AREAS
2016 EVALUATION WORK PLAN
JAMESTOWN, NEW YORK

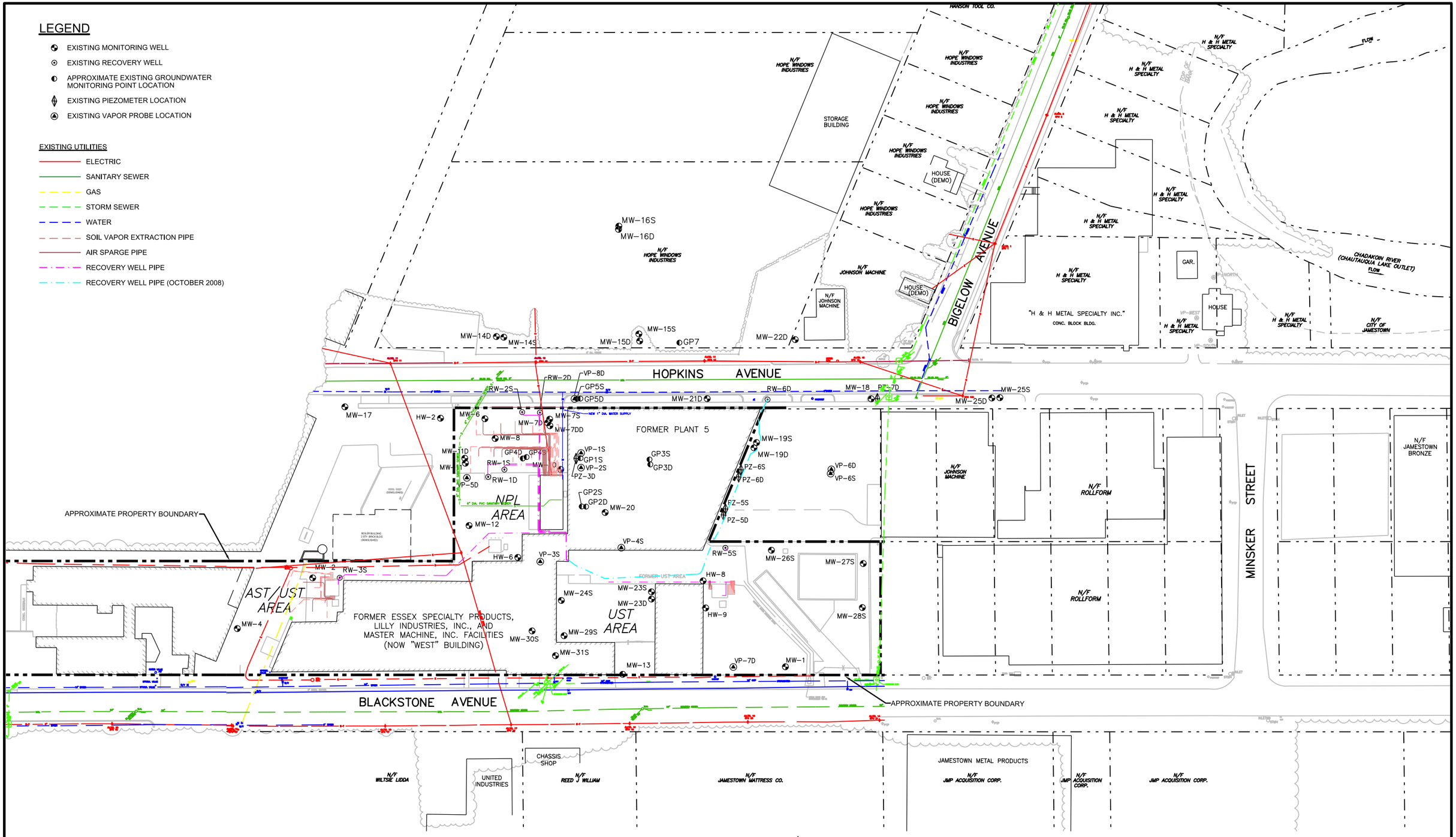
ch2m

LEGEND

- EXISTING MONITORING WELL
- EXISTING RECOVERY WELL
- APPROXIMATE EXISTING GROUNDWATER MONITORING POINT LOCATION
- EXISTING PIEZOMETER LOCATION
- EXISTING VAPOR PROBE LOCATION

EXISTING UTILITIES

- ELECTRIC
- SANITARY SEWER
- GAS
- STORM SEWER
- WATER
- SOIL VAPOR EXTRACTION PIPE
- AIR SPARGE PIPE
- RECOVERY WELL PIPE
- RECOVERY WELL PIPE (OCTOBER 2008)



SITE PLAN

0 40 80 120
SCALE IN FEET

Figure 3
Existing Sample Locations and Utilities
DOW CHEMICAL CORPORATION
ESSEX/HOPE SITE
CITY OF JAMESTOWN, NEW YORK

662242
005-F-0003_674604.dgn

LEGEND

- EXISTING MONITORING WELL
- EXISTING RECOVERY WELL
- APPROXIMATE EXISTING GROUNDWATER MONITORING POINT LOCATION
- EXISTING PIEZOMETER LOCATION
- EXISTING VAPOR PROBE LOCATION
- PROPOSED MEMBRANE INTERFACE PROBE (MIP)
- PROPOSED MEMBRANE INTERFACE PROBE (MIP) SHALLOW
- PROPOSED DEEP MONITORING WELL
- PROPOSED SHALLOW MONITORING WELL
- PROPOSED SHALLOW SOIL SAMPLE (DPT)
- PROPOSED RECOVERY WELL
- EXISTING WELLS TO BE SAMPLED (ALL NEW WELLS WILL BE SAMPLED) (MW-4, MW-15D, MW-1, MW-22D, MW-23D, MW-25S, MW-26S, MW-27S, MW-30S, MW-7D)
- WELL INSTALLATION LOCATION WHERE GEOTECHNICAL SOIL SAMPLE WILL BE COLLECTED (RW-6D-R, MW-106D, MW-107S, MW-113D)
- WELL INSTALLATION LOCATION WHERE ANALYTICAL SOIL SAMPLE WILL BE COLLECTED (MW-115D, RW-6D-R, MW-114S, MW-111D)

HANSON TOOL CO.
N/F HOPE WINDOWS INDUSTRIES
STORAGE BUILDING
HOUSE (DEMO)
N/F H & H METAL SPECIALTY
N/F JOHNSON MACHINE
"H & H METAL SPECIALTY INC." CONC. BLOCK BLDG.
GAR.
HOUSE
N/F CITY OF JAMESTOWN
CHADAKOIN RIVER (CHAUTAUQUA LAKE OUTLET)
FLOW
TOP BANK
BIGELOW AVENUE
HOPKINS AVENUE
BLACKSTONE AVENUE
MINSKER STREET
N/F JAMESTOWN BRONZE
N/F ROLLFORM
MW-104S
MW-105S
MW-109S
MW-108S
MW-107S
MW-16S
MW-16D
MW-110D
MW-103S
MW-22D
MW-106S
MW-106D
MW-15D
MW-14D
MW-14S
MW-15S
GP7
MIP-001
MIP-002
MIP-003
MIP-012
MW-101S
MW-102S
RW-6D-R
MIP-004
MIP-005
MIP-006
MIP-011
MW-25D
MW-25S
MW-17
HW-2
MW-6
MW-7S
MW-7D
MW-7DD
DPT-07
MW-8
MW-11D
MW-11
DPT-06
GP4D
GP4S
MW-10
RW-1S
RW-1D
VP-5D
MW-19S
MW-19D
PZ-6S
PZ-6D
VP-6D
VP-6S
PZ-5S
PZ-5D
MIP-007
FORMER PLANT 5
MIP-008
MIP-009
MIP-010
GP1S
GP2S
GP2D
GP3S
GP3D
MW-20
MW-12
DPT-05
NPL AREA
APPROXIMATE PROPERTY BOUNDARY
DPT-04
MW-2
RW-3S
HW-6
MW-111D
VP-3S
VP-4S
DPT-01
DPT-02
MW-26S
MW-27S
FORMER UST AREA
HW-8
HW-9
MW-23S
MW-23D
MW-24S
MW-28S
DPT-03
VP-7D
MW-1
AST/UST AREA
MW-115D
MW-4
MW-112S
MW-113D
MW-30S
FORMER ESSEX SPECIALTY PRODUCTS, LILLY INDUSTRIES, INC., AND MASTER MACHINE, INC. FACILITIES (NOW "WEST" BUILDING)
MW-114S
MW-116S
MW-117S
MW-29S
MW-31S
MW-13
UST AREA
APPROXIMATE PROPERTY BOUNDARY
N/F WILTSIE LIDDA
UNITED INDUSTRIES
CHASSIS SHOP
N/F REED J WILLIAM
N/F JAMESTOWN MATTRESS CO.
JAMESTOWN METAL PRODUCTS
N/F JMP ACQUISITION CORP.
N/F JMP ACQUISITION CORP.
N/F JMP ACQUISITION CORP.

NOTE:
1. THREE MEMBRANE INTERFACE PROBE LOCATIONS WILL BE SAMPLED BY DPT FOR SOIL ANALYTICAL SAMPLES AND GROUNDWATER GRAB SAMPLES.

SITE PLAN

N

0 40 80 120
SCALE IN FEET

Figure 4
Proposed Sample Locations

DOW CHEMICAL CORPORATION
ESSEX/HOPE SITE
CITY OF JAMESTOWN, NEW YORK

ch2m:

662242
005-F-0004_674604.dgn

Appendix A
Quality Assurance Project Plan

DRAFT

Quality Assurance Project Plan, Site Characterization Investigation Activities, Essex-Hope Site, Jamestown, New York

Prepared for

Essex Specialty Products, Inc.

June 2016

ch2m

Contents

Tables

Appendixes

Acronyms and Abbreviations

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
%R	percent recovery
°C	degrees Celsius
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
CH2M	CH2M HILL
CLP	Contract Laboratory Program
COC	chain-of-custody
DQO	data quality objective
EDD	electronic data deliverable
FTL	field team leader
H_2SO_4	sulfuric acid
HCl	hydrochloric acid
HNO_3	nitric acid
ID	identification
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LIMS	Laboratory Information Management System
MDL	method detection limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mL	milliliter
MS	matrix spike
MSD	matrix spike duplicate
NA	not applicable
NaOH	sodium hydroxide
NELAP	National Environmental Laboratory Accreditation Program
NYSDEC	New York State Department of Environmental Conservation
oz	ounce
PDF	portable document format
PM	project manager

QA	quality assurance
QAM	quality assurance manual
QAPP	quality assurance project plan
QC	quality control
RAO	remedial action objective
RL	reporting limit
ROD	Record of Decision
RPD	relative percent difference
RRF	relative response factor
SOP	standard operating procedure
SOW	scope of work
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound

SECTION 1

Project Management

This document presents the project specific Quality Assurance Project Plan (QAPP) for site characterization and investigative activities being conducted at the Essex-Hope State Superfund site located at 125 Blackstone Avenue in Jamestown, New York (site) in accordance with the Site Characterization Investigation Work Plan (CH2M HILL [CH2M] 2016)

This QAPP has been prepared to provide the guidelines and procedures for implementing the analytical and field activities performed at the site. This QAPP has been prepared in accordance with the U.S. Environmental Protection Agency's (USEPA's) *Requirements for Quality Assurance Project Plans* (USEPA 2001).

This document specifies the policies, objectives, organization, functional activities, and quality assurance (QA) and quality control (QC) criteria designed to achieve data quality objective (DQO) goals of the field sampling and ensuing analytical laboratory support for the site. This QAPP complements the project-specific work plan prepared separately to provide a more-detailed understanding of the scope of work (SOW) and additional guidance on field procedures and protocols.

1.1 Project Objectives and Background

1.1.1 Site Description

The project objectives and background are provided in detail in Section 2 of the work plan.

1.1.2 Site History

The site history is provided in detail in Section 2 of the work plan.

1.1.2.1 West Building and Former AST and UST Areas

The background and history of the West Building and former aboveground storage tank (AST) and former underground storage tank (UST) areas are provided in detail in Section 2.1.2 of the work plan.

1.1.2.2 Plant 5 Building and North Parking Lot

The background and history of the Plant 5 Building and the North Parking Lot are provided in detail in Section 2.1.1 of the work plan.

1.1.3 Remedial Actions

The historical remedial actions taken at the site are provided in Section 2.6 of the work plan.

1.2 Project/Task Description

The investigation SOW and related project tasks are provided in detail in Sections 1.1 and 3 of the work plan.

1.3 Project Task/Organization

The project organization and responsibilities are presented in Section 1.2 of the work plan.

1.3.1 Contract Laboratories

The selected laboratories are responsible for analyzing samples collected during field activities, in accordance with the QAPP, the laboratory's quality assurance manual (QAM), and the referenced

methods. The laboratory project manager (PM) or client service manager acts as a liaison between the project chemist, the field and laboratory operations, and is responsible for the following:

- Receipt of sample custody from the field team members, verification of sample integrity, and transfer of sample fractions to the appropriate analytical departments
- Coordination of sample analyses to meet project objectives
- Preparation of analytical reports
- Review of laboratory data for compliance with method requirements
- Review of any QC deficiencies reported by the analytical department manager
- Coordination of necessary changes
- Completion of data package deliverables
- Communication with the project chemist pertaining to analytical and QC issues
- Response to questions from the project team during the data quality evaluation process

1.3.2 Subcontractors

Subcontractors may be used for any of the activities in the QAPP and are required to read and understand this document. These potential subcontractor activities will be addressed in the project-specific work plans.

1.4 Special Training Requirements/Certification

CH2M personnel engaged in field activities will have completed the Occupational Safety and Health Administration 40-hour health and safety training that meets the requirements of 29 Code of Federal Regulations (CFR) 1910.120 and Title 8 CFR 5192 and will have completed a site-specific safety training orientation with the CH2M technical or compliance managers. Subcontracted personnel will be notified by the health and safety manager on what requirements need to be met prior to sampling. Subcontracted project personnel will read the project-specific health and safety plan. Documentation will be maintained to demonstrate that requirements of the plan are followed.

Subcontracted laboratories and lower-tiered subcontracted laboratories participating in analytical services will be certified by the National Environmental Laboratory Accreditation Program (NELAP) and the state of New York for the requested parameters. The laboratory managers will be responsible for ensuring personnel have been properly trained and are qualified to perform their assigned tasks.

SECTION 2

Data Quality Indicators

2.1 Data Precision, Accuracy, Comparability, Completeness, and Sensitivity

Field QA/QC samples and laboratory internal QA/QC samples will be collected and analyzed to assess the data's usability. The laboratory's standard operating procedures (SOPs) provide acceptance criteria for precision and accuracy requirements for these QC samples to assess their usability. Completeness is the percentage of usable data obtained during the sampling event, and its acceptance criteria is project-specific.

2.1.1 Precision

Precision is a measure of reproducibility of analytical results. It can be defined as the degree of mutual agreement among individual measurements obtained under similar conditions. Total precision is a function of the variability associated with both sampling and analysis.

Precision of laboratory analysis will be assessed by comparing the analytical results between the laboratory control sample (LCS)/laboratory control sample duplicates (LCSDs), matrix spike (MS)/matrix spike duplicates (MSDs), and laboratory duplicates. The precision of the field sampling procedures will be assessed by reviewing field duplicate sample results. The relative percent difference (RPD) will be calculated for the duplicate samples using the following equation:

$$RPD = \{(S - D)/[(S + D)/2]\} \times 100$$

Where: S = First sample value (original value)
D = Second sample value (duplicate value)

A control limit of ± 30 percent for the RPD will be used for original and field duplicate concentrations greater than five times the reporting limit (RL) in water matrices. A control limit of ± 50 percent for the RPD will be used for original and field duplicate concentrations greater than five times the RL in soil matrices. A control limit of ± two times the RL will be used for waters and ± four times the RL for soil when concentrations are reported as less than five times the RL.

A control limit ± 20 percent will be used for LCS/LCSD and MS/MSD precision criteria in water matrices and ± 30 percent for soil matrices associated with organic analyses. A control limit of ± 20 percent for both water and soil matrices will be used for inorganic analyses.

A control limit of ± 20 percent for water and ± 35 for soil will be used for laboratory duplicate concentrations greater than five times the RL. A control limit of ± the RL for water and ± two times the RL for soil will be used when concentrations are less than five times the RL.

2.1.2 Accuracy

Accuracy is of the degree of agreement between an observed value and a "true" value (correctness) and includes a combination of the random error (precision) and systematic error (bias) components that result from the sampling and analytical procedures. It reflects the total error associated with a measurement. A measurement is considered accurate when the reported value agrees with the true value or known concentration of the spike or standard within acceptable limits.

Accuracy of laboratory results will be assessed for compliance with the established QC criteria using the analytical results of method blanks/field blanks, reagent/preparation blanks, LCS/LCSD samples, MS/MSD samples, and surrogate spikes. Laboratory results accuracy will be assessed for compliance

with the established QC criteria described in the SOPs. The percent recovery (%R) of LCSs will be calculated using the following equation:

$$\%R = (A/B) \times 100$$

Where: A = The analyte concentration determined experimentally from the LCS
B = The known amount of concentration in the sample

The accuracy criteria for the QA/QC samples are those stated in Appendix A.

2.1.3 Completeness

The data completeness of laboratory analyses results will be assessed for compliance with the amount of data required for decision making. Complete data are data that are not rejected for projected use. Data qualified with qualifiers such as a "J" or a "UJ" are still deemed acceptable and can still be used to make project decisions. The completeness of the analytical data is calculated using the following equation:

$$\% \text{ Completeness} = [(\text{Valid data obtained}) / (\text{Total data planned})] \times 100$$

The completeness goal is 95 percent for aqueous samples and 90 percent for soil samples.

2.1.4 Representativeness

Representativeness is the degree to which sampling data accurately and precisely represent facility conditions, and depends on sampling and analytical variability and the variability of environmental media at the facility. Representativeness is a qualitative "measure" of data quality.

The goal of achieving representative data in the field starts with a properly designed and executed sampling program that carefully considers the overall DQOs for the project. Proper location controls and sample handling are critical to obtaining representative samples.

The goal of achieving representative data in the laboratory is measured by assessing accuracy and precision. A laboratory will provide representative data when all of the analytical systems are in control; therefore, representativeness is a redundant DQO for laboratory systems if proper analytical procedures are followed and holding times are met.

In addition, laboratories must demonstrate that the laboratory staffs are qualified to perform the analyses, are certified, and are proficient with analytical methods being employed.

2.1.4.1 Comparability

Comparability is the degree of confidence with which one data set can be compared to another. Comparability is a qualitative "measure" of data quality.

The goal of achieving comparable data in the field starts with a properly designed and executed sampling program that carefully considers the overall DQOs for the project. Proper location controls and sample handling are critical to obtaining comparable samples.

The goal of achieving comparable data in the laboratory is measured by assessing accuracy and precision. A laboratory will provide comparable data when all of the analytical systems are in control; therefore, comparability is a redundant DQO for laboratory systems if proper analytical procedures are followed and holding times are met.

2.1.4.2 Sensitivity

Sensitivity is defined as the ability of the method or instrument to detect the constituent of concern and other target compounds at the level of interest. Appropriate sampling and analytical methods that have method detection and quantification limits that support the achievement of the desired sensitivity and established performance criteria will be selected.

2.2 Method Detection Limits and Reporting Limits

2.2.1 Method Detection Limits

The method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. Each participating laboratory will determine the MDL for each method, matrix, and analyte for each instrument that will be used to analyze samples. The MDLs will be initially determined before analyzing samples, and will be verified at least annually in accordance with NELAP requirements.

2.2.2 Reporting Limits

RLs should be greater than two times the calculated MDL. RLs used by the laboratory should not be greater than the detection limit objectives presented in Appendix A.

Analytes that are not detected greater than the RL will be reported as not detected at the RL and flagged "U". Detects below the RL (but above the MDL) will be reported with the appropriate laboratory flag/qualifier ("J").

RLs, as well as sample results shall be reported to two significant figures if less than 10 and to three significant figures otherwise. RLs shall be reported on a dry-weight basis for soil samples.

SECTION 3

Data Generation and Acquisition

This section describes the procedures for collection, handling, measurement, data acquisition, and management activities to be performed in support of field investigations. It addresses the following aspects of measurement and data acquisition:

- Sampling process design
- Sampling method requirements
- Sample handling and custody requirements
- Analytical method requirements
- QC requirements
- Instrument and equipment testing, inspection, and maintenance requirements
- Instrument calibration and frequency
- Inspection and acceptance requirements for supplies and consumables
- Data acquisition requirements
- Field and laboratory instrument and equipment testing, inspection, and maintenance requirements
- Data management

3.1 Measurement Performance Criteria

Each measurement performance criterion is checked on several levels, as follows:

- Built-in QC standards
- Senior review
- Management controls

The measurement data will be given specific QC standards by which they must abide. If these standards are not met, the data will be qualified. The analytical data and the QC results will be checked by the bench chemist, the laboratory's QA manager, and a CH2M data validator.

3.2 Senior Review/Management Controls

All documents that pertain to the quality standards of the project are drafted by and reviewed internally by CH2M personnel with relevant technical experience. While performing field sampling activities, the field team leader (FTL) will supervise activities to assess if SOPs are being followed. Specific QC checks and corrective action measures for the data are described in Appendix A.

3.3 Sampling Process Design and Rationale

Project-specific sampling plans will be developed following the logical process provided in USEPA's *Guidance on Systemic Planning using the Data Quality Objective Process* (USEPA 2006). The sampling design is a function of the matrix sampled, information about the sampling site, the type of data to be collected, and how the data are to be used. These sampling plans will be incorporated in the site work plan.

3.3.1 Sampling Method Requirements

Sampling methods are described in the work plan. Detailed SOPs for the common methods have been prepared and are in the work plan. These SOPs include instructions for the following procedures:

- Field parameter measurement
- Surface soil sample collection

- Subsurface soil sample collection
- Water sample collection
- Decontamination and cleaning of sampling equipment

3.4 Sample Handling and Custody Requirements

3.4.1 Sample Handling, Preservation, Transportation, and Storage Procedures

Laboratories will provide the required sample containers for all environmental and associated QC samples. Containers will be certified free of the analytes of concern for this project. No sample containers will be reused. The contract laboratory will add preservatives, if required, before shipping the sample containers to the field. Upon receipt of the samples, the laboratory will verify the adequacy of the preservation and add additional preservatives if necessary. Adjustments made by the laboratory will be documented on the appropriate sample receipt forms and noted in the case narrative. The analytical methods, sample containers, minimum quantities, required preservatives, and maximum holding times for select parameters are shown in Table 3-1. Extraction and preparatory methods are shown in Table 3-2.

Table 3-1. Required Analytical Method, Sample Containers, Preservation, and Holding Times
Essex-Hope Site, Jamestown, New York

Analyses	Analytical Method	Sample Matrix[a]	Container[b]	Qty	Preservative[c]	Holding Time [d]
Volatile Organic Compounds	SW-846 8260C	W	40-mL, glass	3	HCl, pH<2; cool to 4°C	14 days
		S	5 g–Encore or equivalent sampling technique	3	Cool 4°C	48 hours from collection to preservation, 14 days to analysis
Select Metals (Dissolved)	SW-846 6020A	W	500-mL polyethylene	1	Field filter if dissolved; HNO_3, pH < 2; Cool 4°C	180 days
Dissolved Gases (Methane, Ethane, Ethene)	RSK-175	W	40-mL VOA vial	2	HCl, pH<2; cool to 4°C	14 days
Total Organic Carbon	SM 5310C/LloydKahn	W	40-mL, glass	2	H_2SO_4 pH < 2; Cool 4°C	28 days
		S	4-oz glass	1	Cool 4°C	28 days
Percent Moisture	EPA 160.3/ASTM D2216	S	16-oz glass	1	None	NA
Chloride, Sulfate	EPA 300.0 or SW-846 9056	W	250-mL polyethylene	1	Cool 4°C	28 days
Nitrate, Nitrite	SM 4500NO3-F	W	250-mL polyethylene	1	Cool 4°C	48 hours
Sulfide	SW-846 9030B/9034	W	500-mL polyethylene	1	Cool 4°C NaOH, Zinc Acetate	7 days
Alkalinity	SM 2320B	W	250-mL polyethylene	1	Cool 4°C	14 days
pH	SW-846 9040C/9045D	W	250-mL polyethylene	1	Cool 4°C	Within 24 hours of sample receipt
		S	4-oz glass	1	Cool 4°C	Within 7 days of sample collection

Table 3-1. Required Analytical Method, Sample Containers, Preservation, and Holding Times
Essex-Hope Site, Jamestown, New York

Analyses	Analytical Method	Sample Matrix[a]	Container[b]	Qty	Preservative[c]	Holding Time [d]
Grain Size		S	2 inch brass sleeve[e]	1	None	NA
Atterberg Limits						
Bulk Density						

Notes:
Sample container, and volume requirements will be specified by the analytical laboratory performing the tests.
Three times the required volume should be collected for samples designated as MS/MSD samples.
[a] Sample matrix: S = surface soil, subsurface soil; W = surface water
[b] All containers will be sealed with Teflon-lined screw caps.
[c] All samples will be stored promptly at 4°C in an insulated chest.
[d] Holding times are from the time of sample collection.
[e] Same container for all three geotechnical analyses (grain size, atterburg limits, and bulk density)
°C = Degrees Celsius
NaOH = Sodium hydroxide
mL = Milliliter
HCl = Hydrochloric acid
H_2SO_4 = Sulfuric acid
oz = Ounce
HNO_3 = Nitric acid
USEPA = U.S. Environmental Protection Agency
ASTM = American Society for Testing and Materials
NA = Not applicable

Table 3-2. Extraction and Digestion Methods
Essex-Hope Site, Jamestown, New York

Analytical Method	Parameter	Preparatory Methods
SW6020A	Trace metals by ICP (water)	SW3005A
SW8260C	Volatile Organics (water and soil)	SW5030C, SW5035
EPA 300.0 or SW9056	Chloride, Sulfate (water)	See analytical method
RSK-175	Dissolved Gases (water)	See analytical method

Sample containers should be received from the laboratory pre-labeled with the preservative. The sample identification (ID), and date and time of sampling will be entered on the label immediately after collection. The labels must be secured using clear tape to maintain the identification of each sample.

3.4.2 Transport

Sample coolers will be transported to the laboratory (an overnight courier may be used) immediately after sample collection. Intermediate stops should be avoided, with the exception of emergencies only, in which case the situation should be noted in the field notebooks. The laboratory should be notified that samples are being shipped.

3.4.2.1 Sample Packaging

Sample packaging and shipping procedures are designed to ensure the samples will arrive intact at the laboratory, along with the chain-of-custody (COC) forms. Samples will be batched according to their analytical groups and sample locations in a manner to prevent cross-contamination of other samples. The procedures used to pack and ship samples are addressed in the field SOPs.

3.4.2.2 Shipping Airbills

If samples are shipped, airbills will be retained to provide a record for sample shipment to the laboratory. Completed airbills will accompany shipped samples to the laboratory and will be forwarded

along with data packages. The airbill number will be documented on the COC form accompanying the samples to the laboratory for sample tracking purposes. Airbills will be kept as part of the data packages in the project files.

3.5 Sample Custody

Sample custody is necessary to provide relevant and defensible data. Custody is addressed during field sample collection, data analyses in the laboratory, and through proper handling of project files. Persons will have custody of samples when samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured to prevent tampering. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel.

Chain-of-custody forms will provide the record of responsibility for sample collection, transport, and submittal to the laboratory. Field personnel designated as responsible for sample custody will fill out COC forms at each sampling location, at a group of sampling locations, or at the end of each day of sampling. Whenever possible, sample tags and COC forms will be produced by the project database management system. If the designated sampling person relinquishes samples to other sampling or field personnel, COC forms will be signed and dated by the appropriate personnel to document the sample transfer. Original COC forms will accompany samples to the laboratory, and copies will be forwarded to the project files. At a minimum, the COC form must include the following:

- Site name
- Project manager name, telephone number, and fax number
- Unique sample ID
- Date and time of sample collection
- Source of sample (including name, location, sample type, and matrix)
- Number of containers
- Designation of MS/MSD
- Preservative used
- Analyses required
- Name of sampler
- Custody transfer signatures and dates and times of sample transfer from the field to transporters and to the laboratories
- Bill of lading or transporter tracking number (if applicable)
- Turnaround time
- Laboratory name, address, and contact information
- Any special instructions

Erroneous entries on COC records will be corrected by drawing a single line through the error and entering the corrected information. The person performing the correction will date and initial each change made on the COC form.

3.5.1 Field Custody

Chain-of-custody forms will be required for all samples. The sampling crew in the field will initiate COC forms. Chain-of-custody forms will contain the sample's unique ID number, sample date and time, sample description, sample type, preservation (if any), and analyses required. Original COC forms, signed by the sampling crew, will accompany the samples to the laboratory. A copy of relinquished COC forms will be retained with the field documentation. COC forms will remain with the samples at all times. Samples and signed COC forms will remain in the possession of the sampling crew until samples are delivered to the express carrier (e.g., FedEx), or hand delivered to the laboratory, or placed in secure storage.

3.5.2 Laboratory Sample Custody

Laboratory custody procedures will be in place to ensure the integrity of sample and laboratory-produced data handling. Laboratory custody procedures are defined in their individual laboratory SOPs regarding sample custody.

3.5.2.1 Laboratory Sample Receipt

Upon sample receipt, the laboratory sample custodian will verify package seals, open the packages, check temperature blanks (and record temperatures), verify sample integrity, and inspect contents against COC forms. Inspection procedures and corrective actions shall be in compliance with the laboratory's SOPs. The occurrence of any anomalies in the received samples and their resolution will be documented in laboratory records. The project manager will be contacted to resolve any discrepancies between sample containers and COC forms.

Along with sample receipt documentation, the following information will be documented on sample receipt forms by the sample custodian:

- Date samples received
- Temperature
- CH2M sample ID
- Laboratory sample ID
- Analytical tests requested for the sample batch
- Sample matrix
- Number of samples in the batch
- Container description and location in the laboratory
- Verification of sample preservation

Sample receipt documentation must be submitted to the project chemist within 48 hours of sample receipt.

Sample holding time tracking begins with the collection of samples and continues until the analysis is complete. **Samples not analyzed in accordance with the requirements in this QAPP will be re-sampled and analyzed at no additional cost to CH2M.** Ideally, sample custody will be maintained using an internal custody system that requires samples to be kept in a secured and restricted area when not in use and to be checked out and checked back in by the analysts who use the samples. Internal custody records must be maintained by the laboratory as part of the documentation file for each sample. Specific instructions concerning the analysis specified for each sample will be communicated to the analysts. Analytical batches will be created, and laboratory QC samples will be introduced into each batch.

3.5.2.2 Laboratory Sample Storage

After the laboratory labels the samples, they will be stored in compliance with their SOP for sample storage. No samples or extracts will be disposed of without prior written approval from an appropriate

member of the project team. The sample custodian will note sample disposal date in the sample ledger. The laboratory will dispose of samples in accordance with applicable regulations. The laboratory will be required to retain the sample for a minimum of 90 days and sample extracts for a minimum of 60 days after submission, pending the need for reanalysis.

3.5.2.3 Laboratory Logbooks

Workbooks, bench sheets, instrument logbooks, and instrument printouts will be used to trace the history of samples through the analytical process and document important aspects of the work, including associated quality controls. As such, all logbooks, bench sheets, instrument logs, and instrument printouts will be part of the permanent record of the laboratory. In addition, relevant information will be entered into the Laboratory Information Management System (LIMS) at the time information is generated.

Each page or entry will be dated and initialed by the analyst at the time of entry. Errors in entry will be crossed out in indelible ink with a single stroke, corrected without obliterating or writing directly over the erroneous entry, and initialed and dated by the individual making the correction. Lining out unused portions and initialing by the person lining out the page will complete pages of logbooks that are not used.

The analyst will record information regarding the sample, analytical procedures performed, and results on laboratory forms or personal notebook pages and enter this information in LIMS. These notes will be dated and will also identify the analyst, instruments used, and instrument conditions.

Sufficient raw data records must be retained to permit reconstruction of initial instrument calibrations (e.g., calibration date, test method, instrument, analysis date, each analyte name, concentrations and responses, calibration curves, response factors, or unique equations or coefficients used to reduce instrument responses into concentrations).

Laboratory notebooks will be reviewed periodically by the laboratory group leaders for accuracy, completeness, and compliance with this QAPP. The laboratory group leader will verify all entries and calculations. If all entries on the pages are correct, the laboratory group leader will initial and date the pages. Corrective action will be taken for incorrect entries before the laboratory group leader signs.

3.5.2.4 Laboratory Project File

Documentation will be placed in a single, secured project file that will be maintained by the laboratory PM. This file will consist of the following components, all filed chronologically:

- Agreements
- Correspondence
- Memorandums
- Notes and data

Reports (including QA reports) will be filed with correspondence. Analytical laboratory documentation and field data will be filed with notes and data. Filed materials may only be removed by authorized personnel on a temporary basis. The name of the person removing the file will be recorded. Laboratories will retain all project files and data packages for a minimum of seven years unless otherwise agreed upon.

3.5.2.5 Computer Tape and Hard Copy Storage

Electronic files will be maintained on CD-ROM (preferred), magnetic tape, or diskette for 7 years; hard copy data packages (including chromatograms) will be maintained in files for 7 years. The computer tape and hard copy storage should include notation of instrument run files and calibration.

3.6 Analytical Method Requirements

Once samples have been properly collected and documented, they will be submitted to the analytical laboratory. Samples will be analyzed in accordance with this QAPP and the specified USEPA method. Target analyte lists and RL objectives for each method are specified in Appendix A. Requested RLs will be based on meeting New York State Department of Environmental Conservation (NYSDEC) unrestricted use soil cleanup objectives or water quality standards. (Note: NYSDEC soil cleanup objectives for unrestricted use [NYSDEC 2006, 2010] are presented for selecting appropriate MDLs and RLs. Site-specific remedial action objectives (RAOs) were presented in the 1994 Record of Decision (ROD) and are the site cleanup goals). Required QC checks, minimum frequencies, acceptance criteria, corrective actions, and validation flagging criteria are also included in Appendix A.

Samples will be analyzed using USEPA-approved methods or other recognized standard methods (USEPA 1998a, 1998b). The principal sources for analytical methods are as follows:

- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (USEPA SW-846, Third Edition, and its updates, 1998a)
- *Methods for Chemical Analysis of Water and Wastes* (USEPA 1983)
- *Standard Methods for the Examination of Water and Wastewater*, 20th Edition (USEPA 1998b)

Deviations from specified methods will be communicated to the contractor's PM before initiating test procedures. Any deviations also must be addressed in the laboratory case narrative.

Samples must be analyzed undiluted or at the lowest possible dilution. The laboratory will contact the project chemist when dilutions are required because of matrix interference. When a target analytes' concentration exceeds the calibration range, a dilution analysis will be performed to accurately determine the analytes' concentration. The laboratory will report the undiluted/lowest dilution performed and any diluted analyses that are required.

3.7 Analytical Standard Operating Procedures

The laboratory uses analytical SOPs to ensure the samples submitted are accurately and precisely analyzed. The laboratory will follow their analytical SOP or the USEPA method guidance when this QAPP does not specify QC criteria. If not otherwise stated within this QAPP, the QC criteria used during the analyses are those stated within the analytical SOPs.

3.8 Quality Control Requirements

The purpose and creation of field and laboratory QC samples is discussed and summarized below.

3.8.1 Field Quality Control Samples

Field QC samples will be collected to determine the accuracy and precision of the analytical results. The QC sample frequencies are as stated in this section below. All sampling activities will be conducted in accordance with the health, safety, and environment plan, and sample handling procedures will be performed in accordance to those specified in this QAPP.

3.8.1.1 Equipment Blanks

Equipment blanks are collected to monitor the cleanliness of sampling equipment and the effectiveness of decontamination procedures. Contamination from the sampling equipment can bias the analytical results high. Equipment blanks will be prepared by filling sample containers with analyte-free water that has been passed through a decontaminated sampling device. Equipment blanks will be sampled at a frequency of 1 for every 20 samples collected with **nondedicated** equipment and should be analyzed for

the same parameters as the samples; however, certain parameters may not require equipment blanks. The results from the equipment blanks will be assessed for bias resulting from contamination. If bias is present, the usability of the associated analytical results will be further assessed and qualified, as appropriate.

3.8.1.2 Matrix Spike/Matrix Spike Duplicates

MS/MSDs will be used to assess the effects of sample matrix interference on the precision and accuracy of analyte recovery. MS/MSD pairs will be analyzed at a frequency of 1 pair for every 20 samples. The duplicate aliquots for MS/MSD analyses should be collected simultaneously or in immediate succession with the parent sample. They will be treated in the same manner as the parent sample during storage and shipment. The sampling locations for the MS/MSD will be documented in the field logbook.

3.8.1.3 Field Duplicates

Field duplicates are collected in the field from a single aliquot of sample to assess the precision and accuracy of the sampling procedures of the field team. *Technically, a volatile organic compound (VOC)-in-soil sample is considered a "co-located" sample, not a "duplicate" because of the differences in homogenization; however, the term "duplicate" is applied in this document to simplify discussion.* A field duplicate will be collected and analyzed for the same parameters as the parent sample at a frequency of 1 duplicate for every 10 samples.

3.8.1.4 Trip Blanks

Trip blanks will be collected and analyzed to assess for possible VOC contamination that could occur during sample shipment. Trip blanks will be provided by the subcontracted laboratory. The trip blanks will consist of laboratory grade deionized water, preserved in hydrochloric acid. Trip blanks are used to assess the potential introduction of constituents from sample containers or during the transportation and storage procedures. One set of trip blanks will accompany each sample cooler containing one or more VOC samples.

3.8.1.5 Ambient Blank Samples

Ambient blanks are samples of American Society for Testing and Materials (ASTM) Type II or laboratory grade water used in mimicking water sample collection procedures that involve the sample exposure to ambient air, such as surface water collection. The ambient blanks are designed to capture airborne contaminants that may get entrained in the sample while transferring the sample to the container. The blank shall be analyzed for the analyses deemed to be potentially impacted by site conditions. Individual site personnel should make a specific determination if the ambient blanks need to be collected for their sampling event. If so, one ambient blank will be collected for every 20 field water samples or per event if less than 20 samples collected.

3.8.2 Laboratory Quality Control Samples

The contracted analytical laboratory has a QC program to assess the reliability and validity of the analyses being performed. The purpose and creation of QC samples is discussed and summarized below. Laboratory QC checks indicate the state of control that prevailed at the time of sample analysis. QC checks that involve field samples, such as matrix, surrogate spikes, and field duplicates, also indicate the presence of matrix effects. Field-originated blanks provide a way to monitor for potential contamination to which field samples are subjected. This QAPP specifies requirements for method blanks, LCSs, surrogate spikes, field duplicates and MS/MSDs that laboratories participating in the data collection effort must follow.

All QC will be in accordance with method specifications including the following:

- Method blanks
- Hold time

- Initial calibrations
- Continuing calibrations
- Second source check samples
- Instrument tuning
- LCS
- MS/MSD
- Surrogate spikes
- Post-digestion spikes and serial dilutions
- Internal standards
- Retention time window studies

A laboratory QC batch is defined as a method blank, LCS, MS/MSD, or a sample duplicate, depending on the method and 20 or fewer environmental samples of similar matrix that are extracted or analyzed together. For gas chromatography/mass spectrometry volatile analyses, a method blank and LCS must be analyzed in each 12-hour period. The number of environmental samples allowed in the laboratory QC batch is defined by the remaining time in the method-prescribed, 12-hour tune period divided by the analytical run time. Each preparation or analytical batch will be identified in such a way as to be able to associate environmental samples with the appropriate laboratory QC samples.

3.9 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

3.9.1 Laboratory Equipment/Instruments

Only qualified personnel will service instruments and equipment. Repairs, adjustments, and calibrations will be documented in the appropriate logbook or data sheet.

3.9.1.1 Instrument Maintenance

Preventive maintenance of laboratory equipment will follow guidelines established by each laboratory's SOPs for instrument inspection and maintenance. The laboratory will maintain a sufficient supply of spare parts for its instruments to minimize downtime. Whenever possible, backup instrumentation will be on hand.

Whenever practical, analytical equipment should be maintained under a service contract. Such contracts allow for preventative system maintenance and repair on an "as-needed" basis. The laboratory should have sufficient trained staff to allow for the day-to-day maintenance of equipment. All laboratory instruments will be maintained in accordance with manufacturer's specifications and within the requirements of the laboratory QAM. Maintenance activities are required to be documented in the logbooks to provide a history of maintenance records.

3.9.1.2 Equipment Monitoring

On a daily basis, operation of balances, ovens, refrigerators, and water purification systems will be checked and documented. Any discrepancies will be immediately reported to the appropriate laboratory personnel for resolution. Specific laboratory preventative maintenance procedures are found in the laboratory's internal QAM.

3.10 Instrument Calibration and Frequency

3.10.1 Field Instruments

The field instruments to be used will be calibrated at least daily, or more frequently depending on manufacturer's recommendations or field performance questions. All calibrations will be performed by

using factory-approved methods, and the calibration methods, times, and responses will be recorded in a field logbook. The serial numbers of the field instruments also will be recorded in the field logbooks at the time of calibration. The instruments include those that measure field conditions (pH, conductance, temperature, etc.) and health and safety conditions (photoionization detector, combustible gas indicator, etc.). Some field instruments have no applicable calibration procedure (such as water level indicators). These items will be evaluated and removed from service if performance issues arise.

3.10.2 Laboratory Instruments

The instrument calibration procedures are described in the internal laboratory SOPs. Records of calibrations will be filed and maintained by the laboratory. These records will be subject to QA audit. For all instruments, the laboratory will maintain trained repair staff with in-house spare parts or will maintain service contracts with vendors.

All standards used in the calibration of equipment will be traceable, directly or indirectly, to the National Institute of Standards and Technology. All standards received will be logged into standard receipt logs maintained by the individual analytical groups. Each group maintains a standards log that tracks the preparation of standards used for calibration and QC purposes.

3.11 Inspection/Acceptance Requirements for Supplies and Consumables

Subcontractor services must meet the project scope, specified levels of quality, and the submittal schedule. Project contractors or vendors should have contractual arrangements with their suppliers of materials.

Purchased or rented supplies and consumables will be inspected to assure the quality and function will adhere to the standards necessary to meet the project objectives. Field equipment will be checked and calibrated (if necessary) according to documentation provided. Performance assessment (calibration, trial checks, etc.) will be documented in field logbooks and will become part of the project record. Bottles will be checked to assure the quality is sufficient to meet the analytical needs as outlined in the certificate of analysis provided with each shipment. The documentation of certified cleanliness will become part of the project files. Chemicals (ASTM water for blanks, chemical preservatives, etc.) will be inspected to confirm that the required specifications needed to achieve project objectives are met. Inspection and acceptance requirements are the responsibility of the FTL or their designated agent.

3.12 Data Acquisition Requirements (Nondirect Measurements)

This subsection identifies the types of data needed for project implementation and decision-making that are not obtained from direct measurements.

The project objectives are first identified to assess what types of information are needed to implement a project plan to meet these proposed objectives. Project objectives are summarized in Section 1. Typically, the data needed to achieve the project objectives include facility maps, sampling location selection and sample identifiers, laboratory method selection and detection limit verification, analytical parameter lists and critical values, field measurement lists, and a project schedule.

3.13 Documentation of Records

3.13.1 Data Reporting

Portable document format (PDF) deliverables, in Level 3 summary format, containing the necessary information to perform data evaluation/data validation are required; however, there may be instances where a different format is required. Any change to the report format will be documented in the laboratory SOW before sampling. Reporting formats similar to those specified in the latest versions of *USEPA Contract Laboratory Program Statements of Work for Organics and Inorganics* are preferred (USEPA 2004). The laboratory data report will be organized in a format that facilitates identification and retrieval of data. Table 3-3 summarizes the requested data format.

3.13.1.1 Field Data Reporting

Field sampling activities will be recorded in field logbooks. Field logbook entries will be described with as much detail as possible so reviewers can reconstruct a particular situation without reliance on field personnel memory. Modifications to field sampling protocols must be documented in the field logbook. The FTL is responsible for ensuring modifications to sampling protocols are documented.

The field logbooks to be used will be bound field survey books or notebooks. Logbooks will be assigned to the field crew, but stored in a secure location when not in use. Project-specific document numbers will identify each logbook, the title page of which will contain the following:

- Name of the person to whom the logbook is assigned
- Logbook number
- Project name
- Project start date
- Project end date

At the beginning of each entry, the date, start time, weather, names of all sampling team members present, and the signature of the person making the entry will be documented. Specific information and observations will be recorded in the field notebook during all field investigation activities. The information to be documented includes the following:

- Names of all field team members present and the level of personal protective equipment
- Names of site visitors, field sampling or investigation team personnel, and the nature of their visit
- Equipment model and calibration information
- Groundwater sample locations, identification, analyses to be performed, method of collection, odor, visual descriptions, date and time of collection
- Groundwater sample physical data–purge rate, total volume removed, water levels, temperature, pH, dissolved oxygen, turbidity, specific conductance, and oxidation-reduction potential
- Management of purge water
- Miscellaneous observations regarding other nearby site activities and equipment problems/troubleshooting measures

All entries will be made in ink, and no erasures will be allowed. If an incorrect entry is made, the information will be crossed out with a single strike mark and initialed. Any blank or unused portions of a page will be crossed out with a single diagonal line and initialed by the field personnel. Blank pages will be noted as being intentionally blank in the same manner.

Samples will be collected following the sampling procedures documented in the SOPs in Appendix B or in the site-specific work plans. Sample collection equipment will be identified, along with the time of

sampling, sample description, parameters being analyzed, and number of containers used. Unique sample ID numbers will be assigned to each sample and field duplicate samples, which will receive a unique sample ID, will be noted in the field logbook.

Field data calculations, transfers, and interpretations will be reviewed for accuracy by the FTL or project chemist. The appropriate task manager will review field documentation, data reduction, and accuracy of data entries into the data log. The data logs and documents will be checked for the following:

- General completeness
- Readability
- Use of appropriate procedures
- Whether modifications to sampling procedures are clearly stated
- Appropriate instrument calibration and maintenance records
- Reasonability of data collected
- Correctness of sample locations
- Correctness of reporting units, calculations, and interpretations

Field personnel will provide comprehensive documentation of all aspects of field sampling, field analysis, and sample COC. This documentation constitutes a record that allows for the reconstruction of all field events to aid in the data review and interpretation process. The documents, records, and information relating to the performance of the fieldwork will be retained in the project file.

3.13.1.2 Laboratory Data Reporting

Data reduction will be done manually or using appropriate application software. Quantitation procedures specified for each method must be followed. Calculations for analyses are based on regression analyses of calibration curves. Regression analysis is used to fit a curve through calibration standard data. Sample concentrations are calculated using the resulting regression equations. If data are reduced manually, the documentation must include the formulas used. Any application software used for data reduction must have been previously verified by the laboratory for accuracy. Documentation of the software's verification must be maintained on file in the laboratory. The documentation of data reduction must allow recreation of the calculations.

Whenever possible, analytical data will be transferred directly from the instrument to a computerized data system. Raw data will be stored electronically, and a hard-copy file will be maintained. Laboratory data entered will be sufficient to document information used to arrive at reported values.

The data will undergo at least two levels of review at the laboratory before release. The analyst performing the tests initially will review 100 percent of the data. After the analyst's review has been completed, 100 percent of the data will be reviewed independently by a senior analyst or by the section supervisor for accuracy, compliance with calibration, and QC requirements, holding time compliance, and for completeness. Analyte identification and quantitation must be verified. Calibration and QC results will be compared with the applicable control limits. RLs should be reviewed to make sure they meet the project objectives. Results of multiple dilutions should be reviewed for consistency. Any discrepancies must be resolved and corrected. Laboratory qualifiers will be applied when there are nonconformances that could potentially affect data usability. These qualifiers must be properly defined as part of the deliverables. Issues relevant to the quality of the data must be addressed in a case narrative. A copy of the data package will be filed in the project file. Mailed data packages, along with applicable electronic data deliverables (EDDs), will be sealed in an appropriate shipping container with a custody seal and logged on a document mailing log.

Electronic data storage will be used when possible. Electronic data will be maintained in a manner that prevents inadvertent loss, corruption, and inappropriate alteration. Electronic data will be accessible and retrievable for a period of 10 years after project completion by the laboratory and The Dow Chemical Company.

Raw data will be examined to assess compliance with QC guidelines. Surrogate, MS, and QC check sample recoveries will be checked. In addition, samples and laboratory blanks will be checked for possible contamination or interferences. Chromatograms and concentrations will be checked to ensure sample results are within the calibration range; if necessary, dilutions will be performed as defined by the initial calibration range.

Deviations from guidelines will call for corrective action. Deviations determined to be caused by factors outside the laboratory's control, such as matrix interference, will be noted with an explanation in the report narrative. Calculations will be checked and the report reviewed for errors and oversights. The hard copy and electronic laboratory reports for samples and analyses will contain the information necessary to perform data evaluation.

Table 3-3. Data Package Deliverables

Essex-Hope Site, Jamestown, New York

All Analytical Fractions				
Case Narrative – A detailed case narrative per analytical fraction is required and will include explanation of any noncompliance and/or exceptions and corrective action. Exceptions will be noted for receipt, holding times, methods, preparation, calibration, blanks, spikes, surrogates (if applicable), and sample exceptions.				•
Sample ID Cross Reference Sheet (Lab IDs and Client IDs)				•
Completed Chain of Custody and any sample receipt information				•
Sample preparation (extraction/digestion) logs				•
Copies of nonconformance memos and corrective actions				•
Form *	**GC/MS Organic Fractions**	**Level II**	**Level III**	**Level IV**
1	Sample results	•	•	• + raw
2	Surrogate Recovery Summary (w/ applicable control limits)	•	•	•
3	MS/MSD Accuracy & Precision Summary **	•	•	• + raw
3	LCS Accuracy Summary	•	•	• + raw
4	Method Blank Summary	•	•	• + raw
5	Instrument Tuning Summary (including tuning summary for applicable initial calibrations)		•	•
6	Initial Calibration Summary (including concentration levels of standards)		•	• + raw
7	Continuing Calibration Summary		•	• + raw
8	Internal Standard Summary (including applicable initial calibrations)		•	•
Form *	**GC/HPLC Organic Fractions**	**Level II**	**Level III**	**Level IV**
1	Sample results	•	• ***	• + raw
2	Surrogate Recovery Summary (w/ applicable control limits)	•	•	•
3	MS/MSD Accuracy & Precision Summary **	•	•	• + raw
3	LCS Accuracy Summary	•	•	• + raw
4	Method Blank Summary	•	•	• + raw
6	Initial Calibration Summary (including concentration levels of standards) ***		•	• + raw
7	Continuing Calibration Summary ***		•	• + raw
7	Degradation Summary (Organochlorine Pesticides only) ***		•	• + raw
8	Analytical Sequence (including internal standard area performance where applicable) ***		•	•
10	Compound Identification Summary (where confirmation required) ***		•	•

Table 3-3. Data Package Deliverables

Essex-Hope Site, Jamestown, New York

Form *	Metals Inorganic Fractions	Level II	Level III	Level IV
1	Sample Results	•	•	• + raw
2A	Initial and Continuing Calibration Summary		•	• + raw
3	Initial and Continuing Calibration Blanks and Method Blanks Summary	•	•	• + raw
4	Interference Check Standard Summary		•	• + raw
5A	Pre-digestion Matrix Spike Recoveries Summary	•	•	• + raw
5B	Post-digestion Spike Recoveries Summary		•	• + raw
6	Native Duplicate or MS/MSD Precision Summary **	•	•	• + raw
7	Laboratory Control Sample Recovery Summary	•	•	• + raw
8	Method of Standard Addition (if necessary)		•	• + raw
9	Serial Dilution		•	• + raw
10	Instrument or Method Detection Limit Summary		•	•
11	ICP Interelement Correction Factors		•	•
12	Linear Range Summary		•	•
13	Preparation Log Summary		•	• + raw
14	Analytical Run Sequence and GFAA Post-spike Recovery Summary		•	• + raw
Form *	**General Chemistry Fractions: (Includes potentiometric, gravimetric, colorimetric, and titrimetric analytical techniques. Examples, TPH (418.1), TOC, etc.)**	**Level II**	**Level III**	**Level IV**
1	Sample Results	•	•	• + raw
2A	Initial and Continuing Calibration Summary		•	• + raw
3	Initial and Continuing Calibration Blanks and Method Blanks Summary	•	•	• + raw
5A	Pre-digestion Matrix Spike Recoveries Summary	•	•	• + raw
6	Native Duplicate or MS/MSD Precision Summary **	•	•	• + raw
7	Laboratory Control Sample Recovery Summary	•	•	• + raw
10	Instrument or Method Detection Limit Summary		•	•

* Contract Laboratory Program (CLP) Form or summary form with equivalent information

** with RPD calculated according to method specifications (CLP using % recovery, SW-846 using concentration)

*** including deliverables for primary and confirmation analysis (where applicable)

3.13.2 Electronic Analytical Record Format

Concurrently with the submittal of the hard copy deliverables, the laboratory will deliver electronic data in the EarthSoft EQuIS 6 format. There shall be no discrepancies between the hard copy reports and the electronic reports.

3.13.3 Project Record Maintenance and Storage

Project records will be stored and maintained in accordance with CH2M's data management plan described below. Each project team member is responsible for filing all project information or providing it to the administrative assistant familiar with the project filing system. Individual team members may maintain separate files or notebooks for individual tasks but must provide such files to the project file room upon completion of each task.

The general project file categories are as follows:

- Correspondence
- Non-laboratory project invoices and approvals by vendor
- Original unbound reports
- Non-laboratory requests for proposal, bids, contracts, and SOWs
- Field data
- Data evaluation and calculations
- Facility reports from others
- Photographs
- Insurance documentation
- Laboratory analytical data and associated documents and memorandums
- Regulatory submittals, licensing, and permitting applications
- Facility and reference material
- Health, safety, and environment plans
- Figures and drawings
- Project Instructions
- Work plans

3.14 Data Quality Management

Data management entails storing, handling, accessing, and securing data collected during the project. Data gathered during this project will be consolidated and compiled into a project database that can be used to support project data reporting and exports. The following sections describe the project's data management process.

3.14.1 Archiving

Hard copy and electronic versions will be archived in project files and on electronic archive tapes for the duration of the project, 10 years, or as specified in contractual agreements.

3.14.2 Data Flow and Transfer

The data flow from the laboratory and field to the project staff and data users will be sufficiently documented to ensure that data are properly tracked, reviewed, and validated for use.

3.14.3 Record Keeping

In addition to the data management procedures outlined in Section 3.13 for analytical data, the laboratory will ensure that it maintains electronic and hard copy records sufficient to recreate each analytical event. The minimum records the laboratory will keep contain the following:

- Raw data, including instrument printouts, bench work sheets, and/or chromatograms with compound ID and quantitation reports
- Laboratory-specific written SOPs for each analytical method and QA/QC function in place at the time of analysis of project samples

3.14.4 Final Evidence File

The final evidence file will be the central repository for all documents that constitute evidence relevant to sampling and analysis activities. CH2M is the custodian of the evidence file and maintains the contents of the evidence files for the project, including relevant records, reports, logs, field notebooks, pictures, contractor reports, and data reviews in a secured, limited access area under the custody of CH2M.

CH2M will keep all records until project completion and project closeout. As necessary, records may be transferred to an off-facility records storage facility. The records storage facility must provide secure, access-controlled storage of records. Records of raw analytical laboratory data, QA data, and reports will be kept by the subcontract laboratory for a minimum of 7 years.

SECTION 4

Assessment and Oversight

4.1 Assessments and Response Actions

Field and laboratory assessments are performed to assess technical and procedural compliance with this QAPP. Performance and system audits are key to ensuring this compliance. Purposes of the audits are as follows:

- Confirm appropriate documents are properly completed and are kept current and orderly
- Ensure measurement systems are accurate
- Identify nonconformance or deficiencies and to initiate necessary corrective actions
- Verify that field and laboratory QA procedures called for in this QAPP are properly followed and executed

The project chemist and laboratory QAM are responsible for ensuring conformance with the QAPP. The FTL is responsible for ensuring conformance with field QA/QC requirements. Activities selected for audit will be evaluated against specified requirements, which will include an evaluation of the method, procedures, and instructions. Documents and records will be examined as necessary to evaluate whether the QA program is effective and properly implemented. Reports and recommendations must be prepared on all audits and submitted to the QA manager for retention in the project files.

4.1.1 Field Audits

Planning, scheduling, and conducting QA audits and surveillance are required to verify facility activities are being performed efficiently in conformance with approved plans, standards, federal and state regulatory requirements, sound scientific practices, and contractual requirements. Planned and scheduled audits may be performed to verify compliance with aspects of the QA program and to evaluate the effectiveness of the QA program. Audits include an objective examination of work areas, activities, processes, review of documents and records, interviews with project personnel, and review of plans and standards.

Internal review of the sampling program will be conducted after each sampling event by the FTL. The FTL will pay particular attention to the sampling program with respect to representativeness, comparability, and completeness of the specific measurement parameters involved.

Field documentation (e.g., COC forms, field daily sheets, logbooks) will be reviewed as generated by the FTL or designee for accuracy, completeness, and compliance with QAPP requirements. The FTL will audit field sampling procedures periodically for compliance with QAPP procedures. The auditor will check for the following:

- Sampling protocols are being followed.
- Samples are placed in proper containers.
- Samples are stored and transported properly.
- Field documentation is complete and accurate.

4.1.2 Field Corrective Action

Any project team member may initiate a field corrective action process. The corrective action process consists of identifying a problem, acting to eliminate the problem, monitoring the effectiveness of the corrective action, verifying that the problem has been eliminated, and documenting the corrective action.

Corrective actions include correcting COC forms; problems associated with sample collection, packaging, shipping, field record keeping; or additional training in sampling and analysis. Additional approaches may include resampling or evaluating and amending sampling procedures. The team member in charge of field operations (FTL) will summarize the problem, establish possible causes, and designate the person responsible for a corrective action. The FTL will verify that the initial action has been taken and whether it appears to be effective. The FTL will additionally follow up to verify that the problem has been resolved.

Technical staff and project personnel will be responsible for reporting suspected technical or QA nonconformances or suspected deficiencies to the FTL. The FTL will be responsible for assessing suspected problems in consultation with the QA manager and the PM as to whether the situation affects data quality. If it is concluded that the situation warrants a reportable nonconformance requiring corrective action, a nonconformance report will be initiated by the FTL.

The FTL will be responsible for ensuring that corrective action for nonconformances are initiated by the following:

- Evaluating all reported nonconformances
- Controlling additional work on nonconforming items
- Selecting disposition or action to be taken
- Maintaining a log of nonconformances
- Reviewing nonconformance reports and corrective actions taken
- Ensuring nonconformance reports are included in the final documentation in the project files

4.1.3 Laboratory Audits

The laboratory QA manager may conduct internal system audits. An internal audit is a qualitative evaluation of all components of the laboratory QC measurement system. The audit serves to determine if all measurement systems are being used appropriately. The system audits are conducted to evaluate the following:

- Sample handling procedures
- Calibration procedures
- Analytical procedures
- QC results
- Safety procedures
- Record keeping procedures
- Timeliness of analysis and reporting

In addition, laboratories are subject to external audits. The focus of these audits is to assess general laboratory practices and conformance to the QAPP. Laboratory audits may be performed before starting analyses for this project and at any time during the project as deemed necessary.

The laboratory QA manager will review internal laboratory performance and will evaluate laboratory precision and accuracy by comparing results of duplicate samples, QC samples, spikes, and blanks. When a beyond-control limit situation is encountered, the laboratory manager or other client services will check analytical results prior to distribution.

4.1.4 Laboratory Corrective Action

Corrective actions may be required for two classes of problems: analytical/equipment problems and noncompliance problems. Analytical/equipment problems may occur during sampling, sample handling, sample preparation, laboratory instrumental analysis, or data review.

For noncompliance problems, a corrective action program will be developed and implemented at the time the problem is identified. The person who identifies the problem will be responsible for notifying the proper project member. If the problem is analytical in nature, information on these problems will be communicated to the laboratory QAM and the QA manager, who will in turn direct information to proper project members. Implementation of corrective action will be confirmed through similar channels.

Implementation of all corrective actions will be documented. No staff member will initiate corrective action without prior communication of action needing correction and proposed corrective action through the proper channels. If corrective actions are insufficient, the PM or the QA manager may issue a stop work order.

Corrective actions are required whenever an out-of-control event or potential out-of-control event is noted. The investigative action taken is somewhat dependent on the analysis and the event. Laboratory personnel are alerted that corrective actions may be necessary if the following occurs:

- QC data are outside the warning or acceptable windows for precision and accuracy
- Blanks contain target analytes above acceptable levels
- Undesirable trends are detected in spike recoveries or RPD between duplicates
- Unusual changes in detection limits occur
- Inquiries concerning data quality are received
- Deficiencies are detected by the laboratory QA manager during internal or external audits or from results of performance evaluation samples

Corrective action procedures are often handled at the bench level by the analyst, who reviews preparation or extraction procedures for possible errors, checks instrument calibrations, spike and calibration mixes, and instrument sensitivity. If problems persist or cannot be identified, matters are referred to the laboratory supervisor, laboratory PM, and/or laboratory QA manager for further investigation. Once resolved, full documentation of the corrective action procedures is filed with the laboratory QA manager after approval by CH2M. Corrective action may include the following:

- Resampling and analyzing
- Evaluating and amending sampling procedures
- Evaluating and amending analytical procedures
- Accepting data and acknowledging the level of uncertainty
- Reanalyzing the samples, if sample or extract volume is adequate and holding time criteria permits

If resampling is deemed necessary because of laboratory problems, the PM must identify the appropriate approach, including cost recovery from the laboratory, for the additional sampling effort.

4.2 Reports to Management

If audits are conducted, audit reports will be submitted to the PM to address any QA issues or proposed corrective actions to maintain QA standards. In addition, after the sample results are received from the laboratory and validated, reduced, and tabulated, a comprehensive data evaluation report will be submitted documenting the field investigation.

SECTION 5

Data Validation and Usability

5.1 Data Review, Validation, and Verification Requirements

Data review and validation are processes whereby data generated in support of this project are reviewed against the QA/QC requirements. The data are evaluated for precision and accuracy against the analytical protocol requirements. Nonconformances or deficiencies that could affect the usability of data are identified as noted. The effect on the result is then considered when assessing whether the result is sufficient to achieve DQOs. **Deficiencies discovered as a result of data verification, review and/or validation, as well as corrective actions implemented in response, will be documented and submitted in the form of a written report.**

5.2 Verification and Validation Methods

5.2.1 Data Verification

Before the analytical results are released by the laboratory, both the sample and QC data will be reviewed carefully to verify sample identity, instrument calibration, detection limits, dilution factors, numerical computations, accuracy of transcriptions, and chemical interpretations. Additionally, the QC data will be reduced and spike recoveries will be included in control charts, and the resulting data will be reviewed to ascertain whether they are within the laboratory-defined limits for accuracy and precision. Any nonconforming data will be discussed in the data package cover letter and case narrative. The laboratory will retain all of the analytical and QC documentation associated with each data package.

As discussed previously, the data are also verified to assess whether the EDDs and the PDF data deliverables are consistent with one another to ensure an accurate database.

5.2.2 Data Validation

Depending upon the project-specific objectives, the analytical results of the data collection effort will be validated by CH2M. In general, there are four levels of validation that correspond to the reports described in Table 3-3. All data for this program will undergo **Level 3** validation unless otherwise noted.

- **Level 1 –** Verification that samples were analyzed for the methods requested and review of the data for outliers and anomalies.
- **Level 2 –** Verification that samples were analyzed for the methods requested, review of the laboratory case narrative for events in the laboratory that affect the accuracy or precision of the data, review of QC indicator data, including method blank, LCS/LCSD, MS/MSD, and surrogate recoveries and a “sanity” review of the data.
- **Level 3 –** Validation of the analytical data as described below without review of any raw data or analyte verification.
- **Level 4 –** Validation of the analytical data will be performed as described below, including review of the analytical raw data.

5.2.3 Level 3 Validation Procedures

Personnel involved in the data validation function will be independent of the data generation effort. The project chemist will be responsible for oversight of the data validation effort. Data validation will be carried out when the data packages are received from the laboratory. Project-specific plans will specify which samples require data validation and the extent of that validation. It will be performed on an

analytical batch basis using the summary results of calibration and laboratory QC, as well as those of the associated field samples. Raw data will be reviewed when deemed necessary by the project chemist. Data validation procedures will include the following:

- Review of the data package for completeness
- Review of COC records for discrepancies that might degrade data quality
- Review for compliance with holding time and QC frequency requirements
- Evaluation of all calibration and QC summary results against the project requirements
- Qualification of the data using appropriate qualifier flags, as necessary, to reflect data usability limitations
- Initiation of corrective actions, as necessary, based on the data review findings

Data validation will be patterned after the *National Functional Guidelines for Superfund Organic Methods Data Review* (USEPA 2014a) and *National Functional Guidelines for Inorganic Superfund Data Review* (USEPA 2014b), substituting method criteria and the QC criteria presented in this QAPP for those in the guidelines. QC requirements specified herein shall take precedence over the functional guidelines. When no specific guidance exists, method requirements will be used.

It is important to note that laboratory qualifying flags are included on the data summary forms (Form I) that are submitted to the project by the laboratory; however, during the data review and validation process, the laboratory qualifying flags are reviewed along with the project-specific validation flags to determine the final project qualifier applied to the data. Data qualifier flags, if required, are defined below and will be applied to the sample results. If multiple flags are required for a result, the most severe flag will be applied to the result.

- **U** Undetected. Samples were analyzed for this analyte, but it was not detected above the RL or was qualified as not detected due to blank contamination.
- **UJ** Not detected. Quantitation limit may be inaccurate or imprecise.
- **J** Estimated. The analyte was present, but the reported value may not be accurate or precise.
- **R** Rejected. The data are unusable. (NOTE: Analyte/compound may or may not be present.)

A data quality evaluation report will be generated and submitted to the PM after validation.

5.3 Reconciliation of Validated Data with Data Quality Objectives

The final data validation activity is assessing whether the data meet the planned DQOs for the project-specific activity. The final results, as adjusted for the findings of any data validation and data evaluation, will be checked against the DQOs, and an assessment will be made as to whether the data are of sufficient quality to support them. The decision as to data sufficiency may be affected by the overall precision, accuracy, and completeness of the data as demonstrated by the data validation process. If the data are sufficient to achieve project objectives, the PM will release the data and work may proceed. If not, corrective action will be required.

SECTION 6

References

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Appendix A
Analytical Method Requirements

Table A-1. Metals in Groundwater by Method SW6020A

Essex-Hope Site, Jamestown, New York

Parameter	CAS Number	NYSDEC Water Quality Standards[a] (mg/L)	Method Detection Limit (mg/L)	Reporting Limit (mg/L)
Iron	7439-89-6	0.1	0.013	0.05
Manganese	7439-96-5	0.015	0.0001	0.0005

[a] NYSDEC Water Quality Standards and Guidance Values (1998)
mg/L – milligrams per liter

Table A-2. Volatile Organic Compounds in Groundwater by Method SW8260C

Essex-Hope Site, Jamestown, New York

Parameter	CAS Number	Site-Specific Remedial Action Objective	NYSDEC Water Quality Standards[a] (µg/L)	Method Detection Limit (µg/L)	Reporting Limit (µg/L)
1,1,1,2-Tetrachloroethane	630-20-6		--	0.7	2.5
1,1,1-Trichloroethane	71-55-6		5.0	0.7	2.5
1,1,2,2-Tetrachloroethane	79-34-5		5.0	0.14	0.5
1,1,2-Trichloroethane	79-00-5		1.0	0.5	1.5
1,1-Dichloroethane	75-34-3		5.0	0.7	2.5
1,1-Dichloroethene	75-35-4		5.0	0.14	0.5
1,1-Dichloropropene	563-58-6		--	0.7	2.5
1,2,3-Trichlorobenzene	87-61-6		5.0	0.7	2.5
1,2,3-Trichloropropane	96-18-4		--	0.7	2.5
1,2,4-Trichlorobenzene	120-82-1		5.0	0.7	2.5
1,2,4-Trimethylbenzene	95-63-6		--	0.7	2.5
1,2-Dibromo-3-chloropropane	96-12-8		0.04	0.7	2.5
1,2-Dibromoethane	106-93-4		0.0006	0.65	2.0
1,2-Dichlorobenzene	95-50-1		3.0	0.7	2.5
1,2-Dichloroethane	107-06-2		0.6	0.13	0.5
1,2-Dichloropropane	78-87-5		1.0	0.13	1.0
1,3,5-Trimethylbenzene	108-67-8		--	0.7	2.5
1,3-Dichlorobenzene	541-73-1		3.0	0.7	2.5
1,3-Dichloropropane	142-28-9		--	0.7	2.5
1,4-Dichlorobenzene	106-46-7		3.0	0.7	2.5
1,4-Dioxane	123-91-1		--	41	250
2,2-Dichloropropane	594-20-7		--	0.7	2.5
2-Butanone	78-93-3		50	1.9	5.0
2-Chlorotoluene	95-49-8		--	0.7	2.5
2-Hexanone	591-78-6		50	1.0	5.0
4-Chlorotoluene	106-43-4		--	0.7	2.5
4-Methyl-2-pentanone	108-10-1		--	1.0	5.0
Acetone	67-64-1		50	1.5	5.0
Benzene	71-43-2		1.0	0.16	0.5
Bromobenzene	108-86-1		--	0.7	2.5

Table A-2. Volatile Organic Compounds in Groundwater by Method SW8260C

Essex-Hope Site, Jamestown, New York

Parameter	CAS Number	Site-Specific Remedial Action Objective	NYSDEC Water Quality Standards[a] (µg/L)	Method Detection Limit (µg/L)	Reporting Limit (µg/L)
Bromochloromethane	74-97-5		5.0	0.7	2.5
Bromodichloromethane	75-27-4		50	0.19	0.5
Bromoform	75-25-2		50	0.65	2.0
Bromomethane	74-83-9		5.0	0.7	2.5
Carbon disulfide	75-15-0		60	1.0	5.0
Carbon tetrachloride	56-23-5		5.0	0.13	0.5
Chlorobenzene	108-90-7		5.0	0.7	2.5
Chloroethane	75-00-3		5.0	0.7	2.5
Chloroform	67-66-3		7.0	0.7	2.5
Chloromethane	74-87-3		--	0.7	2.5
cis-1,2-Dichloroethene	156-59-2		5.0	0.7	2.5
cis-1,3-Dichloropropene	10061-01-5		0.4	0.14	0.5
Chlorodibromomethane	124-48-1		50	0.15	0.5
Dibromomethane	74-95-3		--	1.0	5.0
Dichlorodifluoromethane	75-71-8		5.0	1.0	5.0
Ethylbenzene	100-41-4	5.0	5.0	0.7	2.5
Hexachlorobutadiene	87-68-3		--	0.7	2.5
Isopropylbenzene	98-82-8		5.0	0.7	2.5
m-,p-Xylene	179601-23-1	5.0	5.0	0.7	2.5
Methylene chloride	75-09-2		5.0	0.7	2.5
Methyl t-Butyl Ether (MTBE)	1634-04-4		--	0.7	2.5
n-Butylbenzene	104-51-8		--	0.7	2.5
n-Propylbenzene	103-65-1		--	0.7	2.5
Naphthalene	91-20-3		--	0.7	2.5
o-Xylene	95-47-6	5.0	5.0	0.7	2.5
p-Isopropyltoluene	99-87-6		--	0.7	2.5
sec-Butylbenzene	135-98-8		--	0.7	2.5
Styrene	100-42-5		5.0	0.7	2.5
tert-Butylbenzene	98-06-6		--	0.7	2.5
Tetrachloroethene	127-18-4		5.0	0.18	0.5
Toluene	108-88-3	5.0	5.0	0.7	2.5
trans-1,2-Dichloroethene	156-60-5	5.0	5.0	0.7	2.5
trans-1,3-Dichloropropene	10061-02-6		0.4	0.16	0.5
Trichloroethene	79-01-6	5.9	5.0	0.18	0.5
Trichlorofluoromethane	75-69-4		5.0	0.7	2.5
Vinyl acetate	108-05-4		--	1.0	5.0
Vinyl chloride	75-01-4	5.0	2.0	0.07	1

[a] NYSDEC Ambient Water Quality Standards and Guidance Values (1998) and 2000 Addendum

µg/L – micrograms per liter

Table A-3. Volatile Organic Compounds in Soils by Method SW8260c

Essex-Hope Site, Jamestown, New York

Parameter	CAS Number	Site Specific Remedial Action Objective	NYSDEC Unrestricted Use SCO[a] Screening Criteria (µg/kg)	Method Detection Limit (µg/kg)	Reporting Limit (µg/kg)
1,1,1,2-Tetrachloroethane	630-20-6	1,000	--	0.32	1.0
1,1,1-Trichloroethane	71-55-6	1,000	680	0.11	1.0
1,1,2,2-Tetrachloroethane	79-34-5	1,000	--	0.10	1.0
1,1,2-Trichloroethane	79-00-5	1,000	--	0.30	1.5
1,1-Dichloroethane	75-34-3	1,000	270	0.086	1.5
1,1-Dichloroethene	75-35-4	1,000	330	0.26	1.0
1,1-Dichloropropene	563-58-6	1,000	--	0.14	5.0
1,2,3-Trichlorobenzene	87-61-6	1,000	--	0.15	5.0
1,2,3-Trichloropropane	96-18-4	1,000	--	0.16	10
1,2,4-Trichlorobenzene	120-82-1	1,000	--	0.18	2.0
1,2,4-Trimethylbenzene	95-63-6	1,000	3,600	0.14	5.0
1,2-Dibromo-3-chloropropane	96-12-8	1,000	--	0.40	5.0
1,2-Dibromoethane	106-93-4	1,000	--	0.17	4.0
1,2-Dichlorobenzene	95-50-1	1,000	1,100	0.15	5.0
1,2-Dichloroethane	107-06-2	1,000	20	0.11	1.0
1,2-Dichloropropane	78-87-5	1,000	--	0.23	3.5
1,3,5-Trimethylbenzene	108-67-8	1,000	8,400	0.14	5.0
1,3-Dichlorobenzene	541-73-1	1,000	2,400	0.14	5.0
1,3-Dichloropropane	142-28-9	1,000	--	0.15	5.0
1,4-Dichlorobenzene	106-46-7	1,000	1,800	0.14	5.0
1,4-Dioxane	123-91-1	1,000	100	14	100
2,2-Dichloropropane	594-20-7	1,000	--	0.23	5.0
2-Butanone	78-93-3	1,000	120	0.27	10
2-Chlorotoluene	95-49-8	1,000	--	0.16	5.0
2-Hexanone	591-78-6	1,000	--	0.67	10
4-Chlorotoluene	106-43-4	1,000	--	0.13	5.0
4-Methyl-2-pentanone	108-10-1	1,000	--	0.24	10
Acetone	67-64-1	1,000	50	1.0	10
Benzene	71-43-2	1,000	60	0.12	1.0
Bromobenzene	108-86-1	1,000	--	0.21	5.0
Bromochloromethane	74-97-5	1,000	--	0.28	5.0
Bromodichloromethane	75-27-4	1,000	--	0.17	1.0
Bromoform	75-25-2	1,000	--	0.24	4.0
Bromomethane	74-83-9	1,000	--	0.34	2.0
Carbon disulfide	75-15-0	1,000	--	1.1	10
Carbon tetrachloride	56-23-5	1,000	760	0.21	1.0
Chlorobenzene	108-90-7	1,000	1,100	0.35	1.0
Chloroethane	75-00-3	1,000	--	0.32	2.0
Chloroform	67-66-3	1,000	370	0.37	1.5

Table A-3. Volatile Organic Compounds in Soils by Method SW8260c

Essex-Hope Site, Jamestown, New York

Parameter	CAS Number	Site Specific Remedial Action Objective	NYSDEC Unrestricted Use SCO[a] Screening Criteria (µg/kg)	Method Detection Limit (µg/kg)	Reporting Limit (µg/kg)
Chloromethane	74-87-3	1,000	--	0.29	5.0
cis-1,2-Dichloroethene	156-59-2	1,000	250	0.14	1.0
cis-1,3-Dichloropropene	10061-01-5	1,000	--	0.12	1.0
Chlorodibromomethane	124-48-1	1,000	--	0.15	1.0
Dibromomethane	74-95-3	1,000	--	0.16	10
Dichlorodifluoromethane	75-71-8	1,000	--	0.19	10
Ethylbenzene	100-41-4	1,000	1,000	0.13	1.0
Hexachlorobutadiene	87-68-3	1,000	--	0.23	5.0
Isopropylbenzene	98-82-8	1,000	2,300	0.10	1.0
m-,p-Xylene	179601-23-1	1,000	260	0.20	2.0
Methylene chloride	75-09-2	1,000	50	1.1	10
Methyl t-Butyl Ether (MTBE)	1634-04-4	1,000	930	0.084	2.0
n-Butylbenzene	104-51-8	1,000	12,000	0.11	1.0
n-Propylbenzene	103-65-1	1,000	3,900	0.11	1.0
Naphthalene	91-20-3	1,000	12,000	0.14	5.0
o-Xylene	95-47-6	1,000	260	0.17	2.0
p-Isopropyltoluene	99-87-6	1,000	10,000	0.13	1.0
sec-Butylbenzene	135-98-8	1,000	11,000	0.12	1.0
Styrene	100-42-5	1,000	--	0.40	2.0
tert-Butylbenzene	98-06-6	1,000	5,900	0.14	5.0
Tetrachloroethene	127-18-4	1,000	1,300	0.14	1.0
Toluene	108-88-3	1,000	700	0.19	1.5
trans-1,2-Dichloroethene	156-60-5	1,000	190	0.21	1.5
trans-1,3-Dichloropropene	10061-02-6	1,000	--	0.12	1.0
Trichloroethene	79-01-6	1,000	470	0.13	1.0
Trichlorofluoromethane	75-69-4	1,000	--	0.39	5.0
Vinyl acetate	108-05-4	1,000	--	0.13	10
Vinyl chloride	75-01-4	1,000	20	0.12	2.0

[a] NYSDEC Soil Cleanup Objectives (SCO) for Unrestricted Use (NYSDEC 2006, 2010) are presented for selecting appropriate Method Detection Limits and Reporting Limits. Site-specific RAOs were presented in the 1994 ROD and are the site cleanup goals

µg/kg – micrograms per kilogram

Table A-4. Reporting Limit Objectives for General Chemistry and Other Parameters in Groundwater by Various Methods
Essex-Hope Site, Jamestown, New York

Analyte	Method	NYSDEC Water Quality Standards[a] (mg/L)	Method Detection Limits (mg/L)	Reporting Limits (mg/L)
Chloride	EPA 300.0 or SW9056	500	0.054	0.5
Nitrate	SM 4500NO3-F	10	0.01	0.05
Nitrite	SM 4500NO3-F	1	0.01	0.05
Sulfate	EPA 300.0 or SW9056	250	0.15	1.0
Sulfide	SW9030/9034	1	0.1	0.1
Alkalinity	SM 2320B	--	--	2.0
Total Organic Carbon	SM 5310C	--	0.11	0.5
Methane	RSK-175	--	0.0005	0.0005
Ethane	RSK-175	--	0.0005	0.0005
Ethene	RSK-175	--	0.0005	0.0005

[a] NYSDEC Water Quality Standards and Guidance Values (1998)
mg/L – milligrams per liter

Table A-5. Reporting Limit Objectives for Total Organic Carbon in Soil by Lloyd Kahn
Essex-Hope Site, Jamestown, New York

Analyte	NYSDEC Unrestricted Use SCO[a] Screening Criteria (mg/kg)	Method Detection Limits (mg/kg)	Reporting Limits (mg/kg)
Total Organic Carbon	--	100 (or 0.01%)	100 (or 0.01%)

[a] NYSDEC Soil Cleanup Objectives (SCO) for Unrestricted Use (NYSDEC 2006 and 2010) are presented for selecting appropriate Method Detection Limits and Reporting Limits. Site-specific RAOs were presented in the 1994 ROD and are the site cleanup goals
mg/kg – milligrams per kilogram

Table A-6. Accuracy and Precision for Metals by Method SW6020A
Essex-Hope Site, Jamestown, New York

Analyte	LCS Accuracy (%R)	MS/MSD Accuracy (%R)	Precision (% RPD)
Iron	80-120	75-125	≤ 20
Manganese	80-120	75-125	≤ 20

%R = percent recovery
RPD = relative percent difference

Table A-7. Accuracy and Precision for Volatile Organic Compounds by Method SW8260C

Essex-Hope Site, Jamestown, New York

Parameter	LCS/LCSD/MS/MSD Accuracy Water (%R) LCL	LCS/LCSD/MS/MSD Accuracy Water (%R) UCL	Precision Water (%RPD)	LCS/LCSD/MS/MSD Accuracy Soil (%R) LCL	LCS/LCSD/MS/MSD Accuracy Soil (%R) UCL	Precision Soil (%RPD)
1,1,1,2-Tetrachloroethane	64	130	≤ 20	70	130	≤ 30
1,1,1-Trichloroethane	67	130	≤ 20	70	130	≤ 30
1,1,2,2-Tetrachloroethane	67	130	≤ 20	70	130	≤ 30
1,1,2-Trichloroethane	70	130	≤ 20	70	130	≤ 30
1,1-Dichloroethane	70	130	≤ 20	65	135	≤ 30
1,1-Dichloroethene	61	145	≤ 20	70	130	≤ 30
1,1-Dichloropropene	70	130	≤ 20	70	130	≤ 30
1,2,3-Trichlorobenzene	70	130	≤ 20	70	130	≤ 30
1,2,3-Trichloropropane	64	130	≤ 20	68	130	≤ 30
1,2,4-Trichlorobenzene	70	130	≤ 20	70	130	≤ 30
1,2,4-Trimethylbenzene	70	130	≤ 20	70	130	≤ 30
1,2-Dibromo-3-chloropropane	41	144	≤ 20	68	130	≤ 30
1,2-Dibromoethane	70	130	≤ 20	70	130	≤ 30
1,2-Dichlorobenzene	70	130	≤ 20	70	130	≤ 30
1,2-Dichloroethane	70	130	≤ 20	70	130	≤ 30
1,2-Dichloropropane	70	130	≤ 20	70	130	≤ 30
1,3,5-Trimethylbenzene	64	130	≤ 20	70	130	≤ 30
1,3-Dichlorobenzene	70	130	≤ 20	70	130	≤ 30
1,3-Dichloropropane	70	130	≤ 20	69	130	≤ 30
1,4-Dichlorobenzene	70	130	≤ 20	70	130	≤ 30
1.4-Dioxane	56	162	≤ 20	65	136	≤ 30
2,2-Dichloropropane	63	133	≤ 20	70	130	≤ 30
2-Butanone (MEK)	63	138	≤ 20	70	130	≤ 30
2-Chlorotoluene	70	130	≤ 20	70	130	≤ 30
2-Hexanone	57	130	≤ 20	70	130	≤ 30
4-Chlorotoluene	70	130	≤ 20	70	130	≤ 30
4-Methyl-2-pentanone (MIBK)	59	130	≤ 20	70	130	≤ 30
Acetone	58	148	≤ 20	54	140	≤ 30
Benzene	70	130	≤ 20	70	130	≤ 30
Bromobenzene	70	130	≤ 20	70	130	≤ 30
Bromochloromethane	70	130	≤ 20	70	130	≤ 30
Bromodichloromethane	67	130	≤ 20	70	130	≤ 30
Bromoform	54	136	≤ 20	70	130	≤ 30
Bromomethane	39	139	≤ 20	57	147	≤ 30
Carbon disulfide	51	130	≤ 20	59	130	≤ 30
Carbon tetrachloride	63	132	≤ 20	70	130	≤ 30
Chlorobenzene	75	130	≤ 20	70	130	≤ 30
Chlorodibromomethane	63	130	≤ 20	70	130	≤ 30
Chloroethane	55	138	≤ 20	50	151	≤ 30

Table A-7. Accuracy and Precision for Volatile Organic Compounds by Method SW8260C

Essex-Hope Site, Jamestown, New York

Parameter	LCS/LCSD/MS/MSD Accuracy Water (%R) LCL	LCS/LCSD/MS/MSD Accuracy Water (%R) UCL	Precision Water (%RPD)	LCS/LCSD/MS/MSD Accuracy Soil (%R) LCL	LCS/LCSD/MS/MSD Accuracy Soil (%R) UCL	Precision Soil (%RPD)
Chloroform	70	130	≤ 20	70	130	≤ 30
Chloromethane	64	130	≤ 20	52	130	≤ 30
cis-1,2-Dichloroethene	70	130	≤ 20	70	130	≤ 30
cis-1,3-Dichloropropene	70	130	≤ 20	70	130	≤ 30
Dibromomethane	70	130	≤ 20	70	130	≤ 30
Dichlorodifluoromethane	36	147	≤ 20	30	146	≤ 30
Ethylbenzene	70	130	≤ 20	70	130	≤ 30
Hexachlorobutadiene	63	130	≤ 20	67	130	≤ 30
Isopropylbenzene	70	130	≤ 20	70	130	≤ 30
Methylene Chloride	70	130	≤ 20	70	130	≤ 30
Methyl-t butyl ether	63	130	≤ 20	66	130	≤ 30
m,p-xylene	70	130	≤ 20	70	130	≤ 30
n-Butylbenzene	53	136	≤ 20	70	130	≤ 30
N-Propylbenzene	69	130	≤ 20	70	130	≤ 30
Naphthalene	70	130	≤ 20	70	130	≤ 30
o-xylene	70	130	≤ 20	70	130	≤ 30
p-Isopropyltoluene	70	130	≤ 20	70	130	≤ 30
sec-Butylbenzene	70	130	≤ 20	70	130	≤ 30
Styrene	70	130	≤ 20	70	130	≤ 30
tert-Butylbenzene	70	130	≤ 20	70	130	≤ 30
Tetrachloroethene	70	130	≤ 20	70	130	≤ 30
Toluene	70	130	≤ 20	70	130	≤ 30
trans-1,2-Dichloroethene	70	130	≤ 20	70	130	≤ 30
trans-1,3-Dichloropropene	70	130	≤ 20	70	130	≤ 30
Trichloroethene	70	130	≤ 20	70	130	≤ 30
Trichlorofluoromethane	62	150	≤ 20	70	139	≤ 30
Vinyl Acetate	70	130	≤ 20	70	130	≤ 30
Vinyl chloride	55	140	≤ 20	67	130	≤ 30
Surrogates						
1,2-Dichloroethane-d4	70	130	--	70	130	--
4-Bromofluorobenzene	70	130	--	70	130	--
Dibromofluoromethane	70	130	--	70	130	--
Toluene-d8	70	130	--	70	130	--

%R = percent recovery
RPD = relative percent difference

Table A-8. Accuracy and Precision Limits for General Chemistry and Other Parameters
Essex-Hope Site, Jamestown, New York

Analyte	Method	LCS Accuracy Water (%R)	MS/MSD Accuracy Water (%R)	Precision Water (% RPD)
Chloride	EPA 300.0 or SW9056	90-110	64-148	20
Nitrate	SM 4500NO3-F	90-110	80-120	15
Nitrite	SM 4500NO3-F	90-110	80-120	20
Sulfate	EPA 300.0 or SW9056	90-110	72-124	20
Sulfide	SW9030/9034	75-125	70-130	20
Alkalinity	SM 2320B	90-110	86-116	10
Total Organic Carbon	SM 5310C	90-110	80-120	20
Methane	RSK-175	80-120	80-120	25
Ethane	RSK-175	80-120	80-120	25
Ethene	RSK-175	80-120	80-120	25

%R = percent recovery
RPD = relative percent difference

Table A-9. Accuracy and Precision Limits for Total Organic Carbon (Soil)
Essex-Hope Site, Jamestown, New York

Analyte	Method	LCS/MS/MSD Accuracy Soil (%R)	Precision Soil (% RPD)
Total Organic Carbon	Lloyd Kahn	75-125	25

%R = percent recovery
RPD = relative percent difference

Table A-10. Calibration and QC Requirements for Metals by SW6020A

Essex-Hope Site, Jamestown, New York

QC Check	Frequency	Criteria	Corrective Action
Initial calibration (a blank and at least one standard)	Before sample analysis, every 24 hours, whenever modifications are made to the system, or when continuing calibration verification fails	If more than one standard is used, correlation coefficient must be > 0.995	NA
Second-source calibration verification	Immediately following each initial calibration	All analytes within ±10% of expected value	Correct problem and repeat initial calibration.
Calibration blank	After every Second-source or Continuing calibration verification analysis	No analytes detected at or above the reporting limit	Correct the problem, then reanalyze previous 10 samples
Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within ±10% of expected value	Recalibrate and reanalyze all samples since the last acceptable continuing calibration verification
Method Blank	At least one per analytical batch	No analytes detected at or above the reporting limit	Correct the problem and re-prep and reanalyze all associated samples
Interference check standard	At the start and end of each analytical sequence or twice during an 8-hour period, whichever is more frequent	All analytes within ±20% of expected value	Correct the problem, recalibrate, reanalyze ICS and all affected samples
MS/MSD	One set per 20 project-specific samples. MSD is optional if a laboratory sample duplicate is performed	All analytes within limits specified in Accuracy and Precision table	None
Laboratory sample duplicate	Once per analytical batch if MSD not performed	Concentration of reported analytes are > 5 times the reporting limit in either sample and RPD >20% One sample result < RL and a difference of ±RL	None
LCS	At least one per analytical batch	All analytes within limits specified in Accuracy and Precision table	Correct the problem, and re-prep and reanalyze the LCS and all samples in the analytical batch.
Dilution test	Each new sample matrix	Result from 1:5 dilution must be within ±10% of the undiluted sample result (applies only if undiluted sample result is at least 25 times the reporting limit)	Perform post-digestion spike addition.
Linear Range Calibration check standard	Once per quarter	All analytes within ± 10% of expected value	Correct problem then reanalyze or re-set linear range
Post-digestion spike addition	When dilution test fails	Recovery within 75-125% of expected value	None

Table A-11. Calibration and QC Requirements for Volatile Organic Compounds by SW8260C

Essex-Hope Site, Jamestown, New York

QC Check	Frequency	Criteria	Corrective Action
BFB Tuning	Prior to initial calibration and calibration verification (every 12 hours)	Refer to criteria listed in the method	Retune instrument and verify
Multi-point initial calibration (minimum five points)	Prior to sample analysis, or when calibration verification fails	Average RF for all analytes ≥ 0.10[a] and one option below: Option 1: %RSD for all analytes ≤ 20% Option 2: Least squares regression r ≥ 0.990	Correct the problem and repeat the initial calibration.
Second-source calibration verification	Once for each multi-point initial calibration	All analytes within ±30% of expected value	Correct the problem and repeat initial calibration.
Continuing calibration verification	At the start of each analytical sequence and every 12 hours thereafter	Average RF for all analytes ≥ 0.10[a] All analytes within + 20% of expected value.	Correct the problem, then recalibrate and reanalyze all samples since the last acceptable continuing calibration verification.
Retention time window calculated for each analyte	Each analyte	Relative retention time of each analyte within + 0.06 relative retention time units of the continuing calibration verification	Not applicable (used for identification of analyte)
Internal Standards	Each sample and QC sample, method blank, MS/MSD and LCS	Retention time within ±30 seconds from retention time of the daily continuing calibration verification standard. EICP area within –50% to +100% of the daily continuing calibration verification standard	Inspect mass spectrometer and gas chromatography for malfunctions; reanalyze all affected samples
Method Blank	At least one per analytical batch	No analytes detected at or above the reporting limit	Correct the problem, then re-prep and reanalyze all associated samples
Surrogate spike	Every standard, sample, method blank, MS/MSD and LCS	All surrogates in samples, method blank and LCS within limits specified in Accuracy and Precision table	Correct the problem and reanalyze (re-prep if necessary).
MS/MSD	One set per 20 project-specific samples	Within limits specified in Accuracy and Precision table	None
LCS	At least one per analytical batch	Within limits specified in Accuracy and Precision table	Correct the problem, then re-prep and reanalyze the LCS and all samples in the analytical batch.

[a]Average relative response factor (RRF) specific for each comment. See Table 4 in SW8260C method.

Table A-12. Calibration and QC Requirements for General Chemistry and Other Parameters[a]

Essex-Hope Site, Jamestown, New York

QC Check	Frequency	Criteria	Corrective Action
Multi-point initial calibration (a blank and at least five standards) – does not apply to titrimetric method	Before initial sample analysis, every 24 hours, whenever modifications are made to the analytical system, or when continuing calibration verification fails	Correlation coefficient of linear regression is ≥ 0.995	Correct the problem and repeat the initial calibration.
Second-source calibration verification	Immediately following each initial calibration	Analytes within ±15% (±10% for SW9056/ EPA300.0) of expected value	Correct the problem and repeat initial calibration.
Calibration blank – does not apply to titrimetric method	After every Second-source or Continuing calibration verification analysis	No analytes detected at or above the reporting limit	Correct the problem, then reanalyze previous 10 samples.
Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	Within ±15% (±10% for SW9056/EP300.0) of expected value	Recalibrate and reanalyze all samples since the last acceptable continuing calibration verification
Method Blank	At least one per analytical batch	No analytes detected at or above the reporting limit	Correct the problem and re-prep and reanalyze all associated samples
MS/MSD	One set per 20 project-specific samples. MSD is optional if a laboratory sample duplicate is performed	All analytes within limits specified in Accuracy and Precision table	None
Laboratory sample duplicate	Once per analytical batch if MSD not performed	Concentration of reported analytes are > 5 times the reporting limit in either sample and RPD >20%. One sample result < RL and a difference of ±2 times the reporting limit	None
LCS	At least one per analytical batch	All analytes within limits specified in Accuracy and Precision table	Correct the problem, and re-prep and reanalyze the LCS and all samples in the analytical batch

[a]Unless calibration and QC requirements are specified for an individual method.

Table A-13. Calibration and QC Requirements for RSK-175

Essex-HopeSite, Jamestown, New York

QC Check	Frequency	Criteria	Corrective Action
Multi-point initial calibration (minimum five points)	Prior to sample analysis, or when calibration verification fails	If the %RSD is ≤ 20%, the average RRF may be used for quantitation; otherwise use calibration curve with coefficient of correlation or determination ≥ 0.99.	Reanalyze one point or two points if six points are included in the initial calibration. Correct the problem and repeat the initial calibration.
Second Source/Continuing calibration verification	At the start of each analytical sequence and after every 10 samples, and at the end of the sequence	Analytes within ±20%	Reanalyze. Correct the problem, then recalibrate and reanalyze all samples since the last acceptable CCV, if possible (enough sample vials submitted) or flag all data associated. .
LCS	At least one per analytical batch	Within limits specified in accuracy and precision table	Correct the problem, and re-prep and reanalyze the LCS and all samples in the analytical batch.
Method Blank	At least one per analytical batch	No analytes detected at or above the reporting limit.	Correct the problem and re-prep and reanalyze all associated samples
MS/MSD	One set per 20 samples	Within limits specified in Accuracy and Precision table.	None

RRF = relative response factor

Table A-14. Data Qualifying Conventions—General

Essex-HopeSite, Jamestown, New York

QC Requirement	Criteria	Flag	Flag Applied To
Holding Time	Time exceeded for extraction or analysis	J for positive results; R or UJ for nondetects*	All analytes in the sample
Sample Preservation	Sample not preserved (if sample preservation was not done in the field but was performed at the laboratory upon sample receipt, no flagging is required)	J for positive results; R or UJ for nondetects*	Sample
Sample Integrity	Temperature out of control VOCs received with headspace >6mm	J for positive results; R or UJ for nondetects*	Sample
Initial Calibration	All analytes must be within method specified RSD criteria	J for positive results; R or UJ for nondetects*	All associated samples in analysis batch
	RRF <0.05 but >0.01	J for positive results; UJ for nondetects	
	RRF<0.01	J for positive results; R for nondetects	

Table A-14. Data Qualifying Conventions—General

Essex-HopeSite, Jamestown, New York

QC Requirement	Criteria		Flag	Flag Applied To
Second Source Check or CCV	All analytes must be within method specified %D criteria		High Bias: J for positive results, no flag for nondetects Low Bias: J for positive results, UJ for nondetects R for all nondetects greater than twice the control criteria	All associated samples in analysis batch
	RRF<0.05 but >0.01		J for positive results; UJ for nondetects	
	RRF<0.01		J for positive results; R for nondetects	
Low-level Calibration Check or Interference Check Sample	All analytes must be within method specified criteria		High Bias: J positive results, no flag for nondetects Low Bias: J positive results, UJ nondetects R for all nondetects greater than twice the control criteria	All associated samples in analysis batch
Internal Standards	Area > upper control limit		J for positive results, no flag for nondetects	Sample
	Area < lower control limit		J for positive results; UJ for nondetects	
	Area < 20%		J for positive results; R for nondetects	
Surrogates	% R > upper control limit		J for positive results, no flag for nondetects	Sample
	%R < lower control limit		J for positive results; UJ for nondetects	
	%R <10%		J for positive results; R for nondetects	
LCS	% R > upper control limit		J for positive results, no flag for nondetects	The specific analyte(s) in all samples in the associated batch
	%R < lower control limit		J for positive results; UJ for nondetects	
	%R <10%		J for positive results; R for nondetects	
Blanks (Method, Field, Equipment, Trip or Calibration)	Blank Result	Sample		
	< RL	<RL	Flag U and raise to RL	
		≥ RL	Use professional judgment	
	≥ RL	<RL	Flag U and raise to RL	Sample
		≥ RL but < blank result	U at sample concentration	
		≥ RL and ≥ blank result	Use professional judgment	

Table A-14. Data Qualifying Conventions—General

Essex-HopeSite, Jamestown, New York

QC Requirement	Criteria	Flag	Flag Applied To
Field Duplicates	RPD > control limit	J for positive results, no flag for nondetects	The specific analyte(s) in the associated sample Note: No flagging is required for results less than the reporting limit
Laboratory Duplicates	RPD > control limit (20% GW; 35% soil)	J for positive results, no flag for nondetects	The specific analyte(s) in the associated sample
MS/MSD and Post-digestion Spikes	%R > upper control limit	J for positive results, no flag for nondetects	The specific analyte(s) in the parent sample
	%R < lower control limit	J for positive results; UJ for nondetects	
	MS/MSD %R <10%	J for positive results; R for nondetects	
	MS/MSD RPD > control limit	J for positive results, no flag for nondetects	
	Sample concentration > 4 times the spike concentration	No flag required	
	Excessive dilution*	No flag required	
Serial Dilutions	All analytes must be within 10% of expected value	J positive results, UJ nondetects	The specific analyte(s) in the parent sample
	Sample concentration < 50x MDL	No flag required	

* Based on analyte-specific review

%R = percent recovery
RRF = relative response factor

Appendix B
Health and Safety Plan

Health and Safety Plan

The Dow Chemical Company Jamestown Essex/Hope Site, Jamestown, New York

Operations and Maintenance/Additional Investigation

Prepared for

Dow Chemical

July 2016

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Emergency Contacts

24-hour CH2M HILL Injury Reporting – 1-866-893-2514
24-hour CH2M HILL Serious Incident Reporting Contact – 720-286-4911

Medical Emergency 911	**CH2M HILL – Medical Consultant** WorkCare Dr. Peter Greaney M.D. 300 S. Harbor Blvd, Suite 600 Anaheim, CA 92805 800-455-6155/866-893-2514 714-978-7488
Fire/Spill Emergency 911	**CH2M HILL Director – Health, Safety, Security & Environment** Andy Strickland/DEN 720-480-0685 (cell) or 720-286-2393 (office)
Security & Police 911	**CH2M HILL Responsible Health and Safety Manager (RHSM)** Jason Kearns/SCH 304-747-2511 (o) / 304-610-6951 (m)
Utilities Emergency Phone Numbers 911	**CH2M HILL Human Resources Department** Employee Connect toll-free number 1-877-586-4411 (U.S. and Canada)
CH2M HILL Project Manager Kyle Block/BOS 617-626-7013 (o) / 610-389-0899 (m)	**CH2M HILL Worker's Compensation:** Contact Business Group HR dept. to have form completed
CH2M HILL Safety Coordinator (SC)/Lead Operator Travis Pendry/FER 248-545-3075 Jon Gowing/KWO 519-579-3500	**Media Inquiries Corporate Strategic Communications** Lorrie Crum/DEN 720-286-0255
CH2M HILL HILL Project Environmental Manager Hope Wilson/ATL 678-656-5411 (m)	**Automobile Accidents** Rental: Mary Ellegood-Oberts/DEN: 720-286-2291 CH2M HILL owned vehicle: Linda George/DEN: 720-286-2057
Federal Express Dangerous Goods Shipping 800-238-5355 **CH2M HILL Dangerous Goods Shipping Advisor** Rob Strehlow/MKW 414-272-1052 ext. 40387	**CHEMTEL (hazardous material spills)** **800-255-3924**

Facility/Site Evacuation Route(s):

In a severe emergency, such as a large fire, explosion, or large chemical release, site evacuation may become necessary. The Safety Coordinator (SC)/Operator will be responsible for informing site personnel of the anticipated routes of evacuation during the initial site training. If the situation permits, the SC/Operator will ensure that all combustion equipment has been shut down. The evacuation route and assembly area will depend upon the wind direction, topography, and the nature of the incident. Personnel will be advised to move to an upwind location at least 100 yards from any fires and/or releases, and will be advised to continually monitor wind direction for changes.

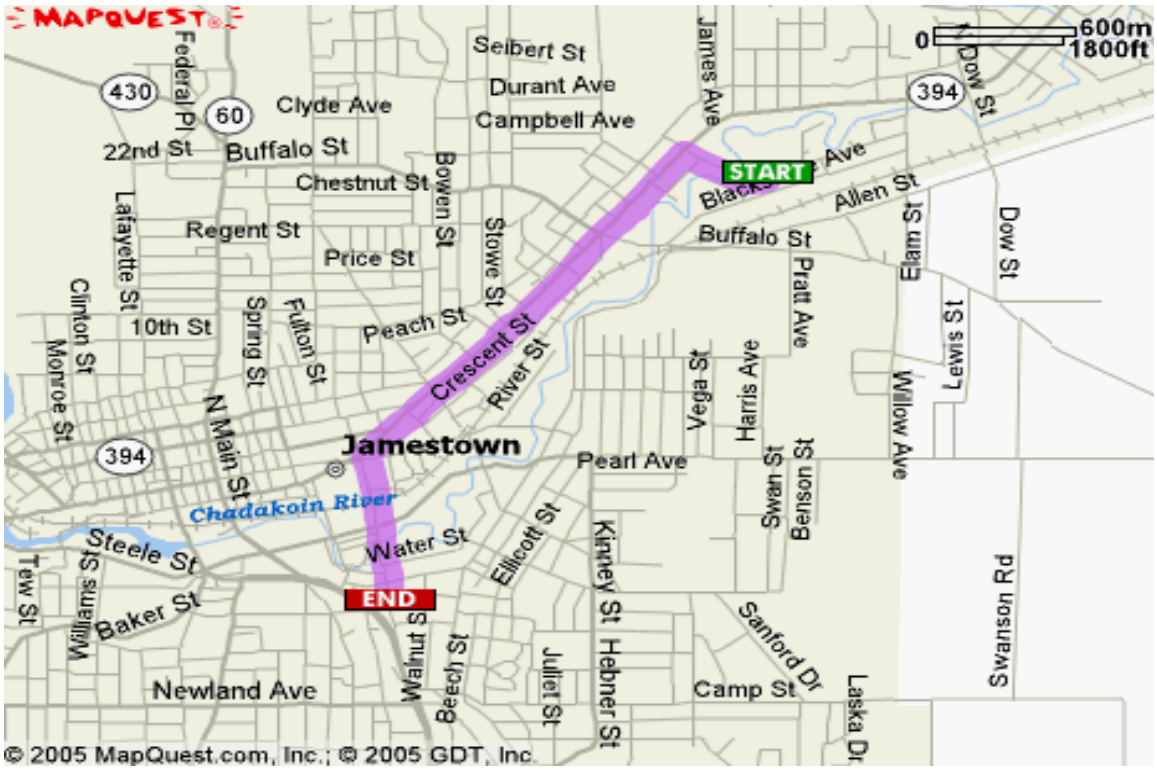
If moving upwind is not possible without encountering the incident, personnel will be advised to move crosswind or downwind to a distance necessary to be out of the path of vapor releases, smoke, odors, or spills.

Once staff has evacuated to a safe distance, the SC/Operator will do the following:

- Contact emergency response personnel.
- Conduct a roll call to ensure all staff are accounted for.
- Ensure that emergency equipment and response personnel have adequate site access.
- All site personnel assembled at the designated safe evacuation area will wait for further instructions from emergency response personnel.

Directions and MAP to Local Hospital

Local Hospital:
Women's Christian Association (WCA) Hospital
207 Foote Avenue
Jamestown, NY 14701
716-487-0141



1. Exit Site to LEFT and follow Hopkins Avenue to Red Light (0.2 miles).

2. Turn LEFT onto NY-394/East 2nd Street. Follow East 2nd Street to intersection with Foote Avenue (1.2 miles).

3. Turn LEFT onto Foote Avenue, Hospital on LEFT-hand side (0.4 miles).

Contents

Attachments

Approval

This Health and Safety Plan (HASP) has been written for use by CH2M HILL Engineers, Inc. (CH2M) only. CH2M claims no responsibility for its use by others unless that use has been specified and defined in project or contract documents. The plan is written for the specific project and site conditions and identified scope(s) of work and must be amended if those conditions or scope(s) of work change.

By approving this HASP, the Responsible Health and Safety Manager (RHSM) certifies that the personal protective equipment has been selected based on the project-specific hazard assessment.

ORIGINAL PLAN

Original Plan Written by: Jason Kearns **Date**: 7/12/2016

RHSM Approval: Jason Kearns **Date**: 7/12/2016

Project Manager Approval: Kyle Block **Date:** 7/18/2016

REVISIONS:

Revisions Made By: **Date:**

Description of Revisions to Plan:

Revisions Approved By: **Date:**

1. Applicability

This HASP applies to:

All CH2M HILL Engineers, Inc. (CH2M) staff, including subcontractors and tiered subcontractors of CH2M working on the site.

All visitors to CH2M construction sites in the custody of CH2M (including visitors from the Client, the Government, the public, and other staff of any CH2M company).

In addition, Subcontractors and tiered subcontractors shall also follow any of their company HSE programs, and site-specific HASPs and Activity Hazard Analysis (AHAs).

This HASP does not apply to the third-party contractors, their workers, their subcontractors, their visitors, or any other persons not under the direct control or custody of CH2M.

This HASP defines the procedures and requirements for the health and safety of CH2M staff and visitors when they are physically on the work site. The work site includes the project area (as defined by the contract documents) and the project offices, trailers, and facilities thereon.

This HASP will be kept onsite during field activities and will be reviewed as necessary. The HASP will be revised as project activities or conditions change or when supplemental information becomes available. The HASP adopts, by reference, the CH2M Enterprise-wide Core Standards and Standard Operating Procedures (SOPs), as appropriate. In addition, applicable requirements contained in the Environmental Services Business Group (ESBG) Health, Safety, Security, and Environment (HSSE) Guidelines (Guidelines) will be implemented. The Guidelines are attached to this HASP. OR The Guidelines are available as a stand-alone handbook at the project site. The HASP may adopt procedures from the project Work Plan and any governing regulations. If there is a contradiction between this HASP and any governing regulation, the more stringent and protective requirement shall apply.

All CH2M staff and subcontractors must sign the employee sign-off form (attached to this HASP) to acknowledge review of this document. Copies of the signature page will be maintained onsite by the Safety Coordinator (SC).

2. General Project Information

2.1 Project Information and Background

Project Number: 671439	**Project/Site Name: Dow JMS AS/SVE Remediation System**
Client: Dow Chemical	**Site Address: 125 Blackstone Avenue Jamestown, NY 14701**
CH2M Project Manager: Kyle Block	**CH2M Office: BOS**
Date HASP Prepared: 7/12/2016	**Date(s) of Site Work: 2016/2017**

2.2 Site Background

The Essex/Hope Site is located on a 4.7-acre parcel of land that is currently owned and occupied by Custom Production Manufacturing, Inc. (CPM) at 125 Blackstone Avenue in the City of Jamestown, New York. The site is located in a highly industrialized area of the city that has seen various degrees of industrial use for the past 75 years. Contamination onsite is the result of historical practices conducted at the facility as discussed in the Remedial Investigation (RI) Report dated October 1992.

There are three separate areas that are the focus of remedial action and include the North Parking Lot (NPL) Area, the former Underground Storage Tank (UST) Area, and the former Aboveground Storage Tank/Underground Storage Tank (AST/UST) Area.

- The remedial systems at the Essex/Hope Site were designed and constructed to address impacted groundwater and soils by a combination of soil vapor extraction, air sparging, and a groundwater extraction and treatment. The original remedial action design and implementation was based upon the March 1994 Record of Decision (ROD) issued by the New York State Department of Environmental Conservation (NYSDEC) and included the following:
- Groundwater remediation system consisting of an extraction well network of five (5) shallow and two (2) deep recovery wells and activated carbon groundwater treatment with onsite discharge to the local publicly owned treatment works (POTW).
- Soil remediation in the AST/UST and UST Areas by soil vapor extraction (SVE) for volatile organic constituents (VOCs) occurring above the shallow water table.
- Soil excavation in the NPL Area, conducted in September and October of 1996, to remove impacted soils in the former sump and surrounding areas.
- Air sparging in the shallow water-bearing zone of the NPL, UST and AST/UST Areas to supplement the treatment of impacted groundwater via enhanced biodegradation and volatilization of organic constituents. An SVE system was added to the NPL Area to collect VOCs volatilized from the shallow groundwater in this area.
- The remedial areas were capped with either asphalt or concrete to enhance surface water runoff and minimize infiltration.
- A network of monitoring wells across the site (as designated in the Performance Monitoring Plan) is used to measure the effectiveness of the groundwater remedial activities.

2.3 Description of Tasks

Below is a description of the tasks covered by this plan. Any additions or changes in scope will require a revision to this HASP; see Change Management below.

The scope of work covered by this HASP includes:

- Mobilization/Demobilization
- Water Level Measurements
- Groundwater Sampling
- System Startup
- System Shutdown
- Routine System Maintenance
- Decontamination
- Waste Management
- Utility Clearance
- Direct-push Technology (DPT)/ Sonic Drilling
- Soil / Groundwater (GW) Grab Sampling
- Well Installation
- Membrane Interface Probe
- Vapor Intrusion Sampling

2.4 Change Management

Changes to this HASP shall be documented and approved by the CH2M Responsible Health and Safety Manager for the project. The following are examples of changes that may require a revision to the plan:

- Change in CH2M staff
- New subcontractor to perform work
- New chemicals brought to site for use
- Change in scope or addition of new tasks
- Change in contaminants of concern (COCs) or change in concentrations of COCs
- New hazards or hazards not previously identified that are not addressed in this HASP

2.5 Changes to the Health and Safety Plan

Changes to the HASP shall be documented and accepted by using the Health and Safety Field Change Request (FCR) form (included in the attachments) or by resubmitting a revised HASP for acceptance. A revised HASP should be produced when a large number of changes (e.g., 15 or more, not including AHAs) using FCRs has been employed. The CH2M Project Manager (PM) and RHSM shall be responsible for the review and acceptance of the FCR, and the RHSM will maintain an FCR log of approved changes. FCRs are not required for safety-related changes that an SC or RHSM would normally make in the field, such as upgrade or downgrade to personal protective equipment (PPE) within pre-established action levels, expansion or reduction of work control zones based on air monitoring results, and similar changes made within the operating parameters of the HASP. The field copy of the HASP shall be kept up to date by annotating the appropriate section (i.e., update to AHA) to indicate that an FCR is in effect; copies of FCRs should be kept with the HASP. The FCR number must be referenced in the HASP and available for review.

2.6 Daily Safety Briefing

Safety briefings are to be held with all project personnel in attendance to review the hazards, controls, and required procedures/AHAs that apply for each day's activities:

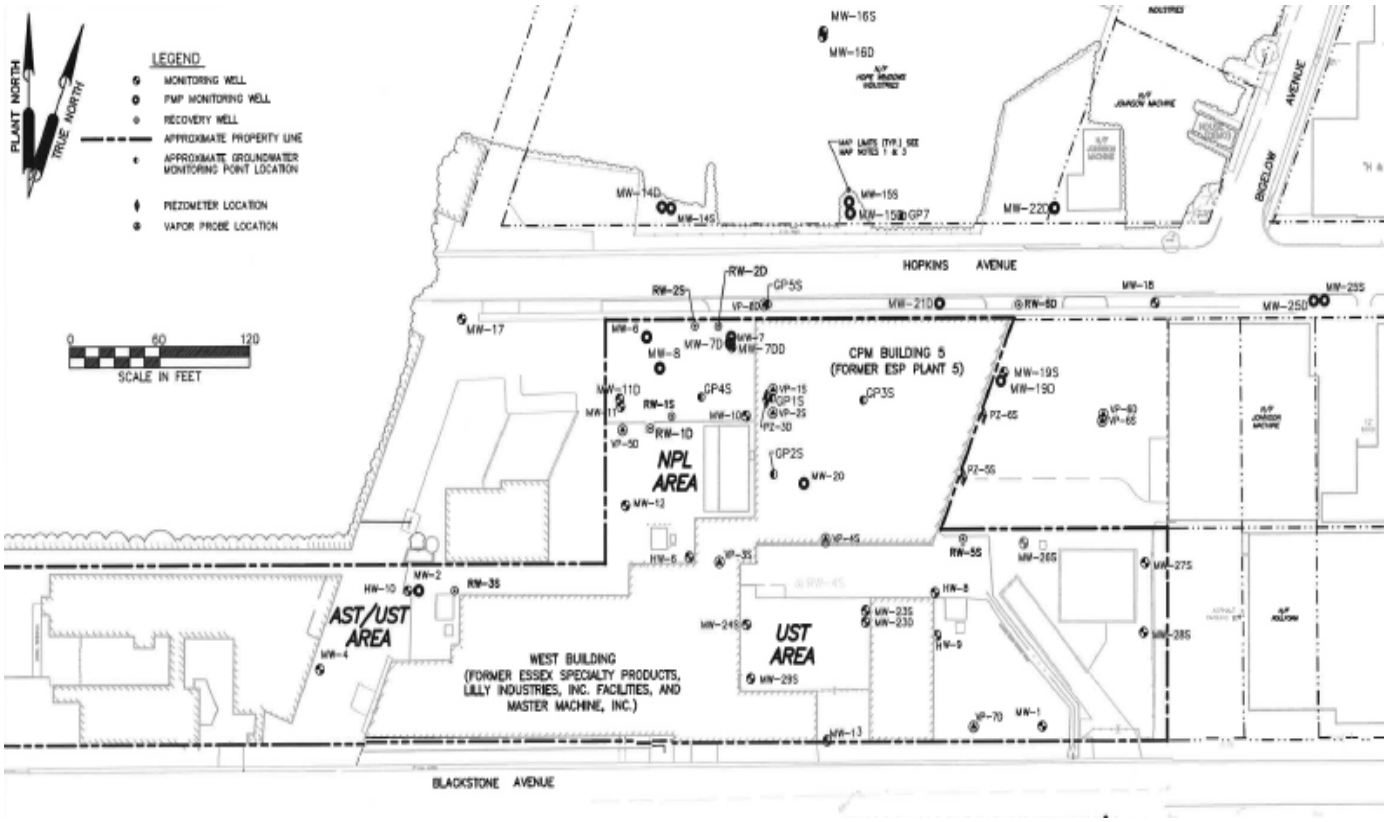
Everyone involved in the day's work needs to sign a sign-in form to show they have had a briefing/attended a meeting.

A copy of the Daily Safety Briefing is included as an attachment to this HASP.

2.7 Subcontractor HSE Chartering Meeting

A subcontractor HSE chartering meeting shall be held with subcontractors performing fieldwork on the project. The purpose of the meeting is to discuss and agree on key HSE requirements on a project, and to emphasize and reinforce CH2M's expectations for subcontractor HSE performance. The target audience includes key CH2M project staff with HSE responsibilities (e.g., PM, RHSM, SC, Field Team Leader [FTL]) and key Subcontractor staff (e.g., project manager, supervisors, designated field HSE contact, drill team leads, and foreman). For small-scale projects (e.g., small drill crew and limited CH2M staff), all the subcontractor crew members should attend if available. The meeting should be held prior to mobilization with enough time to ensure that HSE issues identified can be addressed prior to the start of work. The meeting can be held over the phone or in person depending on project needs. An example agenda can be found in the E&NM Program Element Guideline, "Subcontractor HSSE Chartering Meeting."

Site Map



3. Project Organization and Responsibilities

A full description of responsibilities, including Employee Responsibilities and Authority, can be found in the Guidelines, Section 3, "Roles and Responsibilities."

3.1 Client

Contact Name:	Tim King
Phone:	304-747-3763

3.2 CH2M

Project Manager:	
PM Name:	Kyle Block
Office:	BOS
Telephone number:	617-626-7013
Cellular Number:	610-389-0899

Environmental Manager:	
EM Name:	Hope Wilson
Office:	ATL
Telephone number:	678-530-4226
Cellular Number:	678-656-5411

Safety Coordinator/Lead Operator:	
SC Name:	Travis Pendry
Office:	FER
Telephone number:	248-545-3075
Cellular Number:	

Responsible Health and Safety Manager:	
RHSM Name:	Jason Kearns
Office:	SCH
Telephone number:	304-747-2511
Cellular Number:	304-610-6951

Safety Coordinator/Lead Operator:	
SC Name:	John Gowing
Office:	KWO
Telephone number:	519-579-3500
Cellular Number:	

Safety Coordinator:	
RHSM Name:	Ben Thompson
Office:	CVO
Telephone number:	541-768-3132
Cellular Number:	541-760-9738

3.3 CH2M Subcontractors

Subcontractor:	
Contact Name:	
Telephone number:	
Cellular Number:	

Subcontractor:	
Contact Name:	
Telephone	
Cellular Number:	

Subcontractor:	
Contact Name:	
Telephone number:	
Cellular Number:	

Subcontractor:	
Contact Name:	
Telephone	
Cellular Number:	

3.4 Client Contractors

Client Contractor:	
Contact Name:	
Telephone number:	
Cellular Number:	

Client Contractor:	
Client Name:	
Telephone	
Cellular Number:	

This HASP does not cover contractors that are contracted directly to the client or the owner. CH2M is not responsible for the health and safety or means and methods of the client contractor's work, and we must never assume such responsibility through our actions (such as advising on health and safety issues).

3.5 Subcontractor Oversight

Task Management Requirements					
Task	**Subcontractor Oversight?**			**AHA/ Procedure Required?**	**Active Sites**
	Continuous	**Effective**	**NA**		**Permit Required?**
Mobilization/Demobilization	X			X	NA
Routine System Maintenance	X			X	NA
Decontamination	X			X	NA
Waste Management	X			X	NA
Utility Clearance	X			X	NA
DPT / Sonic Drilling	X			X	NA
Soil / GW Grab Sampling	X			X	NA
Well Installation	X			X	NA
MIP	X			X	NA

4. Standards of Conduct

All individuals associated with this project must work injury-free and drug-free and must comply with the standards of conduct stated in the Guidelines (Section 4, “Standards of Conduct”), comply with all requirements of this HASP, and Subcontractors must also comply with the safety requirements of the Subcontractor HASP. Forms related to Subcontractor Safety (i.e., Observation Hazard Form and Stop Work Order Form) are attached to this HASP.

5. Project Hazard Analysis

A health and safety risk analysis (Table 1) has been completed for this project. Specific project activities are listed in Table 1 with a designation of who performs the task, CH2M (C) or Subcontractor (S). An AHA has been developed for each project activity. AHAs prepared for CH2M activities are included as an attachment to this HASP.

CH2M subcontractors are required to provide AHAs specific to their scope of work on the project for acceptance by CH2M prior to the start of work. Each subcontractor shall submit AHAs for their field activities, as defined in their scope of work, along with their project-specific safety plan and procedures. Additions or changes in field activities, equipment, tools, or material used to perform work or hazards not addressed in existing AHAs requires either a new AHA to be prepared or an existing AHA to be revised.

TABLE 1
Health and Safety Risk Analysis

Associated Hazard Section / Project Activity	Mobilization/ Demobilization	Water Level Measurements	GW Sampling	System Startup	System Shutdown	Routine System Maintenance	Decontamination	Waste Management	Utility Clearance	DPT / Sonic Drilling	Soil / GW Grab Sampling	Well Installation	MIP	Vapor Intrusion Sampling
Blood borne Pathogens	C,S	C	C	C	C	C,S	C	C	C,S	C,S	C,S	C,S	C,S	C
Chemical Storage	C,S	C	C	C	C	C,S	C	C	C,S	C,S	C,S	C,S	C,S	C
Driving Safety	C,S	C	C	C	C	C,S	C	C	C,S	C,S	C,S	C,S	C,S	C
Electrical Safety	C,S	C	C	C	C	C,S			C,S	C,S	C,S	C,S	C,S	
Field Vehicles	C,S	C	C	C	C	C,S	C	C	C,S	C,S	C,S	C,S	C,S	C
Fire Prevention	C,S	C	C	C	C	C,S	C	C	C,S	C,S	C,S	C,S	C,S	C
General Practices and Housekeeping	C,S	C	C	C	C	C,S	C	C	C,S	C,S	C,S	C,S	C,S	C
Hazard Communication	C,S	C	C	C	C	C,S	C	C	C,S	C,S	C,S	C,S	C,S	C
Lighting	C,S	C	C	C	C	C,S	C	C	C,S	C,S	C,S	C,S	C,S	C
Manual Lifting	C,S	C	C	C	C	C,S	C	C	C,S	C,S	C,S	C,S	C,S	C
Personal Hygiene	C,S	C	C	C	C	C,S	C	C	C,S	C,S	C,S	C,S	C,S	C
Personal Security	C,S	C	C	C	C	C,S	C	C	C,S	C,S	C,S	C,S	C,S	C
Shipping and Transportation of Hazardous Waste		C	C	C	C	C		C	C	C	C	C	C	C
Substance Abuse	C,S	C	C	C	C	C,S	C	C	C,S	C,S	C,S	C,S	C,S	C
Aerial Lifts						C,S								
Benzene		C	C	C	C	C,S		C	C,S	C,S	C,S	C,S	C,S	C
Compressed Gas Cylinders		C	C	C	C	C,S		C	C,S	C,S	C,S	C,S	C,S	C

TABLE 1
Health and Safety Risk Analysis

Associated Hazard Section / Project Activity	Mobilization/ Demobilization	Water Level Measurements	GW Sampling	System Startup	System Shutdown	Routine System Maintenance	Decontamination	Waste Management	Utility Clearance	DPT / Sonic Drilling	Soil / GW Grab Sampling	Well Installation	MIP	Vapor Intrusion Sampling
Drum and Portable Tank Handling								C		C,S	C,S	C,S	C,S	
Drum Sampling Safety								C		C,S	C,S	C,S	C,S	
Energized Electrical Work						CS								
Fall Protection						C,S								
Forklifts Operations						S		C			C,S			
Groundwater Sampling/Water Level Measurements		C	C			C					C			
Hand and Power Tools	C,S	C	C	C,S	C	C,S		C	S	S	C,S			C
Lockout /Tagout Activities					C	C,S								
Pressurized Lines/Equipment				C	C	C,S	S			C,S	C,S	C,S	C,S	C
Process Safety Management				C	C	C,S								C
Stairways and Ladders						C,S								
Welding and Cutting						S								
Working around Material Handling Equipment						C,S		C,S						
Working Alone		C	C	C	C	C	C	C						C
Noise				C	C	C,S			C,S	C,S	C,S	C,S	C,S	C
Ultraviolet Light exposure (sunburn)	C,S	C	C			C,S	C,S	C	C,S	C,S	C,S	C,S	C,S	
Temperature Extremes	C,S	C	C	C	C	C,S	C,S	C	C,S	C,S	C,S	C,S	C,S	C
Bees and Other Stinging Insects	C,S	C	C	C	C	C,S	C	C	C,S	C,S	C,S	C,S	C,S	C
Mosquito Bites	C,S	C	C	C	C	C,S	C	C	C,S	C,S	C,S	C,S	C,S	C

C – Hazard section applicable to CH2M personnel
S – Hazard section applicable to Subcontractor personnel

6. Hazards and Controls

Safe work practices and hazard control measures to reduce or eliminate potential hazards as identified in Table 1 are stated in the Guidelines, Sections 7 to 10, the associated CH2M SOP, and are addressed in project AHAs. Any additional project-specific control measures, or those hazards requiring additional emphasis, are identified in the following sections.

Always consult the appropriate CH2M Enterprise SOP to ensure all requirements are implemented. CH2M employees and subcontractors must remain aware of the hazards affecting them regardless of who is responsible for controlling the hazards. CH2M employees and subcontractors who do not understand any of these provisions should contact the RHSM for clarification.

6.1 Electrical Safety

(Reference CH2M SOP HSE-206, *Electrical Safety*)

Below are the hazard controls and safe work practices to follow when using electrical tools, extension cords, and/or other electrical-powered equipment or when exposed to electrical hazards. Ensure the requirements of the referenced SOP are followed:

- Only qualified personnel are permitted to work on unprotected energized electrical systems.
- Only authorized personnel are permitted to enter high-voltage areas.
- CH2M employees who might from time to time work in an environment influenced by the presence of electrical energy must complete Awareness Level Electrical Safety Training located on the CH2M Virtual Office.
- Do not tamper with electrical wiring and equipment unless qualified to do so. All electrical wiring and equipment must be considered energized until lockout/tagout procedures are implemented.
- Inspect electrical equipment, power tools, and extension cords for damage prior to use. Do not use defective electrical equipment, remove from service.
- CH2M has selected Ground Fault Circuit Interrupters (GFCIs) as the standard method for protecting employees from the hazards associated with electric shock.
- GFCIs shall be used on all 120-volt, single phase 15 and 20-amphere receptacle outlets which are not part of the permanent wiring of the building or structure.
- An assured equipment grounding conductor program may be required under the following scenarios:
- GFCIs cannot be utilized.
- Client requires such a program to be implemented.
- Business group decides to implement program in addition to GFCI protection.
- Extension cords must be equipped with third-wire grounding. Cords passing through work areas must be covered, elevated or protected from damage. Cords should not be routed through doorways unless protected from pinching. Cords should not be fastened with staples, hung from nails, or suspended with wire.
- Electrical power tools and equipment must be effectively grounded or double-insulated and Underwriters Laboratory (UL) approved.
- Operate and maintain electric power tools and equipment according to manufacturers' instructions.
- Maintain safe clearance distances between overhead power lines and any electrical conducting material unless the power lines have been de-energized and grounded, or where insulating barriers have been installed to prevent physical contact. Maintain at least 10 feet (3 meters) from overhead power lines for voltages of 50 kilovolts (kV) or less, and 10 feet (3 meters) plus 0.4 inches (1.0 centimeter) for every 1 kV over 50 kV.

- Temporary lights shall not be suspended by their electric cord unless designed for suspension. Lights shall be protected from accidental contact or breakage; and
- Protect all electrical equipment, tools, switches, and outlets from environmental elements.

6.2 Compressed Gas Cylinders

(Reference CH2M SOP HSE-403, *Hazardous Materials Handling*)

Below are the hazard controls and safe work practices to follow when working around or using compressed gas cylinders. Ensure the requirements in the referenced SOP are followed.

- Cylinders and pressure-controlling apparatus shall be inspected for defects and leakage prior to use. Damaged or defective items shall not be used. If a cylinder is found to be defective, the gas distributor shall be notified and subsequent instructions followed. If a leak should develop at a fuse plug or other safety device, the cylinder shall be removed from the work area.
- Cylinders shall be labeled with the identity of the contents. Cylinders not labeled shall be sent back to the cylinder distributor. The color of the cylinder shall not be used exclusively to identify cylinder contents.
- Valve caps must be in place when cylinders are transported, moved, or stored.
- Cylinders must be secured in an upright position at all times.
- Cylinder valves must be closed when cylinders are not being used and when cylinders are being moved.
- Cylinders must be secured on a cradle, basket, or pallet when hoisted; they may not be hoisted by choker slings.
- Eye protection (safety glasses or goggles) shall be worn when using cylinders.
- Cylinders must be shielded from welding and cutting operations and positioned to avoid being struck or knocked over; contacting electrical circuits; or exposed to extreme heat sources.
- Cylinders inside buildings shall be stored in dry, well-ventilated locations at least 20 feet (6.1 meters) from highly combustible materials. Cylinders should be stored in definitely assigned places away from elevators, stairs, or gangways. Assigned storage areas shall be located where cylinders will not be knocked over or damaged.
- Oxygen cylinders in storage shall be separated from fuel gas cylinders or combustible materials by a minimum of 20 feet (6.1 meters) or by a noncombustible barrier at least 5 feet (1.5 meters) high, having a fire resistance rating of at least 0.5 hours.
- Signs indicating no smoking shall be provided for storage areas containing flammable gas cylinders.
- Complete the self-assessment checklist for compressed gas cylinders are being used.

6.3 Drilling Safety

(Reference CH2M SOP HSE-204, *Drilling*)

Below are the hazard controls and safe work practices to follow when working around or performing drilling. Ensure the requirements in the referenced SOP are followed.

- The drill rig is not to be operated in inclement weather.
- The driller is to verify that the rig is properly leveled and stabilized before raising the mast.
- Personnel should be cleared from the sides and rear of the rig before the mast is raised.
- The driller is not to drive the rig with the mast in the raised position.

- The driller must check for overhead power lines before raising the mast. Maintain a minimum distance of 10 feet (3 meters) between mast and overhead lines (<50 kV) and an additional 0.4 inches for every 1 kV over 50 kV. Verify the voltage of nearby overhead power lines to determine the minimum distance.
- If the project site is suspected of munitions or explosives of concern (MEC) contamination, requirements of the *Explosives Usage and Munitions Response (MR)* SOP HSE-610 shall be followed. MECs include unexploded ordnance (UXO), discarded military munitions, materials that present a potential explosive hazard, chemical warfare materials, munitions constituents, and contaminated soil or groundwater. "Down-hole" avoidance support may be required to prevent accidental contact with UXO. Safety requirements will be based on the risk assessment identified within the MR (safety) ORE (Opportunity Risk Evaluation).
- Personnel should stand clear before rig startup.
- The driller is to verify that the rig is in neutral when the operator is not at the controls.
- Become familiar with the hazards associated with the drilling method used (i.e., cable tool, air rotary, hollow-stem auger, etc.).
- Do not wear loose-fitting clothing, watches, etc., that could get caught in moving parts.
- Do not smoke or permit other spark-producing equipment around the drill rig.
- The drill rig must be equipped with a kill wire or switch, and personnel are to be informed of its location.
- Be aware and stand clear of heavy objects that are hoisted overhead.
- The driller is to verify that the rig is properly maintained in accordance with the drilling company's maintenance program.
- The driller is to verify that all machine guards are in place while the rig is in operation.
- The driller is responsible for housekeeping (maintaining a clean work area).
- The drill rig should be equipped with at least one fire extinguisher.
- If the drill rig comes into contact with electrical wires and becomes electrically energized, do not touch any part of the rig or any person in contact with the rig, and stay as far away as possible. Notify emergency personnel immediately.
- Use the drilling self-assessment checklist to evaluate drilling operations.

6.4 Drum and Portable Tank Handling

Below are the hazard controls and safe work practices to follow when overseeing the movement of drums or when handling drums:

- Ensure that personnel are trained in proper lifting and moving techniques to prevent back injuries.
- Ensure drum or tank bungs and lids are secured and are labeled prior to moving.
- Ensure that drums and tanks remain covered except when removing or adding material or waste. Covers and/or lids will be properly secured at the end of each workday.
- Provide equipment to keep the operator removed from the drums to lessen the likelihood of injury. Such equipment might include: a drum grappler attached to a hydraulic excavator; a small front-end loader, which can be either loaded manually or equipped with a bucket sling; a rough terrain forklift; roller conveyor equipped with solid rollers; or drum carts designed specifically for drum handling.
- Make sure the vehicle selected has sufficient rated load capacity to handle the anticipated loads, and make sure the vehicle can operate smoothly on the available road surface.

- Ensure there are appropriately designed Plexiglas cab shields on loaders, backhoes, etc., when handling drums containing potentially explosive materials.
- Equipment cabs should be supplied with fire extinguishers, and should be air-conditioned to increase operator efficiency.
- Supply operators with appropriate respiratory protective equipment when needed.
- Ensure that drums are secure and are not in the operator's view of the roadway.
- Prior to handling, all personnel should be warned about hazards of handling.
- Before moving anything, determine the most appropriate sequence in which the various drums, portable tanks, and other containers should be moved (e.g., small containers may have to be removed first to permit heavy equipment to enter and move the drums).
- Overpack drums and an adequate volume of absorbent should be kept near areas where minor spills may occur.
- Use containers or overpacks that are compatible with the waste or materials.
- Drums containing liquids or hazardous waste will be provided with secondary containment and may not be located near a storm water inlet or conveyance.
- Allow enough aisle space between drum pallets and between drums and other equipment that the drums can be easily accessed (at least 2 to 3 feet) by fire control equipment and similar equipment.
- Make sure that a spill kit is available in drum or tank storage areas (or where liquids are transferred from one vessel to another).

6.5 Drum Sampling Safety

Personnel are permitted to handle and/or sample drums containing certain types of waste (drilling waste, investigation-derived waste, and waste from known sources) only. Handling or sampling drums with unknown contents requires a plan revision or amendment approved by the RHSM. The following control measures will be taken when sampling drums:

- Minimize transportation of drums.
- Sample only labeled drums or drums from a known waste stream.
- Do not sample bulging or swollen drums. Contact the RHSM.
- If drums contain, or potentially contain, flammable materials, use non-sparking tools to open.
- Use the proper tools to open and seal drums.
- Reseal bung holes or plugs whenever possible.
- Avoid mixing incompatible drum contents.
- Sample drums without leaning over the drum opening.
- Transfer/sample the content of drums using a method that minimizes contact with material.
- Use the PPE and perform air monitoring as specified in the PPE and Site Monitoring sections of the project safety plan.
- Take precautions to prevent contaminated media from contacting the floor or ground, such as having plastic under the sampling area, having a spill kit accessible during sampling activities.
- If transferring/sampling drums containing flammable or combustible liquids, drums and liquid transfer equipment should be grounded and bonded to reduce the potential of a static discharge.

6.6 Groundwater Sampling/Water Level Measurements

When conducting groundwater sampling/water level measurements at SCF, the Dow WVO Groundwater Sampling Safe Work Procedure will be followed (attached to this HASP).

Below are the hazard controls and safe work practices to follow when personnel or subcontractors are performing groundwater sampling and/or water level measurements.

- Full coolers are heavy. Plan in advance to have two people available at the end of the sampling effort to load full coolers into vehicles. If two people are not available, use several smaller coolers instead of fewer large ones.
- Wear the appropriate PPE when sampling, including safety glasses, nitrile gloves, and steel toe boots (see PPE section of the project safety plan).
- Monitor headspace of wells prior to sampling to minimize any vapor inhalation (refer to the "Site Monitoring" section of the project safety plan).
- Use caution when opening well lids. Wells may contain poisonous spiders and hornet or wasp nests.
- Use the appropriate lifting procedures (see CH2M SOP HSE-112) when unloading equipment and sampling at each well.
- Avoid sharp edges on well casings.
- If dermal contact occurs with groundwater or the acid used in sample preservation, immediately wash all affected skin thoroughly with soap and water.
- Avoid eating and drinking on site and during sampling.
- Use ear plugs during sampling if sampling involves a generator.
- Containerize all purge water and transport to the appropriate storage area.
- Use two people to transport full coolers/containers whenever possible. If two people are not available use a dolly to move coolers. If the coolers weigh more than 40 pounds, Attachment 1 of the HSE-112, *Manual Lifting,* shall be completed by the SC. If the coolers weigh more than 50 pounds they should never be lifted by one person.

6.7 Hand and Power Tools

(Reference CH2M SOP HSE-210, *Hand and Power Tools*)

Hands are one of the most complex parts of the body. Every employee uses their hands to help them make a living. There are more on-the-job injuries to hands than any other body part.

Below are the hazard controls and safe work practices to follow when personnel or subcontractors are using hand and power tools. Ensure the requirements in the referenced SOP are followed.

General

- Always select the right tool for the job.
- Keep cutting tools sharp—less force will be needed for the cut. Do not use pocket knives—only safety cutting tools and if using these be sure to comply with the "Knife Use" section of the Guidelines.
- Carry and store tools correctly and never put sharp or pointed tools in your pocket or belt.
- Tools shall be inspected prior to use and damaged tools will be tagged and removed from service.
- Store tools properly in a place where they will not be damaged or come in contact with hazardous materials.

- Tools used in an explosive environment must be rated for work in that environment (i.e., intrinsically safe, spark-proof, etc.).

Hand and Power Tools

- Hand and power tools will be used for their intended use and operated in accordance with manufacturer's instructions and design limitations.
- Screwdrivers are one of the most used and abused tools, never:
- Hammer with a screwdriver
- Use as a pry bar
- Use with a broken handle
- Use with worn out tips
- Maintain all hand and power tools in a safe condition.
- Use PPE (i.e., gloves, safety glasses, earplugs, and face shields) when exposed to a hazard from a tool.
- Do not carry or lower a power tool by its cord or hose.
- Portable power tools will be plugged into GFCI protected outlets.
- Portable power tools will be UL listed and have a three-wire grounded plug or be double-insulated.
- Disconnect tools from energy sources when they are not in use, before servicing and cleaning them, and when changing accessories (i.e., blades, bits, and cutters).
- Safety guards on tools must remain installed while the tool is in use and must be promptly replaced after repair or maintenance has been performed.
- If a cordless tool is connected to its recharge unit, both pieces of equipment must conform strictly with electrical standards and manufacturer's specifications.
- Working with manual and pistol-grip hand tools may involve highly repetitive movement, extended elevation, constrained postures, and/or awkward positioning of body members (e.g., hand, wrist, arm, shoulder, neck, etc.). Consider alternative tool designs, improved posture, the selection of appropriate materials, changing work organization, and sequencing to prevent muscular, skeletal, repetitive motion, and cumulative trauma stressors.

Machine Guarding

- Ensure that all machine guards are in place to prevent contact with drive lines, belts, chains, pinch points or any other sources of mechanical injury.
- Unplugging jammed equipment will only be performed when equipment has been shut down, all sources of energy have been isolated and equipment has been locked/tagged and tested.
- Maintenance and repair of equipment that results in the removal of guards or would otherwise put anyone at risk requires lockout of that equipment prior to work.

6.8 Lockout/Tagout Activities

Lockout/tagout (LO/TO) shall be performed whenever service or maintenance is necessary on equipment that could cause injury to personnel from the unexpected equipment energizing or start-up or unexpected release of stored energy. Energy sources requiring lockout/tagout may include electrical, pneumatic, kinetic, and potential.

If work on energized electrical systems is necessary—contact the RHSM. Specific training and procedures are required to be followed before any work on energized electrical systems can be performed and are NOT covered in this section. Energized electrical work is defined as work performed **on or near** energized electrical systems or

equipment with exposed components operating at 50 volts or greater. Working near energized live parts is any activity inside a Limited Approach Boundary (anywhere from 3.5 feet to 24 feet [1 meter to 7.3 meters] depending on voltage). Examples of energized electrical work include using a voltmeter to troubleshoot electrical systems and changing out controllers.

When lockout/tagout is necessary to perform maintenance/repair of a system Lockout and Tagout, shall be met including the following bulleted items:

- When CH2M controls the work, CH2M must verify that subcontractors affected by the unexpected operation of equipment develop a written lockout/tagout program, provide training on lockout/tagout procedures and coordinate its program with other affected subcontractors. This may include compliance with the owner or facility lockout/tagout program.
- When CH2M personnel are affected by the unexpected operation of equipment they must complete the electrical safety awareness module on the VO. Authorized personnel shall inform the affected personnel of the LO/TO. Affected personnel shall not tamper with LO/TO devices.
- Standard lockout/tagout procedures include the following six steps: 1) notify all personnel in the affected area of the lockout/tagout, 2) shut down the equipment using normal operating controls, 3) isolate all energy sources, 4) apply individual lock and tag to each energy isolating device, 5) relieve or restrain all potentially hazardous stored or residual energy, and 6) verify that isolation and de-energization of the equipment has been accomplished. Once verified that the equipment is at the zero energy state, work may begin.
- All safe guards must be put back in place, all affected personnel notified that lockout has been removed and controls positioned in the safe mode prior to lockout removal. Only the individual who applied the lock and tag may remove them.
- CH2M authorized employees shall complete the LO/TO training module on the Virtual Office (VO) and either the electrical safety training module on the VO or 10-hour construction training. The authorized employee must also be trained and qualified on the system they are working on (e.g., qualified electrician for working on electrical components of a system).

When equipment-specific LO/TO procedures are not available or when existing procedures are determined to be insufficient, CH2M authorized employees shall also complete the Equipment-Specific LO/TO Procedure Development Form, provided as an attachment to the SOP, to create an equipment-specific lockout/tagout procedure.

6.9 Noise

(Reference CH2M SOP HSE-108, *Hearing Conservation*)

CH2M is required to control employee exposure to occupational noise levels of 85 decibels, A-weighted (dBA) and above by implementing a hearing conservation program that meets the requirements of the Occupational Safety and Health Administration (OSHA) Occupational Noise Exposure standard, 29 *Code of Federal Regulations* (CFR) 1910.95. A noise assessment may be conducted by the RHSM or designee based on potential to emit noise above 85 dBA and also considering the frequency and duration of the task. The following applies:

- Areas or equipment emitting noise at or above 90 dBA shall be evaluated to determine feasible engineering controls. When engineering controls are not feasible, administrative controls can be developed and appropriate hearing protection will be provided.
- At areas or equipment emitting noise levels at or above 85 dBA, hearing protection must be worn.
- Employees exposed to 85 dBA or a noise dose of 50 percent must participate in the Hearing Conservation program including initial and annual (as required) audiograms.
- The RHSM will evaluate appropriate controls measures and work practices for employees who have experienced a standard threshold shift (STS) in their hearing.

- Employees who are exposed at or above the action level of 85 dBA are required to complete the online Noise Training Module located on CH2M's VO.
- Hearing protection will be maintained in a clean and reliable condition, inspected prior to use and after any occurrence to identify any deterioration or damage, and damaged or deteriorated hearing protection repaired or discarded.
- In work areas where actual or potential high noise levels are present at any time, hearing protection must be worn by employees working or walking through the area.
- Areas where tasks requiring hearing protection are taking place may become hearing protection required areas as long as that specific task is taking place.
- High noise areas requiring hearing protection should be posted or employees must be informed of the requirements in an equivalent manner and a copy of the OSHA standard 29 CFR 1910.95 shall be posted in the workplace.

6.10 Pressure Line/Vessel Systems

- Operate and maintain pressure vessels, pumps and hosing in accordance with the manufacturer's recommendations.
- Do not exceed the rated pressure of the vessels and hosing of the system.
- The system must be provided with a pressure relief valve/controller that safely reduces the system pressure to within the system rated pressure.
- The pressure relief valve must be rated at no more than 110 percent the rated pressure of the system and must be tested at regular intervals.
- Each vessel must be equipped with a functioning pressure gauge to monitor pressure.

6.11 Working Alone

(Reference CH2M Core Standard, *Working Alone*)

7. Hazard Communication

As indicated in Section 7, “Hazard Communication,” in the Guidelines, the hazard communication (HazCom) coordinator (the SC or qualified designee) must perform the following (additional HazCom duties are outlined in the Guidelines):

- Complete an inventory of chemicals brought on site by CH2M using the chemical inventory form included as an attachment to this HASP.
- Confirm that an inventory of chemicals brought on site by CH2M subcontractors is available.
- Before or as the chemicals arrive on site, obtain a Safety Data Sheet (SDS) for each hazardous chemical and include on the chemical inventory sheet (attached to this HASP) and add the SDS to the SDS attachment section of this HASP.
- Give employees required chemical-specific HazCom training using the chemical-specific training form included as an attachment to this HASP.

8. Contaminants of Concern

The table below summarizes the potential COCs and their occupational exposure limit and signs and symptoms of exposure. The table also includes the maximum concentration of each COC and the associated location and media that was sampled (groundwater, soil boring, surface soil). These concentrations were used to determine engineering and administrative controls described in the "Project-Specific Hazard Controls" section of this HASP, as well as PPE and site monitoring requirements.

Contaminants of Concern

Contaminant	Location and Maximum Concentration (ppm)	Exposure Limits	IDLHc	Symptoms and Effects of Exposure	PIPd (eV)
Acetone	GW: 678 (MW-21D) SB: SS:	250 ppm	2,500 ppm	Irritation to the eyes, nose, throat. Headaches, dizziness, central nervous system depression, dermatitis.	9.69
cis-1,2-Dichloroethene	GW: 185 (MW-21D) SB: SS:	200 ppm	1,000 ppm	Irritated eyes, CNS depression	10.0
Ethylbenzene	GW: 13.3 (MW-29S) SB: SS:	100 ppm	800	Eye, skin, and mucous membrane irritation; headache; dermatitis; narcotic; coma	8.76
Tetrachloroethene	GW: ND SB: SS:	25 ppm	150 Ca	Eye, nose, and throat irritation; nausea; flushed face and neck; vertigo; dizziness; sleepiness; skin redness; headache; liver damage	9.32
Toluene	GW: 0.512 (MW-29S) SB: SS:	20 ppm	500	Eye and nose irritation, fatigue, weakness, confusion, dizziness, headache, dilated pupils, excessive tearing, nervousness, muscle fatigue, paresthesia, dermatitis, liver and kidney damage	8.82
Trichloroethene	GW: 30 (MW-21D) SB: SS:	10 ppm	1,000 Ca	Headache, vertigo, visual disturbance, eye and skin irritation, fatigue, giddiness, tremors, sleepiness, nausea, vomiting, dermatitis, cardiac arrhythmia, paresthesia, liver injury	9.45
Vinyl Chloride	GW: 63.4 (MW-21D) SB: SS:	1 ppm	NL Ca	Weakness, abdominal pain, gastrointestinal bleeding, enlarged liver, pallor or cyanosis of extremities	9.99
Xylenes	GW: 41.15 (MW-29S) SB: SS:	100 ppm	900	Irritated eyes, skin, nose, and throat; dizziness; excitement; drowsiness; incoherence; staggering gait; corneal vacuolization; anorexia; nausea; vomiting; abdominal pain; dermatitis	8.56

Footnotes:

[a] Specify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), SS (Surface Soil), SL (Sludge), SW (Surface Water).

[b] Appropriate value of permissible exposure limit (PEL), recommended exposure limit (REL), or threshold limit value (TLV) listed.

[c] IDLH = immediately dangerous to life and health (units are the same as specified "Exposure Limit" units for that contaminant); NL = No limit found in reference materials; CA = Potential occupational carcinogen.

[d] PIP = photoionization potential; NA = Not applicable; UK = Unknown.

eV = electron volt

Potential Routes of Exposure		
Dermal: Contact with contaminated media. This route of exposure is minimized through use of engineering controls, administrative controls and proper use of PPE.	**Inhalation:** Vapors and contaminated particulates. This route of exposure is minimized through use of engineering controls, administrative controls and proper use of respiratory protection when other forms of control do not reduce the potential for exposure.	**Other:** Inadvertent ingestion of contaminated media. This route should not present a concern if good hygiene practices are followed (e.g., wash hands and face before drinking or smoking).

9. Site Monitoring

(Reference CH2M SOP HSE-207, *Exposure Monitoring for Airborne Chemical Hazards*)

For each task listed in the table below, perform the associated monitoring ensuring the equipment is calibrated according to the manufacturer's recommendations. Use the Daily Site Monitoring Form (or equivalent) to document the calibration and the readings taken. Retain area monitoring readings with project records.

Exposure records (breathing zone and personal air sampling) must be preserved for the duration of employment plus 30 years. Copies of all project exposure records (e.g., copies of Daily Site Monitoring form or field logbook pages where breathing zone readings are recorded along with associated calibration) shall be sent to the Sector Safety Program Assistant (SPA) for retention and also maintained in the project files.

Subcontractors are responsible for monitoring and performing integrated personal sampling for their employees as documented in their HASP or, if permitted, according to the table below.

9.1 Direct Reading Monitoring Specifications

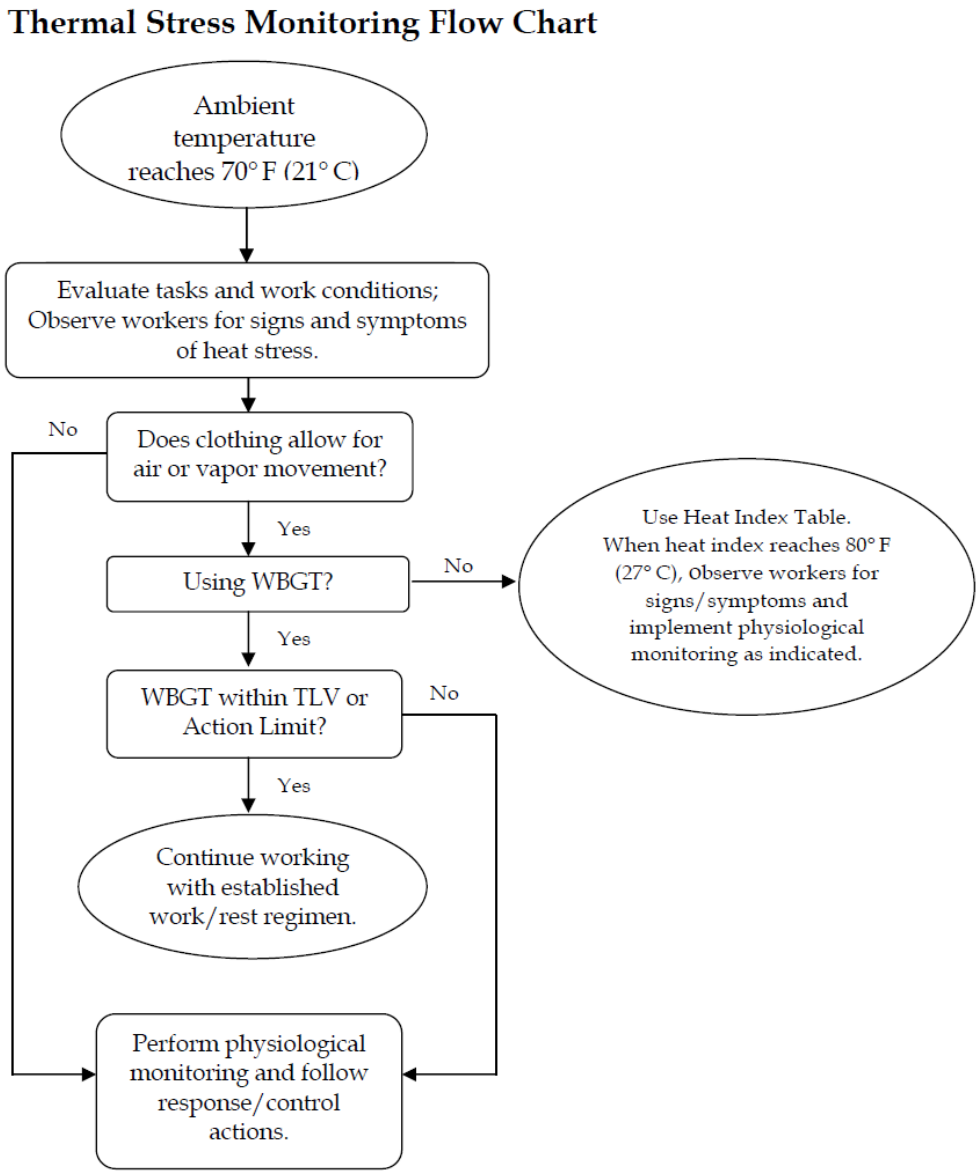
Instrument	Tasks	Action Levels[a]	Action to be Taken when Action Level reached	Frequency[b]	Calibration
PID: MiniRAE PID with 10.6 eV lamp or equivalent	Water Level Measurements GW Sampling Routine System Maintenance (on equipment containing contaminants) Waste Management DPT/ Sonic Drilling Soil/ GW Grab Sampling Well Installation MIP VI Sampling	BG - 0.5 ppm = or > 0.5 ppm	Level D Stop Work, collect benzene detector tube and contact HSM.	Initially and periodically during tasks	Bump Test Daily Calibrate per manufacturer recommendations
CGI: MSA model 260 or 261 or equivalent	DPT/Sonic Drilling Soil/ GW Grab Sampling Well Installatioin MIP	0-10%: 10-25% LEL: >25% LEL:	No explosion hazard Potential explosion hazard Explosion hazard; evacuate or vent	Continuous During Task	Daily
Dust Monitor: Visual	All Tasks	No Visible Dust Visible Airborne Dust	Level D Level D. Institute Dust Suppression Techniques	Continuous During Task	Not applicable

Instrument	Tasks	Action Levels[a]	Action to be Taken when Action Level reached	Frequency[b]	Calibration
Noise-Level Monitor:[d] Voice	All Tasks	Conversations can be held at distances of 3 feet without shouting Conversations cannot be held at a distances of 3 feet without shouting	No action required Hearing protection required	Initially and periodically during task	Not applicable
Heat Stress Monitor - Refer to Flow Chart Below ☐ Ambient Temperature ☒ Heat Index ☐ WBGT ☒ Physiological ☒ Pulse ☒ Temperature	When heat index reaches 80°F (27°C).	Refer to the Guidelines for the type of monitoring conducted.	Refer to the Guidelines for the type of monitoring conducted.	When Heat Index reaches criteria.	Not applicable

[a] Action levels apply to sustained breathing-zone measurements above background.
[b] The exact frequency of monitoring depends on field conditions and is to be determined by the SC; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate.
[c] If the measured percent of O_2 is less than 10, an accurate LEL reading will not be obtained. Percent LEL and percent O_2 action levels apply only to ambient working atmospheres, and not to confined-space entry. More-stringent percent LEL and O_2 action levels are required for confined-space entry.
[d] Noise monitoring and audiometric testing also required.

Heat Stress Monitoring Flow Chart

Use the flow chart below and refer to the applicable protocol in Section 9 of the Guidelines for heat stress monitoring.



10. Personal Protective Equipment

(Reference CH2M SOP HSE-117, *Personal Protective Equipment*, and Section 11 of the Guidelines)

10.1 Required Personal Protective Equipment

PPE must be worn by employees when actual or potential hazards exist and engineering controls or administrative practices cannot adequately control those hazards.

A PPE assessment has been conducted by the RHSM based on project tasks (see PPE specifications below). Verification and certification of assigned PPE by task is completed by the RHSM that approved this plan. Refer to the Guidelines, Section 11, "Personal Protective Equipment," for requirements on the use, care, and maintenance of PPE.

The table below outlines PPE to be used according to task based on project-specific hazard assessment. If a task other than the tasks described in this table needs to be performed, contact the RHSM so this table can be updated.

Project-Specific Personal Protective Equipment Requirements[a]

Task	Level	Body	Head	Respirator[b]
General field work (not in contact with contaminants) Mobilization/Demobilization	D	☒ Work clothes (sleeved shirt, long pants) ☐ Cotton Coveralls ☒ Safety-toed Boots ☒ Gloves (leather) ☐ ANSI/ISEA 107-2010 high visibility vest ☐ Other: (specify)	☒ANSI Z89.1 Hardhat [c] ☒ANSI Z87.1 Safety glasses ☒Hearing protection [d] (As needed)	None required
Accessing Electrical Panels	D Hazard Category 0	☒Work clothes (Long sleeve work clothes made of non melting or untreated natural fiber) ☐ Cotton coveralls ☐ ANSI/ISEA 107-2010 high visibility vest ☒ Safety-toed boots ☐ Safety-toed rubber boots (can be deconned in a boot wash) ☐ Outer boot covers ☒ Leather work gloves ☐ Inner surgical-style nitrile ☐ Outer PVC gloves ☐ Other: (specify)	☒ANSI Z89.1 Hardhat [c] ☒ANSI Z87.1 Safety glasses ☒Hearing protection [d] (As needed) ☐ Face shield ☐ Chemical goggles	None required
Water Level Measurements Groundwater Sampling System Startup System Shutdown Routine System Maintenance Decontamination Waste Management DPT/Sonic Drilling Soil/ GW Grab Sampling Well Installation	Modified D	☒ Work clothes (Long sleeve) ☐ Cotton coveralls ☐ ANSI/ISEA 107-2010 high visibility vest ☒ Safety-toed boots ☐ Safety-toed rubber boots (can be deconned in a boot wash) ☐ Outer boot covers ☒ Leather Gloves (as needed) ☒ Inner surgical-style nitrile ☐ Outer chemical-resistant nitrile gloves.	☒ANSI Z89.1 Hardhat [c] ☒ANSI Z87.1 Safety glasses ☒ Face shield (as needed when splash hazards exist) ☒Hearing protection [d]	None required

Project-Specific Personal Protective Equipment Requirements[a]

Task	Level	Body	Head	Respirator[b]
MIP Vapor Intrusion Sampling				
Equipment decontamination if using pressure washer	Modified D with splash protection	☒ Polycoated Tyvek ☐ Rain Suit ☐ ANSI/ISEA 107-2010 high visibility vest ☒ Safety-toed boots ☒ Safety-toed rubber boots (can be deconned in a boot wash) ☒ Outer boot covers ☒ Inner surgical-style nitrile ☒ Outer chemical-resistant nitrile gloves. ☐ Other: (specify)	☒ ANSI Z89.1 Hardhat[c] ☒ ANSI Z87.1 Safety glasses ☒ Hearing protection[d] ☒ Face shield ☐ Chemical goggles	None required.
When action levels above are exceeded **Not Authorized Without HSM Approval**	C	☐ Uncoated Tyvek ☐ Polycoated Tyvek ☐ ANSI/ISEA 107-2010 high visibility vest ☐ Safety-toed boots ☐ Safety-toed rubber boots (can be deconned in a boot wash) ☐ Outer boot covers ☐ Inner surgical-style nitrile ☐ Outer chemical-resistant nitrile gloves. ☐ Other: (specify)	☐ ANSI Z89.1 Hardhat [c] ☐ ANSI Z87.1 Safety glasses ☐ Hearing protection [d]	☐ Full-face MSA Ultratwin or equivalent air-purifying respirator ☐ Cartridges [e]: _____.

Reasons for Upgrading or Downgrading Level of Protection (with approval of the RHSM)

Upgrade[f]	Downgrade
• Request from individual performing tasks. • Change in work tasks that will increase contact or potential contact with hazardous materials. • Occurrence or likely occurrence of gas or vapor emission. • Known or suspected presence of dermal hazards. • Instrument action levels in the "Site Monitoring" section exceeded.	• New information indicating that situation is less hazardous than originally thought. • Change in site conditions that decrease the hazard. • Change in work task that will reduce contact with hazardous materials.

[a] Modifications are as indicated. CH2M will provide PPE only to CH2M employees.
[b] No facial hair that would interfere with respirator fit is permitted.
[c] Hardhat and splash-shield areas are to be determined by the SC.
[d] Ear protection should be worn when conversations cannot be held at distances of 3 feet (1 meter) or less without shouting.
[e] See cartridge change-out schedule.
[f] Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level C) is permitted only when the PPE requirements have been approved by the RHSM, and an SC qualified at that level is present.

11. Worker Training and Qualification

11.1 CH2M Worker Training

(Reference CH2M SOP HSE-110, *Training*, and Section 12 of the Guidelines)

The following training is required for CH2M personnel working onsite. Copies of training will either be available onsite, or readily available from the CH2M HandS training database system. Refer to Section 12 of the Guidelines for a description of HAZWOPER-related and SC training.

Required CH2M Worker Training	CH2M Task or Equipment-Specific Training (if performing task)
☒ 40-hour HAZWOPER Training	☐ Aerial Lift Operator Training
☒ 8-hour HAZWOPER Refresher	☐ Confined Space Entry Training
☒ 3-day HAZWOPER OJT	☐ Excavation Competent Person
☒ CH2M HILL HASP Training	☐ Fall Protection (site-specific)
☒ CH2M HILL ESBG HSSE Guidelines	☐ Forklift Operator
☒ CH2M HILL AHAs	☒ Hazard Communication
☐ Subcontractor HASP	☐ On-Track Railroad Safety Training
☐ 10-hour OSHA Construction Safety Training	☒ NFPA 70E Training (energized electrical safety training)
☒ At least one SC-HW (refer to worker category for all applicable training needed)	☐ Qualified Earthmoving Equipment Operator
☒ HWW (refer to worker category for all applicable training needed)	☐ Scaffold Training
☒ At least one SC-C (refer to worker category for all applicable training needed)	☐ Other (specify):
☐ Other (specify)	☐ Other (specify):

Project-specific Required (VO) Training	
☐ 3R Munitions Safety Awareness Training	☒ Hand Safety Training
☐ Arsenic Training	☐ Hydrogen Sulfide Hazard Recognition Training
☐ Asbestos Awareness Training	☐ Ionizing Radiation Training
☐ Bear Awareness Training	☐ Lead Exposure Training
☒ Benzene Training	☒ Lockout/Tagout Training
☐ Cadmium Training	☒ Manual Lifting Training
☐ Chromium Training	☐ Methylene Chloride Training
☐ Confined Space Awareness Training	☒ Noise Training
☒ Drum Handling Training	☐ Radio Frequency Safety Awareness
☒ Electrical Safety Training	☐ Railroad Safety On-line Training
☐ Excavation Safety Training	☐ Respirators Level C Training
☒ Fall Protection Training	☒ Stairways and Ladders

Required CH2M Worker Training	CH2M Task or Equipment-Specific Training (if performing task)
☐ Formaldehyde Training	☐ Traffic Safety Training
☒ Drum Handling Training	☐ Vinyl Chloride Training

11.2 Subcontractor Worker Training

The following training is required for Subcontractor personnel working onsite. Copies of training shall be available onsite.

Required Subcontractor Worker Training	Subcontractor Task or Equipment-Specific Training (required if performing this work)
☒ 40-hour HAZWOPER Training	☒ Aerial Lift Operator Training
☒ 8-hour HAZWOPER Refresher	☐ Asbestos Competent Person
☒ 8-hour HAZWOPER Supervisor	☐ Asbestos Training (Supervisor, Worker)
☒ 3-day HAZWOPER OJT	☐ Confined Space Entry Training
☒ CH2M HILL HASP Training	☐ Certified Crane Operator
☒ Subcontractor AHAs	☐ Crane Assembly/Disassembly Competent Person
☐ Subcontractor HASP	☐ Demolition Competent Person
☐ 10-hour OSHA Construction Safety Training	☐ Excavation Competent Person
☐ 30-hour OSHA Construction Safety Training	☒ Fall Protection (site-specific)
☐ Respiratory Protection Training	☐ Flagger Training
☐ CH2M HILL ESBG HSSE Guidelines	☒ Forklift Operator
☒ First Aid/CPR/BBP – at least 2 people	☒ Hazard Communication
☐ Other (specify)	☒ Ladder Safety Training
	☐ Lead Training
	☒ Lockout/Tagout Training
	☐ On-Track Railroad Safety Training
	☒ NFPA 70E Training (energized electrical safety training)
	☒ Qualified Drill Rig Operator
	☐ Qualified Earthmoving Equipment Operator
	☐ Qualified Rigger
	☐ Qualified Crane Signaler
	☐ Scaffold Training
	☐ Other (specify):

11.3 HAZWOPER-Exempted Tasks

The following tasks are not within the scope of the HAZWOPER standard so HAZWOPER training is not required for workers performing these tasks:

Task
Mobilization/Demobilization
Some Routine System Maintenance Tasks (Electrical Tasks and Work on Lines Free of Contaminated Material)

12. Medical Surveillance and Qualification

(Reference CH2M SOP HSE-113, *Medical Surveillance*, and Section 13 of the Guidelines)

The following medical surveillance is required for CH2M and subcontractor personnel working onsite. Copies of physician's medical opinion will either be available onsite, or for CH2M staff, readily available from the CH2M HandS training database system. Refer to Section 13 of the Guidelines for a description of HAZWOPER, respirator user, and hearing conservation medical surveillance.

General Required Medical Surveillance	Job or Activity-Specific Medical Surveillance (required if performing this work)
☒ HAZWOPER Medical Clearance	☒ Noise
☐ Respirator Medical Clearance	☐ Baseline Blood Lead
	☐ Asbestos Medical Clearance
	☐ Other (specify):
Personnel or Tasks Not Requiring Medical Surveillance	
Mobilization/Demobilization	
Some Routine System Maintenance Tasks (Electrical Tasks and Work on Lines Free of Contaminated Material)	

13. Site-control Plan

(Reference CH2M SOP HSE-218, *Hazardous Waste Operations*, and Section 14 of the Guidelines)

Site control is established to prevent the spread of contamination throughout the site and to ensure that only authorized individuals are permitted into potentially hazardous areas. Task-specific control measures are listed below. **Use of the Buddy System will be implemented unless a Working Alone protocol has been established and approved as indicated in Sections 5 and 6 above.**

Site Control for General Work Area(s)			
☒ Perimeter fencing	Location: Around Facility	☒ Barricades	Location: As needed.
☒ Signage	Location: At all entrances	☐ Other:	Location:
☒ Traffic control devices	Location: When working near roadways.	☐ Other: _____	Location:

14. Decontamination

(Reference CH2M SOP HSE-218, *Hazardous Waste Operations*, and Section 15 of the Guidelines)

Refer to the Guidelines, Section 15, "Decontamination," for a complete description of decontamination activities and diagrams of typical decontamination areas. Decontamination areas will be established for work in potentially contaminated areas to prevent the spread of contamination. Decontamination areas should be located upwind of the exclusion zone where possible and should consider any adjacent or nearby projects and personnel. No eating, drinking, or smoking is permitted in contaminated areas and in exclusion or decontamination zones.

All contaminated material generated through the personnel and equipment decontamination processes (e.g., contaminated disposable items, gross debris, liquids, and sludges) will be properly containerized and labeled, stored at a secure location, and disposed in accordance with project plans.

Type of Decon	Activity	Equipment	Process/Protocol
Personnel	☒ When dealing with contaminated media	☐ Tubs/brushes for boot/glove wash ☒ Solids disposal bag or drum (used PPE) ☐ Liquid disposal drum (decon water)	☐ Boot wash/rinse ☒ PPE disposal (no decon) ☒ PPE waste area identified ☐ Other: _____
Equipment	☒ When dealing with contaminated media	☒ Table for equipment decon/staging ☐ Decon pad for vehicles ☒ Pressure Washer (drill rig decon) ☒ PPE used during decon ☒ Decon supplies (brushes, brooms) ☒ Containers/method to capture decon water and or sludge (drill rig decon)	☒ Equipment wiped/cleaned before leaving CRZ ☐ Vehicle tires dry deconned prior to leaving site ☐ Vehicle tires washed prior to leaving site ☐ Other: _____

14.1 Decontamination During Medical Emergencies

Standard personnel decontamination practices will be followed whenever possible. For emergency lifesaving first aid and/or medical treatment, normal decontamination procedures may need to be abbreviated or omitted. In this situation, site personnel shall accompany contaminated victims to advise emergency response personnel on potential contamination present and proper decontamination procedures.

Outer garments may be removed if they do not cause delays, interfere with treatment, or aggravate the problem. Protective clothing can be cut away. If the outer garments cannot be safely removed, a plastic barrier between the individual and clean surfaces should be used to help prevent contaminating the inside of ambulances or medical personnel. Outer garments can then be removed at the medical facility.

15. Communications

A primary and backup means of communication for field crews have been established as described below:

Type of Communication	Primary Means	Backup Means
Communication between field crew	☒ Voice	☐ Voice
	☐ Radio	☐ Radio
	☐ Phone	☒ Phone
Communication with Office crew	☐ Radio	☐ Radio
	☒ Phone	☐ Phone
Communication with Fire and Emergency Services	☐ Radio	☒ Radio
	☒ Phone	☐ Phone

16. Required Facilities and Equipment

The following facilities and equipment are required and used for safe completion of work:

Facility	Type	Location
☐ Worker Showers/lockers		
☐ Restrooms		
☐ Supplementary Illumination		
☒ Emergency Eyewash	Portable	Field Vehicle/Treatment Building
☐ Emergency Shower		
☒ First aid kit/supplies	Portable	Field Vehicle
☒ Fire extinguishers	ABC	Fixed locations throughout Treatment Building/field vehicle
☒ Spill Kit(s)	Universal	Stored At Site
☒ Potable Water	Bottled	Cooler on Site
☐ Shade/rest area		
☐ Heated rest area		
☐ Other_____		

17. Emergency Response Plan

(Reference CH2M SOP HSE-106, *Emergency Planning*, and Section 16 of the Guidelines)

Also for site specific guidance review the SCF MI2 Emergency Response Plan / Fire Response Plan / Spill Response Plan.

Personnel responsible for coordinating emergency situations during site activity are identified below. The Emergency Contacts Page is at the front of this Plan. A site map showing assembly points and directions to the authorized medical facility is attached. Documented rehearsal and critique of this plan is required at least once during the task, or more often as necessary.

Responsibility	Name	Phone Number(s)
Emergency Response Coordinator (ERC) for coordination response on project.	Travis Pendry Jon Gowing	248.545.3075 519.579.3500

If an emergency situation develops which requires evacuation of the work area, the following steps shall be implemented.

Evacuation Step	Methods and comments:
Notify affected workers	Contact in person or by phone to notify them of the situation.
Evacuate to safe location	Assemble at parking lot outside treatment building.
Assemble and account for workers	Ensure all staff are accounted for.
Notify Supervisor/Manager	Contact Kyle Block (610. 389.0899) and Jason Kearns (304.610.6951)
Complete incident report	PM or HSM will complete incident report.

Potential emergency situations and response actions are identified below.

In case of:	Response actions:
Injury or illness	Contact emergency services at 911. Contact the Occupational Health Nurse at 1-866-893-2514 then contact the HSM and PM to notify them of the situation.
Chemical exposure	Contact emergency services at 911. Contact HSM and PM to notify them of the situation and contact the Occupational Health Nurse at 1-866-893-2514.
Fire or explosion	Contact emergency services at 911. If the fire is small, manageable, and doesn't place you in any danger, find the nearest extinguisher and attempt to put it out. Contact HSM and PM to notify them of the situation and contact the Occupational Health Nurse at 1-866-893-2514.
Adverse weather	If lightening or thunder is observed, stop work for a minimum of 30 minutes. Work should not continue until 30 minutes has passed since the last lightening or thunder is observed.
Heat Stroke	Contact emergency services at 911. Contact the Occupational Health Nurse at 1-866-893-2514 then contact the HSM and PM to notify them of the situation.
Material spill or release	Contact emergency services at 911. Attempt to contain with the appropriate spill kit, if it does not put personnel in danger. Contact EM, HSM, and PM to notify them of the situation. Also notify Incident Commander to alert them of the spill/release, no matter how small.

Evacuation Signals:	Meaning:
Grasping throat with hand	Emergency-help me.
Thumbs up	OK; understood.
Grasping buddy's wrist	Leave area now.
Continuous sounding of horn	Emergency; leave site now.

In the event of a **large quantity spill** notify emergency services. Personnel discovering a spill shall (only if safe to do so):

- Stop or contain the spill immediately (if possible) or note source. Shut off the source (e.g., pump, treatment system) if possible. If unsafe conditions exist, then leave the area, call emergency services, inform nearby personnel, notify the site supervisors, and initiate incident reporting process. The SC shall be notified immediately.
- Extinguish sources of ignition (flames, sparks, hot surfaces, cigarettes).
- Clear personnel from the spill location and barricade the area.
- Use available spill control equipment in an effort to ensure that fires, explosions, and releases do not occur, recur, or spread.
- Use sorbent materials to control the spill at the source.
- Construct a temporary containment dike of sorbent materials, cinder blocks, bricks or other suitable materials to help contain the spill.
- Attempt to identify the character, exact source, amount, and extent of the released materials. Identification of the spilled material should be made as soon as possible so that the appropriate cleanup procedure can be identified.
- Contact the RHSM and Project EM in the event of a spill or release immediately so evaluation of reportable quantity requirements and whether agency reporting is required.
- Assess possible hazards to human health or the environment as a result of the release, fire or explosion.
- Follow incident notification, reporting, and investigation section of this plan.

18. Incident Notification, Reporting, and Investigation

(Reference Section 16 of the Handbook for complete definitions and protocol)

18.1 Incident Notification

All employees and subcontractors' employees shall immediately report any incident (including "near misses") in which they are involved or witness to their supervisor.

The CH2M or Subcontractor supervisor, upon receiving an incident report, shall inform his immediate superior and the CH2M SC (see incident notification flowchart at the end of this section).

The SC shall immediately report the following information to the RHSM and PM by phone and e-mail:

- Project Name and Site Manager
- Date and time of incident
- Description of incident
- Extent of known injuries or damage
- Level of medical attention
- Preliminary root cause/corrective actions

If the incident was an environmental permit issue (potential permit non-compliance, other situation that result in a notice of violation) or a spill or release, contact the Project EM immediately so evaluation of reportable quantity requirements and whether agency reporting is required.

18.2 Drug and Alcohol Testing for CH2M Employees

As required by CH2M HILL Policy 810, U.S. Employees are subject to post-incident and reasonable suspicion drug and alcohol testing. The Employee must submit to drug and alcohol testing if the supervisor has a reasonable suspicion, and when any of the following occur:

- Work-related injury in which the Company reasonably believes (under the Reasonable Suspicion provisions in the Policy) that drug and/or alcohol use is a contributing factor.
- Incident resulting in property damage over USD $500 as determined by the Company.
- Injury on or in Company Property/Workplace (to Employee or third parties) involving the Employee's use of heavy machinery as determined by the Company.
- Incident considered to be a serious near-miss injury that occurs in the field or in the office as determined by the Company and where the Company reasonably believes (under the Reasonable Suspicion provisions in the Policy) that drug and/or alcohol use is a contributing factor to the serious near miss injury.
- Other circumstances as dictated by Employee Relations.
- An Employee contributes to any of the above.

Refer to the E&NBG HSE Handbook and CH2M HILL Policy 810 for additional information and specific requirements.

18.3 Drug and Alcohol Testing for Subcontractors

The drug and alcohol testing requirements stated above apply to subcontractors when required by the subcontract.

18.4 HITS System and Incident Report Form

The SC shall complete an entry into the Hours and Incident Tracking System (HITS) database system located on CH2M's VO (or if VO not available, use the hard copy Incident Report Form and Root Cause Analysis Form and forward it to the RHSM) within 24 hours and finalize those forms within 3 calendar days.

18.5 Injury Management/Return-to-Work (for U.S./Puerto Rico-based CH2M Staff Only)

- In the event of an injury, or potential injury (i.e., involvement in motor vehicle collision with no apparent injury; a puncture wound with no bleeding or apparent infection, etc.), the following actions shall be taken:
- Employee informs their supervisor.
- Employee calls the Injury Management Program toll free number 1-866-893-2514 immediately and speaks with the Occupational Injury Nurse. This number is operable 24 hours per day, 7 days a week. **Employees are encouraged to enter this phone number into their cell phones prior to starting field work**.
- Supervisor ensures employee immediately calls the Injury Management Program number. Supervisor makes the call with the injured worker or for the injured worker, if needed.
- Nurse assists employee with obtaining appropriate medical treatment, as necessary schedules clinic visit for employee (calls ahead, and assists with any necessary follow up treatment). The supervisor or SC accompanies the employee if a clinic visit is necessary to ensure that employees receive appropriate and timely care.
- Supervisor or SC completes the HITS entry or Incident Report Form immediately (within 24 hours) and forwards it to the Project Manager and RHSM.
- Nurse notifies appropriate CH2M staff by e-mail (supervisor, Health & Safety, Human Resources, Workers' Compensation).
- Nurse communicates and coordinates with and for employee on treatment through recovery.
- Supervisor ensures suitable duties are identified and available for injured or ill workers who are determined to be medically fit to return to work on transitional duty (temporary and progressive).
- Supervisor ensures medical limitations prescribed (if any) by physician are followed until the worker is released to full duty.

18.6 Serious Incident Reporting Requirements

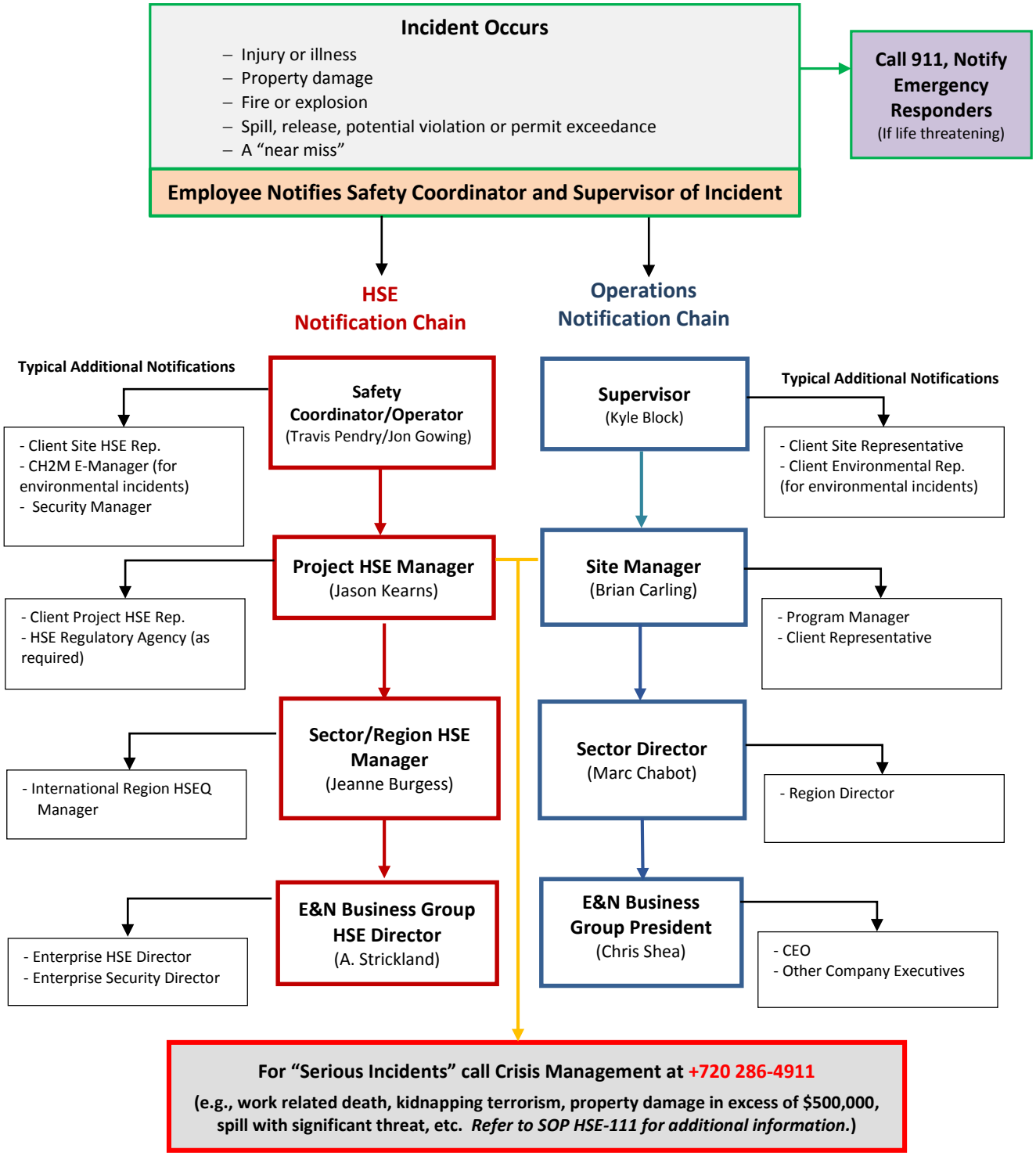
Serious incidents include the following:

- Work-related death, or life threatening injury or illness of a CH2M employee, subcontractor, or member of the public
- Kidnap or missing person
- Acts or threats of terrorism
- Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than $ 500,000 in damage
- Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment

If an incident meets the "Serious Incident" criteria, the Project Manager is to immediately contact the Crisis Manager at 720-286-4911, then follow the standard incident reporting procedure.

Verbal Incident Notification *– to be implemented as soon as possible after an incident.*

Verbal incident notification is made to **both the HSE and the Operations chains** to the indicated group depending on the severity, and any project, geographic, or client specific notification and reporting requirements as shown below *(Refer to SOP HSE-111 for additional information).* After verbal notification, complete a HITS report.



Third Party Incidents –
Incidents outside of our contractual obligations do not need to be reported UNLESS they are serious and may affect CH2M HILL or our work. The Project and Sector HSE Managers will determine the level of communication necessary for third party incidents.

19. Inspections

19.1 Project Activity Self-Assessment Checklists

The following self-assessment checklists are required when the task or exposure is initiated and quarterly thereafter. The checklists shall be completed by the SC or other CH2M representative and maintained in project files.

Hand and Power Tools **PPE** **Manual Lifting**	All Tasks	Initially when these task are conducting during the project.
Electrical Safety	Routine System Maintenance System Shutdown System Startup	Prior to initially accessing the electrical panel.
LO/TO	Routine System Maintenance System Shutdown	Prior to conducting Isolation of Equipment or Line and Equipment Opening
Groundwater Monitoring	Water Level Measurements GW Sampling	Prior to conducting Groundwater Sampling
Drilling	DPT / Sonic Drilling Soil / GW Grab Sampling Well Installation MIP	Initially when drilling is conducted during the project.
Vehicle / Equipment Spotting PTHA Card	Backing/Spotting	For daily routine backing task, this document will be reviewed weekly. The spotter reviews with new driver bringing in fill dirt/gravel.

19.2 Safe Behavior Observations

The SC or designee shall perform at least one Safe Behavior Observation (SBO) each week for any fieldwork performed by subcontractors or when there are at least two CH2M personnel performing fieldwork.

E-mail completed forms to:

Federal Sector: CH2M HILL ES FED Safe Behavior Observation

Commercial Sector: CH2M HILL ES COM Safe Behavior Observation

Canada: cnressafe@ch2m.com

International: ESINTLSafeBehaviorObservation@ch2m.com

20. Records and Reports

Refer to the Guidelines, Section 19, “Records and Reports,” for a complete description of HSE recordkeeping requirements. Below are examples of records that must be maintained as the project progresses:

- Exposure records includes air monitoring data (including calibration records), SDSs, exposure modeling results
- Training records
- Respiratory fit test records
- Incident reports, investigations and associated back-up information
- Federal or state agency inspection records
- HSE audits and assessments
- Confined space entry permits
- Equipment inspections
- Equipment maintenance
- Emergency equipment inspection records
- SBOs
- Self-assessment checklists
- Daily Safety Meeting Sign-In forms/PTSPs

21. Employee Signoff Form

EMPLOYEE SIGNOFF FORM

Health and Safety Plan

The CH2M project employees and subcontractors listed below have been provided with a copy of this HASP, have read and understood it, and agree to abide by its provisions.

Project Name: 2016 JMS O&M / Investigation HASP **Project Number:** 671439

EMPLOYEE NAME (Please print)	**EMPLOYEE SIGNATURE**	**COMPANY**	**DATE**

EMPLOYEE SIGNOFF FORM

Health and Safety Plan

The CH2M project employees and subcontractors listed below have been provided with a copy of this HASP, have read and understood it, and agree to abide by its provisions.

Project Name: 2016 JMS O&M / Investigation HASP **Project Number:** 671439

EMPLOYEE NAME (Please print)	**EMPLOYEE SIGNATURE**	**COMPANY**	**DATE**

EMPLOYEE SIGNOFF FORM

Health and Safety Plan

The CH2M project employees and subcontractors listed below have been provided with a copy of this HASP, have read and understood it, and agree to abide by its provisions.

Project Name: 2016 JMS O&M / Investigation HASP **Project Number:** 671439

EMPLOYEE NAME (Please print)	**EMPLOYEE SIGNATURE**	**COMPANY**	**DATE**

EMPLOYEE SIGNOFF FORM

Health and Safety Plan

The CH2M project employees and subcontractors listed below have been provided with a copy of this HASP, have read and understood it, and agree to abide by its provisions.

Project Name: 2016 JMS O&M / Investigation HASP **Project Number:** 671439

EMPLOYEE NAME (Please print)	**EMPLOYEE SIGNATURE**	**COMPANY**	**DATE**

Attachment A
Safety Briefing Forms

Safety Briefing Record

Dow Program - March 2008

Location/Project:	Date of Meeting: _____/_____/_____ Time: Start:_____:_____ End _____:_____
Safety Coordinator: FTL/CM:	Other CH2M HILL employees present:
Subcontractors Involved in Tailgate Meeting: 1. _____ # workers _____ 2. _____ # workers _____ 3. _____ # workers _____	
Scope of Today's Work:	
Hazards & Controls	
Today's Weather and Impact on Work Activities:	
☐ Key Hazards & Controls Discussed:	
☐ Personal Protective Equipment: PPE Requirements discussed:	☐ Safety-related permits required: ☐ Safe Work Permit (Active) ☐ Utility locate clearance ☐ Confined space ☐ Energized electrical ☐ Other: _____

☐ Req'd Notifications or Communications:	☐ Alarms & Evacuation:
☐ Change Conditions:	☐ "Lessons Learned" generated or shared:

Is a **Safe Work Observation** required for today? (see HASP for req'd frequency) ☐ Yes ☐ No

If yes, today's SWO will be performed by:

Describe a key observation/near miss from yesterday's work:

Crew Attendance & Participation

Comments: Safety focus for today, interventions, observations, feedback, near misses, etc.

Name/Phone Number:	Comments:	Signature:

Meeting Facilitator's Signature: _____ _____/_____/_____

CH2M HILL Hours Worked Today: _____ Subcontractor Hours Worked Today: _____

Attachment B
Safe Work Observation Forms

CH2MHILL

Safe Behavior Observation Form

☐ Federal ☐ Commercial (check one) ☐ International	☐ Construction or ☐ Consulting (check one)	
Project Number:	Client/Program:	
Project Name:	Observer:	Date:
Position/Title of worker observed:	Background Information/ comments:	
Task/Observation Observed:		

- ❖ Identify and reinforce safe work practices/behaviors
- ❖ Identify and improve on at-risk practices/acts
- ❖ Identify and improve on practices, conditions, controls, and compliance that eliminate or reduce hazards
- ❖ Proactive PM support facilitates eliminating/reducing hazards (do you have what you need?)
- ❖ Positive, corrective, cooperative, collaborative feedback/recommendations

Actions & Behaviors	Safe	At-Risk	Observations/Comments
Current & accurate Pre-Task Planning/Briefing (Project safety plan, STAC, AHA, PTSP, tailgate briefing, etc., as needed)			**Positive Observations/Safe Work Practices:**
Properly trained/qualified/experienced			
Tools/equipment available and adequate			
Proper use of tools			**Questionable Activity/Unsafe Condition Observed:**
Barricades/work zone control			
Housekeeping			
Communication			
Work Approach/Habits			
Attitude			
Focus/attentiveness			**Observer's Corrective Actions/Comments:**
Pace			
Uncomfortable/unsafe position			
Inconvenient/unsafe location			
Position/Line of fire			
Apparel (hair, loose clothing, jewelry)			
Repetitive motion			**Observed Worker's Corrective Actions/Comments:**
Other…			

For ES Federal Sector projects please email completed forms to: CH2MHILLESFEDSafeBehaviorObservation@ch2m.com
For ES Commercial Sector projects please email completed forms to: SafeBehaviorObservations@ch2m.com
For CNR ES staff please email completed forms to: cnressafe@ch2m.com
For International ES projects please e-mail completed forms to: ESINTLSafeBehaviorObservation@ch2m.com

Attachment C
Project Activity Self-Assessment Checklists

HS&E Self-Assessment Checklist - DRILLING

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's written safety plan.

This checklist is to be used at locations where: 1) CH2M HILL employees are potentially exposed to drilling hazards, 2) CH2M HILL staff are providing support function related to drilling activities, and/or 3) CH2M HILL oversight of a drilling subcontractor is required.

Safety Coordinator may consult with drilling subcontractors when completing this checklist, but shall not direct the means and methods of drilling operations nor direct the details of corrective actions. Drilling subcontractors shall determine how to correct deficiencies and we must carefully rely on their expertise. Items considered to be imminently dangerous (possibility of serious injury or death) shall be corrected immediately, or all exposed personnel shall be removed from the hazard until corrected.

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposures to drilling hazards (complete Section 1).
☐ Evaluate CH2M HILL support functions related to drilling activities (complete Section 2)
☐ Evaluate a CH2M HILL subcontractor's compliance with drilling safety requirements (complete entire checklist).
Subcontractors Name: _____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the drilling subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in SOP HSE-35.

SECTION 1 - SAFE WORK PRACTICES (4.1)

	Yes	No	N/A	N/O
1. Personnel cleared during rig startup	☐	☐	☐	☐
2. Personnel clear of rotating parts	☐	☐	☐	☐
3. Personnel not positioned under hoisted loads	☐	☐	☐	☐
4. Loose clothing and jewelry removed	☐	☐	☐	☐
5. Smoking is prohibited around drilling operation	☐	☐	☐	☐
6. Personnel wearing appropriate personal protective equipment (PPE), per written plan	☐	☐	☐	☐
7. Personnel instructed not to approach equipment that has become electrically energized	☐	☐	☐	☐

SECTION 2 - SUPPORT FUNCTIONS (4.2)

FORMS/PERMITS (4.2.1)

8. Driller license/certification obtained	☐	☐	☐	☐
9. Well development/abandonment notifications and logs submitted and in project files	☐	☐	☐	☐
10. Water withdrawal permit obtained, where required	☐	☐	☐	☐
11. Dig permit obtained, where required	☐	☐	☐	☐

UTILITY LOCATING (4.2.2)

12. Location of underground utilities and structures identified	☐	☐	☐	☐

SECTION 2 (Continued)

	Yes	No	N/A	N/O
WASTE MANAGEMENT (4.2.3)				
13. Drill cuttings and purge water managed and disposed properly	☐	☐	☐	☐
DRILLING AT HAZARDOUS WASTE SITES (4.2.4)				
14. Waste disposed of according to project's written safety plan	☐	☐	☐	☐
15. Appropriate decontamination procedures being followed, per project's written safety plan	☐	☐	☐	☐
DRILLING AT ORDNANCE EXPLOSIVES (OE)/UNEXPLODED ORDNANCE (UXO) SITES (4.2.5)				
16. OE plan prepared and approved	☐	☐	☐	☐
17. OE/UXO avoidance provided, routes and boundaries cleared and marked	☐	☐	☐	☐
18. Initial pilot hole established by UXO technician with hand auger	☐	☐	☐	☐
19. Personnel remain inside cleared areas	☐	☐	☐	☐
SECTION 3 - DRILLING SAFETY REQUIREMENTS (4.3)				
GENERAL (4.3.1)				
20. Only authorized personnel operating drill rigs	☐	☐	☐	☐
21. Daily safety briefing/meeting conducted with crew	☐	☐	☐	☐
22. Daily inspection of drill rig and equipment conducted before use	☐	☐	☐	☐
DRILL RIG PLACEMENT (4.3.2)				
23. Location of underground utilities and structures identified	☐	☐	☐	☐
24. Safe clearance distance maintained from overhead power lines	☐	☐	☐	☐
25. Drilling pad established, when necessary	☐	☐	☐	☐
26. Drill rig leveled and stabilized	☐	☐	☐	☐
27. Additional precautions taken when drilling in confined areas	☐	☐	☐	☐
DRILL RIG TRAVEL (4.3.3)				
28. Rig shut down and mast lowered and secured prior to rig movement	☐	☐	☐	☐
29. Tools and equipment secured prior to rig movement	☐	☐	☐	☐
30. Only personnel seated in cab are riding on rig during movement	☐	☐	☐	☐
31. Safe clearance distance maintained while traveling under overhead power lines	☐	☐	☐	☐
32. Backup alarm or spotter used when backing rig	☐	☐	☐	☐
DRILL RIG OPERATION (4.3.4)				
33. Kill switch clearly identified and operational	☐	☐	☐	☐
34. All machine guards are in place	☐	☐	☐	☐
35. Rig ropes not wrapped around body parts	☐	☐	☐	☐
36. Pressurized lines and hoses secured from whipping hazards	☐	☐	☐	☐
37. Drill operation stopped during inclement weather	☐	☐	☐	☐
38. Air monitoring conducted per written safety plan for hazardous atmospheres	☐	☐	☐	☐
39. Rig placed in neutral when operator not at controls	☐	☐	☐	☐
DRILL RIG SITE CLOSURE (4.3.5)				
40. Ground openings/holes filled or barricaded	☐	☐	☐	☐
41. Equipment and tools properly stored	☐	☐	☐	☐
42. All vehicles locked and keys removed	☐	☐	☐	☐
DRILL RIG MAINTENANCE (4.3.6)				
28. Defective components repaired immediately	☐	☐	☐	☐
29. Lockout/tagout procedures used prior to maintenance	☐	☐	☐	☐
30. Cathead in clean, sound condition	☐	☐	☐	☐
31. Drill rig ropes in clean, sound condition	☐	☐	☐	☐
32. Fall protection used for fall exposures of 6 feet (U.S.) 1.5 meters (Australia) or greater	☐	☐	☐	☐
33. Rig in neutral and augers stopped rotating before cleaning	☐	☐	☐	☐
34. Good housekeeping maintained on and around rig	☐	☐	☐	☐

SECTION 4

Complete this section for all items checked "No" in previous sections. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: ________________________________ Project Manager: __________________________________

CH2MHILL

HS&E Self-Assessment Checklist – Electrical Safety

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's written safety plan.

This checklist is to be used at locations when: (1) CH2M HILL employees are required to use electrical appliances, are exposed to electrical hazards, or are working on or near exposed energized electrical equipment; and/or (2) CH2M HILL provides oversight of an electrical subcontractor.

The Safety Coordinator (SC) may consult with electrical subcontractors when completing this checklist, but shall not direct the means and methods of electrical operations nor direct the details of corrective actions. Subcontractors shall determine how to correct deficiencies, and CH2M HILL must carefully rely on their expertise. Items or conditions considered to be imminently dangerous (possibility of serious injury or death) shall be corrected immediately, or all exposed personnel shall be removed from the hazard until corrected.

Project Name: _____ Project No.: _____

Location: _____ Project Manager: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposure to electrical hazards (Complete Section 1)

☐ Evaluate a CH2M HILL subcontractor's compliance with electrical safety requirements (Complete entire checklist)
Subcontractor's Name: _____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HSE-206.

SECTION 1 – SAFE WORK PRACTICES

General Requirements (5.1)	**Yes**	**No**	**N/A**	**N/O**
1. Personnel have completed electrical safety training.	☐	☐	☐	☐
2. Attempts are made to locate all energized electrical circuits before work begins.	☐	☐	☐	☐
3. Installation/repair areas sufficiently guarded with barriers and signs to prevent unauthorized entry.	☐	☐	☐	☐
4. Only qualified employees installing or working with electrical equipment.	☐	☐	☐	☐
5. Electrical circuits that may be contacted are de-energizing and grounded or guarded.	☐	☐	☐	☐
6. Lockout/Tagout procedures when required verified using the checklist provided in HSE-307.	☐	☐	☐	☐
7. Only qualified electrical workers defeating electrical safety interlocks.	☐	☐	☐	☐
8. Where the location of underground power lines is unknown, insulated gloves are used.	☐	☐	☐	☐
Electrical Power Tools and Extension Cords (5.3)				
9. Electric power tools and extension cords inspected prior to use. Damaged equipment not used.	☐	☐	☐	☐
10. Extension cords supplying power tools provided with Ground Fault Circuit Interrupters (GFCI).	☐	☐	☐	☐
11. Electric power tools operated and maintained according to manufacturer's instructions.	☐	☐	☐	☐
12. Electric power tools effectively grounded or double-insulated.	☐	☐	☐	☐
13. Extension cords grounded and designed for heavy duty or industrial grade.	☐	☐	☐	☐
14. Extension cords not substituted for fixed wiring.	☐	☐	☐	☐
15. Extension cords covered, elevated, or protected when passing through work areas.	☐	☐	☐	☐
16. Extension cords passing through doorways or other pinch points protected from damage.	☐	☐	☐	☐
17. Extension cords not concealed or run through walls, ceilings, or floors.	☐	☐	☐	☐
18. Extension cords not fastened with staples, hung from nails, or suspended with wire.	☐	☐	☐	☐
19. Working space, walkways, and similar areas are kept clear of cords to prevent tripping hazards.	☐	☐	☐	☐

SECTION 1 – SAFE WORK PRACTICES (Continued)

Portable Lighting (5.4)	**Yes**	**No**	**N/A**	**N/O**
20. Portable lamps wired with flexible cord with grounded plugs.	☐	☐	☐	☐
21. Portable lights not suspended by their electric cords unless designed for suspension.	☐	☐	☐	☐
22. Portable lights protected from contact or breakage.	☐	☐	☐	☐
23. Portable lights used in wet locations operated at 12 volts or less or used with GFCI.	☐	☐	☐	☐
Overhead Power Lines (5.5)				
24. Lines de-energized and grounded, insulated, or safe clearance distance maintained.	☐	☐	☐	☐
25. Personnel stay clear of grounding point of equipment intentionally grounded.	☐	☐	☐	☐
26. Personnel do not touch or approach equipment that has become energized.	☐	☐	☐	☐

SECTION 2 – ELECTRICAL SAFETY REQUIREMENTS

General Installation Requirements (5.7)				
35. Competent person overseeing electrical activities, including inspections.	☐	☐	☐	☐
36. Subcontractor personnel using appropriate safety and protective equipment.	☐	☐	☐	☐
37. Electrical equipment free from recognized hazards.	☐	☐	☐	☐
38. Equipment approved for intended use and installed according to approvals.	☐	☐	☐	☐
39. Manufacturer's name, trademark, or other descriptive marking placed on equipment.	☐	☐	☐	☐
40. Energized parts > 50 volts guarded against accidental contact.	☐	☐	☐	☐
41. Electrical equipment > 600 volts placed in a vault, room, closet, or protected area.	☐	☐	☐	☐
42. Sufficient access and working clearances provided and maintained for all electric equipment.	☐	☐	☐	☐
43. Means provided to disconnect conductors from the service-entrance conductors.	☐	☐	☐	☐
44. Circuit breakers sufficient for system current load.	☐	☐	☐	☐
45. Over-current protection devices readily accessible and legibly marked to indicate purpose.	☐	☐	☐	☐
46. Equipment firmly secured to surface on which it is mounted.	☐	☐	☐	☐
47. Electrical equipment ventilated for cooling as required.	☐	☐	☐	☐
48. Electrical equipment protected from damage by environmental conditions.	☐	☐	☐	☐
49. Equipment in hazardous locations maintained in a dust-tight, ignition-proof condition.	☐	☐	☐	☐
50. Equipment producing arcs, sparks, flames, enclosed or separated from combustible material.	☐	☐	☐	☐
51. Conductors spliced or joined properly and free ends covered with insulation.	☐	☐	☐	☐
52. Equipment grounding provided on all equipment requiring such grounding.	☐	☐	☐	☐
Ground-fault Protection (5.6)				
53. GFCIs used or an assured equipment-grounding conductor (AEGC) program implemented.	☐	☐	☐	☐
54. When GFCIs used, installed on all 120-volt, 15- and 20-ampere temporary receptacle outlets.	☐	☐	☐	☐
55. When AEGC program used, covers all extension cords and temporary receptacles.	☐	☐	☐	☐
56. AEGC program also covers all equipment connected by cord and plug.	☐	☐	☐	☐
57. Under AEGC program, equipment visually inspected for external defects before each day's use.	☐	☐	☐	☐
58. Under AEGC program, continuity and grounding testing performed at least every 3 months.	☐	☐	☐	☐
59. Records maintained for all AEGC program testing.	☐	☐	☐	☐

SECTION 3

Complete this section for all items checked "No" in Sections 1 or 2. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: _____ Project Manager: _____

CH2MHILL

HSE Self-Assessment Checklist—Groundwater Monitoring/Sampling

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where: (1) CH2M HILL employees or subcontractors conduct groundwater sampling.

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employees conducting GW sampling

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

SECTION 1

	Yes	No	N/A	N/O
GENERAL GW Monitoring				
1. AHA/THA includes precautions for moving heavy coolers and they are followed.	☐	☐	☐	☐
2. Well Head Space is monitored in accordance with the HSP (PID)	☐	☐	☐	☐
3. Well enclosures are evaluated for biological hazards before opening (spiders, wasps)	☐	☐	☐	☐
4. Correct lifting procedures are used unloading equipment at each sampling location.	☐	☐	☐	☐
5. Well casing is evaluated for sharp edges and precautions are taken before opening	☐	☐	☐	☐
6. Place all purge water in containers and manage in accordance with site plans	☐	☐	☐	☐
GENERAL - PPE				
7. PPE available for use by employees.	☐	☐	☐	☐
8. PPE stored appropriately to prevent deformation or distortion.	☐	☐	☐	☐
EYEWEAR (Glasses/Goggles/Face Shields)				
9 Eyewear cleaning supplies available.	☐	☐	☐	☐
10 Safety glasses in good condition and lenses free of scratches.	☐	☐	☐	☐
11 Goggles adjustment strap not cracked or frayed, not deformed, or lenses not scratched.	☐	☐	☐	☐
12 Face shields in good condition, including adjustment band, and free of scratches or chips.	☐	☐	☐	☐
HEAD PROTECTION				
13. Hard hat bill and suspension attached as allowed by manufacturer.	☐	☐	☐	☐
14. Shell is pliable, free of dents, cracks, nicks, or any damage due to impact.	☐	☐	☐	☐
15. Suspension free of cuts or fraying, torn headband, adjustment strap workable.	☐	☐	☐	☐
HAND PROTECTION				
16. Available in sizes matched to employee.	☐	☐	☐	☐
17. Gloves free of rips tears, abrasions, or holes.	☐	☐	☐	☐
18. Matched to manufacturer's specification for chemicals used onsite.	☐	☐	☐	☐
19. Maintained in a clean and sanitary condition, decontaminated or disposed properly.	☐	☐	☐	☐

BODY PROTECTION

20.	Available in sizes matched to employee.	☐	☐	☐	☐
21.	Maintained in a clean and sanitary condition, decontaminated or disposed properly.	☐	☐	☐	☐
22.	Flame-resistant clothing matched to electrical hazard and arc flash rating and site requirements.	☐	☐	☐	☐
23	Welding gear matched to degree of hazard and free of cuts, tears or burn holes.	☐	☐	☐	☐
24	Flotation gear available for work near or on water and in good condition.	☐	☐	☐	☐

HOT AND COLD BODY PROTECTION

25	Cooling gear available based on degree of heat stress hazard.	☐	☐	☐	☐
26	Cooling gear in operable, clean, and sanitary condition.	☐	☐	☐	☐
27	Cold-weather gear provided based on needs assessment.	☐	☐	☐	☐
28	Cold-weather gear available in sizes to match employees.	☐	☐	☐	☐
29	Cold-weather gear is in free of tears, rips, or holes and in maintained in a clean condition.	☐	☐	☐	☐

GENERAL - Tools

30.	Fixed open blade knives are not used.	☐	☐	☐	☐
31.	All tools operated according to manufacturer's instructions and design limitations.	☐	☐	☐	☐
32.	All hand and power tools maintained in a safe condition and inspected and tested before use.	☐	☐	☐	☐
33.	Defective tools are tagged and removed from service until repaired.	☐	☐	☐	☐
34.	PPE is selected and used according to tool-specific hazards anticipated.	☐	☐	☐	☐
35.	Power tools are not carried or lowered by their cord or hose.	☐	☐	☐	☐
36.	Tools are disconnected from energy sources when not in use, servicing, cleaning, etc.	☐	☐	☐	☐
37.	Safety guards remain installed or are promptly replaced after repair.	☐	☐	☐	☐
38.	Tools are stored properly.	☐	☐	☐	☐
39	Cordless tools and recharging units both conform to electrical standards and specifications.	☐	☐	☐	☐
40.	Tools used in explosive environments are rated for such use.	☐	☐	☐	☐
41	Consider controls to avoid muscular skeletal, repetitive motion, and cumulative trauma stressors.	☐	☐	☐	☐

ELECTRIC-POWERED TOOLS (5.2.3)

42.	Electric tools are approved double insulated or grounded and used according to instructions.	☐	☐	☐	☐
43.	Electric cords are not used for hoisting or lowering tools.	☐	☐	☐	☐
44.	Electric tools are used in damp/ wet locations are approved for such locations or GFCI installed.	☐	☐	☐	☐
45.	Hand-held tools are equipped with appropriate on/off controls appropriate for the tool.	☐	☐	☐	☐
46.	Portable, power-driven circular saws are equipped with proper guards.	☐	☐	☐	☐

HAND TOOLS (5.2.9)

47	Wrenches/Spanners are not used when jaws are sprung to the point of slippage.	☐	☐	☐	☐
48	Impact tools are kept free of mushroomed heads.	☐	☐	☐	☐

SECTION 3

Complete this section for all items checked "No" in Sections 1 or 2. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: _____ Project Manager: _____

CH2MHILL

H&S Self-Assessment Checklist – HAND AND POWER TOOLS

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where: 1) CH2M HILL employees are exposed to hand and power tool hazards and/or 2) CH2M HILL provides oversight of subcontractor personnel who are exposed to hand and power tool hazards.

SSC or DSC may consult with subcontractors when completing this checklist, but shall not direct the means and methods of hand and power tool use nor direct the details of corrective actions. Subcontractors shall determine how to correct deficiencies and we must carefully rely on their expertise. Items considered to be imminently dangerous (possibility of serious injury or death) shall be corrected immediately or all exposed personnel shall be removed from the hazard until corrected.

Completed checklists shall be sent to the HS&E Staff for review.

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposure to hand and power tool hazards.
☐ Evaluate a CH2M HILL subcontractor's compliance with hand and power tool requirements.
Subcontractors Name: _____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HS-50.

SECTION 1

	Yes	No	N/A	N/O
SAFE WORK PRACTICES (3.1)				
1. All tools operated according to manufacturer's instructions and design limitations.	☐	☐	☐	☐
2. All hand and power tools maintained in a safe condition and inspected and tested before use.	☐	☐	☐	☐
3. Defective tools are tagged and removed from service until repaired.	☐	☐	☐	☐
4. PPE is selected and used according to tool-specific hazards anticipated.	☐	☐	☐	☐
5. Power tools are not carried or lowered by their cord or hose.	☐	☐	☐	☐
6. Tools are disconnected from energy sources when not in use, servicing, cleaning, etc.	☐	☐	☐	☐
7. Safety guards remain installed or are promptly replaced after repair.	☐	☐	☐	☐
8. Tools are stored properly.	☐	☐	☐	☐
9. Cordless tools and recharging units both conform to electrical standards and specifications.	☐	☐	☐	☐
10. Tools used in explosive environments are rated for such use.	☐	☐	☐	☐
11. Knife or blade hand tools are used with the proper precautions.	☐	☐	☐	☐
12. Consider controls to avoid muscular skeletal, repetitive motion, and cumulative trauma stressors.	☐	☐	☐	☐

SECTION 2	Yes	No	N/A	N/O
GENERAL (3.2.1)				
13. PPE is selected and used according to tool-specific hazards anticipated.	☐	☐	☐	☐
14. Tools are tested daily to assure safety devices are operating properly.	☐	☐	☐	☐
15. Damaged tools are removed from service until repaired.	☐	☐	☐	☐
16. Power operated tools designed to accommodate guards have guards installed.	☐	☐	☐	☐
17. Rotating or moving parts on tools are properly guarded.	☐	☐	☐	☐
18. Machines designed for fixed locations are secured or anchored.	☐	☐	☐	☐
19. Floor and bench-mounted grinders are provided with properly positioned work rests.	☐	☐	☐	☐
20. Guards are provided at point of operation, nip points, rotating parts, etc.	☐	☐	☐	☐
21. Fluid used in hydraulic-powered tools is approved fire-resistant fluid.	☐	☐	☐	☐
ELECTRIC-POWERED TOOLS (3.2.2)				
22. Electric tools are approved double insulated or grounded and used according to SOP HS-23.	☐	☐	☐	☐
23. Electric cords are not used for hoisting or lowering tools.	☐	☐	☐	☐
24. Electric tools are used in damp/ wet locations are approved for such locations or GFCI installed.	☐	☐	☐	☐
25. Hand-held tools are equipped with appropriate on/off controls appropriate for the tool.	☐	☐	☐	☐
26. Portable, power-driven circular saws are equipped with proper guards.	☐	☐	☐	☐
ABRASIVE WHEEL TOOLS (3.2.3)				
27. All employees using abrasive wheel tools are wearing eye protection.	☐	☐	☐	☐
28. All grinding machines are supplied with sufficient power to maintain spindle speed.	☐	☐	☐	☐
29. Abrasive wheels are closely inspected and ring-tested before use.	☐	☐	☐	☐
30. Grinding wheels are properly installed.	☐	☐	☐	☐
31. Cup-type wheels for external grinding are protected by the proper guard or flanges.	☐	☐	☐	☐
32. Portable abrasive wheels used for internal grinding are protected by safety flanges.	☐	☐	☐	☐
33. Safety flanges are used only with wheels designed to fit the flanges.	☐	☐	☐	☐
34. Safety guards on abrasive wheel tools are mounted properly and of sufficient strength.	☐	☐	☐	☐
PNEUMATIC-POWERED TOOLS (3.2.4)				
35. Tools are secured to hoses or whip by positive means to prevent disconnection.	☐	☐	☐	☐
36. Safety clips or retainers are installed to prevent attachments being expelled.	☐	☐	☐	☐
37. Safety devices are installed on automatic fastener feed tools as required.	☐	☐	☐	☐
38. Compressed air is not used for cleaning unless reduced to < 30 psi, with PPE, and guarded.	☐	☐	☐	☐
39. Manufacturer's safe operating pressure for hoses, pipes, valves, etc. are not exceeded.	☐	☐	☐	☐
40. Hoses are not used for hoisting or lowering tools.	☐	☐	☐	☐
41. All hoses >1/2-inch diameter have safety device at source to reduce pressure upon hose failure.	☐	☐	☐	☐
42. Airless spray guns have required safety devices installed.	☐	☐	☐	☐
43. Blast cleaning nozzles are equipped with operating valves, which are held open manually.	☐	☐	☐	☐
44. Supports are provided for mounting nozzles when not in use.	☐	☐	☐	☐
45. Air receiver drains, handholes, and manholes are easily accessible.	☐	☐	☐	☐
46. Air receivers are equipped with drainpipes and valves for removal of accumulated oil and water.	☐	☐	☐	☐
47. Air receivers are completely drained at required intervals.	☐	☐	☐	☐
48. Air receivers are equipped with indicating pressure gauges.	☐	☐	☐	☐
49. Safety, indicating, and controlling devices are installed as required.	☐	☐	☐	☐
50. Safety valves are tested frequently and at regular intervals to assure good operating condition.	☐	☐	☐	☐

SECTION 2 (continued)

	Yes	No	N/A	N/O
LIQUID FUEL-POWERED TOOLS (3.2.5)				
51. Liquid fuel-powered tools are stopped when refueling, servicing, or maintaining.	☐	☐	☐	☐
52. Liquid fuels are stored, handled, and transported in accordance with SOP HS-21	☐	☐	☐	☐
53. Liquid fuel-powered tools are used in confined spaces in accordance with SOP HS-17.	☐	☐	☐	☐
54. Safe operating pressures of hoses, valves, pipes, filters, and other fittings are not exceeded.	☐	☐	☐	☐
POWDER-ACTUATED TOOLS (3.2.6)				
55. Only trained employee operates powder-actuated tools.	☐	☐	☐	☐
56. Powder-actuated tools are not loaded until just prior to intended firing time.	☐	☐	☐	☐
57. Tools are not pointed at any employee at any time.	☐	☐	☐	☐
58. Hands are kept clear of open barrel end.	☐	☐	☐	☐
59. Loaded tools are not left unattended.	☐	☐	☐	☐
60. Fasteners are not driven into very hard or brittle materials.	☐	☐	☐	☐
61. Fasteners are not driven into easily penetrated materials unless suitable backing is provided.	☐	☐	☐	☐
62. Fasteners are not driven into spalled areas.	☐	☐	☐	☐
63. Powder-actuated tools are not used in an explosive or flammable atmosphere.	☐	☐	☐	☐
64. All tools are used with correct shields, guards, or attachments recommended by manufacturer.	☐	☐	☐	☐
JACKING TOOLS (3.2.7)				
65. Rated capacities are legibly marked on jacks and not exceeded.	☐	☐	☐	☐
66. Jacks have a positive stop to prevent over-travel.	☐	☐	☐	☐
67. The base of jacks are blocked or cribbed to provide a firm foundation, when required.	☐	☐	☐	☐
68. Wood blocks are place between the cap and load to prevent slippage, when required.	☐	☐	☐	☐
69. After load is raised, it is cribbed, blocked, or otherwise secured immediately.	☐	☐	☐	☐
70. Antifreeze is used when hydraulic jacks are exposed to freezing temperatures.	☐	☐	☐	☐
71. All jacks are properly lubricated.	☐	☐	☐	☐
72. Jacks are inspected as required.	☐	☐	☐	☐
73. Repair or replacement parts are examined for possible defects.	☐	☐	☐	☐
74. Jacks not working properly are removed from service and repaired or replaced.	☐	☐	☐	☐
HAND TOOLS (3.2.8)				
75. Wrenches are not used when jaws are sprung to the point of slippage.	☐	☐	☐	☐
76. Impact tools are kept free of mushroomed heads.	☐	☐	☐	☐
77. Wooden handles of tools are kept free of splinters or cracks and are tightly fitted in tool.	☐	☐	☐	☐

H&S Self-Assessment Checklist – HAND AND POWER TOOLS

SECTION 3

Complete this section for all items checked "No" in Sections 1 or 2. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: _____ Project Manager: _____

Attachment 2: Self-Assessment Checklist—Manual Lifting

CH2MHILL

HSE Self-Assessment Checklist—Lifting

This checklist shall be used **only** by CH2M HILL personnel and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where: (1) CH2M HILL employees perform manual lifting activities (office or projects), and/or (2) CH2M HILL provides oversight of a subcontractor performing manual lifting activities. SC or Office Safety Coordinators/Committee members may consult with subcontractors (if applicable) when completing this checklist but shall not direct the means and methods of activities nor direct the details of corrective actions. Subcontractors shall determine how to correct deficiencies, and we must carefully rely on their expertise. Conditions considered imminently dangerous (possibility of serious injury or death) shall be corrected immediately or all exposed personnel shall be removed from the hazardous area until corrected.
Complete the appropriate project or office information:

Project Information
Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

Office Information
Office Location: _____
Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:
☐ Evaluate CH2M HILL employee manual lifting activities.
☐ Evaluate a CH2M HILL subcontractor's manual lifting activities.
Subcontractor Name: _____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor.
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HSE-112.

Planning Activities	**Yes**	**No**	**N/A**	**N/O**
1. Efforts have been made to inquire about receiving equipment or supplies in containers weighting less than 50 pounds (23 kilograms).	o	o	o	o
2. Equipment or supplies are being delivered as close as possible to their use point.	o	o	o	o
3. Heavy equipment or supplies are being stored off the ground and no lower than knee height.	o	o	o	o
4. Adequate space has been provided to access and lift equipment or supplies without reaching or twisting.	o	o	o	o
Safe Work Practices (5.1)	**Yes**	**No**	**N/A**	**N/O**
5. Tasks or activities have been modified to reduce or minimize manual lifting.	o	o	o	o
6. All employees performing manual lifting have received training on how to lift safely.	o	o	o	o

7. Manual lifting control measures are evaluated during assessments.	o	o	o	o
8. Manual lifting incidents are reviewed as part of the HSE Program reviews.	o	o	o	o
9. Manual lifting incidents are reviewed as part of the HSE Program reviews.	o	o	o	o
Office Environments (5.1.1)	**Yes**	**No**	**N/A**	**N/O**
10. Employees have received lifting training.	o	o	o	o
11. Mechanical devices are readily available to employees handling equipment or supplies weighing more than 40 pounds (18 kilograms).	o	o	o	o
Field Projects (5.1.2)	**Yes**	**No**	**N/A**	**N/O**
12. All manual lifting tasks or activities have been addressed in the written site safety plan.	o	o	o	o
13. Employees have received safe lifting training as required by the written site safety plan.	o	o	o	o
Mechanical Lifting (5.2)	**Yes**	**No**	**N/A**	**N/O**
14. Hand trucks and trolleys are visually inspected before use.	o	o	o	o
15. Hand trucks and trolleys do not have any broken or damaged parts.	o	o	o	o
16. Hand truck and trolley paths are free of uneven surfaces, water, oil, or cracks and holes.	o	o	o	o
17. Loads carried by hand trucks are balanced and sturdy.	o	o	o	o
18. Hand trucks or dollies are being pushed when on level ground.	o	o	o	o
19. When going up or down a slope using a hand truck or trolley, the load is downslope of the person.	o	o	o	o
20. Employees using hand trucks or dollies are moving slowly and cautiously.	o	o	o	o
21. Employees using hand trucks or trolleys are able to see over the load.	o	o	o	o
Assisted Lifting (5.3)	**Yes**	**No**	**N/A**	**N/O**
22. Personnel are not performing manual lifting beyond their physical capabilities.	o	o	o	o
23. Loads are evenly distributed when being handled by multiple people.	o	o	o	o
Manual Lifting (5.4)	**Yes**	**No**	**N/A**	**N/O**
24. Before the lift, the load and path was assessed.	o	o	o	o
25. Loads being lifted are free of sharp edges, slivers, or wet or greasy spots.	o	o	o	o
26. Gloves are used for manual lifts of loads with sharp or splintered edges.	o	o	o	o
27. Employees performing manual lifts use the proper lifting techniques.	o	o	o	o
28. Special tools fabricated for lifting grates or manhole covers are used.	o	o	o	o

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: _____ Project Manager: _____

CH2MHILL

Attachment 2: HS&E Self-Assessment Checklist
Lockout/Tagout

CH2MHILL

HS&E Self-Assessment Checklist – LOCKOUT/TAGOUT

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's written safety plan.

This checklist is to be used when: 1) CH2M HILL staff are exposed to lockout/tagout hazards (complete Section 1), 2) CH2M HILL staff are self-performing lockout/tagout activities (completed Section 2), or 3) CH2M HILL provides oversight of subcontractor personnel who are performing lockout/tagout activities (complete Sections 1 and 2).

Safety Coordinator may consult with subcontractors when completing this checklist, but shall not direct the means and methods of lockout/tagout operations nor direct the details of corrective actions. Subcontractors shall determine how to correct deficiencies and we must carefully rely on their expertise. Items considered to be imminently dangerous (possibility of serious injury or death) shall be corrected immediately, or all exposed personnel shall be removed from the hazard until corrected.

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

☐ Evaluate CH2M HILL affected employee exposure to equipment during lockout/tagout
☐ Evaluate CH2M HILL authorized employee exposure to equipment requiring lockout/tagout
☐ Evaluate a CH2M HILL subcontractor's compliance with lockout/tagout requirements
Subcontractors Name: _____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HSE-33.

SECTION 1

	Yes	No	N/A	N/O
SAFE WORK PRACTICES (5.4)				
1. Only trained and authorized personnel are performing lockout/tagout activities	☐	☐	☐	☐
2. All affected employees notified prior to lockout/tagout activities	☐	☐	☐	☐
3. Equipment has been shutdown using normal operating controls	☐	☐	☐	☐
4. Employees do not attempt to start, energize or use equipment that is locked out or tagged	☐	☐	☐	☐
5. Employees do not remove locks or tags placed on equipment by other personnel	☐	☐	☐	☐
6. Affected employees are notified after lockout/tagout is completed	☐	☐	☐	☐
7. Employees verify that all safe guards have been replaced prior to equipment start-up	☐	☐	☐	☐

SECTION 2	Yes	No	N/A	N/O
GENERAL (5.5.1)				
8. Only trained and authorized personnel are performing lockout/tagout activities	☐	☐	☐	☐
9. Daily safety briefing/meeting conducted with affected and authorized employees	☐	☐	☐	☐
10. Employees made aware of any equipment-specific lockout/tagout procedures	☐	☐	☐	☐
11. Authorized employees provided with lockout devices, locks, tags and other isolation devices	☐	☐	☐	☐
12. New or modified equipment designed to accept lockout devices	☐	☐	☐	☐
EQUIPMENT-SPECIFIC LOCKOUT/TAGOUT PROCEDURES (5.5.2)				
13. LOTO procedures available when required to be documented	☐	☐	☐	☐
14. Equipment-specific LOTO procedures developed when not available from the facility	☐	☐	☐	☐
15. Affected employees notified that equipment will be shut down for LOTO	☐	☐	☐	☐
16. Energy sources, hazards, and control measures determined	☐	☐	☐	☐
17. Orderly shutdown of equipment is conducted that does not increase hazards	☐	☐	☐	☐
18. Energy isolating devices operated to isolate energy sources	☐	☐	☐	☐
19. Authorized employees apply personal lockout devices and tags to energy isolating device	☐	☐	☐	☐
20. Lockout devices are applied to secure equipment in the “off” position	☐	☐	☐	☐
21. Lockout tags applied to clearly indicate that operating the equipment is prohibited	☐	☐	☐	☐
22. Tags are located as close to or at the energy isolating device	☐	☐	☐	☐
23. All hazardous stored or residual energy is relieved, disconnected or restrained.	☐	☐	☐	☐
24. Isolation of energy sources has been verified (tested) prior to of work on equipment	☐	☐	☐	☐
25. Lockout tags are used alone only where lockout devices cannot be applied	☐	☐	☐	☐
LOCKOUT DEVICES AND TAGS (5.5.4)				
26. Lockout devices and tags only used to isolate energy sources	☐	☐	☐	☐
27. Lockout devices and tags are standardized by color, shape, size, print, and format	☐	☐	☐	☐
28. Lockout devices and tags indicate identity of employee applying the devices	☐	☐	☐	☐
29. Lockout devices and tags capable of withstanding anticipated environmental conditions of use	☐	☐	☐	☐
30. Lockout devices are substantial enough to prevent removal without the use of excessive force	☐	☐	☐	☐
31. Tags and their means of attachment are substantial enough to prevent inadvertent removal	☐	☐	☐	☐
32. Tags are legible and understandable by all employees	☐	☐	☐	☐
33. Tags warn against hazardous conditions if equipment is energized	☐	☐	☐	☐
RELEASING LOTO CONTROL (5.5.5)				
34. Work area inspected prior to removing LOTO devices and reenergization	☐	☐	☐	☐
35. LOTO devices only removed by authorized employees who applied the device	☐	☐	☐	☐
36. If employee not available to remove LOTO devices, steps in Section 4.2.4 of SOP followed	☐	☐	☐	☐
37. All affected employees notified prior to starting equipment previously locked or tagged out	☐	☐	☐	☐
GROUP LOTO (5.5.6)				
38. Group LOTO procedures followed when more than one employees is to work on equipment	☐	☐	☐	☐
39. Primary authorized person assigned to coordinate LOTO process	☐	☐	☐	☐
40. Normal steps for initiating LOTO control completed as above	☐	☐	☐	☐
41. Primary authorized person applies own lockout device and tag	☐	☐	☐	☐
42. Each authorized person applies own lockout device and tag	☐	☐	☐	☐
43. Primary authorized person removes LOTO devices after all other LOTO devices are removed	☐	☐	☐	☐
SPECIAL CONDITIONS (5.5.7)				
44. Shift or personnel changes coordinated to ensure LOTO protection is always provided	☐	☐	☐	☐
45. Procedures followed when LOTO devices are temporarily removed to test or reposition	☐	☐	☐	☐

Attachment 2: PPE Inspection Checklist

CH2MHILL

HS&E Self-Assessment Checklist: PERSONAL PROTECTIVE EQUIPMENT

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where CH2M HILL employees are required to wear PPE or are required to perform oversight of a subcontractor using PPE or both.

CH2M HILL staff shall not direct the means and methods of subcontractor use of PPE nor direct the details of corrective actions. The subcontractor must determine how to correct deficiencies and CH2M HILL staff must carefully rely on their expertise. Conditions considered to be imminently dangerous (possibility of serious injury or death) must be corrected immediately or all exposed personnel must be removed from the hazard until corrected.

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to (check only one of the boxes below):

☐ Evaluate CH2M HILL compliance with its PPE program (SOP HSE-117)
☐ Evaluate a CH2M HILL subcontractor's compliance with its PPE program
Subcontractor's Name: _____

Check the appropriate box, as follows:

- Check "Yes" if an assessment item is complete or correct.
- Check "No" if an item is incomplete or deficient. Section 2 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HSE-121.

SECTION 1	**Yes**	**No**	**N/A**	**N/O**
GENERAL				
1. Required PPE listed in HSP FSI or AHA.	☐	☐	☐	☐
2. PPE available for use by employees.	☐	☐	☐	☐
3. PPE cleaning supplies available for use.	☐	☐	☐	☐
4. PPE stored appropriately to prevent deformation or distortion.	☐	☐	☐	☐
5. PPE written certification has been completed.	☐	☐	☐	☐
EYEWEAR (Glasses/Goggles/Face Shields)				
6 Eyewear cleaning supplies available.	☐	☐	☐	☐
7 Safety glasses in good condition and lenses free of scratches.	☐	☐	☐	☐
8 Goggles adjustment strap not cracked or frayed, not deformed, or lenses not scratched.	☐	☐	☐	☐
9. Face shields in good condition, including adjustment band, and free of scratches or chips.	☐	☐	☐	☐

CH2MHILL

HS&E Self-Assessment Checklist: PERSONAL PROTECTIVE EQUIPMENT

SECTION 1 (Continued)	Yes	No	N/A	N/O
HEAD PROTECTION				
10. Hard hat bill and suspension attached as allowed by manufacturer.	☐	☐	☐	☐
11. Shell is pliable, free of dents, cracks, nicks, or any damage due to impact.	☐	☐	☐	☐
12. Suspension maintained at 1.25 inches from inside of shell.	☐	☐	☐	☐
13. Suspension free of cuts or fraying, torn headband, adjustment strap workable.	☐	☐	☐	☐
14. Electrical hard hat matched to hazard classification.	☐	☐	☐	☐
15. Dated to determine whether within manufacturer's allowable 5-year use time period.	☐	☐	☐	☐
HAND PROTECTION				
16. Available in sizes matched to employee.	☐	☐	☐	☐
17. Gloves free of rips tears, abrasions, or holes.	☐	☐	☐	☐
18. Matched to manufacturer's specification for chemicals used onsite.	☐	☐	☐	☐
19. Electrical gloves matched to hazard and periodically inspected for insulating rating.	☐	☐	☐	☐
20. Maintained in a clean and sanitary condition, decontaminated or disposed properly.	☐	☐	☐	☐
BODY PROTECTION				
21. Available in sizes matched to employee.	☐	☐	☐	☐
22. Maintained in a clean and sanitary condition, decontaminated or disposed properly.	☐	☐	☐	☐
23. Vapor-tight fully encapsulated suits tested at required periodic intervals.	☐	☐	☐	☐
24. Flame-resistant clothing matched to electrical hazard and arc flash rating.	☐	☐	☐	☐
25 Welding gear matched to degree of hazard and free of cuts, tears or burn holes.	☐	☐	☐	☐
26 Flotation gear available for work near or on water and in good condition.	☐	☐	☐	☐
HOT AND COLD BODY PROTECTION				
27 Cooling gear available based on degree of heat stress hazard.	☐	☐	☐	☐
28 Cooling gear in operable, clean, and sanitary condition.	☐	☐	☐	☐
29 Cold-weather gear provided based on needs assessment.	☐	☐	☐	☐
30. Cold-weather gear available in sizes to match employees.	☐	☐	☐	☐
31 Cold-weather gear is in free of tears, rips, or holes and in maintained in a clean condition.	☐	☐	☐	☐
TRAINING				
32 Initial PPE training completed by employees.	☐	☐	☐	☐
33 Training conducted when new types or styles of PPE are issued.	☐	☐	☐	☐
34 PPE selection, use, and maintenance reviewed at daily safety briefings.	☐	☐	☐	☐

SECTION 2

Complete this section for all items checked “No” in Section 1. Deficient items must be corrected in a timely manner.

Item #	**Corrective Action Planned or Taken**	**Date Corrected**

Auditor: ________________________________ Project Manager: ___________________________________

, Vehicle or Equipment Spotting Pre-Task Hazard Analysis Card

Walk Through

The driver and the spotter must walk through the route prior to performing the task to assess the following:

Yes No

☐ ☐ Can the distance of reversing the vehicle be eliminated or minimized?
Describe actions taken_____

☐ ☐ Are there any hazards along the route that would interfere with safe completion of the job?
Describe actions taken _____

☐ ☐ Can the route be modified to make the task safer?
Describe actions taken _____

☐ ☐ Can the route be cleared of workers (pedestrians) within 8 feet (2.5 m) of the moving vehicle? If not, do not proceed and get supervisor's approval?
Describe actions taken _____

IF any of the following agreed upon communication plan or individual's responsibilities are not met, STOP IMMEDIATELY

obtain Second level (Supervisor) approval if ANY of the responsibilities CANNOT be met

Communication Plan

- Apart from verbal communication, the driver and the spotter must agree to communicate via one of the following:
  - ☐ Hand signals (consider high visibility gloves)
  - ☐ Two-Way Radios (if allowed)
  - ☐ Lights
  - ☐ Hand held Air Horn
  - ☐ Other:_____

Note: Verbal only communication is not an acceptable method

- Consider having only the spotter, or only the vehicle, moving at one time in order to maintain visual contact

Spotter's Responsibilities

As the SPOTTER on this job I WILL:

- Position myself to enable the driver to maintain visual contact with me
- Never cross the path of travel of a **moving** vehicle
- Maintain a minimum 8 ft (2.5 m) distance from **moving** vehicle
- Wear a high visibility vest
- Wear the PPE requirements for the area
- Communicate to the driver to **STOP** immediately if I spot any unexpected hazards
- Never ride on the vehicle while it is moving
- Keep the route free of people that don't need to be there

I understand the communication plan and my responsibilities
Spotter's Name _____ Date: _____

Driver's Responsibilities

As the Driver on this job I WILL:

- **STOP** immediately if I lose visual contact with the spotter
- **STOP** immediately if instructed by the spotter
- **STOP** immediately if anyone comes within 8 ft (2.5 m) of my vehicle
- Operate the vehicle so my speed does not exceed the walking pace of the spotter
- Communicate the blind spots of the vehicle to the spotter
- Turn my radio and any other distractions off in the cab of my vehicle
- Make sure my window(s) are open to receive spotter communications
- Make sure my windows and mirrors are clear to ensure good visibility

I understand the communication plan and my responsibilities
Driver's Name _____ Date:_____

The Spotter shall keep this PTHA Card with them for the duration of the task

Attachment D
CH2M AHAs / Safe Work Procedures

SWP Filter Changeout

Scope

This procedure is to be used by the site personnel who perform filter changeout activities involved with operation of remediation system located at the Dow Jamestown site.

☐ Critical ☐ Emergency ☐ Non-Routine ☑ Routine

Hazards and precautions

The table below lists job hazards and the precautions that should be taken for safety, environmental, quality, and Good Manufacturing Practices before beginning this procedure. Specific hazards may also be addressed in the procedure steps.

Hazard	Precaution
Driving / Parking	Spotters will be used when backing. If alone, before backing get out of vehicle and conduct a complete survey around vehicle looking for any obstructions. Exercise caution when traveling with vehicle through the worksite (travel at slow speed) When parking, put vehicle in park and set parking brake. Wear seatbelt. Set parking brake when parking.
Fire / Explosion	Smoking is prohibited in all buildings at the site. Make sure there is a clear path to the exits and fire extinguisher is accessible. Ensure fire extinguisher is fully charged and being inspected monthly.
Chemical	Request and review all necessary Safety Data sheets for chemicals, preservatives and decontaminating cleaners. SDS will be maintained at site in a three ring binder for easy access. Utilize appropriate PPE to prevent dermal contact with media and approved safety glasses with side shields to prevent eye contact.

Biological	Identify if any personnel are allergic to specific biological hazards, and make sure that the appropriate first aid is available for that hazard. Know the location of a person's epinephrine, if that person would happen to become incapacitated from a sting.
Heat	Schedule regular breaks based on the conditions. Take breaks in a cool dry location. Drink plenty of water: 16 ounces before beginning work and a minimum of 4 cups an hour. Avoid drinking caffeine. Try to conduct more strenuous activities in the morning if possible. ***REFER TO HASP SECTION ON HEAT STRESS***.
Slips, trips and falls	Never walk backwards or pull equipment towards you. Ensure stable footing at all times to avoid slips and falls. Maintain good housekeeping practices to keep work area clear of hazards Eliminate slip, trip, fall hazards. Barricade around any slip, trip, fall hazards that cannot be eliminated.
Abrasions, Lacerations	Make sure to wear appropriate PPE such as long trousers, leather gloves, steel toed boots, etc. that protect against the risk of abrasions/lacerations. Exercise caution when handling valves, tools, and cords/cables.

Severe Weather	Protective measures during a storm include seeking shelter; avoiding projecting above the surrounding landscape (don't stand on a hilltop--seek low areas) and ceasing work and seeking shelter inside a building or project vehicle, staying away from open water, metal equipment, railroad tracks, wire fences, and metal pipes; and positioning people several yards apart. Remember that lightning may strike several miles from the parent cloud, so work should be stopped/restarted accordingly. **Seek refuge when thunder sounds or lightening is seen and do not resume activity until 30 minutes after the last thunder clap is heard or lightening strike is seen.**
Pinch Points	Be aware of pinch points and avoid those areas (opening doors; turning valves; handling and moving tools and equipment; etc.). Avoid placing hands and feet under objects. Look at line of fire hazards and avoid placing any part of body in that hazard.
Electrical Hazards	Anyone opening electrical panels located will be required to have attended NFPA 70E Arc Flash Protection training. Inspect all electrical equipment prior to use. If found to be defective (cut wire, abrasion, exposed wire, etc.) place out of service.
Hot Surfaces	Label surfaces that are hot to the touch. Avoid touching surfaces that are hot. Wear clothing that protects against burns in the event that a hot surface is touched.
Noise	Wear earplugs and/or muffs while in areas that require noise protection. In areas outside of designated areas, if a person has to raise there voice to speak with someone who is 3 feet away then hearing protection should be worn.

Lifting	Use proper technique: - Feet should width apart. - Bend at knees not the back - Position object close to the body - Secure a firm grip - Keep object close to body - Lift with legs - Avoid twisting at the waist. No one is to lift loads weighing 40 lbs or more without assistance. Know your limitations, if load is too heavy for one person, ask for help, or if possible split the load into multiple trips.

Tools and equipment *The tools and equipment listed below are needed to do this job.*

Safety Glasses	Ear plugs/muffs	Steel toed boots
Hard Hat	Nitrile gloves	Leather Gloves
Mini-RAE/Multi-RAE	STAC Card	Calibration Gas/ Solutions
Bloodborne Pathogen Kit	Eye Wash Kit/Station	First aid/Sting kit
Face shield		

Consequence of deviation from this procedure

Possible bodily harm and/or death and potential loss of primary containment (LOPC).

Overview of tasks

This procedure will invole the following tasks

1. Set Up
2. Replacing Filter
3. Cleanup

Task #1 **Set Up**

Step	Action	Initial
1	Ensure that the area is accessible.	
2	Don steel toe boots, safety glasses, hard hat, nitrile gloves, and leather gloves.	
3	Check to make sure that the work area is clear of unnecessary equipment.	

4	Calibrate all appropriate instruments according to manufacturer's instructions. Record all calibrations in the logbook.	
5	Check room containing remediation equipment with monitoring equipment to ensure it safe to enter. Refer to HASP for air monitoring requirements.	

Task #2 **Replacing Filter**

Step	Action	Initial
1	Close valves 4 and 5.	
		
2	Don faceshield to protect against any potential splash.	
3	Drain excess water from system by opening valve 6 and allowing water to drain into bucket.	
		
3	Close valve 7 and 8 on each side of filter housing A.	

		
4	Drain excess water from system by opening valve 11 and allowing water to drain into bucket.	
		
5	Close valve 9 and 10 on each side of filter housing B.	
		
6	Place bucket under filter housing A to catch water. Loosen knob on top of filter housing A to lower filter housing and remove filter.	
7	Place bucket under filter housing B to catch water. Loosen knob on top of filter housing B to lower filter housing and remove filter.	

8	Place filter housing A back in place and tighten knob on top of filter housing.	
9	Place filter housing B back in place and tighten knob on top of filter housing.	
10	Close valve 6 and 11.	
11	Open valves 7 and 8 next to filter housing A.	
12	Open valves 9 and 10 next to filter housing B.	

Task #3

Cleanup

Step	Action	Initial
1	Make sure used gloves and filter are disposed of proper container. Ensure container is properly labeled.	
2	Place tools and equipment in its proper storage location.	

Resources and references

The following background information is available.

JMS O&M Health and Safety Plan— Dow Jamestown, New York
System Operations and Maintenance Plan

Revision history

Below are at least the last three revisions of this document but includes all revisions within the last 6 months.

Date	By	Description

This procedure was validated as the best known way to do this job by:

Jason Kearns / Health and Safety Manager — 7/18/2016

Validation (Name/Job Title) (Date)

Approved Users	Employee Name (Print)	Employee Name (Signature)	Date Trained
Travis Pendry			
Jon Gowing			

Attachment E
Subcontractor AHAs

Attachment F
Heat Stress Monitoring Form

HEAT STRESS PHYSIOLOGICAL MONITORING FORM

Project:

Date: | Company:

1. Take and record measurement of temperature or pulse at the frequency indicated in the safety plan.
2. Follow the Physiological Monitoring Protocol in the safety plan.
3. Never continue work if your body temperature is more than 100.4° F/38° C, or if you are experiencing sudden and severe fatigue, nausea, dizziness, or lightheadedness.

Employee:

Describe action taken below if measurements are exceeded:

Time								
Temp								
Heat Index								
Pulse								

Employee:

Describe action taken below if measurements are exceeded:

Time								
Temp								
Heat Index								
Pulse								

Employee:

Describe action taken below if measurements are exceeded:

Time								
Temp								
Heat Index								
Pulse								

Employee:

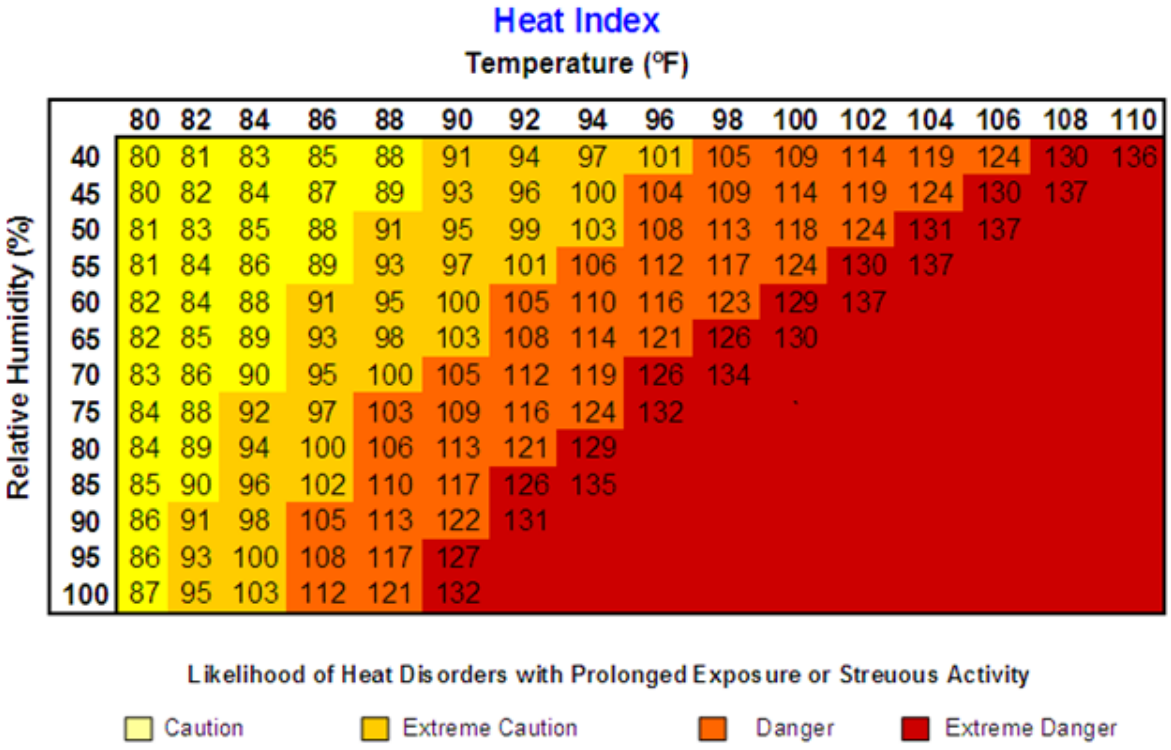
Describe action taken below if measurements are exceeded:

Time								
Temp								
Heat Index								
Pulse								

Thermal Stress Monitoring – Permeable or Impermeable Clothing

When permeable work clothes are worn (street clothes or clothing ensembles over street clothes), regularly observe workers for signs and symptoms of heat stress and implement physiological monitoring as indicated below. This should start when the heat index reaches 80° F (27° C) [see Heat Index Table below], or sooner if workers exhibit symptoms of heat stress indicated in the table above. These heat index values were devised for shady, light wind conditions; exposure to full sunshine can increase the values by up to 15°F (8°C). Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

When wearing **impermeable clothing** (e.g., clothing doesn't allow for air or water vapor movement such as Tyvek), physiological monitoring as described below shall be conducted when the ambient temperature reaches 70° F (21° C) or at a lower temperature when workers begin to exhibit signs and symptoms of heat stress.



Heat Index	Possible Heat Disorders	Minimum Frequency of Physiological Monitoring
80°F - 90°F (27°C - 32°C)	Fatigue possible with prolonged exposure and/or physical activity	Conduct initial monitoring as baseline and observe workers for signs of heat stress and implement physiological monitoring if warranted.
90°F - 105°F (32°C - 41°C)	Sunstroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity	Conduct initial monitoring as baseline, then at least every hour, or sooner, if signs of heat stress are observed.
105°F - 130°F (41°C - 54°C)	Sunstroke, heat cramps, or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity.	Conduct initial monitoring as baseline, then every 30 minutes or sooner if signs of heat stress are observed.
130°F or Higher (54°C or Higher)	Heat/Sunstroke highly likely with continued exposure.	Conduct initial monitoring as baseline, then every 15 minutes or sooner if signs of heat stress are observed.
Source: National Weather Service		

Attachment G
Calibration Log

Instrument Calibration Log

Project Name/Number:

Field Personnel:

Make, Model and Serial Number of Unit:

Date:

Time	Gas	Concentration of Gas	Calibration Gas Lot Number	Instrument Reading	Comments	Initial
	Methane					
	Isobutylene					
	Oxygen					
	Hydrogen Sulfide					
	Carbon Monoxide					

Make, Model and Serial Number of Unit:

Date:

Time	Gas	Concentration of Gas	Calibration Gas Lot Number	Instrument Reading	Comments	Initial
	Methane					
	Isobutylene					
	Oxygen					
	Hydrogen Sulfide					
	Carbon Monoxide					

Make, Model and Serial Number of Unit:

Date:

Time	Gas	Concentration of Gas	Calibration Gas Lot Number	Instrument Reading	Comments	Initial
	Methane					
	Isobutylene					
	Oxygen					
	Hydrogen Sulfide					
	Carbon Monoxide					

Attachment H
Safety Data Sheets

Isobutylene (0.0005% - 1.34%), Oxygen (19.5 - 23.5%) in balance Nitrogen

Safety Data Sheet 50054

according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

Date of issue: 03/24/2015 Version: 1.0

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product form : Mixture

Product name : Isobutylene (0.0005% - 1.34%), Oxygen (19.5 - 23.5%) in balance Nitrogen

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Test gas/Calibration gas.

1.3. Details of the supplier of the safety data sheet

Calgaz, division of Air Liquide
821 Chesapeake Drive
Cambridge, 21613 - USA
T 1-410-228-6400 - F 1-410-228-4251
info@Calgaz.com - www.Calgaz.com

1.4. Emergency telephone number

Emergency number : CHEMTREC: 1-800-424-9300
Internationally: 1-703-527-3887

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Classification (GHS-US)

Compressed gas H280

Full text of H-phrases: see section 16

2.2. Label elements

GHS-US labeling

Hazard pictograms (GHS-US) :

GHS04

Signal word (GHS-US) : Warning

Hazard statements (GHS-US) : H280 - Contains gas under pressure; may explode if heated

Precautionary statements (GHS-US) : P202 - Do not handle until all safety precautions have been read and understood
P271 - Use only outdoors or in a well-ventilated area
P403 - Store in a well-ventilated place
CGA-PG02 - Protect from sunlight when ambient temperature exceeds 52°C (125°F)
CGA-PG05 - Use a back flow preventive device in the piping
CGA-PG06 - Close valve after each use and when empty
CGA-PG10 - Use only with equipment rated for cylinder pressure
CGA-PG14 - Approach suspected leak area with caution
CGA-PG21 - Open valve slowly

2.3. Other hazards

No additional information available

2.4. Unknown acute toxicity (GHS-US)

Not applicable

SECTION 3: Composition/information on ingredients

3.1. Substance

Not applicable

3.2. Mixture

Name	Product identifier	%	Classification (GHS-US)
Nitrogen	(CAS No) 7727-37-9	75.16 - 80.4995	Compressed gas, H280
Oxygen	(CAS No) 7782-44-7	19.5 - 23.5	Ox. Gas 1, H270
Isobutylene	(CAS No) 115-11-7	0.0005 - 1.34	Flam. Gas 1, H220 Liquefied gas, H280

Full text of H-phrases: see section 16

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general : Adverse effects not expected from this product. If you feel unwell, seek medical advice (show the label where possible).

First-aid measures after inhalation : Adverse effects not expected from this product.

First-aid measures after skin contact : Adverse effects not expected from this product.

First-aid measures after eye contact : Adverse effects not expected from this product.

First-aid measures after ingestion : Ingestion is not considered a potential route of exposure.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/injuries after inhalation : Adverse effects not expected from this product.

Symptoms/injuries after skin contact : Adverse effects not expected from this product.

Symptoms/injuries after eye contact : Adverse effects not expected from this product.

Symptoms/injuries after ingestion : Ingestion is not considered a potential route of exposure.

Symptoms/injuries upon intravenous administration : Not known.

Chronic symptoms : Adverse effects not expected from this product.

4.3. Indication of any immediate medical attention and special treatment needed

If you feel unwell, seek medical advice. If breathing is difficult, give oxygen.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : Use extinguishing media appropriate for surrounding fire.

Unsuitable extinguishing media : Do not use water jet to extinguish.

5.2. Special hazards arising from the substance or mixture

Fire hazard : The product is not flammable.

Explosion hazard : Product is not explosive. Heat may build pressure, rupturing closed containers, spreading fire and increasing risk of burns and injuries.

Reactivity : None known.

5.3. Advice for firefighters

Firefighting instructions : In case of fire: Evacuate area. Fight fire remotely due to the risk of explosion. Use water spray or fog for cooling exposed containers. Exercise caution when fighting any chemical fire.

Protection during firefighting : Standard protective clothing and equipment (e.g., Self Contained Breathing Apparatus) for fire fighters. Do not enter fire area without proper protective equipment, including respiratory protection.

Specific methods : Exposure to fire may cause containers to rupture/explode. Continue water spray from protected position until container stays cool. Move containers away from the fire area if this can be done without risk.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures : Ensure adequate ventilation.

6.1.1. For non-emergency personnel

Protective equipment : Wear protective equipment consistent with the site emergency plan.

Emergency procedures : Escape the danger area by the closest safe route. Close doors and windows of adjacent premises. Keep containers closed. Mark the danger area. Seal off low-lying areas. Keep upwind.

6.1.2. For emergency responders

Protective equipment	:	Standard protective clothing and equipment (e.g., Self Contained Breathing Apparatus) for fire fighters. Equip cleanup crew with proper protection.
Emergency procedures	:	Evacuate and limit access. Ventilate area.

6.2. Environmental precautions

Try to stop release if safe to do so.

6.3. Methods and material for containment and cleaning up

For containment	:	Try to stop release if safe to do so.
Methods for cleaning up	:	Dispose of this material and its container in accordance with local regulations.

6.4. Reference to other sections

See also Sections 8 and 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Additional hazards when processed	:	Pressurized container: Do not pierce or burn, even after use. Use equipment rated for cylinder pressure.
Precautions for safe handling	:	Do not handle until all safety precautions have been read and understood. Use only outdoors or in a well-ventilated area.
Safe handling of the gas receptacle	:	Protect cylinders from physical damage; do not drag, roll, slide or drop. Do not remove or deface labels provided by the supplier for the identification of the cylinder contents.
Safe use of the product	:	The substance must be handled in accordance with good industrial hygiene and safety procedures. Only experienced and properly instructed persons should handle gases under pressure. Consider pressure relief device(s) in gas installations. Ensure the complete gas system was (or is regularily) checked for leaks before use. Do not remove or deface labels provided by the supplier for the identification of the cylinder contents. Use only properly specified equipment which is suitable for this product, its supply pressure and temperature. Contact your gas supplier if in doubt.
Hygiene measures	:	Do not eat, drink or smoke when using this product.

7.2. Conditions for safe storage, including any incompatibilities

Technical measures	:	None known.
Storage conditions	:	Do not expose to temperatures exceeding 52°C (125°F). Keep container closed when not in use. Protect cylinder from physical damage. Store in well ventilated area.
Incompatible products	:	None known.
Incompatible materials	:	Flammable materials.
Storage area	:	Store away from heat. Store in a well-ventilated place.

7.3. Specific end use(s)

See Section 1.2.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Isobutylene (0.0005% - 1.34%), Oxygen (19.5 - 23.5%) in balance Nitrogen		
ACGIH	Not applicable	
OSHA	Not applicable	

Isobutylene (115-11-7)		
ACGIH	ACGIH TWA (ppm)	250 ppm
OSHA	Not applicable	

Oxygen (7782-44-7)	
ACGIH	Not applicable
OSHA	Not applicable

Nitrogen (7727-37-9)	
ACGIH	Not applicable
OSHA	Not applicable

8.2. Exposure controls

Appropriate engineering controls	:	Provide adequate general and local exhaust ventilation. Systems under pressure should be regularly checked for leakages. Consider work permit system e.g. for maintenance activities. Ensure exposure is below occupational exposure limits.
Hand protection	:	Wear working gloves when handling gas containers. 29 CFR 1910.138: Hand Protection.
Eye protection	:	Wear safety glasses with side shields. 29 CFR 1910.133: Eye and Face Protection.
Skin and body protection	:	Wear suitable protective clothing, e.g. - lab coats, coveralls or flame resistant clothing.
Respiratory protection	:	None necessary during normal and routine operations. See Sections 5 & 6.
Thermal hazard protection	:	None necessary during normal and routine operations.
Environmental exposure controls	:	Refer to local regulations for restriction of emissions to the atmosphere. See section 13 for specific methods for waste gas treatment.
Other information	:	Wear safety shoes while handling containers. 29 CFR 1910.136: Foot Protection.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	:	Gas
Appearance	:	Clear, colorless gas.
Molecular mass	:	Not applicable for gas-mixtures.
Color	:	Colorless
Odor	:	Coal gas;Odorless
Odor threshold	:	No data available
pH	:	Not applicable for gas-mixtures.
Relative evaporation rate (butyl acetate=1)	:	No data available
Relative evaporation rate (ether=1)	:	Not applicable for gas-mixtures.
Melting point	:	No data available
Freezing point	:	No data available
Boiling point	:	No data available
Flash point	:	No data available
Auto-ignition temperature	:	No data available
Decomposition temperature	:	No data available
Flammability (solid, gas)	:	See Sect. 2.1 & 2.2
Vapor pressure	:	Not applicable.
Relative vapor density at 20 °C	:	No data available
Relative density	:	No data available
Relative gas density	:	Lighter or similar to air.
Solubility	:	Water: Solubility in water of component(s) of the mixture : • : Insoluble • : 39 mg/l • : 20 mg/l
Log Pow	:	Not applicable for gas-mixtures.
Log Kow	:	Not applicable for gas-mixtures.
Viscosity, kinematic	:	Not applicable.
Viscosity, dynamic	:	Not applicable.
Explosive properties	:	Not applicable - not flammable.
Oxidizing properties	:	Supports combustion. Not combustible but enhances combustion of other substances.
Explosive limits	:	Not applicable - not flammable

9.2. Other information

Additional information : None.

SECTION 10: Stability and reactivity

10.1. Reactivity

None known.

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

Can form explosive mixtures with flammable materials.

10.4. Conditions to avoid

None under recommended storage and handling conditions (see section 7).

10.5. Incompatible materials

Flammable materials.

10.6. Hazardous decomposition products

Under normal conditions of storage and use hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Not classified

Isobutylene (115-11-7)	
LC50 inhalation rat (mg/l)	620 mg/l/4h
LC50 inhalation rat (ppm)	239620.46 ppm/4h
ATE US (gases)	271823.000 ppmV/4h
ATE US (vapors)	620.000 mg/l/4h
ATE US (dust, mist)	620.000 mg/l/4h

Oxygen (7782-44-7)	
LC50 inhalation rat (ppm)	800000 ppm/4h

Nitrogen (7727-37-9)	
LC50 inhalation rat (ppm)	820000 ppm/4h

Skin corrosion/irritation : Not classified
pH: Not applicable for gas-mixtures.

Serious eye damage/irritation : Not classified
pH: Not applicable for gas-mixtures.

Respiratory or skin sensitization : Not classified

Germ cell mutagenicity : Not classified

Carcinogenicity : Not classified

Isobutylene (115-11-7)	
National Toxicology Program (NTP) Status	1 - Evidence of Carcinogenicity

Reproductive toxicity : Not classified

Specific target organ toxicity (single exposure) : Not classified

Specific target organ toxicity (repeated exposure) : Not classified

Aspiration hazard : Not classified

Symptoms/injuries after inhalation : Adverse effects not expected from this product.

Symptoms/injuries after skin contact : Adverse effects not expected from this product.

Symptoms/injuries after eye contact : Adverse effects not expected from this product.

Symptoms/injuries after ingestion : Ingestion is not considered a potential route of exposure.

Symptoms/injuries upon intravenous administration : Not known.

Chronic symptoms : Adverse effects not expected from this product.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : No ecological damage caused by this product.

12.2. Persistence and degradability

Isobutylene (0.0005% - 1.34%), Oxygen (19.5 - 23.5%) in balance Nitrogen	
Persistence and degradability	No data available.

Isobutylene (115-11-7)	
Persistence and degradability	The substance is biodegradable. Unlikely to persist.

Oxygen (7782-44-7)	
Persistence and degradability	No ecological damage caused by this product.

Nitrogen (7727-37-9)	
Persistence and degradability	No ecological damage caused by this product.

12.3. Bioaccumulative potential

Isobutylene (0.0005% - 1.34%), Oxygen (19.5 - 23.5%) in balance Nitrogen	
Log Pow	Not applicable for gas-mixtures.
Log Kow	Not applicable for gas-mixtures.
Bioaccumulative potential	No data available.

Isobutylene (115-11-7)	
Log Pow	2.35
Bioaccumulative potential	Not expected to bioaccumulate due to the low log Kow (log Kow < 4). Refer to section 9.

Oxygen (7782-44-7)	
Log Pow	Not applicable for inorganic gases.
Bioaccumulative potential	No ecological damage caused by this product.

Nitrogen (7727-37-9)	
Log Pow	Not applicable for inorganic gases.
Bioaccumulative potential	No ecological damage caused by this product.

12.4. Mobility in soil

Isobutylene (0.0005% - 1.34%), Oxygen (19.5 - 23.5%) in balance Nitrogen	
Mobility in soil	No data available.

Isobutylene (115-11-7)	
Ecology - soil	Because of its high volatility, the product is unlikely to cause ground or water pollution.

Oxygen (7782-44-7)	
Ecology - soil	No ecological damage caused by this product.

Nitrogen (7727-37-9)	
Ecology - soil	No ecological damage caused by this product.

12.5. Other adverse effects

Effect on ozone layer : None.

Effect on the global warming : No known ecological damage caused by this product.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste treatment methods : Contact supplier if guidance is required. Do not discharge into any place where its accumulation could be dangerous. Ensure that the emission levels from local regulations or operating permits are not exceeded.

Waste disposal recommendations : Refer to the CGA Pamphlet P-63 "Disposal of Gases" available at www.cganet.com for more guidance on suitable disposal methods.

SECTION 14: Transport information

In accordance with DOT

Transport document description : UN1956 Compressed gas, n.o.s. (Oxygen, Nitrogen)

UN-No.(DOT) : UN1956

Proper Shipping Name (DOT) : Compressed gas, n.o.s.

Hazard labels (DOT)	:	2.2 - Non-flammable gas

DOT Symbols	:	G - Identifies PSN requiring a technical name
DOT Packaging Exceptions (49 CFR 173.xxx)	:	306;307
DOT Packaging Non Bulk (49 CFR 173.xxx)	:	302;305
DOT Packaging Bulk (49 CFR 173.xxx)	:	314;315
DOT Quantity Limitations Passenger aircraft/rail (49 CFR 173.27)	:	75 kg
DOT Quantity Limitations Cargo aircraft only (49 CFR 175.75)	:	150 kg
DOT Vessel Stowage Location	:	A - The material may be stowed ''on deck'' or ''under deck'' on a cargo vessel and on a passenger vessel.

Additional information

Other information	:	No supplementary information available.
Special transport precautions	:	Avoid transport on vehicles where the load space is not separated from the driver's compartment. Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in the event of an accident or an emergency. Before transporting product containers: - Ensure there is adequate ventilation. - Ensure that containers are firmly secured. - Ensure cylinder valve is closed and not leaking. - Ensure valve outlet cap nut or plug (where provided) is correctly fitted. - Ensure valve protection device (where provided) is correctly fitted.

ADR

Transport document description	:	UN 1956 COMPRESSED GAS, N.O.S., 2.2
Class (ADR)	:	2 - Gases
Hazard labels (ADR)	:	2.2 - Non-flammable compressed gas

Transport by sea

UN-No. (IMDG)	:	1956
Proper Shipping Name (IMDG)	:	COMPRESSED GAS, N.O.S.
Class (IMDG)	:	2.2 - Non-flammable, non-toxic gases

Air transport

UN-No.(IATA)	:	1956
Proper Shipping Name (IATA)	:	COMPRESSED GAS, N.O.S.
Class (IATA)	:	2

SECTION 15: Regulatory information

15.1. US Federal regulations

Isobutylene (115-11-7)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

Oxygen (7782-44-7)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

Nitrogen (7727-37-9)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

15.2. International regulations

CANADA

Isobutylene (115-11-7)
Listed on the Canadian DSL (Domestic Sustances List)

Oxygen (7782-44-7)	
Listed on the Canadian DSL (Domestic Sustances List)	
WHMIS Classification	Class A - Compressed Gas Class C - Oxidizing Material

Nitrogen (7727-37-9)	
Listed on the Canadian DSL (Domestic Sustances List)	
WHMIS Classification	Class A - Compressed Gas

EU-Regulations

Isobutylene (115-11-7)
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)

Oxygen (7782-44-7)
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)

Nitrogen (7727-37-9)
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)

Classification according to Regulation (EC) No. 1272/2008 [CLP]
Not classified

Classification according to Directive 67/548/EEC [DSD] or 1999/45/EC [DPD]

15.2.2. National regulations

Isobutylene (115-11-7)
Listed on the AICS (Australian Inventory of Chemical Substances) Listed on IECSC (Inventory of Existing Chemical Substances Produced or Imported in China) Listed on the Japanese ENCS (Existing & New Chemical Substances) inventory Listed on the Korean ECL (Existing Chemicals List) Listed on NZIoC (New Zealand Inventory of Chemicals) Listed on PICCS (Philippines Inventory of Chemicals and Chemical Substances)

Oxygen (7782-44-7)
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15.3. US State regulations

Isobutylene (115-11-7)
U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

Oxygen (7782-44-7)
U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

Nitrogen (7727-37-9)
U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

SECTION 16: Other information

Indication of changes : Revised safety data sheet in accordance with OSHA final rule on GHS implementation promulgated March 26, 2012.

Other information : This Safety Data Sheet is offered pursuant to OSHA's Hazard Communication Standard, 29 CFR, 1910.1200. Other government regulations must be reviewed for applicability to this product.

Full text of H-phrases:

Compressed gas	Gases under pressure Compressed gas
Flam. Gas 1	Flammable gases Category 1
Liquefied gas	Gases under pressure Liquefied gas
Ox. Gas 1	Oxidizing gases Category 1
H220	Extremely flammable gas
H270	May cause or intensify fire; oxidizer
H280	Contains gas under pressure; may explode if heated

SDS US (GHS HazCom 2012)

This Safety Data Sheet is offered pursuant to OSHA's Hazard Communication Standard, 29 CFR, 1910.1200. Other government regulations must be reviewed for applicability to this gas mixture. To the best of Calgaz's knowledge, the information contained herein is reliable and accurate as of this date; however, accruacy, suitability or completeness are not guaranteed and no warranties of any type, either express or implied, are provided. The information contained herein relates only to this specific product. If this gas mixture is combined with other materials, all component properties must be considered. Data may be changed from time to time. Be sure to consult the latest edition.

Isobutylene (0.0005% - 1.34%), Oxygen (19.5 - 23.5%) in balance Nitrogen

Safety Data Sheet 50054

according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

Date of issue: 03/24/2015 Version: 1.0

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product form : Mixture

Product name : Isobutylene (0.0005% - 1.34%), Oxygen (19.5 - 23.5%) in balance Nitrogen

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Test gas/Calibration gas.

1.3. Details of the supplier of the safety data sheet

Calgaz, division of Air Liquide
821 Chesapeake Drive
Cambridge, 21613 - USA
T 1-410-228-6400 - F 1-410-228-4251
info@Calgaz.com - www.Calgaz.com

1.4. Emergency telephone number

Emergency number : CHEMTREC: 1-800-424-9300
Internationally: 1-703-527-3887

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Classification (GHS-US)

Compressed gas H280

Full text of H-phrases: see section 16

2.2. Label elements

GHS-US labeling

Hazard pictograms (GHS-US) :

GHS04

Signal word (GHS-US) : Warning

Hazard statements (GHS-US) : H280 - Contains gas under pressure; may explode if heated

Precautionary statements (GHS-US) : P202 - Do not handle until all safety precautions have been read and understood
P271 - Use only outdoors or in a well-ventilated area
P403 - Store in a well-ventilated place
CGA-PG02 - Protect from sunlight when ambient temperature exceeds 52°C (125°F)
CGA-PG05 - Use a back flow preventive device in the piping
CGA-PG06 - Close valve after each use and when empty
CGA-PG10 - Use only with equipment rated for cylinder pressure
CGA-PG14 - Approach suspected leak area with caution
CGA-PG21 - Open valve slowly

2.3. Other hazards

No additional information available

2.4. Unknown acute toxicity (GHS-US)

Not applicable

SECTION 3: Composition/information on ingredients

3.1. Substance

Not applicable

3.2. Mixture

Name	Product identifier	%	Classification (GHS-US)
Nitrogen	(CAS No) 7727-37-9	75.16 - 80.4995	Compressed gas, H280
Oxygen	(CAS No) 7782-44-7	19.5 - 23.5	Ox. Gas 1, H270
Isobutylene	(CAS No) 115-11-7	0.0005 - 1.34	Flam. Gas 1, H220 Liquefied gas, H280

Full text of H-phrases: see section 16

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general : Adverse effects not expected from this product. If you feel unwell, seek medical advice (show the label where possible).

First-aid measures after inhalation : Adverse effects not expected from this product.

First-aid measures after skin contact : Adverse effects not expected from this product.

First-aid measures after eye contact : Adverse effects not expected from this product.

First-aid measures after ingestion : Ingestion is not considered a potential route of exposure.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/injuries after inhalation : Adverse effects not expected from this product.

Symptoms/injuries after skin contact : Adverse effects not expected from this product.

Symptoms/injuries after eye contact : Adverse effects not expected from this product.

Symptoms/injuries after ingestion : Ingestion is not considered a potential route of exposure.

Symptoms/injuries upon intravenous administration : Not known.

Chronic symptoms : Adverse effects not expected from this product.

4.3. Indication of any immediate medical attention and special treatment needed

If you feel unwell, seek medical advice. If breathing is difficult, give oxygen.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : Use extinguishing media appropriate for surrounding fire.

Unsuitable extinguishing media : Do not use water jet to extinguish.

5.2. Special hazards arising from the substance or mixture

Fire hazard : The product is not flammable.

Explosion hazard : Product is not explosive. Heat may build pressure, rupturing closed containers, spreading fire and increasing risk of burns and injuries.

Reactivity : None known.

5.3. Advice for firefighters

Firefighting instructions : In case of fire: Evacuate area. Fight fire remotely due to the risk of explosion. Use water spray or fog for cooling exposed containers. Exercise caution when fighting any chemical fire.

Protection during firefighting : Standard protective clothing and equipment (e.g., Self Contained Breathing Apparatus) for fire fighters. Do not enter fire area without proper protective equipment, including respiratory protection.

Specific methods : Exposure to fire may cause containers to rupture/explode. Continue water spray from protected position until container stays cool. Move containers away from the fire area if this can be done without risk.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures : Ensure adequate ventilation.

6.1.1. For non-emergency personnel

Protective equipment : Wear protective equipment consistent with the site emergency plan.

Emergency procedures : Escape the danger area by the closest safe route. Close doors and windows of adjacent premises. Keep containers closed. Mark the danger area. Seal off low-lying areas. Keep upwind.

6.1.2. For emergency responders

Protective equipment	:	Standard protective clothing and equipment (e.g., Self Contained Breathing Apparatus) for fire fighters. Equip cleanup crew with proper protection.
Emergency procedures	:	Evacuate and limit access. Ventilate area.

6.2. Environmental precautions

Try to stop release if safe to do so.

6.3. Methods and material for containment and cleaning up

For containment	:	Try to stop release if safe to do so.
Methods for cleaning up	:	Dispose of this material and its container in accordance with local regulations.

6.4. Reference to other sections

See also Sections 8 and 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Additional hazards when processed	:	Pressurized container: Do not pierce or burn, even after use. Use equipment rated for cylinder pressure.
Precautions for safe handling	:	Do not handle until all safety precautions have been read and understood. Use only outdoors or in a well-ventilated area.
Safe handling of the gas receptacle	:	Protect cylinders from physical damage; do not drag, roll, slide or drop. Do not remove or deface labels provided by the supplier for the identification of the cylinder contents.
Safe use of the product	:	The substance must be handled in accordance with good industrial hygiene and safety procedures. Only experienced and properly instructed persons should handle gases under pressure. Consider pressure relief device(s) in gas installations. Ensure the complete gas system was (or is regularily) checked for leaks before use. Do not remove or deface labels provided by the supplier for the identification of the cylinder contents. Use only properly specified equipment which is suitable for this product, its supply pressure and temperature. Contact your gas supplier if in doubt.
Hygiene measures	:	Do not eat, drink or smoke when using this product.

7.2. Conditions for safe storage, including any incompatibilities

Technical measures	:	None known.
Storage conditions	:	Do not expose to temperatures exceeding 52°C (125°F). Keep container closed when not in use. Protect cylinder from physical damage. Store in well ventilated area.
Incompatible products	:	None known.
Incompatible materials	:	Flammable materials.
Storage area	:	Store away from heat. Store in a well-ventilated place.

7.3. Specific end use(s)

See Section 1.2.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Isobutylene (0.0005% - 1.34%), Oxygen (19.5 - 23.5%) in balance Nitrogen		
ACGIH	Not applicable	
OSHA	Not applicable	

Isobutylene (115-11-7)		
ACGIH	ACGIH TWA (ppm)	250 ppm
OSHA	Not applicable	

Oxygen (7782-44-7)	
ACGIH	Not applicable
OSHA	Not applicable

Nitrogen (7727-37-9)	
ACGIH	Not applicable
OSHA	Not applicable

8.2. Exposure controls

Appropriate engineering controls	:	Provide adequate general and local exhaust ventilation. Systems under pressure should be regularly checked for leakages. Consider work permit system e.g. for maintenance activities. Ensure exposure is below occupational exposure limits.
Hand protection	:	Wear working gloves when handling gas containers. 29 CFR 1910.138: Hand Protection.
Eye protection	:	Wear safety glasses with side shields. 29 CFR 1910.133: Eye and Face Protection.
Skin and body protection	:	Wear suitable protective clothing, e.g. - lab coats, coveralls or flame resistant clothing.
Respiratory protection	:	None necessary during normal and routine operations. See Sections 5 & 6.
Thermal hazard protection	:	None necessary during normal and routine operations.
Environmental exposure controls	:	Refer to local regulations for restriction of emissions to the atmosphere. See section 13 for specific methods for waste gas treatment.
Other information	:	Wear safety shoes while handling containers. 29 CFR 1910.136: Foot Protection.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	:	Gas
Appearance	:	Clear, colorless gas.
Molecular mass	:	Not applicable for gas-mixtures.
Color	:	Colorless
Odor	:	Coal gas;Odorless
Odor threshold	:	No data available
pH	:	Not applicable for gas-mixtures.
Relative evaporation rate (butyl acetate=1)	:	No data available
Relative evaporation rate (ether=1)	:	Not applicable for gas-mixtures.
Melting point	:	No data available
Freezing point	:	No data available
Boiling point	:	No data available
Flash point	:	No data available
Auto-ignition temperature	:	No data available
Decomposition temperature	:	No data available
Flammability (solid, gas)	:	See Sect. 2.1 & 2.2
Vapor pressure	:	Not applicable.
Relative vapor density at 20 °C	:	No data available
Relative density	:	No data available
Relative gas density	:	Lighter or similar to air.
Solubility	:	Water: Solubility in water of component(s) of the mixture : • : Insoluble • : 39 mg/l • : 20 mg/l
Log Pow	:	Not applicable for gas-mixtures.
Log Kow	:	Not applicable for gas-mixtures.
Viscosity, kinematic	:	Not applicable.
Viscosity, dynamic	:	Not applicable.
Explosive properties	:	Not applicable - not flammable.
Oxidizing properties	:	Supports combustion. Not combustible but enhances combustion of other substances.
Explosive limits	:	Not applicable - not flammable

9.2. Other information

Additional information : None.

SECTION 10: Stability and reactivity

10.1. Reactivity

None known.

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

Can form explosive mixtures with flammable materials.

10.4. Conditions to avoid

None under recommended storage and handling conditions (see section 7).

10.5. Incompatible materials

Flammable materials.

10.6. Hazardous decomposition products

Under normal conditions of storage and use hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Not classified

Isobutylene (115-11-7)	
LC50 inhalation rat (mg/l)	620 mg/l/4h
LC50 inhalation rat (ppm)	239620.46 ppm/4h
ATE US (gases)	271823.000 ppmV/4h
ATE US (vapors)	620.000 mg/l/4h
ATE US (dust, mist)	620.000 mg/l/4h

Oxygen (7782-44-7)	
LC50 inhalation rat (ppm)	800000 ppm/4h

Nitrogen (7727-37-9)	
LC50 inhalation rat (ppm)	820000 ppm/4h

Skin corrosion/irritation : Not classified
pH: Not applicable for gas-mixtures.

Serious eye damage/irritation : Not classified
pH: Not applicable for gas-mixtures.

Respiratory or skin sensitization : Not classified

Germ cell mutagenicity : Not classified

Carcinogenicity : Not classified

Isobutylene (115-11-7)	
National Toxicology Program (NTP) Status	1 - Evidence of Carcinogenicity

Reproductive toxicity : Not classified

Specific target organ toxicity (single exposure) : Not classified

Specific target organ toxicity (repeated exposure) : Not classified

Aspiration hazard : Not classified

Symptoms/injuries after inhalation : Adverse effects not expected from this product.

Symptoms/injuries after skin contact : Adverse effects not expected from this product.

Symptoms/injuries after eye contact : Adverse effects not expected from this product.

Symptoms/injuries after ingestion : Ingestion is not considered a potential route of exposure.

Symptoms/injuries upon intravenous administration : Not known.

Chronic symptoms : Adverse effects not expected from this product.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : No ecological damage caused by this product.

12.2. Persistence and degradability

Isobutylene (0.0005% - 1.34%), Oxygen (19.5 - 23.5%) in balance Nitrogen	
Persistence and degradability	No data available.

Isobutylene (115-11-7)	
Persistence and degradability	The substance is biodegradable. Unlikely to persist.

Oxygen (7782-44-7)	
Persistence and degradability	No ecological damage caused by this product.

Nitrogen (7727-37-9)	
Persistence and degradability	No ecological damage caused by this product.

12.3. Bioaccumulative potential

Isobutylene (0.0005% - 1.34%), Oxygen (19.5 - 23.5%) in balance Nitrogen	
Log Pow	Not applicable for gas-mixtures.
Log Kow	Not applicable for gas-mixtures.
Bioaccumulative potential	No data available.

Isobutylene (115-11-7)	
Log Pow	2.35
Bioaccumulative potential	Not expected to bioaccumulate due to the low log Kow (log Kow < 4). Refer to section 9.

Oxygen (7782-44-7)	
Log Pow	Not applicable for inorganic gases.
Bioaccumulative potential	No ecological damage caused by this product.

Nitrogen (7727-37-9)	
Log Pow	Not applicable for inorganic gases.
Bioaccumulative potential	No ecological damage caused by this product.

12.4. Mobility in soil

Isobutylene (0.0005% - 1.34%), Oxygen (19.5 - 23.5%) in balance Nitrogen	
Mobility in soil	No data available.

Isobutylene (115-11-7)	
Ecology - soil	Because of its high volatility, the product is unlikely to cause ground or water pollution.

Oxygen (7782-44-7)	
Ecology - soil	No ecological damage caused by this product.

Nitrogen (7727-37-9)	
Ecology - soil	No ecological damage caused by this product.

12.5. Other adverse effects

Effect on ozone layer : None.

Effect on the global warming : No known ecological damage caused by this product.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste treatment methods : Contact supplier if guidance is required. Do not discharge into any place where its accumulation could be dangerous. Ensure that the emission levels from local regulations or operating permits are not exceeded.

Waste disposal recommendations : Refer to the CGA Pamphlet P-63 "Disposal of Gases" available at www.cganet.com for more guidance on suitable disposal methods.

SECTION 14: Transport information

In accordance with DOT

Transport document description : UN1956 Compressed gas, n.o.s. (Oxygen, Nitrogen)

UN-No.(DOT) : UN1956

Proper Shipping Name (DOT) : Compressed gas, n.o.s.

Hazard labels (DOT)	:	2.2 - Non-flammable gas

DOT Symbols	:	G - Identifies PSN requiring a technical name
DOT Packaging Exceptions (49 CFR 173.xxx)	:	306;307
DOT Packaging Non Bulk (49 CFR 173.xxx)	:	302;305
DOT Packaging Bulk (49 CFR 173.xxx)	:	314;315
DOT Quantity Limitations Passenger aircraft/rail (49 CFR 173.27)	:	75 kg
DOT Quantity Limitations Cargo aircraft only (49 CFR 175.75)	:	150 kg
DOT Vessel Stowage Location	:	A - The material may be stowed ''on deck'' or ''under deck'' on a cargo vessel and on a passenger vessel.

Additional information

Other information	:	No supplementary information available.
Special transport precautions	:	Avoid transport on vehicles where the load space is not separated from the driver's compartment. Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in the event of an accident or an emergency. Before transporting product containers: - Ensure there is adequate ventilation. - Ensure that containers are firmly secured. - Ensure cylinder valve is closed and not leaking. - Ensure valve outlet cap nut or plug (where provided) is correctly fitted. - Ensure valve protection device (where provided) is correctly fitted.

ADR

Transport document description	:	UN 1956 COMPRESSED GAS, N.O.S., 2.2
Class (ADR)	:	2 - Gases
Hazard labels (ADR)	:	2.2 - Non-flammable compressed gas

Transport by sea

UN-No. (IMDG)	:	1956
Proper Shipping Name (IMDG)	:	COMPRESSED GAS, N.O.S.
Class (IMDG)	:	2.2 - Non-flammable, non-toxic gases

Air transport

UN-No.(IATA)	:	1956
Proper Shipping Name (IATA)	:	COMPRESSED GAS, N.O.S.
Class (IATA)	:	2

SECTION 15: Regulatory information

15.1. US Federal regulations

Isobutylene (115-11-7)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

Oxygen (7782-44-7)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

Nitrogen (7727-37-9)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

15.2. International regulations

CANADA

Isobutylene (115-11-7)
Listed on the Canadian DSL (Domestic Sustances List)

Oxygen (7782-44-7)	
Listed on the Canadian DSL (Domestic Sustances List)	
WHMIS Classification	Class A - Compressed Gas Class C - Oxidizing Material

Nitrogen (7727-37-9)	
Listed on the Canadian DSL (Domestic Sustances List)	
WHMIS Classification	Class A - Compressed Gas

EU-Regulations

Isobutylene (115-11-7)
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)

Oxygen (7782-44-7)
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)

Nitrogen (7727-37-9)
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)

Classification according to Regulation (EC) No. 1272/2008 [CLP]
Not classified

Classification according to Directive 67/548/EEC [DSD] or 1999/45/EC [DPD]

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Isobutylene (115-11-7)
Listed on the AICS (Australian Inventory of Chemical Substances) Listed on IECSC (Inventory of Existing Chemical Substances Produced or Imported in China) Listed on the Japanese ENCS (Existing & New Chemical Substances) inventory Listed on the Korean ECL (Existing Chemicals List) Listed on NZIoC (New Zealand Inventory of Chemicals) Listed on PICCS (Philippines Inventory of Chemicals and Chemical Substances)

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Nitrogen (7727-37-9)
Listed on the AICS (Australian Inventory of Chemical Substances) Listed on IECSC (Inventory of Existing Chemical Substances Produced or Imported in China) Listed on the Korean ECL (Existing Chemicals List) Listed on NZIoC (New Zealand Inventory of Chemicals) Listed on PICCS (Philippines Inventory of Chemicals and Chemical Substances)

15.3. US State regulations

Isobutylene (115-11-7)
U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

Oxygen (7782-44-7)
U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

Nitrogen (7727-37-9)
U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

SECTION 16: Other information

Indication of changes : Revised safety data sheet in accordance with OSHA final rule on GHS implementation promulgated March 26, 2012.

Other information : This Safety Data Sheet is offered pursuant to OSHA's Hazard Communication Standard, 29 CFR, 1910.1200. Other government regulations must be reviewed for applicability to this product.

Full text of H-phrases:

Compressed gas	Gases under pressure Compressed gas
Flam. Gas 1	Flammable gases Category 1
Liquefied gas	Gases under pressure Liquefied gas
Ox. Gas 1	Oxidizing gases Category 1
H220	Extremely flammable gas
H270	May cause or intensify fire; oxidizer
H280	Contains gas under pressure; may explode if heated

SDS US (GHS HazCom 2012)

This Safety Data Sheet is offered pursuant to OSHA's Hazard Communication Standard, 29 CFR, 1910.1200. Other government regulations must be reviewed for applicability to this gas mixture. To the best of Calgaz's knowledge, the information contained herein is reliable and accurate as of this date; however, accruacy, suitability or completeness are not guaranteed and no warranties of any type, either express or implied, are provided. The information contained herein relates only to this specific product. If this gas mixture is combined with other materials, all component properties must be considered. Data may be changed from time to time. Be sure to consult the latest edition.

Safety Data Sheet

according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and GHS

Effective date: 05/12/2015 **Revision:** 05/12/2015

LIQUINOX

1 Identification of the Substance/mixture and of the Company/Undertaking

1.1 Product identifier

Trade name: LIQUINOX

Application of the substance / the preparation: Hand detergent.

1.2 Relevant identified uses of the substance or mixture and uses advised against:

No additional information available.

1.3 Details of the supplier of the Safety Data Sheet

Manufacturer/Supplier:

Alconox, Inc.
30 Glenn St., Suite 309
White Plains, NY 10603
Phone: 914-948-4040

Further information obtainable from: Product Safety Department.

1.4 Emergency telephone number:

ChemTel Inc.: (800)255-3924, +1 (813)248-0585

2 Hazards Identification

2.1 Classification of the substance or mixture

Classification according to Regulation (EC) No 1272/2008:

Classification according to Directive 67/548/EEC or Directive 1999/45/EC:

GHS07

Skin Irrit. 2, H315: Causes skin irritation.

Information concerning particular hazards for human and environment:

The product has to be labelled due to the calculation procedure of the "General Classification guideline for preparations of the EU" in the latest valid version.

Classification system:

The classification is according to the latest editions of the EU-lists, and extended by company and literature data

2.2 Label elements

Labelling according to Regulation (EC) No 1272/2008:

The product is classified and labelled according to the CLP regulation.

Hazard pictograms:

GHS07

Signal word: Warning

Hazard-determining components of labelling:

Alkyl benzene sulfonic acid, sodium salt.

Safety Data Sheet
according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and GHS

Effective date: 05/12/2015 **Revision:** 05/12/2015

LIQUINOX

Hazard statements:
H315: Causes skin irritation.

Precautionary statements:

P332+P313: If skin irritation occurs: Get medical advice/attention.

P302+P352: IF ON SKIN: Wash with plenty of soap and water.

P501: Dispose of contents/container in accordance with local/regional/national/international regulations.

Other Hazard description:
WHMIS-classification and symbols:
D2B - Toxic material causing other toxic effects

NFPA ratings (scale 0 - 4)

Health = 1
Fire = 0
Reactivity = 0

HMIS-ratings (scale 0 - 4)

HEALTH	1
FIRE	0
REACTIVITY	0

Health = 1
Fire = 0
Reactivity = 0

2.3 Other hazards
Results of PBT and vPvB assessment
PBT: Not applicable.
vPvB: Not applicable.

3 Composition/Information on Ingredients

3.2 Chemical characterization: Mixture
Description: Hazardous ingredients of mixture listed below.

Identifying Nos.	Description	Wt. %
CAS: 68081-81-2	Alkyl benzene sulfonic acid, sodium salt	10 - 25%
CAS: 1300-72-7 EINECS: 215-090-9	Sodium xylene sulphonate	2.5 - 10%
CAS: 84133-50-6	Alcohol Ethoxylate	2.5 - 10%
CAS: 68603-42-9 EINECS: 271-657-0	Coconut diethanolamide	2.5 - 10%
CAS: 17572-97-3 EINECS: 241-543-5	Ethylenediaminetetraacetic acid, tripotassium salt	2.5 - 10%

Additional information: For the wording of the listed risk phrases refer to section 16.

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4 First Aid Measures

4.1 Description of first aid measures

General information:

Take affected persons out into the fresh air.

After inhalation:

Supply fresh air; consult doctor in case of complaints.

After skin contact:

Immediately wash with water and soap and rinse thoroughly for 30 minutes. If skin irritation continues, consult a doctor.

After eye contact:

Remove contact lenses if worn.

Rinse opened eye for at least 30 minutes under running water, lifting upper and lower lids occasionally. Immediately consult a doctor.

After swallowing:

Do not induce vomiting; call for medical help immediately. Rinse out mouth and then drink plenty of water.

A person vomiting while laying on their back should be turned onto their side.

4.2 Most important symptoms and effects, both acute and delayed:

Irritating, all routes of exposure.

4.3 Indication of any immediate medical attention and special treatment needed:

No additional information available.

5 Firefighting Measures

5.1 Extinguishing media:

Suitable extinguishing agents:

CO2, powder or water spray. Fight larger fires with water spray or alcohol resistant foam.

5.2 Special hazards arising from the substance or mixture:

No additional information available.

5.3 Advice for firefighters:

Protective equipment:

Wear self-contained respiratory protective device.

Wear fully protective suit.

6 Accidental Release Measures

6.1 Personal precautions, protective equipment and emergency procedures:

Ensure adequate ventilation.

Particular danger of slipping on leaked/spilled product.

6.2 Environmental precautions:

Dilute with plenty of water.

Do not allow to enter sewers/ surface or ground water.

6.3 Methods and material for containment and cleaning up:

Absorb with liquid-binding material (sand, diatomite, acid binders, universal binders, sawdust).

Clean the affected area carefully; suitable cleaners are: Warm water

Dispose contaminated material as waste according to item 13. Ensure adequate ventilation.

6.4 Reference to other sections:

See Section 7 for information on safe handling.

See Section 8 for information on personal protection equipment.

See Section 13 for disposal information

7 Handling and Storage

7.1 Precautions for safe handling:

No special precautions are necessary if used correctly.

Information about fire - and explosion protection:

No special measures required.

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7.2 Conditions for safe storage, including any incompatibilities:
Storage:
Requirements to be met by storerooms and receptacles: No special requirements.
Information about storage in one common storage facility: No special requirements.
Further information about storage conditions: None

7.3 Specific end use(s): No additional information available.

8 Exposure Controls/Personal Protection

8.1 Control parameters
Ingredients with limit values that require monitoring at the workplace:
The product does not contain any relevant quantities of materials with critical values that have to be monitored at the workplace.

Additional information: The lists valid during the making were used as basis.

8.2 Exposure controls:
Personal protective equipment:
General protective and hygienic measures:
Keep away from foodstuffs, beverages and feed.
Immediately remove all soiled and contaminated clothing.
Wash hands before breaks and at the end of work.
Avoid contact with the eyes and skin.
Respiratory protection:
Not required under normal conditions of use.
Protection of hands:


Protective gloves

The glove material has to be impermeable and resistant to the product. Selection of the glove material should be based on the penetration time, rates of diffusion and the degradation of the glove material.

Material of gloves:
The selection of a suitable gloves does not only depend on the material, but also on the quality, and varies from manufacturer to manufacturer.
Penetration time of glove material:
The exact break through time has to be determined by the manufacturer of the protective gloves. DO NOT exceed the breakthrough time set by the Manufacturer.
For long term contact, gloves made of the following materials are considered suitable:
Butyl rubber, BR
Nitrile rubber, NBR
Natural rubber (NR)
Neoprene gloves
Eye protection:


Safety glasses
Goggles recommended during refilling.

Body protection: Protective work clothing

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9 Physical and Chemical Properties

9.1 Information on basic physical and chemical properties:

General Information:	
Appearance:	
Form:	Liquid
Color:	Light Yellow
Odor:	Odorless
Odor threshold:	Not determined.
pH-value:	8.5
Change in condition:	
Melting point/Melting range:	Not determined.
Boiling point/Boiling range:	100°C
Flash point:	Not applicable.
Flammability (solid, gaseous):	Not applicable.
Ignition temperature:	Not applicable.
Decomposition temperature:	Not determined.
Self-igniting:	Product is not selfigniting.
Danger of explosion:	Product does not present an explosion hazard.
Explosion limits:	
Lower:	Not determined.
Upper:	Not determined.
Vapor pressure at 20°C:	23 hPa
Density:	1.08 g/cm³
Relative density:	Not determined.
Vapor density:	Not determined.
Evaporation rate:	Not determined.
Solubility in / Miscibility with water:	Fully miscible.
Segregation coefficient (n-octanol/water):	Not determined.
Viscosity:	
Dynamic:	Not determined.
Kinematic:	Not determined.
Solvent content:	
Organic solvents:	Not determined.
Solids content:	Not determined.
9.2 Other information:	No additional information available.

10 Stability and Reactivity

10.1 Reactivity:

10.2 Chemical stability:

Thermal decomposition / conditions to be avoided:

No decomposition if used according to specifications.

10.3 Possibility of hazardous reactions:

Reacts with strong oxidizing agents. Reacts with strong acids.

10.4 Conditions to avoid:

No additional information available.

10.5 Incompatible materials:

No additional information available.

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10.6 Hazardous decomposition products:
Carbon monoxide and carbon dioxide
Sulphur oxides (SOx)
Nitrogen oxides

11 Toxicological Information

11.1 Information on toxicological effects:
Toxicity data: Toxicity data is available for mixture:
Primary irritant effect:
On the skin: Irritating to skin and mucous membranes.
On the eye: Strong irritant with the danger of severe eye injury.
Sensitization: No sensitizing effects known.
Additional toxicological information:
The product shows the following dangers according to the calculation method of the General EU Classification Guidelines for Preparations as issued in the latest version: Irritant

12 Ecological Information

12.1 Toxicity:
Aquatic toxicity: No additional information available.
12.2 Persistence and degradability: Biodegradable.
12.3 Bioaccumulative potential: Does not accumulate in organisms.
12.4 Mobility in soil: No additional information available.
Additional ecological information:
General notes:
Water hazard class 1 (German Regulation) (Self-assessment): slightly hazardous for water.
Do not allow undiluted product or large quantities of it to reach ground water, water course or sewage system.
Must not reach sewage water or drainage ditch undiluted or un-neutralized.
12.5 Results of PBT and vPvB assessment:
PBT: Not applicable.
vPvB: Not applicable.
12.6 Other adverse effects: No additional information available.

13 Disposal Considerations

13.1 Waste treatment methods:
Recommendation:
Smaller quantities can be disposed of with household waste.
Small amounts may be diluted with plenty of water and washed away. Dispose of bigger amounts in accordance with Local Authority requirements.
The surfactant used in this product complies with the biodegradability criteria as laid down in Regulation (EC) No. 648/2004 on detergents. Data to support this assertion are held at the disposal of the competent authorities of the Member States and will be made available to them, at their direct request or at the request of a detergent manufacturer.
Uncleaned packaging:
Recommendation: Disposal must be made according to official regulations.
Recommended cleansing agents: Water, together with cleansing agents, if necessary.

14 Transport Information

14.1 UN-Number:
DOT, ADR, ADN, IMDG, IATA: Not Regulated

14.2 UN proper shipping name:
DOT, ADR, IMDG, IATA: Not Regulated

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14.3 Transport hazard class(es):
DOT, ADR, IMDG, IATA:
Class: Not Regulated
Label: -

14.4 Packing group:
DOT, ADR, IMDG, IATA: Not Regulated

14.5 Environmental hazards:
Marine pollutant: No

14.6 Special precautions for user: Not applicable.

14.7 Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code: Not applicable.

UN "Model Regulation": Not Regulated

15 Regulatory Information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture:
United States (USA):
SARA:
Section 355 (extremely hazardous substances): None of the ingredient is listed.
Section 313 (Specific toxic chemical listings): None of the ingredient is listed.
TSCA (Toxic Substances Control Act): All ingredients are listed.

Proposition 65 (California):
Chemicals known to cause cancer: None of the ingredient is listed.
Chemicals known to cause reproductive toxicity for females: None of the ingredient is listed.
Chemicals known to cause reproductive toxicity for males: None of the ingredient is listed.
Chemicals known to cause developmental toxicity: None of the ingredient is listed.

Carcinogenic Categories:
EPA (Environmental Protection Agency): None of the ingredient is listed.
TLV (Threshold Limit Value established by ACGIH): None of the ingredient is listed.
NIOSH-Ca (National Institute for Occupational Safety and Health): None of the ingredient is listed.
OSHA-Ca (Occupational Safety & Health Administration): None of the ingredient is listed.

Canadá:
Canadian Domestic Substances List (DSL): All ingredients are listed.
Canadian Ingredient Disclosure list (limit 0.1%): None of the ingredient is listed.
Canadian Ingredient Disclosure list (limit 1%): None of the ingredient is listed.

15.2 Chemical safety assessment: A Chemical Safety Assessment has not been carried out.

16 Other Information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

Relevant phrases:
H315: Causes skin irritation.

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Abbreviations and Acronyms:

ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road.
IMDG: International Maritime Code for Dangerous Goods.
DOT: US Department of Transportation.
IATA: International Air Transport Association.
GHS: Globally Harmonized System of Classification and Labelling of Chemicals.
ACGIH: American Conference of Governmental Industrial Hygienists.
NFPA: National Fire Protection Association (USA).
HMIS: Hazardous Materials Identification System (USA).
WHMIS: Workplace Hazardous Materials Information System (Canada).
VOC: Volatile Organic Compounds (USA, EU).
LC50: Lethal concentration, 50 percent.
LD50: Lethal dose, 50 percent.

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Safety Data Sheet

Section 1: Identification of the Substance/Mixture and of the Company/Undertaking

1.1 Product identifier

Product Name
- **0.0015 – 23.5% Oxygen; 0.0005% – 2.5% Methane; 0.0005 – 1.0% Carbon Monoxide; 0.001 – 0.025% Hydrogen Sulfide; Nitrogen Gas balance**

Product Code
- MSDS No. 50018

1.2 Relevant identified uses of the substance or mixture and uses advised against

Relevant identified use(s)
- Calibration of industrial gas devices

1.3 Details of the supplier of the safety data sheet

Manufacturer
- Air Liquide

2700 Post Oak Blvd.
Houston, TX 77056
United States
www.us.airliquide.com
sds@airliquide.com

Telephone (Technical)
- 713-896-2896

Telephone (Technical)
- 800-819-1704

1.4 Emergency telephone number

Manufacturer
- 800-424-9300 - CHEMTREC

Manufacturer
- +1 703-527-3887 - Outside United States

Section 2: Hazards Identification

EU/EEC

According to Regulation (EC) No 1272/2008 (CLP)/REACH 1907/2006 [amended by 453/2010]
According to EU Directive 67/548/EEC (DSD) or 1999/45/EC (DPD)

2.1 Classification of the substance or mixture

CLP
- Compressed Gas - H280
  Reproductive Toxicity 1A - H360D
  Specific Target Organ Toxicity Repeated Exposure 2 - H373

DSD/DPD
- Harmful (Xn)
  Substances Toxic To Reproduction - Category 1
  R8, R20, R61

2.2 Label Elements

CLP

DANGER

Hazard statements
- H280 - Contains gas under pressure; may explode if heated
H360D - May damage the unborn child.
H373 - May cause damage to organs through prolonged or repeated exposure.

Precautionary statements

Prevention
- P201 - Obtain special instructions before use.
P202 - Do not handle until all safety precautions have been read and understood.
P260 - Do not breathe dust, fume, gas, mist, vapours and/or spray.
P281 - Use personal protective equipment as required.

Response
- P309+P311 - IF exposed or if you feel unwell: Call a POISON CENTER or doctor/physician.
P308+P313 - IF exposed or concerned: Get medical advice/attention.

Storage/Disposal
- P410+P403 - Protect from sunlight. Store in a well-ventilated place.
P405 - Store locked up.
P501 - Dispose of content and/or container in accordance with local, regional, national, and/or international regulations.

DSD/DPD

Risk phrases
- R20 - Harmful by inhalation.
R61 - May cause harm to the unborn child.

Safety phrases
- S9 - Keep container in a well ventilated place
S36 - Wear suitable protective clothing.
S53 - Avoid exposure - obtain special instructions before use.

2.3 Other Hazards

CLP
- According to Regulation (EC) No. 1272/2008 (CLP) this material is considered hazardous.

DSD/DPD
- According to European Directive 1999/45/EC this preparation is considered dangerous.

UN GHS

According to Third Revised Edition

2.1 Classification of the substance or mixture

UN GHS
- Compressed Gas - H280
Reproductive Toxicity 1A - H360

2.2 Label elements

UN GHS

DANGER

Hazard statements
- H280 - Contains gas under pressure; may explode if heated
H360 - May damage fertility or the unborn child.

Precautionary statements

Prevention
- P201 - Obtain special instructions before use.
P202 - Do not handle until all safety precautions have been read and understood.
P260 - Do not breathe dust, fume, gas, mist, vapours and/or spray.
P281 - Use personal protective equipment as required.

P280 - Wear protective gloves/protective clothing/eye protection/face protection.

Response
- P308+P313 - IF exposed or concerned: Get medical advice/attention.
  P309+P311 - IF exposed or if you feel unwell: Call a POISON CENTER or doctor/physician.

Storage/Disposal
- P410+P403 - Protect from sunlight. Store in a well-ventilated place.
  P405 - Store locked up.
  P501 - Dispose of content and/or container in accordance with local, regional, national, and/or international regulations.

2.3 Other hazards

UN GHS
- According to the Globally Harmonized System for Classification and Labeling (GHS) this product is considered hazardous.

United States (US)

According to OSHA 29 CFR 1910.1200 HCS

2.1 Classification of the substance or mixture

OSHA HCS 1994
- Compressed Gas

2.2 Label elements

OSHA HCS 1994
- Not required

2.3 Other hazards

OSHA HCS 1994
- Under United States Regulations (29 CFR 1910.1200 - Hazard Communication Standard), this product is considered hazardous.

Canada

According to WHMIS

2.1 Classification of the substance or mixture

WHMIS
- Compressed Gas - A
  Very Toxic - D1A
  Other Toxic Effects - D2A

2.2 Label elements

WHMIS

- Compressed Gas - A
  Very Toxic - D1A
  Other Toxic Effects - D2A

2.3 Other hazards

WHMIS
- In Canada, the product mentioned above is considered hazardous under the Workplace Hazardous Materials Information System (WHMIS).

2.4 Other information

- Note: This SDS has been developed for various gas mixtures with the composition of components within the ranges listed in Section 3(Composition/Information on Ingredients). All classifications provided are based on the highest end of the range provided for each component. Refer to the product label for information on the actual composition of the product.
  Due to the small size of the individual cylinder of this gas mixture, no unusual health effects from exposure to the product are anticipated under routine circumstances of

use.

NFPA

Section 3 - Composition/Information on Ingredients

3.1 Substances

- Material does not meet the criteria of a substance according to United Nations Globally Harmonized System of Classification and Labelling of Chemicals (GHS) Material does not meet the criteria of a substance in accordance with Regulation (EC) No 1272/2008.

3.2 Mixtures

Composition					
Chemical Name	**Identifiers**	**%**	**LD50/LC50**	**Classifications According to Regulation/Directive**	**Comments**
Nitrogen	**CAS:**7727-37-9 **UN:**UN1066 **EINECS:**231-783-9	72.975% TO 99.9965%	NDA	**UN GHS:** Press. Gas - Comp **EU DSD/DPD:** Not Classified **EU CLP:** Self Classified - Press. Gas - Comp, H280	NDA
Oxygen	**CAS:**7782-44-7 **EC Number:**231-956-9 **UN:**UN1072	0.0015% TO 23.5%	NDA	**UN GHS:** Ox. Gas 1 **EU DSD/DPD:** Annex I - O; R8 **EU CLP:** Annex VI - Ox. Gas 1, H270; Press. Gas - Comp, H280	NDA
Methane	**CAS:**74-82-8 **EC Number:**200-812-7 **UN:**UN1971	0.0005% TO 2.5%	NDA	**UN GHS:** Flam. Gas 1; Press. Gas - Comp **EU DSD/DPD:** Annex I - F+; R12 **EU CLP:** Annex VI - Flam. Gas 1, H220; Press. Gas - Comp, H280;	NDA
Carbon monoxide	**CAS:**630-08-0 **EC Number:**211-128-3 **UN:**UN1016 (compressed gas)	0.0005% TO 1%	Inhalation-Rat LC50 • 1807 ppm 4 Hour(s)	**UN GHS:** Acute Tox. 3 (Inhalation); Flam. Gas 1; Repr. 1A; Press. Gas - Comp; **EU DSD/DPD:** Annex I - F+; R12 T; R23 R48/23 Repr.Cat.1; R61 **EU CLP:** Annex VI - Flam. Gas 1, H220; Press. Gas - Comp, H280; Acute Tox. 3*, H331; Repr. 1A, H360D; STOT RE 1, H372;	NDA
Hydrogen sulfide	**CAS:**7783-06-4 **EC Number:**231-977-3 **UN:**UN1053	0.001% TO 0.025%	Inhalation-Rat LC50 • 444 ppm	**UN GHS:** Acute Tox. Inhal. 2; Flam. Gas 1; Press. Gas - Comp **EU DSD/DPD:** Annex I - F+; R12 T+; R26 N; R50 **EU CLP:** Annex VI - Flam. Gas 1, H220; Press. Gas - Comp; Acute Tox 2*, H300; Aquatic Acute 1, H400;	NDA

Section 4 - First Aid Measures

4.1 Description of first aid measures

Inhalation

- IF INHALED: If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, give artificial respiration. If signs/symptoms continue, get medical attention.

Skin
- In case of contact, immediately flush with plenty of water for at least 15 minutes. Take off contaminated clothing. If irritation develops and persists, get medical attention.

Eye
- IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention.

Ingestion
- Ingestion is not considered a potential route of exposure.

4.2 Most important symptoms and effects, both acute and delayed

- Refer to Section 11 - Toxicological Information.

4.3 Indication of any immediate medical attention and special treatment needed

Notes to Physician
- Treat symptoms and eliminate over-exposure. Hyperbaric oxygen is the most efficient antidote to Carbon Monoxide poisoning, the optimum range being 2-2.5 atm. A special mask, or, preferably, a compression chamber to utilize oxygen at these pressures is required. Avoid administering stimulant drugs. Be observant for initial signs of pulmonary edema in the event of severe inhalation over-exposures.

4.4 Other information

- RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO THIS GAS MIXTURE WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT. At a minimum, Self-Contained Breathing Apparatus must be worn. Victim(s) who experience any adverse effect after over-exposure to this gas mixture must be taken for medical attention. Rescuers should be taken for medical attention if necessary. Take a copy of the label and the MSDS to physician or other health professional with victim(s).

Section 5 - Firefighting Measures

5.1 Extinguishing media

Suitable Extinguishing Media
- Non-flammable gas mixture. Use extinguishing media appropriate for surrounding fire.

Unsuitable Extinguishing Media
- No data available

5.2 Special hazards arising from the substance or mixture

Unusual Fire and Explosion Hazards
- This gas mixture contains toxic gases, Hydrogen Sulfide and Carbon Monoxide, and presents a health hazard to firefighters. This gas mixture is not flammable; however, containers, when involved in fire, may rupture or burst in the heat of the fire.

Hazardous Combustion Products
- No data available

5.3 Advice for firefighters

- Structural firefighters' protective clothing will only provide limited protection. Wear positive pressure self-contained breathing apparatus (SCBA).

Section 6 - Accidental Release Measures

6.1 Personal precautions, protective equipment and emergency procedures

Personal Precautions
- Wear appropriate personal protective equipment. See section 8 for more information.

Emergency Procedures
- Due to the small size and content of the cylinder, an accidental release of this gas mixture presents significantly less risk of over-exposure to Hydrogen Sulfide and Carbon Monoxide, the toxic components of this gas mixture, and other safety hazards related to the remaining components of this gas mixture, than a similar release from a larger cylinder. In the event of a release in which the atmosphere is unknown, and in which other chemicals are potentially involved, evacuate immediate area. Such releases should be responded to by trained personnel using pre-planned procedures. Proper protective equipment should be used. In case of a leak, clear the affected area, protect people, and respond with trained personnel.

6.2 Environmental precautions

- Avoid release to the environment.

6.3 Methods and material for containment and cleaning up

Containment/Clean-up Measures

- Allow the gas mixture to dissipate.
If necessary, monitor the surrounding area (and the original area of the release) for concentrations of component gases.
Concentrations of component gases must be below any exposure limits listed in Section 8 and Oxygen levels must be above 19.5% before non-emergency personnel are allowed to re-enter area.

6.4 Reference to other sections

- Refer to Section 8 - Exposure Controls/Personal Protection and Section 13 - Disposal Considerations.

Section 7 - Handling and Storage

7.1 Precautions for safe handling

Handling

- Use good safety and industrial hygiene practices. Use only with adequate ventilation. Be aware of any signs of dizziness or fatigue, especially if work is done in a poorly ventilated area; exposures to fatal concentrations of this gas mixture could occur without any significant warning symptoms, due to olfactory fatigue or oxygen deficiency. Cylinders should be firmly secured to prevent falling or being knocked-over. Do not attempt to repair, adjust, or in any other way modify cylinders. If there is a malfunction or another type of operational problem, contact nearest distributor immediately.

7.2 Conditions for safe storage, including any incompatibilities

Storage

- Cylinders should be stored in dry, well-ventilated areas away from sources of heat, ignition and direct sunlight. Do not allow area where cylinders are stored to exceed 52°C (125°F). Cylinders must be protected from the environment, and preferably kept at room temperature (approximately 21°C (70°F). Cylinders should be firmly secured to prevent falling or being knocked-over. Protect cylinders against physical damage. Store locked up.

7.3 Specific end use(s)

- Refer to Section 1.2 - Relevant identified uses.

Section 8 - Exposure Controls/Personal Protection

8.1 Control parameters

Exposure Limits/Guidelines						
	Result	**ACGIH**	**Canada Ontario**	**Canada Quebec**	**China**	**Germany DFG**
Carbon monoxide (630-08-0)	Ceilings	Not established	Not established	Not established	20 mg/m3 MAC (high altitude area, 2000-3000m); 15 mg/m3 MAC (high altitude area, >3000m)	30 ppm Peak; 35 mg/m3 Peak
	STELs	Not established	100 ppm STEV; 115 mg/m3 STEV	200 ppm STEV; 230 mg/m3 STEV	30 mg/m3 STEL (not in high altitude area)	Not established
	TWAs	25 ppm TWA	25 ppm TWAEV; 29 mg/m3 TWAEV	35 ppm TWAEV; 40 mg/m3 TWAEV	20 mg/m3 TWA (not in high altitude area)	Not established
	MAKs	Not established	Not established	Not established	Not established	30 ppm MAK; 35 mg/m3 MAK
Methane (74-82-8)	TWAs	1000 ppm TWA	1000 ppm TWAEV	Not established	Not established	Not established

Hydrogen sulfide (7783-06-4)	Ceilings	Not established	Not established	Not established	10 mg/m3 MAC	10 ppm Peak; 14.2 mg/m3 Peak
	STELs	5 ppm STEL	15 ppm STEV; 21 mg/m3 STEV	15 ppm STEV; 21 mg/m3 STEV	Not established	Not established
	TWAs	1 ppm TWA	10 ppm TWAEV; 14 mg/m3 TWAEV	10 ppm TWAEV; 14 mg/m3 TWAEV	Not established	Not established
	MAKs	Not established	Not established	Not established	Not established	5 ppm MAK; 7.1 mg/m3 MAK

Exposure Limits/Guidelines (Con't.)

	Result	Germany TRGS	NIOSH	OSHA	Singapore
Carbon monoxide (630-08-0)	TWAs	30 ppm TWA (exposure factor 1); 35 mg/m3 TWA (exposure factor 1)	35 ppm TWA; 40 mg/m3 TWA	50 ppm TWA; 55 mg/m3 TWA	25 ppm PEL; 29 mg/m3 PEL
	Ceilings	Not established	200 ppm Ceiling; 229 mg/m3 Ceiling	Not established	Not established
Hydrogen sulfide (7783-06-4)	STELs	Not established	Not established	Not established	15 ppm STEL; 21 mg/m3 STEL
	TWAs	Not established	Not established	Not established	10 ppm PEL; 14 mg/m3 PEL
	Ceilings	Not established	10 ppm Ceiling (10 min); 15 mg/m3 Ceiling (10 min)	20 ppm Ceiling	Not established

8.2 Exposure controls

Engineering Measures/Controls

- Adequate ventilation systems as needed to control concentrations of airborne contaminants below applicable threshold limit values. If this gas mixture is used in a poorly-ventilated area, install automatic monitoring equipment to detect the levels of component gases.

Personal Protective Equipment

Pictograms

- 

Respiratory

- In case of insufficient ventilation, wear suitable respiratory equipment. Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or symptoms are experienced.

Eye/Face

- Wear safety glasses.

Skin/Body

- Wear protective gloves leather gloves when handling cylinders; chemically resistant gloves when using this gas mixture and clothing .

Environmental Exposure Controls

- Controls should be engineered to prevent release to the environment, including procedures to prevent spills, atmospheric release and release to waterways.

Key to abbreviations

ACGIH = American Conference of Governmental Industrial Hygiene
MSHA = Mine Safety and Health Administration
NIOSH = National Institute of Occupational Safety and Health
OSHA = Occupational Safety and Health Administration
MAK = Maximale Arbeitsplatz Konzentration is the maximum permissible concentration
PEL = Permissible Exposure Level determined by the Occupational Safety and Health Administration (OSHA)
STEL = Short Term Exposure Limits are based on 15-minute exposures
STEV = Short Term Exposure Value
TWAEV = Time-Weighted Average Exposure Value
TWA = Time-Weighted Averages are based on 8h/day, 40h/week exposures

Section 9 - Physical and Chemical Properties

9.1 Information on Physical and Chemical Properties

Material Description			
Physical Form	Gas	Appearance/Description	Gas mixture, colorless gas, which has a rotten egg-like odor, due to the presence of Hydrogen Sulfide.
Color	Colorless	Odor	Rotten-egg
Taste	Data lacking	Particulate Type	Not relevant
Particulate Size	Not relevant	Aerosol Type	Not relevant
Odor Threshold	0.13 ppm Hydrogen sulfide	Physical and Chemical Properties	Data lacking
General Properties			
Boiling Point	-320.4 F(-195.7778 C) Nitrogen	Melting Point	-345.8 F(-209.8889 C) Nitrogen
Decomposition Temperature	Data lacking	Heat of Decomposition	Data lacking
pH	Data lacking	Specific Gravity/Relative Density	Data lacking
Density	0.072 lb(s)/ft^3 Nitrogen	Bulk Density	Data lacking
Water Solubility	0.023 (vol/vol) Nitrogen	Solvent Solubility	Data lacking
Viscosity	Not relevant	Explosive Properties	Data lacking
Oxidizing Properties:	Data lacking		
Volatility			
Vapor Pressure	Not relevant	Vapor Density	0.906 Air=1
Evaporation Rate	Not relevant	VOC (Wt.)	Data lacking
VOC (Vol.)	Data lacking	Volatiles (Wt.)	Data lacking
Volatiles (Vol.)	Data lacking		
Flammability			
Flash Point	Not relevant	UEL	Not relevant
LEL	Not relevant	Autoignition	Not relevant
Burning Time	Data lacking	Flame Height	Data lacking
Flame Extension	Data lacking	Ignition Distance	Data lacking
Flame Duration	Data lacking	Self-Accelerating Decomposition Temperature (SADT)	Data lacking
Heat of Combustion (ΔHc)	Data lacking	Flammability (solid, gas)	Data lacking
Environmental			
Half-Life	Data lacking	Octanol/Water Partition coefficient	Data lacking
Coefficient of water/oil distribution	Not relevant	Bioaccumulation Factor	Data lacking
Bioconcentration Factor	Data lacking	Biochemical Oxygen Demand BOD/BOD5	Data lacking
Chemical Oxygen Demand	Data lacking	Persistence	Data lacking
Degradation	Data lacking		

9.2 Other Information

- No additional physical and chemical parameters noted.

Section 10: Stability and Reactivity

10.1 Reactivity

- No dangerous reaction known under conditions of normal use.

10.2 Chemical stability

- Stable under normal temperatures and pressures.

10.3 Possibility of hazardous reactions

- Hazardous polymerization will not occur.

10.4 Conditions to avoid

- Excess heat. Incompatible materials.

10.5 Incompatible materials

- Oxidizers, Titanium, Lithium.

10.6 Hazardous decomposition products

- Sulfur oxide.

Section 11 - Toxicological Information

11.1 Information on toxicological effects

Component Name	CAS	Data
Oxygen (0.0015% TO 23.5%)	7782-44-7	**Multi-dose Toxicity:** ihl-rat TCLo:95 pph/7D-C; **Reproductive:** ihl-rat TCLo:10 pph/9H (22D preg)
Methane (0.0005% TO 2.5%)	74-82-8	**Acute Toxicity:** ihl-mus LC50:326 gm/m3/2H
Carbon monoxide (0.0005% TO 1%)	630-08-0	**Acute Toxicity:** ihl-rat LC50:1807 ppm/4H; **Reproductive:** ihl-rat TCLo:103 mg/m3 (1-22D preg)
Hydrogen sulfide (0.001% TO 0.025%)	7783-06-4	**Acute Toxicity:** ihl-rat LC50:444 ppm; skn-rbt TDLo:1000 mg/m3/2H; **Irritation:** eye-hmn 0.000125 ppm/5H; **Reproductive:** ihl-rat TCLo:10 mg/m3 (48D pre/1-22D preg)

GHS Properties	Classification
Acute toxicity	**EU/CLP** • Classification criteria not met **UN GHS** • Classification criteria not met
Aspiration Hazard	**EU/CLP** • Not relevant **UN GHS** • Not relevant
Carcinogenicity	**EU/CLP** • Classification criteria not met **UN GHS** • Classification criteria not met
Germ Cell Mutagenicity	**EU/CLP** • Classification criteria not met **UN GHS** • Classification criteria not met
Skin corrosion/Irritation	**EU/CLP** • Classification criteria not met **UN GHS** • Classification criteria not met
Skin sensitization	**EU/CLP** • Classification criteria not met **UN GHS** • Classification criteria not met
STOT-RE	**EU/CLP** • Specific Target Organ Toxicity Repeated Exposure 2 **UN GHS** • Classification criteria not met
STOT-SE	**EU/CLP** • Classification criteria not met **UN GHS** • Classification criteria not met
Toxicity for Reproduction	**EU/CLP** • Toxic to Reproduction 1A **UN GHS** • Toxic to Reproduction 1A

Respiratory sensitization	**EU/CLP** • Classification criteria not met **UN GHS** • Classification criteria not met
Serious eye damage/Irritation	**EU/CLP** • Classification criteria not met **UN GHS** • Classification criteria not met

Route(s) of entry/exposure
- Inhalation, Skin, Eye, Ingestion

Potential Health Effects

Inhalation

Acute (Immediate)
- A potential health hazard associated with this gas mixture is the inhalation of Hydrogen Sulfide, a component of this gas mixture. Such over-exposures may occur if this gas mixture is used in a confined space or other poorly-ventilated area. Over-exposures to Hydrogen Sulfide can cause dizziness, headache, nausea, respiratory arrest, coma, or unconsciousness. Continuous inhalation of low concentrations of Hydrogen Sulfide may cause olfactory fatigue, so that the odor is no longer an effective warning of the presence of this gas. Inhalation over-exposures to atmospheres containing more than the Threshold Limit Value of Carbon Monoxide (25 ppm), another component of this gas mixture, can result in serious health consequences. Carbon Monoxide is classified as a chemical asphyxiant, producing a toxic action by combining with the hemoglobin of the blood and replacing the available oxygen. Through this replacement, the body is deprived of the required oxygen, and asphyxiation occurs. Since the affinity of Carbon Monoxide for hemoglobin is about 200-300 times that of oxygen, only a small amount of Carbon Monoxide will cause a toxic reaction to occur. Carbon Monoxide exposures in excess of 50 ppm will produce symptoms of poisoning if breathed for a sufficiently long time. If this gas mixture is released in a small, poorly ventilated area (i.e. an enclosed or confined space), symptoms which may develop include the following: bright red lips and fingernails, headache progessing to heart palpitations, staggering, confusion, nausea, dizziness and unconsciousness with higher concentration exposures. For exposures greater than 2500 ppm there is potential for collapse and death before warning symptoms are experienced. If the gas mixture being used contains less than 19.5% Oxygen and is released in a small, poorly ventilated area (i.e. an enclosed or confined space), an oxygen-deficient environment may occur. Individuals breathing such an atmosphere may experience symptoms which include headaches, ringing in ears, dizziness, drowsiness, unconsciousness, nausea, vomiting, and depression of all the senses. Under some circumstances of over-exposure, death may occur. The following effects associated with decreased levels of oxygen: increase in breathing and pulse rate, emotional upset, abnormal fatigue, nausea, vomiting, collapse, loss of consciousness, convulsive movements, respiratory collapse and death.

Chronic (Delayed)
- Chronic exposure to oxygen-deficient atmospheres (below 18% oxygen in air) may affect the heart and nervous system.

Skin

Acute (Immediate)
- Hydrogen Sulfide, a component of this gas mixture, may be irritating to the skin.

Chronic (Delayed)
- No data available

Eye

Acute (Immediate)
- May cause mild irritation. Inflammation and irritation of the eyes can occur at very low airborne concentration of Hydrogen Sulfide (less than 10 ppm). Exposure over several hours may result in “gas eyes” or “sore eyes” with symptoms of scratchiness, irritation, tearing and burning. Above 50 ppm of Hydrogen Sulfide, there is an intense tearing, blurring of vision, and pain when looking at light. Over-exposed individuals may see rings around bright lights. Most symptoms disappear when exposure ceases. However, in serious cases, the eye can be permanently damaged.

Chronic (Delayed)
- No data available

Ingestion

Acute (Immediate)
- Under normal conditions of use, no health effects are expected.

Chronic (Delayed)
- No data available

Mutagenic Effects
- The components of this gas mixture are not reported to cause mutagenic effects in humans.

Carcinogenic Effects

- The components of this gas mixture are not found on the following lists: FEDERAL OSHA Z LIST, NTP and IARC; therefore, they are not considered to be, nor suspected to be, cancer-causing agents by these agencies.

Reproductive Effects

- The Carbon Monoxide component of this gas mixture which exists up to 1%, can cause teratogenic effects in humans. Severe exposure to Carbon Monoxide during pregnancy has caused adverse effects and the death of the fetus. In general, maternal symptoms are an indicator of the potential risk to the fetus since Carbon Monoxide is toxic to the mother before it is toxic to the fetus.

Key to abbreviations

TC = Toxic Concentration

TD = Toxic Dose

LC = Lethal Concentration

Section 12 - Ecological Information

12.1 Toxicity

0.0015 – 23.5% Oxygen; 0.0005% – 2.5% Methane; 0.0005 – 1.0% Carbon Monoxide; 0.001 – 0.025% Hydrogen Sulfide; Nitrogen Gas balance					
Dosage	**Species**	**Duration**	**Results**	**Exposure Conditions**	**Comments**
0.0071 to 0.55 mg/L	**Fish:** fathead minnow	96 Hour(s)	LC50	NDA	Hydorgen Sulfide component
0.009 to 0.014 mg/L	**Fish:** Bluegill	96 Hour(s)	LC50	NDA	Hydrogen Sulfide component

12.2 Persistence and degradability

- Material data lacking.

12.3 Bioaccumulative potential

- Material data lacking.

12.4 Mobility in Soil

- Material data lacking.

12.5 Results of PBT and vPvB assessment

- PBT and vPvB assessment has not been conducted.

12.6 Other adverse effects

- No evidence is currently available on this gas mixture's effects on plant, animal or aquatic life. Hydrogen Sulfide and Carbon Monoxide, components of this gas mixture, can be deadly to exposed animal life, producing symptoms similar to those experienced by humans. This gas mixture may also be harmful to plant life. The presence of more than a trace of the Carbon Monoxide component of this gas mixture is a hazard to fish.

Section 13 - Disposal Considerations

13.1 Waste treatment methods

Product waste

- Dispose of content and/or container in accordance with local, regional, national, and/or international regulations.

Packaging waste

- Dispose of content and/or container in accordance with local, regional, national, and/or international regulations.

Section 14 - Transport Information

	14.1 UN number	14.2 UN proper shipping name	14.3 Transport hazard class(es)	14.4 Packing group	14.5 Environmental hazards
DOT	UN1956	Compressed gas, n.o.s. (Oxygen, Nitrogen)	2.2	NDA	NDA
TDG	UN1956	COMPRESSED GAS, N.O.S. (Oxygen, Nitrogen)	2.2	NDA	NDA
IMO/IMDG	UN1956	COMPRESSED GAS, N.O.S. (OXYGEN, NITROGEN)	2.2	NDA	NDA
IATA/ICAO	UN1956	Compressed Gas, n.o.s. (Oxygen, Nitrogen)	2.2	NDA	NDA

14.6 Special precautions for user

- Cylinders should be transported in a secure position, in a well-ventilated vehicle. The transportation of compressed gas cylinders in automobiles or in closed-body vehicles can present serious safety hazards. If transporting these cylinders in vehicles, ensure these cylinders are not exposed to extremely high temperatures (as may occur in an enclosed vehicle on a hot day). Additionally, the vehicle should be well-ventilated during transportation.

14.7 Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

- This product is provided only in non-bulk containers.

Section 15 - Regulatory Information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

State Right To Know				
Component	**CAS**	**MA**	**NJ**	**PA**
Carbon monoxide	630-08-0	Yes	Yes	Yes
Hydrogen sulfide	7783-06-4	Yes	Yes	Yes
Methane	74-82-8	Yes	Yes	Yes
Nitrogen	7727-37-9	Yes	Yes	Yes
Oxygen	7782-44-7	Yes	Yes	Yes

Inventory						
Component	**CAS**	**Canada DSL**	**Canada NDSL**	**China**	**EU EINECS**	**EU ELNICS**
Carbon monoxide	630-08-0	Yes	No	Yes	Yes	No
Hydrogen sulfide	7783-06-4	Yes	No	Yes	Yes	No
Methane	74-82-8	Yes	No	Yes	Yes	No
Nitrogen	7727-37-9	Yes	No	Yes	Yes	No
Oxygen	7782-44-7	Yes	No	Yes	Yes	No

Inventory (Con't.)				
Component	**CAS**	**Japan ENCS**	**Korea KECL**	**TSCA**
Carbon monoxide	630-08-0	Yes	Yes	Yes
Hydrogen sulfide	7783-06-4	Yes	Yes	Yes
Methane	74-82-8	Yes	Yes	Yes

Nitrogen	7727-37-9	No	Yes	Yes
Oxygen	7782-44-7	No	Yes	Yes

Australia

Labor

Australia - Hazardous Substances - Substances Requiring Health Surveillance

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

Australia - High Volume Industrial Chemicals List

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	
• Nitrogen	7727-37-9	
• Methane	74-82-8	Not Listed

Australia - List of Designated Hazardous Substances - Classification

• Hydrogen sulfide	7783-06-4	F+, T+, N R12, R26, R50
• Carbon monoxide	630-08-0	F+, T Repr.Cat.1 R12, R61, R23, R48/23
• Oxygen	7782-44-7	O R8
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	F+ R12

Environment

Australia - National Pollutant Inventory (NPI) Substance List

• Hydrogen sulfide	7783-06-4	10 tonnes/year Threshold category 1
• Carbon monoxide	630-08-0	10 tonnes/year Threshold category 1; 400 tonnes/year Threshold category 2a; 1 tonne/hour Threshold category 2a; 2000 tonnes/year Threshold category 2b; 60000 MWH Threshold category 2b; 20 MW Threshold category 2b
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	15 tonnes/year Threshold category 3 (total)
• Methane	74-82-8	Not Listed

Australia - Ozone Protection Act - Scheduled Substances

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

Australia - Priority Existing Chemical Program

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed

• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

Canada

Labor

Canada - WHMIS - Classifications of Substances

• Hydrogen sulfide	7783-06-4	A, B1, D1A, D2B
• Carbon monoxide	630-08-0	A, B1, D1A, D2A
• Oxygen	7782-44-7	A, C
• Nitrogen	7727-37-9	A
• Methane	74-82-8	A, B1

Canada - WHMIS - Ingredient Disclosure List

• Hydrogen sulfide	7783-06-4	1 %
• Carbon monoxide	630-08-0	0.1 %
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

Environment

Canada - CEPA - Priority Substances List

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

Mexico

Other

Mexico - Hazard Classifications

• Hydrogen sulfide	7783-06-4	Class = 2.3, 2.1
• Carbon monoxide	630-08-0	Class = 2.3, 2.1
• Oxygen	7782-44-7	Class = 2.2, 5.1 UN1072, UN1073
• Nitrogen	7727-37-9	Class = 2.2 UN1066, UN1977
• Methane	74-82-8	Class = 2.1 UN1971, UN1972

Mexico - Regulated Substances

• Hydrogen sulfide	7783-06-4	UN1053
• Carbon monoxide	630-08-0	UN1016
• Oxygen	7782-44-7	UN1073 (refrigerated liquid); UN1072 (compressed)
• Nitrogen	7727-37-9	UN1977 (refrigerated liquid); UN1066 (compressed)
• Methane	74-82-8	UN1972 (refrigerated liquid); UN1971 (compressed)

United States

Labor

U.S. - OSHA - Process Safety Management - Highly Hazardous Chemicals

• Hydrogen sulfide	7783-06-4	1500 lb TQ
• Carbon monoxide	630-08-0	Not Listed

• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

U.S. - OSHA - Specifically Regulated Chemicals

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

Environment

U.S. - CAA (Clean Air Act) - 1990 Hazardous Air Pollutants

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

U.S. - CERCLA/SARA - Hazardous Substances and their Reportable Quantities

• Hydrogen sulfide	7783-06-4	100 lb final RQ; 45.4 kg final RQ
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

U.S. - CERCLA/SARA - Radionuclides and Their Reportable Quantities

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

U.S. - CERCLA/SARA - Section 302 Extremely Hazardous Substances EPCRA RQs

• Hydrogen sulfide	7783-06-4	100 lb EPCRA RQ
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

U.S. - CERCLA/SARA - Section 302 Extremely Hazardous Substances TPQs

• Hydrogen sulfide	7783-06-4	500 lb TPQ
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

U.S. - CERCLA/SARA - Section 313 - Emission Reporting

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

U.S. - CERCLA/SARA - Section 313 - PBT Chemical Listing

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

U.S. - RCRA (Resource Conservation & Recovery Act) - Hazardous Constituents - Appendix VIII to 40 CFR 261

• Hydrogen sulfide	7783-06-4	waste number U135
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

U.S. - RCRA (Resource Conservation & Recovery Act) - U Series Wastes - Acutely Toxic Wastes & Other Hazardous Characteristics

• Hydrogen sulfide	7783-06-4	waste number U135
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

United States - California

Environment

U.S. - California - Proposition 65 - Carcinogens List

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

U.S. - California - Proposition 65 - Developmental Toxicity

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	developmental toxicity, initial date 7/1/89
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

U.S. - California - Proposition 65 - Maximum Allowable Dose Levels (MADL)

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

U.S. - California - Proposition 65 - No Significant Risk Levels (NSRL)

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

U.S. - California - Proposition 65 - Reproductive Toxicity - Female

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

U.S. - California - Proposition 65 - Reproductive Toxicity - Male

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

United States - Pennsylvania

Labor

U.S. - Pennsylvania - RTK (Right to Know) - Environmental Hazard List

• Hydrogen sulfide	7783-06-4	
• Carbon monoxide	630-08-0	
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

U.S. - Pennsylvania - RTK (Right to Know) - Special Hazardous Substances

• Hydrogen sulfide	7783-06-4	Not Listed
• Carbon monoxide	630-08-0	Not Listed
• Oxygen	7782-44-7	Not Listed
• Nitrogen	7727-37-9	Not Listed
• Methane	74-82-8	Not Listed

United States - Rhode Island

Labor

U.S. - Rhode Island - Hazardous Substance List

• Hydrogen sulfide	7783-06-4	Toxic; Flammable
• Carbon monoxide	630-08-0	Toxic
• Oxygen	7782-44-7	Flammable
• Nitrogen	7727-37-9	Flammable
• Methane	74-82-8	Toxic

15.2 Chemical Safety Assessment

- No Chemical Safety Assessment has been carried out.

Section 16 - Other Information

Relevant Phrases (code & full text)

- H220 - Extremely flammable gas
  H270 - May cause or intensify fire; oxidizer
  H300 - Fatal if swallowed
  H331 - Toxic if inhaled
  H372 - Causes damage to organs through prolonged or repeated exposure.
  H400 - Very toxic to aquatic life
  R8 - Contact with combustible material may cause fire.

R12 - Extremely flammable.
R23 - Toxic by inhalation.
R26 - Very toxic by inhalation.
R48/23 - Toxic: danger of serious damage to health by prolonged exposure through inhalation.
R50 - Very toxic to aquatic organisms.

Last Revision Date

- 22/August/2012

Preparation Date

- 10/August/2012

Disclaimer/Statement of Liability

- To the best of Air Liquide's knowledge, the information contained herein is reliable and accurate as of this date; however, accuracy, suitability or completeness are not guaranteed and no warranties of any type, either express or implied, are provided. The information contained herein relates only to this specific product. If this gas mixture is combined with other materials, all component properties must be considered. Data may be changed from time to time. Be sure to consult the latest edition.

Key to abbreviations

NDA = No data available