DRAFT
FIELD ACTIVITIES PLAN
BRAM MANUFACTURING
SITE # 344055

WORK ASSIGNMENT NO. D004434-28

Prepared for:

New York State Department of Environmental Conservation
Albany, New York

Prepared by:

MACTEC Engineering and Consulting, P.C.
Portland, Maine

MACTEC: 3612082098

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Submitted by:

Charles R. Staples
RI Lead

Approved by:

Bryanna Stiles w/permission by J.W.P.

John W. Peterson
Principal Professional

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

1,1,1-TCA	1,1,1-trichloroethane
ASP	Analytical Services Protocols
Ballard	Ballard Engineering Consulting, P.C.
bgs	below ground surface
Bram	Bram Manufacturing
Cis-1,2-DCE	cis-1,2-dichloroethene
CMT	continuous Multichannel Tubing™
ELAP	Environmental Laboratory Approval Program
ESA	Environmental Site Assessment
°F	degrees Fahrenheit
FAP	Field Activities Plan
FS	Feasibility Study
HASP	Health and Safety Plan
HSA	hollow stem auger
IDW	Investigation derived waste
MACTEC	MACTEC Engineering and Consulting, P.C.
msl	mean sea level
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health

GLOSSARY OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

PID	photoionization detector
ppm	parts per million
PVC	polyvinyl chloride
QAPjP	Quality Assurance Project Plan
QAPP	Quality Assurance Program Plan
RCHD	Rockland County Health Department
RI	Remedial Investigation
SII	Subsurface Investigations Inc.
Site	Bram Manufacturing facility site
TEAM	Team Environmental Consultants, Inc.
TCE	trichloroethylene
µg/L	microgram(s) per liter
µg/m^3	microgram(s) per cubic meter
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound
WA	work assignment

1.0 INTRODUCTION

MACTEC Engineering and Consulting, P.C. (MACTEC), under contract to the New York State Department of Environmental Conservation (NYSDEC), is submitting this Draft Field Activities Plan (FAP) for the Bram Manufacturing (Bram) facility site (Site) in Town of Congers, Rockland County, New York (Figure 1.1). The Site is listed as a Class 2 Inactive hazardous waste site; Site No. 344055, in the Registry of Hazardous Waste Sites in New York State (NYS). This FAP has been prepared in accordance with the NYSDEC requirements in work assignment (WA) No. D004434-28, dated January 19, 2008, and with the July 2005 Superfund Standby Contract between MACTEC and the NYSDEC.

This FAP was prepared in accordance with the Site's Project Management Work Plan (MACTEC, 2008) and includes details regarding the proposed Phase II Remedial Investigation (RI) field activities scheduled for the fall of 2009, including a Site-specific Health and Safety Plan (HASP) and a Quality Assurance Project Plan (QAPjP).

This FAP is organized into four sections as follows:

- Section 1.0 – Introduction, Work Objectives, and Site Background;
- Section 2.0 – Site Physical Setting;
- Section 3.0 – Scope of Work, Field Activity Details; and
- Section 4.0 – References.

1.1 WORK ASSIGNMENT OBJECTIVES

Based on the WA and discussions with the NYSDEC project manager, Randy Witcher, as well as results of the Phase I RI, the primary objective is to further evaluate the nature and extent of soil and groundwater contamination at the Site, and down-gradient from the Site. There are several data gaps based on soil and groundwater data collected to date, including the concentrations of contaminants in the overburden and the bedrock zones at the Site and beneath the Site building. Another objective is to evaluate the potential for the chlorinated solvents present in groundwater to off-gas to soil vapor down-gradient of the Site.

The objectives of the field program are described in more detail in Section 3.

1.2 SITE BACKGROUND

Information pertaining to the history of the Site is contained in past reports. This information was reviewed and summarized in the following subsections.

1.2.1 Site Description

The Site is located at 26 Route 9W in the Hamlet of Congers, Town of Clarkstown, Rockland County (Figure 1.1). It is identified on the town of Clarkstown tax map as Section 141, Block A, Lot 8. The Site is located on Route 9W and is within 200 feet of the Kill von Beast (also known as the East Branch of the Hackensack) which connects Swartwout Lake with Rockland Lake, and consists of an open lot and contains a one story 12,300 square foot block construction building. The Site is currently used as both office space and storage.

The property is bordered immediately to the north by a Motel (Holiday Court); to the east by a storage facility, a stream (Kill von Beast), and a wetland; to the south by a commercial, property and to the west by Route 9W. Residences are located further to the north and on the west dies of Route 9W.

1.2.2 Site History

The site was previously used to manufacture lighting fixtures. The practices at the site during the manufacturing of the lighting fixtures appears to have lead to the contamination of Site media, either from disposal of contaminants into floor drains at the site, or spills/disposal to the ground surface, either within, or outside of the building footprint.

1.2.3 Previous Field Investigations

Several investigations have been conducted previously at the site and at several properties surrounding the site. In 1998, Team Environmental Consultants, Inc. (TEAM) conducted a Phase I Environmental Site Assessment (ESA) of the Bram property and two adjacent properties to the east and northeast

(TEAM, 1998). Also in 1998, Ballard Engineering Consulting, P.C. (Ballard), performed a groundwater investigation at the Site (Ballard, 1999). In 1990, three underground storage tanks (USTs) were removed at the request of the Rockland County Health Department (RCHD) from the property south of the Site. The NYSDEC collected groundwater samples in 2003 from an inactive water supply well for the Site. MACTEC performed investigation activities in the fall of 2008 and spring of 2009 (Phase I) as part of RI. Some of these investigations are discussed in more detail below.

ESA. As part of the Phase I ESA performed by TEAM, the inactive water supply well was sampled. Volatile organic compounds (VOCs) were detected in this sample including trichloroethene [7,500 micrograms per Liter (µg/L)], cis-1,2-dichloroethene (cis-1,2-DCE) [2,600 µg/L], 1,3-dichloropropane [510 µg/L], vinyl chloride [280 µg/L], and 1,1,1-trichloroethane (1,1,1-TCA) [87j µg/L]. The ESA notes that the water supply well was inactivated over twenty years ago (CIRCA 1970s). Other recognized environmental conditions were not observed at the time of this ESA publication.

Groundwater Investigation. The investigation by Ballard focused on collecting shallow groundwater from eight direct push borings (GW-B1 through GW-B8). Temporary sampling points were used to collect the groundwater samples. The inactive water supply well was also sampled. Figure 1.2 shows the location of the inactive water supply well (GW-PW). Analytical results indicate part per million concentrations of VOCs in GW-PW, GW-B1, GW-B2, and GW-B8. Compounds detected include the chlorinated solvents trichloroethylene (TCE), 1,1,1-TCA, and cis-1,2-DCE, and vinyl chloride, and the aromatic hydrocarbons trimethylbenzene, ethylbenzene, butylbenzene, propylbenzene, isopropylbenzene and xylenes. Highest levels of the chlorinated solvents were in GW-PW and GW-B8 respectively and are likely related to the former Site activities. Highest concentrations of aromatic hydrocarbons are GW-B2 and GW-B1 respectively. These are presumed upgradient locations from the Site, downgradient of the former USTs, and are likely related to the former USTs.

UST Removal. In the property to the south of the Site, three USTs were removed in 1990 at the request of RCHD (NYSDEC Spill no. 89-1 1904). The UST removals were performed by Tank Tech. Reporting was provided by Subsurface Investigations Inc. (SII) (SII, 1990). The three USTs consisted of two 4,000 gallon diesel fuel tanks and one 2,500 gallon unleaded gasoline tank. The diesel tanks were reported as "intact" and the gasoline tank was reported corroded with holes. Approximately 15 tons of contaminated soil was removed from the gasoline tank excavation. An 18-inch slotted monitoring well (MW-1) was installed in the contaminated soil area to be used as a recovery well if needed. Two 2-inch polyvinyl chloride (PVC) monitoring wells (MW-2 and MW-2) were also installed. Groundwater analytical data detected benzene, toluene, ethylbenzene, and xylene concentrations of 26 µg/L, 10 µg/L, 8 µg/L, and 33 µg/L respectively. VOCs were not detected in the groundwater samples from MW-2 and MW-3. NYSDEC issued a “no further action at this time” decision.

NYSDEC sampling. In 2003, the NYSDEC sampled groundwater from the inactive water supply well (GW-PW) to determine if contaminant concentrations were remaining constant. Samples were obtained at 3 feet below ground surface (bgs) and 45 feet bgs in this well. Detected VOCs included TCE (9,500 µg/L), 1,2 DCE (3,100 µg/L), tetrachloroethene (300 µg/L), vinyl chloride (440 µg/L), and acetone (1,700 µg/L).

Remedial Investigation sampling. In 2008 and 2009 MACTEC conducted Site investigation activities, including: monitoring well installations, groundwater sampling, indoor air and sub-slab soil vapor sampling, pore water sampling, surface water sampling, sediment sampling and surface and subsurface soil sampling. Chlorinated solvents were detected in Site media above New York State Standards, Criteria, and Guidance values. Select VOCs detected in Site media are included on Figure 1.2.

2.0 SITE PHYSICAL SETTING

The physical characteristics of the Site study area are presented in this section.

2.1 TOPOGRAPHY

The Site is located approximately 160 feet above mean sea level (msl). Topography at the Site is fairly level. To the east of the Site is the Palisades Sill, a prominent feature along the Hudson River. Topography begins to rise steeply in this direction at about ½ mile east of the Site. To the southwest, Several Lakes surround the Site and the Hudson River is approximately 4500 feet east of the Site. Figure 1.1 shows these features and the general topography of the surrounding area.

2.2 CLIMATE

The climate of the area is characterized by warm summers and cool winters. Mean monthly temperatures range from 31 degrees Fahrenheit (°F) in January to 75°F in July. Average annual precipitation is 52 inches. Average annual snowfall is 30 inches per year (National Climatic Data Center, 1999).

2.3 SURFACE WATER HYDROLOGY

The Site is located on Route 9W and is within 200 feet of the Kill von Beast (also referred to as the East Branch of the Hackensack) which connects Swartwout Lake with Rockland Lake. Rockland Lake is approximately 1,800 feet south of the Site. Swartwout Lake is approximately 800 feet west and Congers Lake is approximately 2400 feet southwest of the Site. Surface water flow begins at Rockland Lake, through the Kill von Beast to Swartwout Lake, then to Congers Lake.

2.4 GROUNDWATER HYDROLOGY

Groundwater at the Site was determined to be within approximately three to six feet bgs, based on 2008 investigation results. Shallow groundwater flow is interpreted to flow northeast towards the von

Beast. Deeper bedrock groundwater flow is interpreted to flow north, then northwest towards Swartwout Lake.

2.5 GEOLOGY

Overburden in the vicinity of the Site contains fine to medium sand and gravel with some gray silty clay sand according to the ESA (Ballard, 1999). Reference data provided in the UST removal reporting (SII, 1990) notes that the United States Department of Agriculture Soil Conservation Service Classification and Correlation of soils of Rockland County, NY designate the Site soils as WuB, Weathersfield-Urban which consists of very deep, well drained soils of upland areas. This soil is glacial till derived from mainly red sandstone shale and conglomerate. Notes from the tank removal checklists indicate sand, clay and fill. Bedrock in the vicinity of the Site consists of conglomerates, red sandstones, or red shale of the late Triassic or early Jurassic eras (New York State Museum, 1989). The Palisades sill to the east of the Site consists of diabase; however, this formation is not anticipated to be encountered. Bedrock was encountered at the Site between 11.5 feet (MW-2) and 20 feet (MW-5) bgs.

3.0 SCOPE OF WORK

This FAP has been developed to address data gaps identified based on Phase I of the RI. The components of the scope of work include:

- installation of twelve (12) monitoring wells; six (6) overburden shallow monitoring wells and six (6) multichannel bedrock monitoring wells
- completion of Geoprobe groundwater and soil sampling at and in the vicinity of the Site; including the collection of up to 40 groundwater grab samples and 10 soil samples (six of the borings to be completed below the Site building slab)
- installation of six (6) microwells in the above mentioned indoor Geoprobe soil borings beneath the Site building
- collection of pore water samples from up to 15 additional locations north and east of the Site
- collection of synoptic groundwater level measurements
- groundwater sampling of the 12 new wells and 13 existing wells
- collection of indoor air and sub-slab soil vapor samples from six (6) residential/business locations

A summary of these field tasks and methodologies are described in more detail in Table 3.1, as well as in the following subsections. The sample IDs and analytical program is provided in Table 3.2. Proposed sample locations are shown on Figure 3.1 and Figure 3.2.

3.1 FIELD OPERATIONS

Companion documents to this FAP that will govern the execution of the field exploration activities include MACTEC's Program Quality Assurance Program Plan (QAPP) (MACTEC, 2007) and HASP (MACTEC, 2005). In addition to these program documents, Appendix A provides details related to health and safety for on-Site activities as presented in the Site-specific HASP.

Subcontractors chosen to support the field activities include:

- Mitkem Laboratory – NYSDEC Environmental Laboratory Approval Program (ELAP) certified laboratory for the analysis of soil and groundwater samples;
- Con-Test Laboratory – NYSDEC ELAP certified laboratory for the analysis of soil vapor samples;

- GeoLogic NY, Inc. – drilling services to support installation of groundwater monitoring wells; and;
- GeoLogic NY, Inc. - direct push services for collecting soil, groundwater, and soil vapor samples and installation of microwells.

3.1.1 Health and Safety

The Site-specific HASP is provided as Appendix A to this document. Based on available Site information, MACTEC anticipates that the RI fieldwork will be conducted in Level D personal protection. Specific investigation activities and required level of personal protection are set forth in the Site-specific HASP. Criteria for upgrading or downgrading the specified level of protection are also provided in the Site-specific HASP. Additional health and safety requirements are set forth in the Program HASP (MACTEC, 2005). Should Site conditions pose a threat to those present on-Site, and/or should Site conditions warrant an upgrade from Level D, as defined by the HASP, work will stop and the situation will be reevaluated by the NYSDEC and MACTEC. The New York State Department of Health (NYSDOH) Community Air Monitoring Plan will also be followed and is included in Appendix A.

3.1.2 Mobilization

Upon approval of this FAP, MACTEC will begin mobilization efforts. Mobilization will include obtaining utility clearances for all proposed locations, procurement of subcontractors, and the acquisition and coordination of supplies. The NYSDEC will be responsible for obtaining Site access.

3.2 SITE INVESTIGATION ACTIVITIES

The flowing subsections detail the specific field investigation activities proposed for the Site under this FAP and the rationale for the proposed activities.

3.2.1 Groundwater Monitoring Well Installation

The existing Site monitoring well network has several data gaps; there are limited groundwater monitoring points north and east of the Site; the extent of bedrock groundwater contamination north of the Site is not defined; and, the extent of overburden/shallow groundwater contamination east of the Site is not defined.

To fill these data gaps and evaluate the presence of VOCs in both the overburden/shallow groundwater east of the Site, three, two-inch overburden monitoring wells (MW-008, MW-009, and MW-010) will be installed (Figure 3.1). One down-gradient monitoring well will be paired with a multichannel bedrock well (MW-09B) to determine shallow groundwater concentrations east of the Site, as well as if VOCs are migrating into bedrock groundwater. The exact locations of the wells may vary based on access and/or utility clearances.

To determine the extent of VOC contamination in shallow and bedrock groundwater north of the Site, three, two-inch paired overburden and bedrock monitoring wells (MW-013, MW-014, MW-015, MW-13B, MW-14B, and MW-15B) will be installed north of the Site (Figure 3.1). In addition to the paired bedrock wells, two bedrock wells (MW-11B and MW-12B) will be installed northwest and north of the Site to help evaluate the lateral distribution of VOCs in bedrock groundwater north of the Site. The exact locations of the wells may vary based on access and/or utility clearances.

The overburden monitoring well borings will be advanced using hollow stem auger (HSA) drilling techniques into the top of the weathered bedrock. Soil samples will be collected continuously to bedrock using 2-inch split spoons. Photoionization detector (PID) headspace readings will be used to screen soil samples for the presence of VOCs as each soil sample is removed from the split-spoon. Samples will be described using the Unified Soil Classification System. The sample description and classification, VOC headspace reading, and boring observations will be recorded on the Data Record as discussed in Subsection 4.5.2.2 of the QAPP (analytical soil samples will not be collected).

The overburden monitoring wells will be constructed of 2-inch inside diameter schedule 40 PVC with either five foot or ten foot well screens (depending on depth to bedrock and groundwater) and threaded flush joint riser in accordance with Subsection 4.4.4 of the QAPP (MACTEC, 2007). Well screens will have 0.010-inch wide machine slots (unless geologic conditions dictate otherwise) with # 0 sand pack to 2 feet above the screen, a two foot bentonite seal above the sand pack and a bentonite grout backfill to the ground surface. The wells will be completed with a locking cap and a six-inch flush mount cover, with a two foot concrete apron.

The six bedrock monitoring wells (MW-09B, and MW-11B to MW-15B) will be installed up to approximately 75 feet bgs (approximately 60 feet into bedrock), using telescoping techniques to ensure any potential overburden confining layer remains intact. The six bedrock borings will be advanced to the top of bedrock using HSA techniques, as described for the overburden wells. The top 1.5 feet of rock will be drilled using a 6 ¼ tri-cone bit, to allow the setting of a 4-inch steel casing grouted into bedrock. Once set, borings will be continued using HX-size rock coring equipment up to 60 feet into rock to evaluate the potential for water bearing fractures below the shallow weathered bedrock zone. Rock cores will be described using the procedures outlined in Section 4.4.3.5 of the QAPP (MACTEC, 2007). Drilling techniques are described in Subsection 4.4.3 of the QAPP (MACTEC, 2007).

The bedrock monitoring wells will be constructed using a multichannel ground water monitoring system to collect discrete groundwater samples from multiple sealed intervals within the borehole. The multichannel wells are constructed using custom-extruded flexible 1.6-inch (4.1 cm) outside-diameter multichannel high density polyethylene tubing (referred to as continuous Multichannel Tubing™ [CMT]) to monitor as many as seven discrete zones within a single borehole in the bedrock. CMT multichannel bedrock monitoring wells will be constructed and installed in compliance with the manufactures' recommended guidance (Appendix B). The CMT monitoring wells will be completed with a PVC cap and a six-inch flush mount cover, with a two foot concrete apron.

3.2.2 Groundwater Monitoring Well Development

Upon completion of monitoring well installations, the newly installed monitoring wells will be developed (no sooner than 24 hours after installation for wells installed with top of screens below the water table) using pump and surge techniques as described in the Section 4.4.4 of the QAPP (MACTEC, 2007).

3.2.3 Groundwater Sampling

After monitoring wells have been installed and developed, groundwater samples will be collected from selected locations within the 12 newly installed monitoring wells (6 overburden and 6 bedrock wells) and 13 existing monitoring wells (7 overburden and 6 bedrock wells) (Table 3.2 and Table 3.3). Groundwater analytical data will be used to assess the distribution of contamination in the vicinity of the Site. Groundwater samples will be collected no sooner than two weeks following the development of the newly installed monitoring wells. Prior to well sampling, a round of water levels will be collected. Monitoring wells will then be sampled using low-flow sampling procedures as described in the Section 4.5.4.3.2 of the QAPP (MACTEC, 2007). Samples will be collected from the least contaminated to the most contaminated locations as determined from the assumed groundwater flow direction and historic analytical data.

Field measurements for pH, temperature, specific conductivity, oxidation reduction potential, dissolved oxygen, and turbidity will be collected through a flow through cell (with the exception of turbidity) from each monitoring well during pre-sample purging. Field measurements and monitoring well sampling activities will be documented using a Low Flow Groundwater Data Record (QAPP Figure 4-16; MACTEC, 2007).

Purge water will be screened with a PID and observed for sheens and odors. If no evidence of contamination is detected then the water will be allowed to infiltrate into the ground surface at the well location. If contamination is observed, purge water will be containerized and stored on-Site for future disposal. Groundwater samples from monitoring wells will be analyzed for VOCs by United States Environmental Protection Agency (USEPA) Method 8260, as described in the NYSDEC Analytical Services Protocol (ASP) of June 2005 (NYSDEC, 2005). The laboratory will provide NYSDEC Category B deliverables.

3.2.4 Indoor Air and Sub-Slab Soil Vapor Sampling

Indoor air and sub-slab soil vapor samples (SV/IA-14 to SV/IA-19) will be collected to evaluate if contaminants of concern from the Site are migrating off-Site in groundwater and creating a potential exposure pathway via vapor intrusion in buildings north of the Site (Figure 3.1). Indoor air and sub-slab vapor grab sampling will be obtained from six adjacent and down-gradient commercial buildings (a motel and a condo complex clubhouse) and residential dwellings. Samples will be obtained over an approximate 24 hour period (flow rate will be less than 0.2 liters per minute as required by NYSDOH) and collected as described below. Figure 3.1 shows the proposed sample locations.

Prior to collecting samples, an indoor air survey will be completed using the NYSDOH “Indoor Air Quality Questionnaire and Building Inventory” form. Sample collection procedures are further described in the QAPP. Vapor samples will be collected from below the structures' concrete slab. A one-inch diameter hole will be drilled with a hammer drill two inches into the building floor, near the center of the basement/slab-on grade, but away from any cracks or sumps. The hole will be continued with a 3/8-inch drill bit, until the building slab is penetrated. The hole will be continued approximately 3-inches below the slab. The hole will then be swept to remove drill cuttings/dust from the area. A ¼-inch piece of Teflon tubing will be inserted through a 1" diameter rubber stopper, and placed into the hole, so that the bottom of the tubing is below the slab floor and the stopper rests inside the one-inch hole, forming a seal (ensuring that the bottom of the tubing does not become blocked with dirt/concrete at the bottom of the hole). The stopper will then be covered with bees wax to provide a seal to prevent the migration of indoor air into the sub-slab. One 60 cubic centimeter volume of air will be purged from the tubing with a polyethylene syringe. The syringe will be capped and the air released outside the building as to not interfere with the indoor air sample collection. A 6-liter SUMMA®-type canister with a 24-hour flow valve will be connected to the tubing as described in the QAPjP.

Indoor air samples will be collected in 6-liter SUMMA®-type canisters from the vicinity of the sub-slab vapor sample collection points. MACTEC will collect the indoor air samples away from sumps, and if standing water is present it will be noted on the sampling form. If standing water is present, samples will be obtained and analyzed for VOCs by USEPA Method 8260. Indoor air samples will be collected from approximately four to six feet above the floor level (if necessary, Teflon tubing will be extended from the canister to attain the proper intake height). Indoor air samples will be set up with 24-hour flow valves.

Ambient air samples will be collected in 6-liter SUMMA®-type canisters from the vicinity of the homes being sampled for indoor air and sub-slab vapor VOC contamination. Samples will be collected from approximately four to six feet above ground surface. Ambient air samples will be set up with 24-hour flow valves.

Once the sub-slab vapor sample canisters, indoor air sample canisters, and exterior ambient air canister have been set up with 24-hr flow valves for an individual location, the valves from all containers will be opened. The time of sample collection, canister vacuum (in inches Mercury), weather conditions, and barometric pressure will be recorded on the field data record.

Approximately 24 hours after sample collection, the flow valves will be shut off. The time, remaining vacuum in the canister and barometric pressure will be noted on the field data record. The samples will be shipped to Con-test for analyses of VOCs via USEPA Method TO-15 with a detection limit of 1 microgram per cubic meter ($\mu g/m^3$) for most compounds and a detection limit of 0.25 $\mu g/m^3$ for TCE, vinyl chloride, and carbon tetrachloride in the indoor/ambient air samples.

Upon completion of the sampling, the tubing and stopper will be removed from the building floor and the holes will be filled completely with a fast drying hydraulic concrete (i.e. Quickcrete).

Soil vapor sampling activities will be documented using a Soil Vapor Sampling Record (QAPP Figure 4-11, MACTEC, 2007). Table 3.2 summarizes the sample IDs and analytical program.

3.2.5 Geoprobe Soil Borings

Source Area Borings. Based on existing Site soil and groundwater data, the location of contaminant source material is not known. To fill this data gap, approximately six Geoprobe soil borings (PZ-01 to PZ-06) will be completed as microwells beneath the Site building's slab. Figure 3.2 shows the proposed locations of the six microwells. Geoprobe borings will be advanced using direct push technology as described in the Section 4.5.1.1 of the QAPP (MACTEC, 2007). Soil samples will be collected from a four-foot long, 1-to-2 inch diameter core sampler with an acrylic liner. Soil samples will be collected continuously from the ground surface to refusal, estimated at approximately 17 feet bgs. PID headspace readings will be used to screen soil samples for the presence of VOCs as each soil sample is removed from the sample collection tube. Samples will be described using the Unified Soil Classification System. The sample description and classification, VOC headspace reading, and boring observations will be recorded on the Data Record as discussed in Subsection 4.5.2 of the QAPP.

Based on the PID readings and physical evidence such as color or odor, up to 12 soil samples (two per boring, based on PID readings, as well as unsaturated and saturated zone samples), will be collect and screened onsite for tetrachloroethylene, TCE, cis, 1-2-DCE and vinyl chloride with a Photovac Voyager portable gas chromatograph (on-site analytical protocols are described in Appendix C). A subset of soil samples (10 percent) will be submitted to an off-site Laboratory and will be analyzed for VOCs by USEPA Method 8260, as described in the NYSDEC ASP of June 2005 (NYSDEC, 2005). The data will be used to further evaluate the location of source material in Site soil and groundwater.

Microwells will be installed at each of the six boring locations in the Site building, as described in the following subsection.

Delineation Borings. Based on existing data, contaminant distribution is not defined at and in the vicinity of the Site building. To fill this data gap, additional Geoprobe soil borings (GS-07 to GS-40) will be completed to the north, east and south of the Site building. Figure 3.2 shows the proposed locations of the Geoprobe soil borings. Soil samples will be collected continuously from the ground surface to refusal, estimated at approximately 15 feet bgs. PID headspace readings will be used to screen soil samples for the presence of VOCs as each soil sample is removed from the sample collection tube. Samples will be described using the Unified Soil Classification System. The sample description and classification, VOC headspace reading, and boring observations will be recorded on the Data Record as discussed in Subsection 4.5.2 of the QAPP.

Based on the PID readings and physical evidence such as color or odor, up to 10 soil samples will be collect and screened onsite for VOC analyses. A subset of soil samples (10 percent) will be submitted to an off-site Laboratory and will be analyzed for VOCs by USEPA Method 8260, as described in the NYSDEC ASP of June 2005 (NYSDEC, 2005). The laboratory will provide NYSDEC Category B deliverables. The data will be used to further evaluate the vertical and horizontal distribution of contaminants in Site soils and groundwater. The data will be used to further evaluate the vertical and horizontal distribution of contaminant to the north, east and south of the Site building.

3.2.6 Microwell Installation

For future groundwater monitoring purposes, the six Geoprobe source area soil borings described above will be completed with as microwells (PZ-01 to PZ-06). Figure 3.2 shows the proposed locations of the Geoprobe soil borings/microwell explorations. The microwells will be constructed with 1-inch ID schedule 40 PVC. Well screens will be 10 feet long with 0.01” slots and set from approximately 5 to 15 feet bgs. The microwells will be backfilled with #0 sand to approximately 2 feet above the screen if possible and sealed with bentonite chips to approximately 1 foot bgs. Microwells will be completed at the surface with a locking cap and a six inch flush mount casing cemented in place.

3.2.7 Geoprobe Groundwater Points

The existing set of monitoring wells on and off Site do not give sufficient coverage to adequately characterize the limits of the VOC contamination in shallow groundwater. To supplement data from the existing and new monitoring wells and to fill these data gaps, geoprobe groundwater points will be completed in conjunction with the Geoprobe soil borings at approximately 40 locations at and in the vicinity of the Site building (Figure 3.2). Groundwater grab samples will be collected from a depth of approximately 10 to 14 feet bgs at each location. The groundwater samples will be collected by using direct push methods to advance a screen sampler to the desired depth and then pulling the casing back to expose the well screen to the formation (or a similar method). Groundwater will be pumped using a peristaltic pump. One tubing volume of water will be purged and one set of groundwater parameters including temperature, conductivity, pH, and turbidity will be collected before sampling, if possible.

Groundwater grab samples will be collected for VOC analysis at a low purge rate (approximately 100 milliliters per minute) at each location to characterize Site groundwater. Direct push sampling techniques are described in Section 4.5.1 of the QAPP (MACTEC, 2007). Groundwater measurements and sampling activities will be documented using a Groundwater Grab Field Data Record (QAPP Figure 4-10; MACTEC, 2007). VOC samples will be submitted for onsite analysis of VOCs. A subset of groundwater samples (10 percent) will be submitted to an off-site Laboratory and will be analyzed for VOCs by USEPA Method 8260, as described in the NYSDEC ASP of June 2005 (NYSDEC, 2005). The laboratory will provide NYSDEC Category B deliverables.

3.2.8 Pore Water Sampling

Temporary pore water points consisting of a 1/4-inch stainless steel pipe with a two-inch screen will be pushed by hand into the banks of the lake north of the Site and the banks of the Kill von Beast stream east of the Site. Point tips will be pushed to approximately 8-inches to one foot into the sediment. Tubing will be attached to the end of the pore water samplers and water samples will be collected using a Geopump as described in Section 4.5.4.2 of the QAPP.

Nine pore water sample points (PS-12 to PS-20) will be collected north of the Site, from the southern bank of Swartout Lake and the Kill von Beast (Figure 3.1). These points will be used to further evaluate potential groundwater plume discharge points to surface water. An additional 10 pore water sample points (PS-21 to PS-30) will be collected to the east of the Site, along the west bank of the Kill von Beast stream in an attempt to bound the extent and concentrations of the shallow groundwater plume (Figure 3.1).

Pore water samples will be submitted for onsite analysis of VOCs. A subset of groundwater samples (10 percent) will be submitted to an off-site Laboratory and will be analyzed for VOCs by USEPA Method 8260, as described in the NYSDEC ASP of June 2005 (NYSDEC, 2005). The laboratory will provide NYSDEC Category B deliverables. Results from analyses will be used to further evaluate potential groundwater plume discharge locations, as well as shallow groundwater concentrations.

3.3 DECONTAMINATION AND MANAGEMENT OF INVESTIGATION DERIVED WASTE

3.3.1 Decontamination

Sampling methods and equipment for this field program have been chosen to minimize decontamination requirements mitigating potential for cross contamination. Disposable sampling equipment will be used as much as practical to minimize decontamination time and water disposal. Non-disposable sampling equipment will be decontaminated before and after the collection of each sample. Decontamination methods and materials are described in detail in Subsection 4.3 of the QAPP.

Non disposable sampling equipment will be decontaminated by 1) washing the sample collection equipment with potable water and Liquinox, rinsing with potable water, rinsing with deionized water, and then allowing the equipment to air dry, or 2) steam cleaning the equipment and then allowing the equipment to air dry. Drilling equipment will be decontaminated by steam cleaning with potable water prior to each boring, and before leaving the Site. Drilling equipment (i.e. drill rods and casing) will be decontaminated on a temporary decontamination pad constructed at the Site. Decontamination fluids will be released on-Site to the ground surface in the area of decontamination. In the event that decontamination fluids exhibit visual or olfactory evidence of contamination, or PID readings are above background, fluids will be temporarily containerized for disposal in the on-Site treatments system or for testing and off-Site disposal.

3.3.2 Investigation Derived Wastes

The method of disposing investigation derived wastes (IDW) generated during this RI will be based upon whether the wastes are considered hazardous or non-hazardous. The approach to field screening and handling of the IDW are described in the following paragraphs.

United States Department of Transportation (USDOT) -approved 55-gallon containers filled during the field investigation will be staged on-Site in an area designated by the NYSDEC, and approved by the Site owner. Transport and disposal of these containers will be arranged by MACTEC on behalf of NYSDEC. Containers will be labeled with the following information: drum contents; Site name and the NYSDEC Site Number; and date drum filling began and date drum was sealed.

Disposable Sampling Equipment. Used disposable equipment will be double bagged in polyethylene trash bags and sealed with twist ties. MACTEC personnel will measure the headspace in the closed bags with a PID at least one hour after sealing the bags. If the headspace reading is greater than 5 parts per million (ppm), the tubing will be decontaminated by flushing with potable water and re-bagged. This process will be repeated until PID readings are below 5 ppm, or for a maximum of three times. If the headspace is below 5 ppm, the disposable equipment will be disposed of as non-hazardous municipal solid waste. If the headspace readings do not drop below 5 ppm, the disposable equipment will be placed in USDOT approved 55-gallon containers for off-Site disposal.

Personal Protective Equipment. Used protective clothing will be double bagged in polyethylene trash bags and sealed with twist ties. The bags will be disposed of as municipal solid waste.

Well Purge Water. Purge water will be released on-Site to the ground surface in the area of well. Purge water that exhibits visual or olfactory evidence of contamination, or PID readings above background, will be containerized in USDOT approved 55-gallon containers for later disposal in the on-Site system or off-Site disposal.

Drill Cuttings. Direct push and drilling soil cuttings will be screened for VOCs with a PID. Soils with visual evidence of contamination, or with sustained PID readings greater than background will be containerized for off-Site disposal in USDOT-approved 55-gallon drums. Soils with sustained PID readings of less than or equal to background will be considered non-contaminated and will be used as backfill for the borings from which they were extracted. Remaining uncontaminated soils will be spread evenly on the ground surface in unpaved areas of the Site. If no on-Site space is available, remaining soil will be containerized in USDOT 55-gallon drums for off-Site disposal.

3.4 SITE SURVEY

A survey will be performed for the 12 newly installed monitoring wells and the 6 microwells (no formal survey of the Site and surrounding area is scoped). Horizontal locations will be tied to the NYS Plane Coordinate System using North American Datum of 1983, and measured to an accuracy of 0.1 foot. Vertical elevations of groundwater monitoring wells will be tied to msl, using National Geodetic Vertical Datum of 1988, and measured to an accuracy of 0.01 foot. Locations of the Geoprobe borings and pore water sampling points will be surveyed using a Trimble Global Positioning System.

4.0 REFERENCES

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FIGURES

USGS 1:24,000 scale digital topographic map obtained from Cornell University Geospatial Information Repository at: http://cugir.mannlib.cornell.edu

Prepared/Date: BRP 03/25/08
Checked/Date: JWP 03/25/08

RI/FS WORK PLAN
BRAM MANUFACTURING
CONGERS, NEW YORK

MACTEC

SITE LOCATION MAP

Project 3612-08-2098
Figure 1.1

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PS-1	
TCE	5 U
Cis-1,2-DCE	1.2 J
VC	5 U

PS-2	
TCE	380 D
Cis-1,2-DCE	160
VC	18

PS-3	
TCE	1.4 J
Cis-1,2-DCE	5 U
VC	3.7 J

PS-4	
TCE	5 U
Cis-1,2-DCE	5 U
VC	5 U

GW-3	
TCE	4.1 J
Cis-1,2-DCE	3.7 J
PCE	5 U
VC	5 U

PS-5	
TCE	5 U
Cis-1,2-DCE	5 U
VC	5 U

GV-3	
TCE	130
Cis-1,2-DCE	1.1
PCE	37
VC	0.26 U

GV-2	
TCE	0.54 U
Cis-1,2-DCE	3.3
PCE	0.68 U
VC	0.86

GV-1	
TCE	9.6
Cis-1,2-DCE	1.6
PCE	23
VC	0.26 U

PS-6	
TCE	5 U
Cis-1,2-DCE	5 U
VC	5 U

MW-7B (36' bgs)	
TCE	20000 D
Cis-1,2-DCE	450 DJ
PCE	310 DJ
VC	24

MW-7 (16' bgs)	
TCE	5 U
Cis-1,2-DCE	1.2 J
PCE	5 U
VC	5 U

PS-9	
TCE	5 U
Cis-1,2-DCE	5 U
VC	5 U

PS-7	
TCE	5 U
Cis-1,2-DCE	5 U
VC	5 U

PS-8	
TCE	5 U
Cis-1,2-DCE	10
VC	22

MW-5B (60' bgs)	
TCE	110000 D
Cis-1,2-DCE	1300 DJ
PCE	5200 D
VC	150

MW-5 (14' bgs)	
TCE	12
Cis-1,2-DCE	5 U
PCE	3.4 J
VC	5 U

MW-4B (44' bgs)	
TCE	280 B
Cis-1,2-DCE	270
PCE	10 U
VC	17

PS-10	
TCE	1400 E
Cis-1,2-DCE	610 E
VC	5 U

MW-4 (15' bgs)	
TCE	1000 DJ
Cis-1,2-DCE	180000 D
PCE	40
VC	18000 D
BTEX	>75000

MW-1 (10' bgs)	
TCE	2400 D
Cis-1,2-DCE	25000 DJ
PCE	2 J
VC	320 DJ

GW-PW (51' bgs)	
TCE	850 DB
Cis-1,2-DCE	3600 D
PCE	48 DJ
VC	1000 D

PS-11	
TCE	1.4 BJ
Cis-1,2-DCE	1.3 J
VC	5 U

Groundwater/Pore water (MW/GW/PS) results in ug/L
Soil gas (GV) results in ug/m3

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Checked/Date: BAS 06/12/09

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2008 MACTEC REMEDIAL
INVESTIGATION RESULTS
Project 3612-08-2098 Figure 1.2

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Prepared/Date: BJS 10/05/09
Checked/Date: BAS 10/05/09

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PROPOSED PHASE II
EXPLORATION LOCATIONS
Project 3612-08-2098 Figure 3.1

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Prepared/Date: BJS 09/21/09
Checked/Date: BAS 09/21/09

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PROPOSED GEOPROBE
BORING LOCATIONS
Project 3612-08-2098 Figure 3.2

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TABLES

Table 3.1: Proposed Field Tasks and Methodology

LOCATION TYPE	LOCATION ID	DESCRIPTION AND METHODOLOGY	RATIONALE	ANALYTICAL
Sub Slab Vapor and Indoor Air	IA/SV-14 through IA/SV-19	Collect third phase of indoor air and sub-slab vapor samples from commercial and residential structures adjacent to the site.	Indoor air and sub slab vapor samples will be obtained to provide data regarding vapor migration pathways and potential exposure points at additional residences.	TCL VOCs
Pore Water	PS-12 through PS-20	Collect 9 pore water samples to the north of the Site from the southern edge of the Kill von Beast and Swartwout Lake convergence.	Evaluate potential groundwater discharge locations to surface water.	Onsite select groundwater VOCs at 9 locations, offsite TCL VOC at 1 location.
Pore Water	PS-21 through PS-30	Collect 10 pore water samples from the western wetland bank of the Kill von Beast, east of the Site building.	Evaluate potential extent of shallow groundwater plume that may be discharging to wetland/Kill von Beast.	Onsite select groundwater VOCs at 10 locations, offsite TCL VOC at 1 location.
Soil Borings	GS-01 to GS-10	Complete approximately 10 borings to approximately 16 feet bgs (approximately 12 feet into the water table), collecting continuous soil samples for analysis and visual inspection.	Evaluate subsurface soil characteristics and attempt to delineate potential source areas.	Onsite select soils VOCs, offsite TCL VOC at 1 location.
Groundwater Samples	GW-01 to GW-40	Complete approximately 40 (GW-01 through GW-10 to be done in conjunction with the soil borings GS-01 through GS-10) borings to approximately 12 feet bgs (approximately 10 feet into the water table), and collect groundwater samples for onsite analysis.	Evaluate potential source areas and further evaluate the extent of the shallow groundwater plume.	Onsite select groundwater VOCs, offsite TCL VOC at 4 locations.
Microwells	PZ-1 to PZ-6	Complete up to 6 soil borings below the Site building slab to approximately 16 feet below ground surface. Evaluate soils for potential source area material. Install up to 6 piezometers with 10-foot screens below the slab of the Site building.	Installation of piezometes to further evaluate groundwater gradients and help evaluate potential source areas and the extent of the shallow groundwater plume.	Onsite select groundwater and soils VOCs, offsite TCL VOC at 1 location.
Overburden Monitoring Well	MW-008 to MW-010 and MW-013 to MW-015	Install monitoring wells in 6 soil borings to collect groundwater samples.	Wells installed to further define the distribution of groundwater contamination in overburden at and adjacent to the site. Wells will also be used to provide data regarding groundwater flow direction(s) and groundwater permeability data and gradients.	TCL VOCs
Bedrock Monitoring Well	MW-09B, MW-11B through MW-15B	Install multichannel monitoring wells in 6 bedrock borings to collect groundwater samples.	Wells installed to further define the distribution of groundwater contamination in bedrock down-gradient from the site. Wells will also be used to provide data regarding groundwater flow direction(s) and groundwater permeability data and gradients.	TCL VOCs

Prepared by: BAS 9/28/09
Checked by: CRS 10/2/09

NOTES:

TCL	Target Compound List
VOCs	Volatile Organic Compound analyzed by USEPA Method 8260
Select VOCs	VOCs To be screened onsite by MACTEC Chemist using a photovac Voyager Field Portable Gas Chromatograph instrument; Selected VOCs to include: TCE, PCE, cis-1,2-DCE and VC.

Table 3.2: Proposed Sample Identification and Analyses

				QC		**Groundwater Samples**		**Soil Samples**		**Air Samples**
Site Type	**Media**	**Site ID**	**Sample ID**	**DUP**	**MS/ MSD**	**Onsite Select VOCs**	**8260B VOCs**	**Onsite Select VOCs**	**8260B VOCs**	**VOC TO-15**
Geoprobe Boring Soil Sampling										
Geoprobe	Soil	GS-01	344055GS001___	1	1			1	1	
Geoprobe	Soil	GS-02	344055GS002___					1		
Geoprobe	Soil	GS-03	344055GS003___					1		
Geoprobe	Soil	GS-04	344055GS004___					1		
Geoprobe	Soil	GS-05	344055GS005___					1		
Geoprobe	Soil	GS-06	344055GS006___					1		
Geoprobe	Soil	GS-07	344055GS007___					1		
Geoprobe	Soil	GS-08	344055GS008___					1		
Geoprobe	Soil	GS-09	344055GS009___					1		
Geoprobe	Soil	GS-10	344055GS010___					1		
Geoprobe Boring Groundwater Sampling										
Geoprobe	Groundwater	GW-01	344055GW001___	1	1	1	1			
Geoprobe	Groundwater	GW-02	344055GW002___			1				
Geoprobe	Groundwater	GW-03	344055GW003___			1				
Geoprobe	Groundwater	GW-04	344055GW004___			1				
Geoprobe	Groundwater	GW-05	344055GW005___			1				
Geoprobe	Groundwater	GW-06	344055GW006___			1				
Geoprobe	Groundwater	GW-07	344055GW007___			1	1			
Geoprobe	Groundwater	GW-08	344055GW008___			1				
Geoprobe	Groundwater	GW-09	344055GW009___			1				
Geoprobe	Groundwater	GW-10	344055GW010___			1				
Geoprobe	Groundwater	GW-11	344055GW011___			1				
Geoprobe	Groundwater	GW-12	344055GW012___			1				
Geoprobe	Groundwater	GW-13	344055GW013___			1				
Geoprobe	Groundwater	GW-14	344055GW014___			1	1			
Geoprobe	Groundwater	GW-15	344055GW015___			1				
Geoprobe	Groundwater	GW-16	344055GW016___			1				
Geoprobe	Groundwater	GW-17	344055GW017___			1				
Geoprobe	Groundwater	GW-18	344055GW018___			1				
Geoprobe	Groundwater	GW-19	344055GW019___			1				
Geoprobe	Groundwater	GW-20	344055GW020___	1		1				
Geoprobe	Groundwater	GW-21	344055GW021___			1				
Geoprobe	Groundwater	GW-22	344055GW022___			1				
Geoprobe	Groundwater	GW-23	344055GW023___			1				
Geoprobe	Groundwater	GW-24	344055GW024___			1				
Geoprobe	Groundwater	GW-25	344055GW025___			1				
Geoprobe	Groundwater	GW-26	344055GW026___			1	1			
Geoprobe	Groundwater	GW-27	344055GW027___			1				
Geoprobe	Groundwater	GW-28	344055GW028___			1				
Geoprobe	Groundwater	GW-29	344055GW029___			1				
Geoprobe	Groundwater	GW-30	344055GW030___	1		1				
Geoprobe	Groundwater	GW-31	344055GW031___			1				
Geoprobe	Groundwater	GW-32	344055GW032___			1				
Geoprobe	Groundwater	GW-33	344055GW033___			1				
Geoprobe	Groundwater	GW-34	344055GW034___			1				
Geoprobe	Groundwater	GW-35	344055GW035___			1				
Geoprobe	Groundwater	GW-36	344055GW036___			1				
Geoprobe	Groundwater	GW-37	344055GW037___			1				
Geoprobe	Groundwater	GW-38	344055GW038___			1				
Geoprobe	Groundwater	GW-39	344055GW039___			1				
Geoprobe	Groundwater	GW-40	344055GW040___			1				

Table 3.2: Proposed Sample Identification and Analyses

				QC		**Groundwater Samples**		**Soil Samples**		**Air Samples**
Site Type	**Media**	**Site ID**	**Sample ID**	**DUP**	**MS/ MSD**	**Onsite Select VOCs**	**8260B VOCs**	**Onsite Select VOCs**	**8260B VOCs**	**VOC TO-15**
Microwell Boring Groundwater Sampling										
Mircrowell	Groundwater	PZ-01	344055PZ001___01			1				
Mircrowell	Groundwater	PZ-02	344055PZ002___01			1				
Mircrowell	Groundwater	PZ-03	344055PZ003___01			1	1			
Mircrowell	Groundwater	PZ-04	344055PZ004___01			1				
Mircrowell	Groundwater	PZ-05	344055PZ005___01			1				
Mircrowell	Groundwater	PZ-06	344055PZ006___01			1				
Microwell Boring Soil Sampling										
Soil Boring	Soil	PZ-01	344055BSPZ001___01					1		
Soil Boring	Soil	PZ-01	344055BSPZ001___01					1		
Soil Boring	Soil	PZ-02	344055BSPZ002___01					1		
Soil Boring	Soil	PZ-02	344055BSPZ002___01					1		
Soil Boring	Soil	PZ-03	344055BSPZ003___01					1	1	
Soil Boring	Soil	PZ-03	344055BSPZ003___01					1		
Soil Boring	Soil	PZ-04	344055BSPZ004___01					1		
Soil Boring	Soil	PZ-04	344055BSPZ004___01					1		
Soil Boring	Soil	PZ-05	344055BSPZ005___01					1	1	
Soil Boring	Soil	PZ-05	344055BSPZ005___01					1		
Soil Boring	Soil	PZ-06	344055BSPZ006___01					1		
Soil Boring	Soil	PZ-06	344055BSPZ006___01					1		
Pore Water Sampling										
Pore Water	Groundwater	PS-12	344055PS12			1				
Pore Water	Groundwater	PS-13	344055PS13			1				
Pore Water	Groundwater	PS-14	344055PS14			1				
Pore Water	Groundwater	PS-15	344055PS15	1		1	1			
Pore Water	Groundwater	PS-16	344055PS16			1				
Pore Water	Groundwater	PS-17	344055PS17			1				
Pore Water	Groundwater	PS-18	344055PS18			1				
Pore Water	Groundwater	PS-19	344055PS19			1				
Pore Water	Groundwater	PS-20	344055PS20			1				
Pore Water	Groundwater	PS-21	344055PS21			1				
Pore Water	Groundwater	PS-22	344055PS22			1				
Pore Water	Groundwater	PS-23	344055PS23			1				
Pore Water	Groundwater	PS-24	344055PS24			1				
Pore Water	Groundwater	PS-25	344055PS25			1	1			
Pore Water	Groundwater	PS-26	344055PS26			1				
Pore Water	Groundwater	PS-27	344055PS27			1				
Pore Water	Groundwater	PS-28	344055PS28			1				
Pore Water	Groundwater	PS-29	344055PS29			1				
Pore Water	Groundwater	PS-30	344055PS30			1				
Monitoring Well Sampling										
Well	Groundwater	MW-01	344055MW00101003XX				1			
Well	Groundwater	MW-02	344055MW00200703XX				1			
Well	Groundwater	MW-3S	344055MW03S01403XX		1		1			
Well	Groundwater	MW-04	344055MW00401503XX	1			1			
Well	Groundwater	MW-05	344055MW00501403XX				1			
Well	Groundwater	MW-06	344055MW00601403XX				1			
Well	Groundwater	MW-07	344055MW00701403XX				1			
Well	Groundwater	MW-08	344055MW008___03XX				1			
Well	Groundwater	MW-09	344055MW009___03XX				1			
Well	Groundwater	MW-10	344055MW010___03XX				1			
Well	Groundwater	MW-13	344055MW013___03XX				1			
Well	Groundwater	MW-14	344055MW014___03XX				1			
Well	Groundwater	MW-15	344055MW015___03XX		1		1			
Well	Groundwater	MW-3B	344055MW03B03303XX				1			
Well	Groundwater	MW-4B	344055MW04B03303XX				1			
Well	Groundwater	MW-4B	344055MW04B04403XX				1			
Well	Groundwater	MW-4B	344055MW04B05703XX				1			

Table 3.2: Proposed Sample Identification and Analyses

				QC		Groundwater Samples		Soil Samples		Air Samples
Site Type	**Media**	**Site ID**	**Sample ID**	**DUP**	**MS/ MSD**	**Onsite Select VOCs**	**8260B VOCs**	**Onsite Select VOCs**	**8260B VOCs**	**VOC TO-15**
Well	Groundwater	MW-5B	344055MW05B03103XX				1			
Well	Groundwater	MW-5B	344055MW05B06103XX	1			1			
Well	Groundwater	MW-6B	344055MW06B03303XX				1			
Well	Groundwater	MW-7B	344055MW07B03603XX				1			
Well	Groundwater	MW-7B	344055MW07B05403XX				1			
Well	Groundwater	MW-9B	344055MW09B___03XX				1			
Well	Groundwater	MW-9B	344055MW09B___03XX				1			
Well	Groundwater	MW-9B	344055MW09B___03XX				1			
Well	Groundwater	MW-11B	344055MW11B___03XX				1			
Well	Groundwater	MW-11B	344055MW11B___03XX				1			
Well	Groundwater	MW-11B	344055MW11B___03XX				1			
Well	Groundwater	MW-12B	344055MW12B___03XX				1			
Well	Groundwater	MW-12B	344055MW12B___03XX				1			
Well	Groundwater	MW-12B	344055MW12B___03XX				1			
Well	Groundwater	MW-13B	344055MW13B___03XX				1			
Well	Groundwater	MW-13B	344055MW13B___03XX				1			
Well	Groundwater	MW-13B	344055MW13B___03XX				1			
Well	Groundwater	MW-14B	344055MW14B___03XX				1			
Well	Groundwater	MW-14B	344055MW14B___03XX				1			
Well	Groundwater	MW-14B	344055MW14B___03XX				1			
Well	Groundwater	MW-15B	344055MW15B___03XX				1			
Well	Groundwater	MW-15B	344055MW15B___03XX				1			
Well	Groundwater	MW-15B	344055MW15B___03XX				1			
Well	Groundwater	Trip Blanks	TBD				6			
Sub Slab/Indoor Air Sampling										
Sub Slab Vapor	Soil Vapor	SS-14A	344055-SS-14A-03	1						1
Sub Slab Vapor	Soil Vapor	SS-15A	344055-SS-15A-03							1
Sub Slab Vapor	Soil Vapor	SS-16A	344055-SS-16A-03							1
Sub Slab Vapor	Soil Vapor	SS-17A	344055-SS-17A-03							1
Sub Slab Vapor	Soil Vapor	SS-18A	344055-SS-18A-03							1
Sub Slab Vapor	Soil Vapor	SS-19A	344055-SS-19A-03							1
Indoor Air	Basement Air	IA-14A	344055-IA-14A-03							1
Indoor Air	Basement Air	IA-15A	344055-IA-15A-03							1
Indoor Air	Basement Air	IA-16A	344055-IA-16A-03							1
Indoor Air	Basement Air	IA-17A	344055-IA-17A-03							1
Indoor Air	Basement Air	IA-18A	344055-IA-18A-03							1
Indoor Air	Basement Air	IA-19A	344055-IA-19A-03							1
TOTAL SAMPLES				8	4	65	53	22	3	12

NOTES:

Sample ID: __ represents the 3 digit sample depth below ground surface be determined in field

8260B VOCs = Target Compound List Volatile Organic Compounds analyzed by USEPA SW-846 method 8260 for soil and water.

Onsite Selected VOCs = To be screened onsite by MACTEC Chemist using a photovac Voyager Field Portable Gas Chromatograph instrument; Selected VOCs to include: TCE, PCE, cis-1,2-DCE and VC.

Field Quality Control samples (duplicates, matrix spike, matrix spiked duplicates) will be collected at a frequency of 5% (1:20 samples).

Field Screening Quality Control samples (comparison of onsite screening to offsite laboratory VOC samples) will be collected at a frequency of 10% (1:10 samples).

TBD = To Be Determined

Prepared By: BAS 9/28/09
Checked By: CRS 10/2/09

Table 3.3: Well Construction Data

Monitoring Well ID	Channel ID	Type	Northing	Easting	Ground Elevation	Casing Elevation	Riser Elevation	TOC-TOR	BOW (TOR)
MW-1	NA	Overburden	844059.86	649867.47	154.44	154.44	154.25	0.19	12.35
MW-2	NA	Overburden	844028.07	649865.04	153.87	153.87	153.57	0.30	11.25
MW-S3	NA	Overburden	843883.34	649863.26	155.74	155.74	155.41	0.33	16.99
MW-3B	1,2	Bedrock	843931.24	649847.46	156.50	156.50	156.22	0.28	~ 33
MW-3B	3,4	Bedrock	843931.24	649847.46	156.50	156.50	156.22	0.28	~ 48
MW-3B	5,6,7	Bedrock	843931.24	649847.46	156.50	156.50	156.22	0.28	61.6
MW-4	NA	Overburden	844074.59	649964.65	152.93	152.93	152.62	0.31	15.07
MW-4B	1,6	Bedrock	844084.16	649965.53	153.00	153.00	152.58	0.42	~ 33
MW-4B	3,4	Bedrock	844084.16	649965.53	153.00	153.00	152.58	0.42	~ 44
MW-4B	5	Bedrock	844084.16	649965.53	153.00	153.00	152.58	0.42	53.2
MW-4B	7	Bedrock	844084.16	649965.53	153.00	153.00	152.58	0.42	~ 71
MW-5	NA	Overburden	844120.66	649846.49	155.93	155.93	155.43	0.50	15.75
MW-5B	1,6	Bedrock	844120.66	649841.11	155.90	155.90	155.44	0.46	~ 32
MW-5B	4,5	Bedrock	844120.66	649841.11	155.90	155.90	155.44	0.46	~ 42
MW-5B	2,3,7	Bedrock	844120.66	649841.11	155.90	155.90	155.44	0.46	~ 60.5
MW-6	NA	Overburden	844081.38	649734.33	156.63	156.63	156.36	0.27	12.01
MW-6B	1,6	Bedrock	844075.75	649733.82	156.51	156.51	155.84	0.67	32.6
MW-6B	2,3	Bedrock	844075.75	649733.82	156.51	156.51	155.84	0.67	56.8
MW-6B	4,5	Bedrock	844075.75	649733.82	156.51	156.51	155.84	0.67	48.6
MW-6B	7	Bedrock	844075.75	649733.82	156.51	156.51	155.84	0.67	57.2
MW-7	NA	Overburden	844326.42	649859.74	154.81	154.81	154.47	0.34	17.10

Created by: BAS 10/6/09
Checked by: CRS 10/6/09

Table 3.3: Well Construction Data

Monitoring Well ID	Channel ID	Type	Northing	Easting	Ground Elevation	Casing Elevation	Riser Elevation	TOC-TOR	BOW (TOR)
MW-7B	1,2	Bedrock	844327.05	649854.21	154.76	154.76	154.42	0.34	27.0
MW-7B	3,4	Bedrock	844327.05	649854.21	154.76	154.76	154.42	0.34	36.4
MW-7B	5,6,7	Bedrock	844327.05	649854.21	154.76	154.76	154.42	0.34	54.0
GW-PW	1,2	Bedrock	844061.13	649874.09	155.68	155.68	155.53	0.15	40.1
GW-PW	3,4	Bedrock	844061.13	649874.09	155.68	155.68	155.53	0.15	50.9
GW-PW	5,6,7	Bedrock	844061.13	649874.09	155.68	155.68	155.53	0.15	60.3

Notes:

TOC = Top of monitoring well casing
TOR = Top of monitoring well riser
BOW = Bottom of monitoring well
Wells Surveyed by Om Popli Surveyors (12/18/2008).
Northing/Easting = North American Datum 83/96 - NYSPCS WEST (US survey feet)
Elevations = North Atlantic Vertical Datum 88 (US survey feet)
Water levels collected by MACTEC Engineering and Consulting

Created by: BAS 10/6/09
Checked by: CRS 10/6/09

APPENDIX A

MACTEC SHORT FORM HASP

New York State Department of Health
Generic Community Air Monitoring Plan

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

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

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

Community Air Monitoring Plan

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

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

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

VOC Monitoring, Response Levels, and Actions

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

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

- If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

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

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

Particulate Monitoring, Response Levels, and Actions

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

- If the downwind PM-10 particulate level is 100 micrograms per cubic meter (mcg/m^3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 mcg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

- If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 mcg/m^3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 mcg/m^3 of the upwind level and in preventing visible dust migration.

All readings must be recorded and be available for State (DEC and DOH) personnel to review.

June 20, 2000

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MACTEC, Inc.

MACTEC Short Form HASP

Site: Bram Manufacturing (Bram) Job Number: 3612082098
Street Address: 26 N Route 9 West, Congers, New York
Proposed Date(s) of Investigation: May through November 2008
Prepared by: John Peterson Date: 3/26/2008
*Approved by: Kendra Bavor Date: 3/27/2008

Site Description: The former Bram Manufacturing facility reportedly manufactured lighting fixtures. Bram reportedly used solvents (e.g., TCE, PCE) during the manufacturing process. Spills and/or disposal of solvents have resulted in groundwater contamination and the source of contamination is presumed to be under a newer portion of the building (east side). Adjacent to the site to the south and in a presumed upgradient location, three underground storage tanks (2 diesel, 1 unleaded gasoline) were removed. Contamination was present in association with the unleaded gasoline tank. This leak has resulted in fuel contamination in groundwater that is present in groundwater at the Site.
(attach map)

Proposed Activity(s): Bedrock and Overburdened Well Installation, Low-Flow Groundwater Sampling, Surface Water and Sediment Sampling, Soil Sampling, Borehole Geophysics, Sub Slab and Indoor Air Sampling, and a Survey.

*Approval also serves as certification of a Hazard Assessment as required by 29 CFR 1910.132

Dates of Required Training and Medical Surveillance:

		Names of Field Team			
	Req?	**Jerry Rawcliffe**	**Michael Washburn**	**Dates**	**Dates**
Medical Surveillance					
Site Specific Medical Testing:_____________					
40-Hour Initial		5/1/85-4/19/35	3/23/07-3/23/57		
8-Hour Supervisor [1, 3]		8/1/95-7/19/45			
8-Hour Refresher		5/14/07-5/13/08	Due		
First Aid [1,2]		11/15/05-11/14/08			
Respirator Protection[1]		5/14/07-5/13/08			
Respirator Brand [1]					
Hazard Communication [1]					
Fall Protection [1]					
Confined Space Entry [1]		5/3/04-4/21/54			
CPR [1,2]		1/30/07-1/30/08	9/17/05-9/17/07		

[1] If Applicable
[2] At least one worker must be trained in First Aid/CPR and should received Bloodborne Pathogen Training
[3] Required for Field Lead and Site Health and Safety Officer

Known or Suspected Contaminants (include PELs/TLVs):

Contaminants of Concern	Highest Historical	PEL/TLV	Chemical Fact Sheet Attached
1,2-dichloroethene	3100 in 1999&2003	200 ppm	X
Tetrachloroethene	300 in 2003	25 ppm	X
1,1,1-Trichloroethane	87 in 1998	350 ppm	X
cis-1,2-Dichloroethene	2600 in 1998	200 ppm	X
Trichloroethene	9500 in 2004	10 ppm	X
vinyl chloride	440 in 2004	1 ppm	X
n-Butylbenzene	25 in 1999	NA	X
tert-Butylbenzene	370 in 1999	NA	X
Ethylbenzene	210 in 1999	100 ppm	X

Isopropylbenzene (Cumene)	170 in 1999	50 ppm	X
p-isopropyltoluene (p-Cymeme)	12 in 1999	NA	X
n-proprylbenzene	270 in 1999	NA	X
1,2,4-trimethylbenzene	3200 in 1999	25 ppm	X
1,3,5-trimethylbenzene	1800 in 1999	25 ppm	X
o-Xylene	22 in 1999	100 ppm	X
p-&m-Xylene	91 in 1999	100 ppm	X
1,3-dichloropropane	510 in 1998	NA	X
Actetone	1700 in 2003	500 ppm TLV	X

NA = not available

JHAs: Check and attach all that apply (add applicable JHAs not already listed):

Activity Specific JHAs:

☒	Mobilization/Demobilization and Site Preparation
☒	Field Work - General
☒	Decontamination
☒	Groundwater Sampling
☒	Soil Sampling
☒	Drilling Operation (MACTEC Driller)
☐	Geoprobe (MACTEC Geoprobe Operator)
☐	Excavations and Backfilling
☒	Stream/Wetlands Work
☐	

Hazard Specific JHAs:

☒	Insect Stings and Bites
☐	Gasoline
☒	Working with Preservatives (Acids)
☒	Pore Water Sampling
☒	Well Development
☒	Power Tool Use - Electrical
☒	Sub-slab Indoor Air Sampling
☒	Working in Muddy Areas
☐	
☐	

Chemicals Brought to the Site:
List all chemicals brought to the site (e.g., preservatives, decontamination solutions, gasoline, etc.). Attach MSDS

Chemicals	MSDS Attached?
HYDROCHLORIC ACID, NITRIC ACID, SULFRIC ACID, SODIUM HYDROXIDE	☒
LIQUINOX/ALCONOX	☒
ISOBUTYLENE	☒
AUTO CAL COLUTION	☒

Chemicals will be kept in their original containers. If transferred to another container, aside from days use by one individual, the new container will be labeled with the name of the chemical and the hazard warnings.

HAZARD IDENTIFICATION SUMMARY

Complete the checklist for summarizing the hazards identified in the JHAs

Standard Hazards

☒ Falling Objects	☒ Slips and trips	☒ Pinch points	☒ Rotating equipment
☒ Falls	☒ Power equipment/tools	☐ Elevated work surfaces	☐ ___________________

Eye Hazards

☒ Particulates	☒ Liquid splashes	☐ Welding Arc	☐ ___________________

Hearing Hazards

☐ None	☒ Impact noise	☐ High frequency noise	☒ High ambient noise

Respiratory Hazards

☐ None	☒ Dust/aerosols/particulates	☒ Organic Vapors	☐ Acid Gases	☐ O_2 deficient	☐ Metals	☐ Asbestos

Chemical Hazards

☐ None	☒ Organic solvents	☐ Reactive metals	☐ PCBs
☐ Acids / bases	☐ Oxidizers	☒ Volatiles/Semi-volatiles	☐ ___________________

Environmental Hazards

☐ None	☒ Temperature extremes:	☒ Cold ☒ Heat	☒ Wet location	☒ Bio hazards (snakes, insects, spiders, poisonous plants, etc.)
☐ Explosive vapors	☐ Confined space		☐ Engulfment Hazard	☐ ___________________

Electrical Hazards

☐ None	☐ Energized equipment or circuits	☒ Overhead utilities	☒ Underground utilities	☐ Wet location

Fire Hazards

☒ None	☐ Cutting, welding, or grinding generated sparks or heat sources	☐ Flammable materials present	☐ Oxygen enriched location

Ergonomic Hazards

☒ Lifting	☒ Bending	☒ Twisting	☒ Pulling/tugging	☐ Repetitive motion	☒ Carrying
Computer Use in the:	☐ Office	☐ Field		☐ ___________________	

Radiological Hazards

☒ None	☐ Alpha	☐ Beta	☐ Gamma/X-rays	☐ Neutron	☐ Radon	☐ Non-Ionizing

Other Hazards

☒ None known

PPE and Monitoring Instruments

Initial Level of PPE *

☒ Level D	☐ Modified Level D	☐ Level C	* Cannot use Short Form HASP for Level B or A work

Standard PPE

☒ Hard Hat	☒ Safety boots	☒ Safety glasses	☐ Chem. Resistant Boots	☒ High visibility vest	☐ Other:_____

Eye and Face Protection

☐ Face shield	☐ Vented goggles	☐ Unvented goggles	☐ Indirect vented goggles

Hearing Protection

☒ Ear plugs	☒ Ear Muffs	☐ Ear plugs and muffs	☐ Other ______________

Respiratory Protection

☐ None	☐ Dust mask	☐ Full Face APR	☐ Half Face APR	Cartridge Type: __NA_	Change Cartridges: __NA___

Protective Clothing

☐ Work uniform	☐ White uncoated Tyvek®	☐ Poly-coated Tyvek®	☐ Saranex®
☐ Boot covers	☐ Reflective vest	☐ Chaps or Snake Legs	☐ Other ______________

Hand Protection

☐ None	☒ Cotton gloves	☒ Leather gloves	☐ Glove liners	☐ Cut-resistant gloves	☐ Other ______________

☒ Outer Gloves: List Type___Nitrile__	☐ Inner Gloves: List Type______________

Monitoring Instruments Required*

Periodic monitoring shall be conducted when the possibility of an IDLH condition or flammable atmosphere has developed or when there is indication that exposures may have risen over permissible exposure limits or published exposure levels since prior monitoring. Situations where it shall be considered whether the possibility that exposures have risen are as follows:

- When work begins on a different portion of the site.
- When contaminants other than those previously identified are being handled.
- When a different type of operation is initiated (e.g., drum opening as opposed to exploratory well drilling.)
- When employees are handling leaking drums or containers or working in areas with obvious liquid contamination (e.g., a spill or lagoon.)

☐ LEL/O2 Meter	☒ PID: ☒ 10.6 eV Lamp ☐ 11.7 eV Lamp	☐ FID	☐ Hydrogen Sulfide/Carbon Monoxide

☒ Dräger Pump (or equivalent) List Tubes___________________	☒ Dust Meter: ☐ Respirable dust ☒ Total dust	☐ Other ______________

*Monitoring instruments will be calibrated daily in accordance with manufacturer's instructions.

Air Monitoring Action Levels:

PID/FID Reading [1]	Detector Tube [1]	Dust Meter [1]	[1] LEL[2]/O$_2$	Action	Level of PPE
Above background	>0.5 Vinyl Chloride or staining	N/A		Back off, cease work, re-evaluate situation. Contact Division EH&S Manager.	Level D
Background	N/A	Dust monitor respirable dust. Visual dust present - 2.5 mg/m^3		Move upwind. Implement dust control measures. If dust persists, cease work and consult H&S Officer.	Level D
5 ppm to 120 ppm	>0.5 Vinyl Chloride or staining	N/A		Upgrade to Level C	Level C

>120 ppm	>0.5 Vinyl Chloride or staining	N/A		Stop work, contact HSO	Level B
			>10% LEL	Stop work. Evacuate area. If action levels continue to be exceeded, contact HSO, consider return with ventilation system and spark proof/intrinsically safe equipment.	
			<19.5% O_2	Stop work and evacuate area.	
Air monitoring will also be performed in accordance with the NYSDOH Generic Community Air Monitoring Plan (CAMP), which is included in this HASP.					

[1] Sustained readings measured in the breathing zone

[2] Readings at measured at the source (borehole, well, etc.)

PPE Selection Guidelines

When selecting the appropriate PPE for the job, consider the following:

- **Safety glasses** – general eye protection – source of hazard, typically coming from straight on, required at most sites
- **Tinted Safety Glasses** – same as above, but when working in direct sunlight. May need two both tinted and untinted if working in both sunlight and shade/overcast skys.
- **Safety goggles** – needed for splash hazard, more severe eye exposures coming from all directions. Non-vented or indirect venting for chemical splash, non-vented for hazardous gases or very fine dust, vented for larger particulates coming from all directions.
- **Face shield** – needed to protect face from cuts, burns, chemicals (corrosives or chemicals with skin notation), etc.
- **Safety boots** – needed if danger of items being dropped on foot that could injure foot
- **Hard hat** – danger from items falling on head – any overhead work, tools, equipment, etc that is above the head and could fall on head of item fails, or falls off work platform. Typically required at most sites as a general PPE
- **Thin, chemical protective inner gloves** (e.g., thin Nitrile, PVC – do not use latex – many people are allergic to latex) –needed to protect hands from incidental contact with low risk contamination at very low concentrations (ppb or low ppm concentrations in groundwater or soil) or used in combination with outer gloves as a last defense against contamination. Need to specify type
- **Outer gloves** – thicker gloves (e.g., Nitrile, Butyl, Viton, etc.) – used when potential for high concentrations of contaminants (e.g., floating product, percent ranges of contaminant, opening drums, handling pure undiluted chemicals, etc.). Need to specify type.
- **Leather gloves, leather palm, cotton** – good in protecting hands against cuts – no protection from chemicals. May be used in combination with chemical protective gloves.
- **Boot Covers –** when there is contamination in surface soils or waking surface in general. When safety boots need protection from contact with contaminants.
- **White (uncoated) Tyveks** – protect clothing from getting dirty, good for protection against solid, non-volatile chemicals (e.g., asbestos, metals) – no chemical protection.
- **Polycoated Tyveks** – least protective of chemical protective clothing. Used when some risk of contamination getting on skin or clothing. Usually, lower ppm ranges of contaminants.
- **Saranex** – Greater protection against contamination than Polycoated Tyveks. Used to protect against PCBs or higher concentrations of contaminants in the soil or groundwater.
- **Other Chemical protective clothing** – if significant risk of dermal exposure, contact H&S to determine best kind.
- **Long sleeved shirts, long pants** – if working in areas with poison ivy/oak/sumac, poisonous insects, etc. and no chemicals exposure. May want to use uncoated Tyveks for work in areas where poisonous plants are know to be to protect clothing.
- **Cartridge Respirator (Level C PPE)** – Need to calculate change schedule (contact Division EH&S Manager for this) to determine length of use. To be able to use cartridge respirators, need to know contaminants, estimate levels to be encountered in the breathing zone, need to ensure that cartridge will be effective against COCs, and need to be able to monitor for COCs using PID, FID, Dräger tubes, etc.. If can't do any of these, then Level B PPE is probably going to be needed.
- **High Visibility Vest** – needed for any road work (with in 15 feet of a road) or when working on a site with vehicular traffic or working around heavy equipment. Needed if work tasks would take employee concentration away from movement of vehicles and workers would have to rely on the other driver's ability to see the employee in order not to hit them. This includes heavy equipment as well as cars and trucks, on public roads or the jobsite. Not needed if wearing Polycoated Tyveks – as they are already high visibility.
- **Reflective Vest** – see above, but for use at night.
- **Hearing Protection** – needed if working at noise levels above 85 dBA on a time weighted average. If noise measurements are not available, use around noisy equipment, or in general, if you have to raise your voice to be heard when talking to someone standing two feet away.
- **Protective Chaps –** required when using a machete or chain saw or any other cut hazard to legs.

Work Zones:
The work zones will be defined relative to the location of the work activity. The Exclusion Zone is considered the area within a 10-foot diameter of the sampling location. The Contamination Reduction Zone is considered to be the area with in a 20-foot diameter of the sampling location. The decontamination zone being located upwind of the work area. Work zones will be maintained through the use of:

☐ Warning Tape
☒ Visual Observations

Decontamination Procedures and Equipment:
Note: See Decontamination JHA for further information

Level D Decontamination Procedures

Decontamination Solution:	Detergent and Water
Station 1: Equipment Drop	Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, etc. on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, a cool-down station may be set up within this area.
Station 2: Outer Boots, and Gloves Wash and Rinse (if worn)	Scrub outer boots, and outer gloves decon solution or detergent water. Rinse off using copious amounts of water.
Station 3: Outer Boot and Glove Removal (if worn)	Remove outer boots and gloves. Deposit in plastic bag.
Station 4: Inner glove removal	Remove inner gloves and place in plastic bag.
Station 5: Field Wash	Hands and face are thoroughly washed. Shower as soon as possible.

Modified Level D and Level C PPE Decontamination Procedures

Decontamination Solution:	Detergent and Water
Station 1: Equipment Drop	Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, etc. on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, a cool-down station may be set up within this area.
Station 2: Outer Garment, Boots, and Gloves Wash and Rinse	Scrub outer boots, outer gloves, and splash suit with decon solution or detergent water. Rinse off using copious amounts of water.
Station 3: Outer Boot and Glove Removal	Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4: Canister or Mask (Level C only) Change	If worker leaves exclusion zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot covers are donned, joints are taped, and worker returns to duty.
Station 5: Boot, Gloves and Outer Garment Removal	Boots, chemical resistant splash suit, and inner gloves are removed and deposited in separate containers lined with plastic.
Station 6: Face Piece Removal (Level C only)	Facepiece is removed. Avoid touching face with fingers. Facepiece is deposited on plastic sheet.
Station 7: Field Wash	Hands and face are thoroughly washed. Shower as soon as possible.

Site Communication:

- ☒ Verbal
- ☒ Two-way radio
- ☒ Cellular telephone
- ☐ Hand signals

▪ Hand gripping throat	Out of air, can't breathe
▪ Grip partner's wrist or both hands around waist	Leave area immediately
▪ Hands on top of head	Need assistance
▪ Thumbs up	OK, I am all right, I understand
▪ Thumbs down	No, negative

- ☒ Horn
- ☐ Siren
- ☐ Other:

EMERGENCY CONTACTS

NAME	TELEPHONE NUMBERS		DATE OF PRE-EMERGENCY NOTIFICATION (if applicable)
Fire Department:	911		
Primary Hospital: Nyack Hospital	(845) 348-2345		
Secondary Hospital: Good Samaritan Hospital	(845) 368-5000		
Police Department:	911		
Site Health And Safety Officer: Jerry Rawcliffe	Office: 207-775-5401	Home: 207-807-7353	
Client Contact: NYSDEC – Randy Whitcher	Office: 518-402-9662	Pager:	
Project Manager: John Peterson	Office: 207-775-5401	Home:	
Division EH&S Manager: Cindy Sundquist	Office: 207-828-3309 (w) 207-650-7593(c)	Home: 207-892-4402	
EPA/DEP (if applicable):			
OTHER: Ambulance	911		
Health Resources	800-350-4511		

Emergency Equipment:
The following emergency response equipment is required for this project and shall be readily available:

- ☒ Field First Aid Kit
- ☒ Fire Extinguisher (ABC type)
- ☐ Eyewash (Note: 15 minutes of free-flowing fresh water)
- ☐ Other: ____________________

EMERGENCY PROCEDURES

- The HSO (or alternate) should be immediately notified via the on-site communication system. The HSO assumes control of the emergency response.
- The HSO notifies the Project Manager and client contact of the emergency. The HSO shall then contact the Division ES&H Manager who will then contact the Corporate EH&S Manager.
- If applicable, the HSO shall notify off-site emergency responders (e.g. fire department, hospital, police department, etc.) and shall inform the response team as to the nature and location of the emergency on-site.
- If applicable, the HSO evacuates the site. Site workers should move to the predetermined evacuation point (See Site Map).
- For small fires, flames should be extinguished using the fire extinguisher. Large fires should be handled by the local fire department.
- In an unknown situation or if responding to toxic gas emergencies, appropriate PPE, including SCBAs (if available), should be donned. If appropriate PPE is unavailable, site workers should evacuate and call in emergency personnel.
- For chemical spills, follow the job specific JHA for spill containment
- If chemicals are accidentally spilled or splashed into eyes or on skin, use eyewash and wash affected area. Site worker should shower as soon as possible after incident.
- If a worker is injured, first aid shall be administered by certified first aid provider.
- If the emergency involves toxic gases, workers will back off and reassess. Prior to re-entering the work zone, the area must be determined to be safe. Entry will be using Level B PPE and utilize appropriate monitoring equipment to verify that the site is safe.
- An injured worker shall be decontaminated appropriately.
- After the response, the SHSO shall follow-up with the required company reporting procedures, including the completing the MACTEC Incident Analysis Report.

Site Specific Emergency Procedures are as follows:

Refer to project HASP for MACTEC Program information such as Required Training, Medical monitoring, Investigative Derived Waste disposal and Decontamination procedures.

Decontamination and Investigative Derived Waste shall be handled as documented in the work plan.

Perimeter air monitoring with total dust meter – real time readings. Any visual dust – implement dust suppression methods.

FIELD TEAM REVIEW: I acknowledge that I understand the requirements of this HASP, and agree to abide by the procedures and limitations specified herein. I also acknowledge that I have been given an opportunity to have my questions regarding the HASP and its requirements answered prior to performing field activities. Health and safety training and medical surveillance requirements applicable to my field activities at this site are current and will not expire during on-site activities.

Name: ______________________ Date: ______________

Name: ______________________ Date: ______________

Name: ______________________ Date: ______________

Name: ______________________ Date: ______________

Name: ______________________ Date: ______________

Routes to Emergency Medical Facilities

PRIMARY HOSPITAL:

Facility Name:____Nyack Hospital____
Address:_________160 N Midland Ave____
Telephone Number___(845) 348-2345____

DIRECTIONS TO PRIMARY HOSPITAL (attach map):

See map

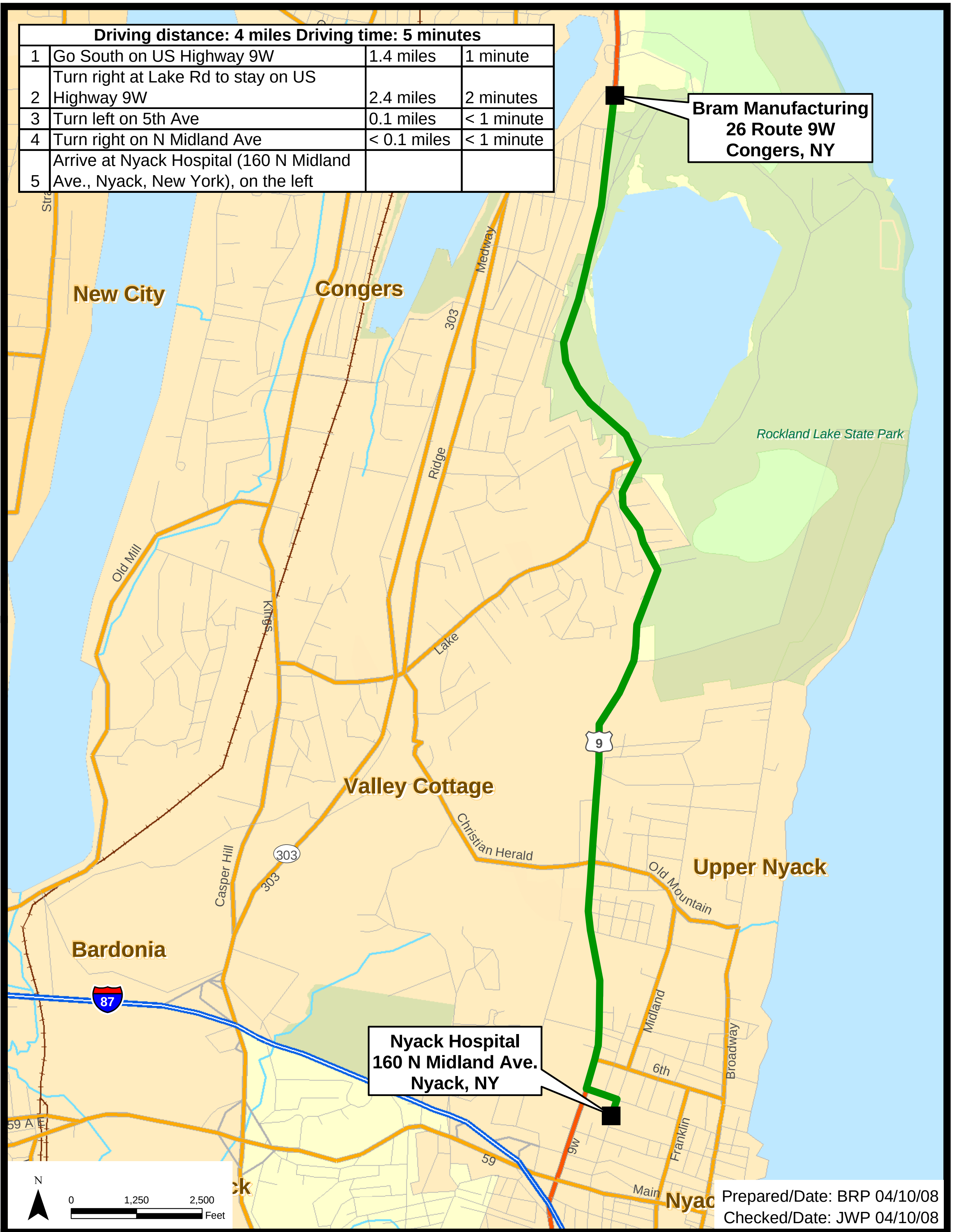
ALTERNATE HOSPITAL:

Facility Name:_________Good Samaritan Hospital____
Address:_____________255 Lafayette Ave.____
Telephone Number____Suffern, NY 10901 ____

DIRECTIONS TO ALTERNATE HOSPITAL (attach map):

See map

Driving distance: 4 miles Driving time: 5 minutes			
1	Go South on US Highway 9W	1.4 miles	1 minute
2	Turn right at Lake Rd to stay on US Highway 9W	2.4 miles	2 minutes
3	Turn left on 5th Ave	0.1 miles	< 1 minute
4	Turn right on N Midland Ave	< 0.1 miles	< 1 minute
5	Arrive at Nyack Hospital (160 N Midland Ave., Nyack, New York), on the left		



Bram Manufacturing
26 Route 9W
Congers, NY

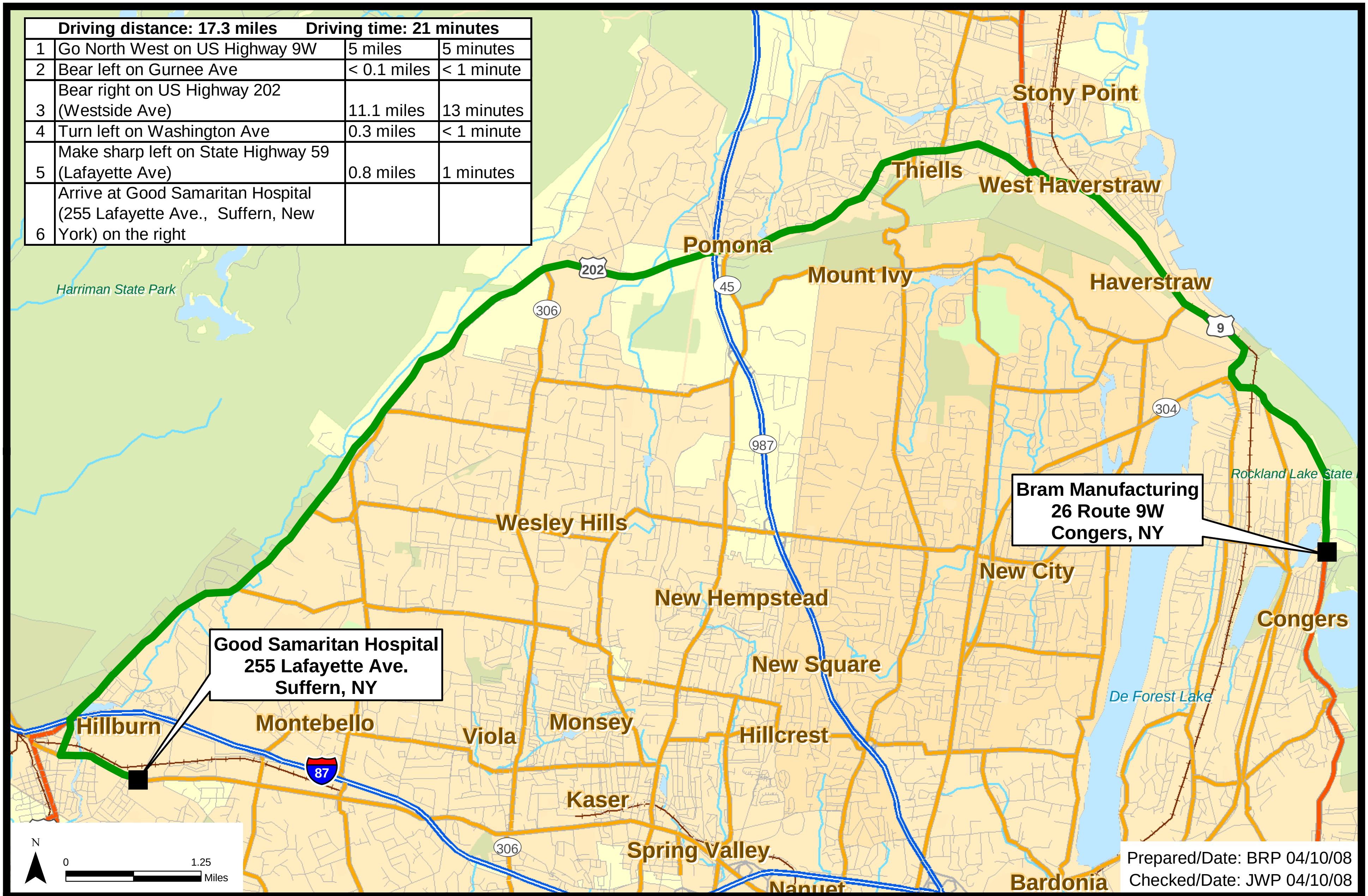
Nyack Hospital
160 N Midland Ave.
Nyack, NY

Prepared/Date: BRP 04/10/08
Checked/Date: JWP 04/10/08

RI/FS WORK PLAN
BRAM MANUFACTURING
CONGERS, NEW YORK

MACTEC

PRIMARY HOSPITAL ROUTE
NYACK HOSPITAL
Project 3612-08-2098
Figure B-1



	Driving distance: 17.3 miles	Driving time: 21 minutes	
1	Go North West on US Highway 9W	5 miles	5 minutes
2	Bear left on Gurnee Ave	< 0.1 miles	< 1 minute
3	Bear right on US Highway 202 (Westside Ave)	11.1 miles	13 minutes
4	Turn left on Washington Ave	0.3 miles	< 1 minute
5	Make sharp left on State Highway 59 (Lafayette Ave)	0.8 miles	1 minutes
6	Arrive at Good Samaritan Hospital (255 Lafayette Ave., Suffern, New York) on the right		

Good Samaritan Hospital
255 Lafayette Ave.
Suffern, NY

Bram Manufacturing
26 Route 9W
Congers, NY

Prepared/Date: BRP 04/10/08
Checked/Date: JWP 04/10/08

RI/FS WORK PLAN
BRAM MANUFACTURING
CONGERS, NEW YORK

MACTEC

SECONDARY HOSPITAL ROUTE
GOOD SAMARITAN HOSPITAL
Project 3612-08-2098
Figure B-2

Document: P:\Projects\nysdec1\projects\Bram Manufacturing\4.0 Project Deliverables\4.5 Databases\GIS\MapDocuments\Bram_HospRoute2_8x11P.mxd PDF: P:\Projects\nysdec1\projects\Bram Manufacturing\4.0 Project Deliverables\4.2 Work Plans\RI Work Plan\NEW Appendix B - HASP\FigureB-2.pdf 04/10/2008 3:01 PM brpeters

Check one
Initial Report: ☐
Update: ☐
Final Report: ☐

Category C: ☐
Category B: ☐
Category A: ☐

ATTACHMENT 1

INCIDENT ANALYSIS REPORT

Attorney-Client Work Product Prepared in Anticipation of Litigation

(Review instructions on page 9 prior to completing this form)

Local Office ID Number: ________

To: Office of the General Counsel

This information has been prepared at your request and under your direction in anticipation of litigation so that you may prove appropriate legal advice to the undersigned and the management of the Company.

Section 1 – General Information

Report Date: ____________________ Incident Date: ________ Time of incident: ________

Employee Name: ____________________ Sex: ☐ M ☐ F

Job Title: ____________________ Hire Date: ________ Time employee began work: ________

Department: ____________________ Project Manager: ____________ Client: ________________

Office where employee works from: ____________ Immediate Supervisor: ____________ Hours employee worked during last 7 days: ____ hr

Location where incident occurred: ______________________________ Is this a Company controlled work site: ☐ Yes ☐ No

---

Section 2 – Incident Type (mark all that apply)

A. Type of incident being reported:

☐ Near Miss ☐ First-aid Case ☐ Medical Treatment ☐ Hospitalization ☐ Day Away Case ☐ Restricted/Transfer Case

☐ Fatality ☐ Vehicle Incident ☐ Notice of Violation ☐ Regulatory Inspection ☐ Environmental Release

☐ Other (please describe): ________

B. If an **injury or illness** - describe the part of the body that was affected and how it was affected:

C. If an **environmental release** - describe the quantity and name and CAS# of material released into the environment:

D. If an **inspection by a regulatory agency** - what agency, who were the inspectors, and supply inspector contact information:

Section 3 – Incident Description (Attach and number additional pages, as needed, to ensure **all details related to the incident are captured.**)

A. List the names of all persons involved in the incident, and employer information:

B. List the names of any witnesses, their employer, and a local/company telephone number or address:

C. What was the employee(s) doing just prior to the incident?

D. Explain in **detail** what happened?

E. Explain in **detail** what object or substance directly harmed the employee?

F. List any damaged equipment or property (other than motor vehicles) model and serial number **and** estimated costs to repair/replace damaged equipment or property, if applicable:

Section 4 - Incident Analysis

A. Was a Job Hazard Analysis (JHA) completed for the work being performed? YES ☐ NO ☐ Who prepared the JHA?

B. When and who was the last safety officer (i.e. LHSR, supervisor, Division ES&H Manager, etc.) at your work site?

C. When and what safety training **directly related** to the incident has the person(s) involved had?

Section 5 - Incident Investigation Results

#	**Causal Factors** (Attach and number any additional pages as needed to completely address this section)
1	
2	
3	
4	
5	

Root Cause(s) Analysis (The below items represent major root cause categories which have been determined to be Less Than Adequate (LTA). A more detailed determination of the root cause will be facilitated, if needed, by your Division's ES&H Manager.)

1. Equipment Reliability Program Implementation
2. Administrative / Management Systems
3. Procedures
4. Human Factors Engineering
5. Training
6. Immediate Supervision
7. Communications
8. Personal Performance

Root Cause #	**Corrective Actions to be taken** (Attach additional pages as needed to completely address this section)	**Responsible Person**	**Proposed Completion Date**	**Closed on Date**	**Verified by and Date Verified**

Section 6 – Notifications, Certification & Approvals

Check the appropriate boxes indicating the applicable reports have been made to the following organizations:

Auto Lessor ☐ **Insurer** ☐ **Workers' Compensation Administrator** ☐

Post-incident Substance Abuse Testing Has Been Performed ☐

Incident investigated by (signatures):			
Employee(s):	Date:	Employee's Supervisor:	Date:
LHSR/Project/Office Manager:	Date:	Division ES&H Manager:	Date:

HIGHEST CONCENTRATIONS OF PREVIOUSLY DETECTED COMPOUNDS
HEALTH AND SAFETY PLAN
BRAM MANUFACTURING, CONGERS, NEW YORK

Parameter	Groundwater Concentration (µg/L)	Year Detected	PELs/TLV	
Bram Site Contaminants				
Chlorinated Hydrocarbons				
1,2-dichloroethene	3100	1999/2003	200	ppm
tetrachloroethene	300	2003	25 / (100 ppm STEL)	ppm
1,1,1-Trichloroethane	87	1998	350 (450 ppm STEL)	ppm
cis-1,2-Dichloroethene	2600	1998	200	ppm
Trichloroethene	9500	2004	100	ppm
vinyl chloride	440	2004	1	ppm
Aromatic Hydrocarbons				
n-Butylbenzene	25	1999	NA	ppm
tert-Butylbenzene	370	1999	NA	ppm
Ethylbenzene	210	1999	100 (75 ppm STEL)	ppm
Isopropylbenzene	170	1999	50	ppm
p-isopopyltoluene	12	1999	NA	ppm
n-propylbenzene	270	1999	NA	ppm
1,2,4-trimethylbenzene	3200	1999	25	ppm
1,3,5-trimethylbenzene	1800	1999	25	ppm
o-Xylene	22	1999	100 (150 ppm STEL)	ppm
p-&m-Xylene	91	1999	100 (150 ppm STEL)	ppm
Other Compounds				
1,3-dichloropropane	510	1998	NA	ppm
actetone	1700	2003	500 / 250 - REL (750 ppm STEL)	ppm

Notes:

PELs/TLV = Permissible Exposure Limits/Threashold Limit Value
ppm = parts per million
ND = not detected
NA = none available

Created by: JWP
Checked by: CRS

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
1,2-Dichloroethylene 156-59-2,
CAS Number: 540-59-0, 156-60-5
Synonyms:
Acetylene dichloride,
cis -Acetylene dichloride,
trans-Acetylene dichloride,

HEALTH HAZARD DATA

Color: Colorless

Physical State: Solid ___ Liquid X Gas ___

Odor: Chloroform-like

Odor Threshold: 0.08-17 ppm

Vapor Density: 3.35 g/L

Ionization Potential (IP): 9.65 eV

IDLH: 1000 ppm

Carcinogen:
OSHA ___
IARC ___
NTP ___
ACGIH ___
NIOSH ___

Skin absorbable: yes ___ no X
Skin corrosive: yes ___ no X

Signs/Symptoms of Acute Exposure:
Irritant to eyes and respiratory system,
CNS, depression

Source	TWA (units)	STEL (units)	C (units)
OSHA PELs	200 ppm		
ACGIH TLVs	200 ppm		
NIOSH RELs	200 ppm		

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID	Microtip 10.6eV	Isobutylene 100 ppm	1.45	290

Checked by: Emmet F. Curtis Date: 12/5/03

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:

Suits	Teflon, Viton, PE/EVAL, Barricade, CPF3, Tychem Responder
Gloves	Viton, Teflon, Polyvinyl Alcohol (do not use in water)
Boots	Teflon, Viton

Service Limit Concentration (ppm): 1000

MUC 1/2 Mask APR = TWA x 10 = 1000 ppm
MUC Full-Face APR = TWA x 10 = 1000 ppm

FIRE/REACTIVITY DATA

Flash Point: 36-39 ° F

LEL/UEL: 5.6% / 12.8%

Fire Extinguishing Media:
Dry Chemical X Foam X
Water Spray X CO_2 X

Incompatibilities:
Strong oxidizers, strong alkalis, potassium hydroxide, copper

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminant exists. Professional judgement and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
Tetrachloroethene
CAS Number: 127-18-4
Synonyms:
tetrachloroethylene
Perchloroethylene (Perc)

HEALTH HAZARD DATA

Color: colorless

Physical State: Solid
Liquid X
Gas

Odor: chloroform-like

Odor Threshold: 47 ppm

Vapor Density: 6.8 g/L

Ionization Potential (IP): 9.32 eV

IDLH: 150 ppm

Carcinogen:	
OSHA	
IARC	
NTP	X
ACGIH	X
NIOSH	X

Skin absorbable: yes __ no X
Skin corrosive: yes __ no X

Signs/Symptoms of Acute Exposure:
Irritation of eyes, nose, and throat; nausea; flushing of the face and neck; vertigo; dizziness; incoherence; headache; sleepiness, and skin irritation

Source	TWA (units)	STEL (units)	C (units)
OSHA PEL	100 ppm		200 ppm
ACGIH TLVs	25 ppm	100 ppm	
NIOSH RELs	Lowest Feasible		

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID	Microtip 10.6 eV	Isobutylene 100 ppm	1.04 ppm	26 ppm
PID	HNu 10.2 eV	Isobutylene 100 ppm	0.86	21.5 ppm
Detecor Tube	Drager 8101 501	2 - 40 ppm		25 ppm

Checked by: Emmet F. Curtis Date: 12/5/03

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:

Suits	Teflon, Viton, CPF3, Barricade, Responder, Trellchem, Tychem
Gloves	Viton, Teflon, and Polyvinyl Alcohol (do not use in (water)
Boots	Nitrile Rubber

Service Limit Concentration (ppm): 1000

MUC 1/2 Mask APR=TWA x 10= 125 ppm
MUC Full-Face APR=TWA x 10= 125 ppm

FIRE/REACTIVITY DATA

Flash Point: NA

LEL/UEL: NA / NA

Fire Extinguishing Media:

Dry Chemical	X	Foam	X
Water Spray	X	CO_2	X

Incompatibilities:
Strong oxidizers, chemically-active metals, caustic soda, sodium hydroxide, and potash

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminants exists. Professional judgment and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
1,1,1-Trichloroethane
CAS Number: 71-55-6
Synonyms:
Methyl chloroform; chlorothene

HEALTH HAZARD DATA

Color: Colorless
Physical State: Solid ___ Liquid X Gas ___
Odor: Chloroform-like
Odor Threshold: 100 ppm
Vapor Density: 5.5 g/L
Ionization Potential (IP): 11.00 eV
IDLH: 700 ppm

Carcinogen: OSHA ___ IARC ___ NTP ___ ACGIH ___ NIOSH ___
Skin absorbable: yes __ no X
Skin corrosive: yes X no ___

Signs/Symptoms of Acute Exposure:
Skin irritation, headaches, dizziness, nausea, vomiting, diarrhea

Source	TWA (units)	STEL (units)	C (units)
OSHA PEL	350 ppm		
ACGIH TLVs	350 ppm	450 ppm	
NIOSH RELs			350 ppm

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID	HNU 11.7eV	Isobutylene 100 ppm	0.48	168

Checked by: Emmet F. Curtis Date: 12/5/03

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:
Suits: Tychem, Teflon, Viton
Gloves: Teflon, Viton, PE/EVAL, Polyvinyl alchohol (Do not use in water)
Boots: Teflon, Viton

Service Limit Concentration (ppm): NA

MUC 1/2 Mask APR=TWA x 10= 700 ppm
MUC Full-Face APR=TWA x 10= 700 ppm

FIRE/REACTIVITY DATA

Flash Point: NA

LEL/UEL: 7.5% / 12.5%

Fire Extinguishing Media:
Dry Chemical X
Water Spray ___
Foam X
CO_2 X

Incompatibilities:
Strong caustics; strong oxidizers; chemically active metals such as: zinc, aluminum, magnesium powders, sodium, and potassium; water

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminants exists. Professional judgment and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
Cis -1,2-Dichloroethylene
CAS Number: 540-59-0
Synonyms:
Acetylene dichloride,
cis -Acetylene dichloride,
trans-Acetylene dichloride,

HEALTH HAZARD DATA

Color: Colorless

Physical State: Solid ___
Liquid X
Gas ___

Odor: Chloroform-like

Odor Threshold: 0.08-17 ppm

Vapor Density: 3.35 g/L

Ionization Potential (IP): 9.65 eV

IDLH: 1000 ppm

Carcinogen: OSHA ___
IARC ___
NTP ___
ACGIH ___
NIOSH ___

Skin absorbable: yes ___ no X
Skin corrosive: yes ___ no X

Signs/Symptoms of Acute Exposure:
Irritant to eyes and respiratory system,
CNS, depression

Source	TWA (units)	STEL (units)	C (units)
OSHA PELs	200 ppm		
ACGIH TLVs	200 ppm		
NIOSH RELs	200 ppm		

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID	Microtip 10.6eV	Isobutylene 100 ppm	0.8	160

Checked by: Emmet F. Curtis Date: 12/5/03

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:

Suits	Teflon, Viton, PE/EVAL, Barricade, CPF3, Tychem Responder
Gloves	Viton, Teflon, Polyvinyl Alcohol (do not use in water)
Boots	Teflon, Viton

Service Limit Concentration (ppm): 1000

MUC 1/2 Mask APR = TWA x 10 = 1000 ppm
MUC Full-Face APR = TWA x 10 = 1000 ppm

FIRE/REACTIVITY DATA

Flash Point: 36-39 ° F

LEL/UEL: 5.6% / 12.8%

Fire Extinguishing Media:

Dry Chemical	X	Foam	X
Water Spray	X	CO_2	X

Incompatibilities:
Strong oxidizers, strong alkalis, potassium hydroxide, copper

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminant exists. Professional judgement and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
Trichloroethene
CAS Number: 79-01-6
Synonyms:
Ethylene trichloride, TCE,
Trichloroethylene, Trilene

HEALTH HAZARD DATA

Color: Colorless

Physical State: Solid ___
Liquid X
Gas ___

Odor: Chloroform-like

Odor Threshold: 82 ppm

Vapor Density: 4.5 g/L

Ionization Potential (IP): 9.45 eV

IDLH: 1000 ppm

Carcinogen: OSHA ___
IARC ___
NTP ___
ACGIH ___
NIOSH X

Skin absorbable: yes ___ no X
Skin corrosive: yes ___ no X

Signs/Symptoms of Acute Exposure:
Irritant to eyes and skin, headache nausea, vomiting, dermatitis, vertigo, visual disturbance, fatigue, giddiness, sleepiness

Source	TWA (units)	STEL (units)	C (units)
OSHA PELs	100 ppm		200 ppm
ACGIH TLVs	10 ppm	100 ppm	
NIOSH RELs	25 ppm		

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID	Microtip 10.6eV	Isobutylene 100 ppm	0.92	23
PID	HNu 10.2eV	Isobutylene 100 ppm	0.90	22.5
Detector Tube	Drager 6828541	2 - 50 ppm		25

Checked by: Emmet F. Curtis Date: 12/5/03

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:

Suits	Viton, PE/EVAL, Tychem, Barricade, Trellchem, Teflon, Responder
Gloves	Viton, Teflon Polyvinyl alcohol (do not use in water)
Boots	Teflon, Viton

Service Limit Concentration (ppm): 1000

MUC 1/2 Mask APR = TWA x 10 = 250 ppm
MUC Full-Face APR = TWA x 10 = 250 ppm

FIRE/REACTIVITY DATA

Flash Point: Unknown

LEL/UEL: 8% / 10.5%

Fire Extinguishing Media:
Dry Chemical X
Water Spray X
Alcohol resistant Foam X
CO_2 X

Incompatibilities:
Strong caustics and alkalis, chemically-active metals (such as barium, lithium, sodium, magnesium, titanium, and beryllium)

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminant exists. Professional judgement and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
Vinyl Chloride
CAS Number: 75-01-4
Synonyms:
Chloroethene, chloroethylene,
ethylene monochloride, VC,
monochloroethene

HEALTH HAZARD DATA

Color: Colorless

Physical State: Solid ___
Liquid X below 7^{0}F
Gas X

Odor: pleasant

Odor Threshold: 10-20 ppm

Vapor Density: 2.15 g/L

Ionization Potential (IP): 9.99 eV

IDLH: Not Determined

Carcinogen: OSHA X
IARC X
NTP X
ACGIH X
NIOSH X

Skin absorbable: yes ___ no X
Skin corrosive: yes ___ no X

Signs/Symptoms of Acute Exposure:
Weakness, abdominal pain, frostbite
paleness or blueness of extremeties

Source	TWA (units)	STEL (units)	C (units)
OSHA PELs	1.0 ppm		5.0 ppm
ACGIH TLVs	1.0 ppm		
NIOSH RELs	Lowest Feasible		

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID	Microtip 10.6eV	Isobutylene 100 ppm	0.67	0.67
PID	HNu 10.2eV	Isobutylene 100 ppm	0.32	0.32
PID	HNu 11.7 eV	Isobutylene 100 ppm	0.78	0.78
Detector Tube	Drager 6728061	0.5 - 3 ppm		1.0 ppm

Checked by: Emmet F. Curtis Date: 12/5/03

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:

Suits	Tychem, Teflon
Gloves	Teflon, Tychem Nitrile Rubber
Boots	Nitrile Rubber, Teflon

Service Limit Concentration (ppm): 1000

MUC 1/2 Mask APR = TWA x 10 = 5 ppm
MUC Full-Face APR = TWA x 10 = 5 ppm

FIRE/REACTIVITY DATA

Flash Point: NA

LEL/UEL: 3.6% / 33%

Fire Extinguishing Media:
Dry Chemical X Foam X
Water Spray X CO_2 X

Incompatibilities:
Copper, oxidizers, aluminum, peroxides,
iron, steel (polymerizes in air, sunlight, or
heat unless stabilized by inhibitors). Attacks
iron and steel in presence of moisture.

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminant exists. Professional judgement and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
n-Butylbenzene
CAS Number: 104-51-8
Synonyms:
Phenyl butane

HEALTH HAZARD DATA

Color: Colorless

Physical State: Solid ___ Liquid X Gas ___

Odor: Sweet odor

Odor Threshold: N/A

Vapor Density: 0.9 g/L
Vapro Pressure: 1.03 mmHg
Ionization Potential (IP): 8.68 eV

IDLH: N/A

Carcinogen:	
OSHA	N/A
IARC	N/A
NTP	N/A
ACGIH	N/A
NIOSH	N/A

Skin absorbable: yes X no ___
Skin corrosive: yes ___ no X

Signs/Symptoms of Acute Exposure:
Irritant to eyes, skin, nose, headache
nausea, staggered gait.

Source	TWA (units)	STEL (units)	C (units)
OSHA PELs	NA		
ACGIH TLVs	NA		
NIOSH RELs	NA		

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID 10.2 eV Lamp	Any	Isobutylene	N/A	>0
PID	No exposure limit. If major contaminant of concern and levels in Breathing zone exceed background, upgrade to level B PPE.			
FID				

Checked by:C. Sundquist Date:10/12/09

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:
Suits: Barricade
Gloves: Viton
Boots: ___

Service Limit Concentration (ppm): >0

MUC 1/2 Mask APR = TWA x 10 = N/A
MUC Full-Face APR = TWA x 10 = N/A

Upgrade to Level B PPE.

FIRE/REACTIVITY DATA

Flash Point: 71 ° C

LEL/UEL: 0.8 / 5.8%

Fire Extinguishing Media:
Dry Chemical X Foam X
Water Spray X CO_2 X

Incompatibilities:
Avoid heat/ ignition sources, and oxidizers
Store in well ventilated area
empty containers with residue are explosive

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminant exists. Professional judgement and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
tert-Butylbenzene
CAS Number: 98-06-6
Synonyms:
2 Methy 2 Phenylpropane

HEALTH HAZARD DATA

Color: Colorless

Physical State: Solid ___
Liquid X
Gas ___

Odor: Benzene like

Odor Threshold: NA

Vapor Density: 4.6
Vapor Pressure 5.7 mmHg
Ionization Potential (IP): 8.68 eV

IDLH: NA

Carcinogen:	
OSHA	NA
IARC	NA
NTP	NA
ACGIH	NA
NIOSH	NA

Skin absorbable: yes X no ___
Skin corrosive: yes __ no X

Signs/Symptoms of Acute Exposure:
Irritant to eyes, skin, nose, headache
nausea, staggered gait.

Source	TWA (units)	STEL (units)	C (units)
OSHA PELs	NA		
ACGIH TLVs	NA		
NIOSH RELs	NA		

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID 10.2 eV Lamp	Any	Isobutylene	N/A	>0
	No exposure limit. If major contaminant of concern and levels in Breathing zone exceed background, upgrade to level B PPE.			

Checked by: C.Sundquist Date:10/12/09

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:
Suits Barricade
Gloves Viton
Boots

Service Limit Concentration (ppm): >0

MUC 1/2 Mask APR = TWA x 10 = N/A
MUC Full-Face APR = TWA x 10 = N/A

Upgrade to Level B PPE

FIRE/REACTIVITY DATA

Flash Point: 140° F

LEL/UEL: 0.8 / 5.8%

Fire Extinguishing Media:
Dry Chemical X Foam ___
Water Spray X CO_2 ___

Incompatibilities:
Keep away from heat or ignition source.
Ground container. Well ventilated area

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminant exists. Professional judgement and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name: Ethylbenzene
CAS Number: 100-41-4
Synonyms: Ethylbenzol, Phenylethane

HEALTH HAZARD DATA

Color: Colorless
Physical State: Solid ___ Liquid X Gas ___
Odor: Aromatic
Odor Threshold: 0.092 - 0.6 PPM
Vapor Density: 3.66 g/L
Ionization Potential (IP): 8.76 eV
IDLH: 800 ppm

Carcinogen: OSHA ___ IARC ___ NTP ___ ACGIH ___ NIOSH ___
Skin absorbable: yes ___ no X
Skin corrosive: yes ___ no ___

Signs/Symptoms of Acute Exposure:
Irritant to eyes, skin, and mucous membranes; dermatitis, and headache

Source	TWA (units)	STEL (units)	C (units)
OSHA PELs	100 ppm		
ACGIH TLVs	100 ppm	125 ppm	
NIOSH RELs	100 ppm	125 ppm	

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID	Microtip 10.6 eV	Isobutylene 100 ppm	1.63	163
PID	HNu 10.2 eV	Isobutylene 100 ppm		
FID	Foxboro TVA 1000 (10.6 eV)	Methane	3.7	370

Checked by: Emmet F. Curtis Date: 12/5/03

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:
Suits: Viton, Barricade, Tychem Responder, Teflon
Gloves: Viton, teflon
Boots: Teflon

Service Limit Concentration (ppm): 1000

MUC 1/2 Mask APR= TWA x 10 = 500 ppm
MUC Full-Face APR= TWA x 10 = 500 ppm

FIRE/REACTIVITY DATA

Flash Point: 55° F

LEL/UEL: 0.8% / 6.7%

Fire Extinguishing Media:
Dry Chemical X
Water Spray ___
Alcohol Resistant Foam X
CO_2 X

Incompatibilities:
Strong oxidizers

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminants exists. Professional judgment and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
Isopropylbenzene
CAS Number: 98-82-8
Synonyms:
Cumene, Cumol, 2-p[henyl propane

HEALTH HAZARD DATA

Color: colorless

Physical State: Solid ___ Liquid x Gas ___

Odor: sharp, penetrating aromatic

Odor Threshold: 0.008-0.132 ppm

Vapor Density: 4.1
Vapor Pressure 8 mmHg
Ionization Potential (IP) 8.75 eV

IDLH: 900 ppm (10% LEL)

Carcinogen: OSHA ___ IARC ___ NTP ___ ACGIH ___ NIOSH ___

Skin absorbabl Yes X No ___
Skin corrosive: Yes ___ No X

Signs/Symptoms of Acute Exposure:
Irritates eyes, skin, and mucous membrane
Causes dermatitis, headaches, narcosos, c

Source	TWA (units) ppm	STEL (units) ppm	C (units) ppm
OSHA PELs	50 ppm Skin		
ACGIH TLVs	50 ppm		
NIOSH RELs	50 ppm Skin		

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID with 10.2 - 10.6 eV lamp	Any	100 ppm isobutyle	1.22	30 ppm*
*PID calibrated to read 1:1 benzene				

Checked by: Date:

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:

Suits: Tychem responder (pure ch
Polycoated/Saranex (low pp
ppb ranges)

Gloves: Viton, Neoprene, Nitrile

Boots: Neoprene, Nitrile

Service Limit Concentration (ppm): 300 ppm*

MUC 1/2 Mask APR = TWA x 10 = 300 ppm*
MUC Full-Face APR = TWA x 10 = 300 ppm*

*meter reading - meter calibrated to read 1:1 benze

FIRE/REACTIVITY DATA

Flash Point: 96°F

LEL/UEL: 0.9 - 6.5%

Fire Extinguishing Media:
Dry Chemical X Foam X
Water Spray X CO_2 X

Incompatibilities:
Oxidizers, nitric acid, sulfuric acid.
Forms cumene hydroperoxide upon long exposure to air.

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminants exists. Professional judgment and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
P-Cymeme
CAS Number: 99-87-6
Synonyms: Isopropyltoluene
1-Methyl-4-isopropylbenzene;
4-Isopropyl-1-methylbenzene; Benzene,
1-isopropyl-4-methyl-;
mol; Dolcymene; p-Isopropylmethylbenzene;
p-Isopropyltoluene; p-Methylisopropyl benzene; Paracymene;
yp Paracymol

HEALTH HAZARD DATA

Color: Colorless, clear

Physical State: Solid ___ Liquid X Gas ___

Odor: Sweetish, aromatic

Odor Threshold: ___

Vapor Density: 4.62
Vapor Pressure 1.5 mmHg
Ionization Potential (IP) ≈ 9-10 eV

IDLH: NA
NA = Not Available

Carcinogen:	
OSHA	NA
IARC	NA
NTP	NA
ACGIH	NA
NIOSH	NA

Skin absorbabl Yes X No ___
Skin corrosive: Yes ___ No X

Signs/Symptoms of Acute Exposure:
skin irritation. Symtoms can include
erythema, dryness and defatting
Irritation to eyes. May cause drowsiness,
central nervous system depression,
unconciousness, somnolence, and
headaches
NA = Not Available

Source	TWA (units) ppm	STEL (units) ppm	C (units) ppm
OSHA PELs	NA		
ACGIH TLVs	NA		
NIOSH RELs	NA		

	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID with 10.2 - 10.6 eV lamp	Any	100 ppm isobutyle	Unk	Level B > 0
Dust Meter		Factory		**
**Action limit will be based on soil concentrations. Contact C. Sundquist for action limits				

Checked by: Cindy Sundquist Date:

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:
Suits Tychem 10,000
Gloves Viton
Boots

Service Limit Concentration (ppm): >0

MUC 1/2 Mask APR = TWA x 10 = N/A
MUC Full-Face APR = TWA x 10 = N/A

Can't monitor, no exposure limit, Level B PID >0

FIRE/REACTIVITY DATA

Flash Point: 117°F

LEL/UEL: 0.7-5.6%

Fire Extinguishing Media:
Dry Chemical X Foam ___
Water Spray X CO_2 ___

Incompatibilities:
Oxidizers

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminants exists. Professional judgment and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
Propylbenzene
CAS Number: 203-132-9
Synonyms:
1-phenyl propane

HEALTH HAZARD DATA

Color:	Clear, colorless
Physical State:	Solid ___ Liquid X Gas ___
Odor:	Benzene-like
Odor Threshold:	N/A
Vapor Density:	4.1
Vapor Pressure	N/A
Ionization Potential (IP	8.72 eV
IDLH:	NA

Carcinogen: OSHA ___
IARC ___
NTP ___
ACGIH ___
NIOSH ___

Skin absorbabl Yes ___ No ___
Skin corrosive: Yes ___ No ___

Signs/Symptoms of Acute Exposure:
Eye and skin irritation. May cause digestive tract irritation with nausea, vomiting, and diarrhea.

Source	TWA (units) ppm	STEL (units) ppm	C (units) ppm
OSHA PELs	N/A		
ACGIH TLVs	N/A		
NIOSH RELs	N/A		

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID with 10.2 - 10.6 eV lamp	Any	100 ppm isobutyle	Unk	Above background
*PID calibrated to read 1:1 benzene				

Checked by: Date:

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:

Suits	Tychem responder (pure chem) Polycoated/Saranex (ppm/ ppb ranges)
Gloves	Rubber
Boots	Rubber

Service Limit Concentration (ppm): N/A

MUC 1/2 Mask APR = TWA x 10 = N/A
MUC Full-Face APR = TWA x 10 = N/A

*meter reading - meter calibrated to read 1:1 benze

FIRE/REACTIVITY DATA

Flash Point: 86°F

LEL/UEL: 6 - 80%

Fire Extinguishing Media:

Dry Chemical	X	Foam	X
Water Spray	X	CO_2	X

Incompatibilities:
Strong oxidizing agents

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminants exists. Professional judgment and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
1,2,4 Trimethylbenzene
CAS Number: 95-63-6
Synonyms:
psi-Cumeme, Pseudodocumene
asymmetrical trimethylbenzene

HEALTH HAZARD DATA

Color: clear, colorless

Physical State: Solid ___
Liquid X
Gas ___

Odor: distinctive, aromatic

Odor Threshold: 0.006 - 2.4 ppm

Vapor Density: 4.2
Vapor Pressure: 1 mm Hg @ 56° I
Ionization Potential (IP): 8.27 eV

IDLH: N.D.

Carcinogen: OSHA ___
IARC ___
NTP ___
ACGIH ___
NIOSH ___

Skin absorbable: Yes
Skin corrosive: No

Signs/Symptoms of Acute Exposure:
Irritates eyes, skin, nose, throat and respiratory system. Causes bronchitis, anemia, headaches drowsiness, lassitude, dizziness, nausia, vomiting confusion, chemical pneumonia.

Source	TWA (units)	STEL (units)	C (units)
OSHA PELs			
ACGIH TLVs	25 ppm		
NIOSH RELs	25 ppm		

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID	Microtip 10.6eV	Isobutylene 100 ppm	0.86	10 ppm*
PID	Hnu 10.2 eV	Isobutylene 100 ppm		10 ppm*
FID	Foxboro OVA 128	Methane	0.63	

* when PID calibrated to read benzene equivalent.

Checked by: Date:

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:

Suits: Tychem responder - pure chem
Polycoated - ppm/ppb

Gloves: Nitrile, neoprene

Boots: Tychem, neoprene

Service Limit Concentration (ppm): 100 ppm*

MUC 1/2 Mask APR = TWA x 10 = 100 ppm*
MUC Full-Face APR = TWA x 10 = 100 ppm*
*Action limit as read on PID calibrated to read 1:1 benzene

FIRE/REACTIVITY DATA

Flash Point: 112° F

LEL/UEL: 0.9% - 6.4%

Fire Extinguishing Media:
Dry Chemical ___ Foam ___
Water Spray ___ CO_2 ___

Incompatibilities:
Oxidizers, Nitric Acid

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminants exists. Professional judgment and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
1,3,5 Trimethylbenzene
CAS Number: 108-67-8
Synonyms:
Mesitylene, Symetrical trimethylbenzene,
sym-trimethylbenzene

HEALTH HAZARD DATA

Color: Clear, colorless

Physical State:
Solid
Liquid X
Gas

Odor: distinctive, aromatic

Odor Threshold: 0.037 - 2.2 ppm

Vapor Density: 4.1
Vapor Pressure: 2 mm Hg
Ionization Potential (IP): 8.39 eV

IDLH: N.D.

Carcinogen:
OSHA
IARC
NTP
ACGIH
NIOSH

Skin absorbable: Yes
Skin corrosive: No

Signs/Symptoms of Acute Exposure:
Irritates eyes, skin, nose, throat and respiratory system. Causes bronchitis, hypochromatic anemia, headaches, drowsiness, lassitude, dizziness, nausia, vomiting, confusion, chemical pneumonia.

Source	TWA (units)	STEL (units)	C (units)
OSHA PELs			
ACGIH TLVs	25 ppm		
NIOSH RELs	25 ppm		

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID	Microtip 10.6eV	Isobutylene 100 ppm	0.68*	8 ppm*
PID	Hnu 10.2 eV	Isobutylene 100 ppm	0.68*	8 ppm*
FID	Foxboro OVA 128	Methane	0.63	

* when PID calibrated to read benzene equivalent.

Checked by: Date:

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:

Suits	Tychem responder - pure chem Polycoated - ppm/ppb
Gloves	Nitrile, neoprene
Boots	Tychem, neoprene

Service Limit Concentration (ppm): 80 ppm*

MUC 1/2 Mask APR = TWA x 10 = 80 ppm*
MUC Full-Face APR = TWA x 10 = 80 ppm*
*Action limit as read on PID calibrated to read 1:1 benzene

FIRE/REACTIVITY DATA

Flash Point: 122°F

LEL/UEL: Unk

Fire Extinguishing Media:

Dry Chemical	Foam
Water Spray	CO_2

Incompatibilities:
Oxidizers, Nitric Acid

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminants exists. Professional judgment and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

APPENDIX A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
Xylene 108-38-3,
CAS Number: 95-47-6, 106-42-3
Synonyms:
Dimethylbenzene, Xylol

HEALTH HAZARD DATA

Color: Colorless

Physical State: Solid X (below 56°F)
Liquid X
Gas

Odor: Aromatic

Odor Threshold: 20 ppm

Vapor Density: 4.3 g/L

Ionization Potential (IP): 8.56 eV

IDLH: 900 ppm

Carcinogen: OSHA
IARC
NTP
ACGIH
NIOSH

Skin absorbable: yes ___ no X
Skin corrosive: yes ___ no X

Signs/Symptoms of Acute Exposure:
Irritant to eyes, skin, nose, throat,
dizziness, drowsiness, excitement

Source	TWA (units)	STEL (units)	C (units)
OSHA PELs	100 ppm		
ACGIH TLVs	100 ppm	150 ppm	
NIOSH RELs	100 ppm	150 ppm	

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID	Microtip 10.6 eV	Isobutylene 100 ppm	1.2	120 ppm
PID	HNu w/ 10.2 eV	Benzene 100 ppm	1.04	104 ppm

Checked by: Emmet F. Curtis Date: 12/5/03

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:
Suits Teflon, Viton, PE/EVAL

Gloves Teflon, Viton
Polyvinyl Alcohol (Do not
use in water)

Boots Teflon, Viton

Service Limit Concentration (ppm): 1000

MUC 1/2 Mask APR=TWA x 10 = 500 ppm
MUC Full-Face APR=TWA x 10 = 500 ppm

FIRE/REACTIVITY DATA

Flash Point: 81° F

LEL/UEL: 0.9% / 6.7%

Fire Extinguishing Media:
Dry Chemical X Foam X
Water Spray X CO_2 X

Incompatibilities:
Strong oxidizers
Strong Acids

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminants exists. Professional judgment and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
1,3-Dichloropropane
CAS Number: 142-28-9
Synonyms:
Trimethylene Dichloride

HEALTH HAZARD DATA

Color: colorless

Physical State: Solid ___ Liquid X Gas ___

Odor: distinct

Odor Threshold: NA

Vapor Density: 3.9
Vapor Pressure 18 mmHg
Ionization Potential (IP): 10.87

IDLH: NA

Carcinogen: OSHA ___
IARC ___
NTP ___
ACGIH ___
NIOSH ___
Skin absorbable: yes X no
Skin corrosive: yes __ no X

Signs/Symptoms of Acute Exposure:
Irritates eyes, skin, and throat,
dizzy when inhaled
Skin and ey redness

NA=Not Available

Source	TWA (units)	STEL (units)	C (units)
OSHA PEL	NA		
ACGIH TLVs	NA		
NIOSH RELs			

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID with 11.7 eV Lamp	Any	Isobutylene 100 ppm	0.7	Anything above Back-ground

Checked by: Emmet F. Curtis Date: 12/5/03

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:
Suits High conc. Tychem 9400 or Barricade

Gloves Polyvinyl alchol - don't immerse in water - glove will melt
Viton

Boots ___

Service Limit Concentration (ppm): >0

MUC 1/2 Mask APR=TWA x 10= N/A
MUC Full-Face APR=TWA x 10= N/A

Upgrade to Level B PPE only No Level C.

FIRE/REACTIVITY DATA

Flash Point: 69.8°F

LEL/UEL: 3.4-14.5%

Fire Extinguishing Media:
Dry Chemical X Foam X
Water Spray X CO_2 X

Incompatibilities:
Highly flammable, gives of toxic fumes,
Explosive above 16 deg C with Vapor/air mix
Forms Hydorgen Chloride and Phosgene gas
keep away from food/feed stock, oxidants
acids, base, alumina. Keep cool and closed.
Well ventilated storage.

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminants exists. Professional judgment and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

ATTACHMENT A

CONTAMINANT FACT SHEET

CONTAMINANT FACT SHEET

Chemical Name:
ACETONE
CAS Number: 67-64-1
Synonyms:
Dimethyl ketone, ketone propane,
2-Propanone

HEALTH HAZARD DATA

Color: colorless

Physical State:
Solid ___
Liquid X
Gas X

Odor: Sweet, fragrant

Odor Threshold: 3.6-653 ppm

Vapor Density: 2.37 g/L

Ionization Potential (IP): 9.69

IDLH: 2500

Carcinogen:
OSHA ___
IARC ___
NTP ___
ACGIH ___
NIOSH ___

Skin absorbable: yes __ no _X_
Skin corrosive: yes __ no _X_

Signs/Symptoms of Acute Exposure:
Eye, nose, and throat irritant, headaches
dizziness, CNS depresent

Source	TWA (units)	STEL (units)	C (units)
OSHA PEL	1000 ppm		
ACGIH TLVs	500 ppm	750 ppm	
NIOSH RELs	250 ppm		

AIR MONITORING

Type	Brand/Model No.	Calibrations Method/Media	Relative Response or Conversion Factor	Meter Specific Action Level
PID	Micro tip 10.6 eV	Isobutylene 100 ppm	0.85	212
PID	HNu w/ 10.2 eV	Isobutylene Span 9.8 / 100 ppm	0.42	105
FID	Century OVA	Methane	0.6	150

Checked by: Emmet F. Curtis Date: 10/30/03

PERSONAL PROTECTIVE EQUIPMENT

Recommended Protective Clothing Materials:
Suits ___
Gloves Butyl Rubber, Teflon
Boots ___

Service Limit Concentration (ppm): 1000

MUC 1/2 Mask APR(ppm)=TWA x 10= 1000
MUC Full-Face APR(ppm)=TWA x 50= 1000

FIRE/REACTIVITY DATA

Flash Point: 0º F

LEL/UEL: 2.5/12.8%

Fire Extinguishing Media:
Dry Chemical _X_ Foam ___
Water Spray ___ CO_2 _X_

Incompatibilities:
Oxidizers, acids

Note: The recommended protective clothing materials assumes that potential for direct contact (by splashing, dust inhalation, or other means) with the contaminants exists. Professional judgment and knowledge of on-site hazards should be used in selecting PPE appropriate to the concentration of the contaminant (trace vs percentage) to which the individual is likely to be exposed.

Job Hazard Analysis Form

JHA No.: JHA -_______-_____-____-____

Job Title: Mobilization/Demobilization, Site Preparation **Date of Analysis:** 5/1/07

Job Location: ______________________________ **Team Leader:** ______________________

Applicable ES&H Procedures:
2.9.A - Hazardous Waste Operations and Emergency Response Program
2.9.B - Hearing Conservation Program
2.9.C - Respiratory Protection Program
2.9.D - Personal Protective Equipment Program
2.9.E - Hazard Communication Program
2.5.1 - Operation of Company Vehicles and Use of Personal Vehicles on Company Business
2.5.1 - Heavy Equipment
2.13.1 - Medical Surveillance

Other Referenced JHAs:

Key Work Steps	Hazards/Potential Hazards	Safe Practices
1. Prepare for Site Visit	1A) N/A	1A) Prior to leaving for site ▪ Obtain and review HASP prior to site visit, if possible ▪ Determine PPE needs – bring required PPE to the site, if not otherwise being provided at the site (e.g., steel toed boots) ▪ Determine training and medical monitoring needs and ensure all required Health and Safety training and medical monitoring has been received and is current ▪ Ensure all workers are fit for duty (alert, well rested, and mentally and physically fit to perform work assignment) ▪ If respiratory protection is required/potentially required, ensure that training and fit-testing has occurred within the past year. ▪ Familiarize yourself with route to the site
	1B) Vehicle defects	1B) Inspect company owned/leased vehicle for defects such as: ▪ Flat tires ▪ Windshield wipers worn or torn ▪ Oil puddles under vehicle ▪ Headlights, brake lights, turn signals not working
	1C) Insufficient emergency equipment, unsecured loads	1C) Insufficient emergency equipment, unsecured loads ▪ Ensure vehicle has first aid kit and that all medications are current (if first aid kits are not provided at the site) ▪ Ensure vehicle is equpped with warning flashers and/or flares and that the warning flashers work ▪ Cell phones are recommended to call for help in the event of an emergency ▪ Vehicles carrying tools must have a safety cage in place. All tools must be properly secured ▪ Vehicles must be equipped with chocks if the vehicle is to be left running, unattended. ▪ Ensure sufficient gasoline is in the tank

Key Work Steps	Hazards/Potential Hazards	Safe Practices
2. Operating vehicles – general	2A) Collisions, unsafe driving conditions	2A) Drive Defensively! ▪ Seat belts must be used at all times when operating any vehicle on company business. ▪ Drive at safe speed for road conditions ▪ Maintain adequate following distance ▪ Pull over and stop if you have to look at a map ▪ Try to park so that you don't have to back up to leave. ▪ If backing in required, walk around vehicle to identify any hazards (especially low level hazards that may be difficult to see when in the vehicle) that might be present. Use a spotter if necessary
3. Driving to the jobsite	3A) Dusty, winding, narrow roads	3A) Dusty, winding, narrow roads ▪ Drive confidently and defensively at all times. ▪ Go slow around corners, occasionally clearing the windshield.
	3B) Rocky or one-lane roads	3B) Rocky or one-lane roads ▪ Stay clear of gullies and trenches, drive slowly over rocks. ▪ Yield right-of-way to oncoming vehicles---find a safe place to pull over.
	3C) Stormy weather, near confused tourists	3C) Stormy weather, near confused tourists ▪ Inquire about conditions before leaving the office. ▪ Be aware of oncoming storms. ▪ Drive to avoid accident situations created by the mistakes of others.
	3D) When angry or irritated	3D) When angry or irritated ▪ Attitude adjustment; change the subject or work out the problem before driving the vehicle. Let someone else drive.
	3E) Turning around on narrow roads	3E) Turning around on narrow roads ▪ Safely turn out with as much room as possible. ▪ Know what is ahead and behind the vehicle. ▪ Use a backer if available.
	3F) Sick or medicated	3F) Sick or medicated ▪ Let others on the crew know you do not feel well. ▪ Let someone else drive.
	3G) On wet or slimy roads	3G) On wet or slimy roads ▪ Drive slow and safe, wear seatbelts.
	3H) Animals on road	3H) Animals on road ▪ Drive slowly, watch for other animals nearby. ▪ Be alert for animals darting out of wooded areas
4. Gain permission to enter site	4A) Hostile landowner, livestock, pets	4A) Hostile landowner, livestock, pets ▪ Talk to land owner, be courteous and diplomatic ▪ Ensure all animals have been secured away from work area
5. Mobilization/ Demobilization of Equipment and Supplies	5A) Struck by Heavy Equipment/Vehicles	5A) Struck by heavy equipment ▪ Be aware of heavy equipment operations. ▪ Keep out of the swing radius of heavy equipment. ▪ Ground personnel in the vicinity of heavy equipment operations will be within the view of the operator at all times ▪ Employees shall wear a high visibility vest or T-shirt (reflective vest required if working at night). ▪ Ground personnel will be aware of the counterweight swing and maintain an adequate buffer zone. ▪ Ground personnel will not stand directly behind heavy equipment when it is in operation.

Key Work Steps	Hazards/Potential Hazards	Safe Practices
	5B) Struck by Equipment/Supplies	5B) Struck by Equipment/Supplies ▪ Workers will maintain proper space around their work area, if someone enters it, stop work. ▪ When entering another worker's work space, give a verbal warning so they know you are there.
	5C) Overexertion Unloading/Loading Supplies	5C) Overexertion Unloading/Loading Supplies ▪ Train workers on proper body mechanics, do not bend or twist at the waist while exerting force or lifting. ▪ Tightly secure all loads to the truck bed to avoid load shifting while in transit.
	5D) Caught in/on/between	5D) Caught in/on/between ▪ Do not place yourself between two vehicles or between a vehicle and a fixed object.
	5E) Slip/Trip/Fall	5E) 1E). Slip/Trip/Fall ▪ Mark all holes and low spots in area with banner tape. Instruct personnel to avoid these areas. ▪ Drivers will maintain 3 point contact when mounting/dismounting vehicles/equipment. ▪ Drivers will check surface before stepping, not jumping down.
	5F) Vehicle Incident	5F) Vehicle accident ▪ Employees should follow MACTEC vehicle operation policy and be aware of all stationary and mobile vehicles.
6. Site Preparation	6A) Slip/Trip/Fall	6A) Slip/Trip/Fall ▪ Mark all holes and low spots in area with banner tape. Instruct personnel to avoid these areas
	6B) Overexertion	6B) Overexertion ▪ Workers will be trained in the proper method of lifting items. ▪ Do not bend and twist at the waist while lifting or exerting force.
	6C) Struck by Equipment/Supplies	6C) Struck by Equipment/Supplies ▪ Workers will maintain proper space around their work area, if someone enters it, stop work. ▪ When entering another worker's work space, give a verbal warning so they know you are there.
7. Driving back from the jobsite	8A) See hazards listed under item #3	8A) See safe work practices under item #3

Job Hazard Analysis Form

JHA No.: JHA -________ -_____ -____ -____

Job Title: Field Work – General **Date of Analysis:** 5/3/07

Job Location: Rochester, NY **Team Leader:** Chuck Staples

Applicable ES&H Procedures:
2.9.A - Hazardous Waste Operations and Emergency Response Program
2.9.B - Hearing Conservation Program
2.9.C - Respiratory Protection Program
2.9.D - Personal Protective Equipment Program
2.9.E - Hazard Communication Program
2.5.1 - Operation of Company Vehicles and Use of Personal Vehicles on Company Business
2.5.1 - Heavy Equipment
2.9.7 - Overhead and Underground Utilities
2.9.8 - Permit-Required Confined Space
2.9.16 - Thermal Stress
2.9.19 - Electrical Safety
2.9.20 - Lockout / Tagout
2.9.21 - Power and Hand Tools
2.13.1 - Medical Surveillance

Other Referenced JHAs:
Mobilization/Demobilization and Site Preparation
Insect Stings and Bites
Poisonous Plants
Confined Space Entry

Key Work Steps	Hazards/Potential Hazards	Safe Practices
1. Mobilization/ Demobilization and Site Preparation	1A) See Mobilization / Demobilization and Site Preparation JHA	1A) See Mobilization/Demobilization and Site Preparation JHA
2. Communication	2A) Safety, crew unity	2A) Talk to each other. ▪ Log all workers and visitor on and off the site. ▪ Let other crewmembers know when you see a hazard. ▪ Avoid working near known hazards. ▪ Always know the wherabouts of fellow crewmembers. ▪ Carry a radio and spare batteries or cell phone ▪ Review Emergency Evacuation Procedures (see below).
3. Walking and working in the field	3A) Falling down, twisted ankles and knees, poor footing	3A) Always watch your footing. ▪ Horseplay is strictly prohibited ▪ Slow down and use extra caution around logs, rocks, and animal holes. ▪ Extremely steep slopes (>50%) can be hazardous under wet or dry conditions; consider an alternate route. ▪ Wear laced boots with a minimum 8" high upper and non-skid Vibram-type soles for ankle support and traction.
	3B) Falling objects	3B) Protect head agains falling objects. ▪ Wear your hardhat for protection from falling limbs and pinecones, and from tools and equipment carried by other crewmembers. ▪ Stay out of the woods during extremely high winds.

Key Work Steps	**Hazards/Potential Hazards**	**Safe Practices**
	3C) Chemical/Toxicological Hazards	3C) Chemical/Toxicological Hazards ▪ See HASP for appropriate level of PPE ▪ Use monitoring equipment, as outlined in HASP, to monitor breathing zone ▪ Read MSDSs for all chemicals brought to the site ▪ Be familiar with hazards associated with site contaminants. ▪ Ensure that all containers are properly labelled ▪ Decon thoroughly prior to consumption of food, beverage or tobacco.
	3D) Damage to eyes	3D) Protect eyes: ▪ Watch where you walk, ecpecially around trees and brush with limbs sticking out. ▪ Exercise caution when clearing limbs from tree trunks. Advise wearing eye protection. ▪ Ultraviolet light from the sun can be damaging to the eyes; look for sunglasses that specify significant protection from UV-A and UV-B radiation. If safety glasses require, use one's with tinted lenses
	3E) Bee and wasp stings	3E) See JHA for Insect Stings and Bites
	3F) Ticks and infected mosquitos	3F) See JHA for Insect Stings and Bites
	3G) Wild Animals	3G) Wild Animals ▪ Avoid phyisical contact with wild animals ▪ Do not threaten and/or conrner animals ▪ Make noise to get the animal to retreat. ▪ Stay in or return to vehicle/equipment if in danger
	3H) Contact with poisonous plants or the oil from those plants:	3H) Contact with poisonous plants or the oil from those plants: ▪ Look for signs of poisonous plants and avoid. ▪ Ensure all field workers can identify the plants. Mark identified poisonous plants with spray paint if working at a fixed location. ▪ Do not allow plant to touch any part of your body/clothing. ▪ Wear PPE as described in the HASP and wear Tyveks, gloves and boot covers if contact with plant is likely ▪ Always wash gloves before removing them. ▪ Discard PPE in accordance with the HASP. ▪ Use commercially available products such as Ivy Block or Ivy Wash as appropriate. ▪ See the JHA for Poisonous Plants
		
	3I) Back Injuries	3I) Back Injuries ▪ Site personnel will be instructed on proper lifting techniques. ▪ Mechanical devices should be used to reduce manual handling of materials. ▪ Split heavy loads in to smaller loads ▪ Team lifting should be utilized if mechanical devices are not available. ▪ Make sure that path is clear prior to lift.

Key Work Steps	Hazards/Potential Hazards	Safe Practices
	3J) Shoveling	3J) Shoveling ▪ Select the proper shovel for the task. A long handled, flat bladed shovel is recommend for loose material ▪ Inspect the handle for splinters and/or cracks ▪ Ensure that the blade is securely attached to the handle ▪ Never be more than 15 inches from the material you are shoveling ▪ Stand with your feet about hip width for balance and keep the shovel close to your body. ▪ Bend from the knees (not the back) and tighten your stomach muscles as you lift. ▪ Avoid twisting movements. If you need to move the snow to one side reposition your feet to face the direction the snow will be going. ▪ Avoid lifting large shoveling too much at once. When lifting heavy material, pick up less to reduce the weight lifted. ▪ Pace yourself to avoid getting out of breath and becoming fatigued too soon. ▪ Be alert for signs of stress such as pain, numbness, burning and tingling. Stop immediately if you feel any of these symptoms.
	3K) Slips/Trips/Falls	3K) Slips/Trips/Falls ▪ Maintain work areas safe and orderly; unloading areas should be on even terrain; mark or repair possible tripping hazards. ▪ Site SHSO inspect the entire work area to identify and mark hazards. ▪ Maintain three points of contact when climbing ladders or onto/off of equipment
	3L) Overhead Hazards	3L) Overhead Hazards ▪ Personnel will be required to wear hard hats that meet ANSI Standard Z89.1. ▪ All ground personnel will stay clear of suspended loads. ▪ All equipment will be provided with guards, canopies or grills to protect the operator from falling or flying objects. ▪ All overhead hazards will be identified prior to commencing work operations.
	3M) Dropped Objects	3M) Dropped Objects ▪ Steel toe boots meeting ANSI Standard Z41 will be worn.
	3N) Noise	3N) Noise ▪ Hearing protection will be worn with a noise reduction rating capable of maintaining personal exposure below 85 dBA (ear muffs or plugs); all equipment will be equipped with manufacturer's required mufflers. Hearing protection shall be worn by all personnel working in or near heavy equipment.
	3O) Eye Injuries	3O) Eye Injuries ▪ Safety glasses meeting ANSI Standard Z87 will be worn.

Key Work Steps	Hazards/Potential Hazards	Safe Practices
	3P) Heavy Equipment (overhead hazards, spills, struck by or against)	3P) Heavy Equipment ▪ All operators will be trained and qualified to operate equipment ▪ Equipment will have seat belts. ▪ Operators will wear seat belts when operating equipment. ▪ Do not operate equipment on grades that exceed manufacturer's recommendations. ▪ Equipment will have guards, canopies or grills to protect from flying objects. ▪ Ground personnel will stay clear of all suspended loads. ▪ Personel are prohibited from riding on the buckets, or elsewhere on the equipment except for designated seats with proper seat belts or lifts specifically designed to carry workers. ▪ Ground personnel will wear high visibility vests ▪ Spill and absorbent materials will be readily available. ▪ Drip pans, polyethylene sheeting or other means will be used for secondary containment. ▪ Ground personnel will stay out of the swing radius of excavators. ▪ Eye contact with operators will be made before approaching equipment. ▪ Operator will acknowledge eye contact by removing his hands from the controls. ▪ Equipment will not be approached on blind sides. ▪ All equipment will be equipped with backup alarms and use spotters when significant physical movement of equipment occurs on-site, (i.e., other than in place excavation or truck loading). ▪ Inspect rigging prior to each use.
	3Q) Struck by vehicle/equipment	3Q) Struck by vehicle/equipment ▪ Be aware of heavy equipment operations. ▪ Keep out of the swing radius of heavy equipment. ▪ Ground personnel in the vicinity of vehicles or heavy equipment operations will be within the view of the operator at all times. ▪ Ground personnel will be aware of the counterweight swing and maintain an adequate buffer zone. ▪ Ground personnel will not stand directly behind heavy equipment when it is in operation. ▪ Drivers will keep workers on foot in their vision at all times, if you lose sight of someone, Stop! ▪ Spotters will be used when backing up trucks and heavy equipment and when moving equipment. ▪ High visibility vests will be worn when workers are exposed to vehicular traffic at the site or on public roads.
	3R) Struck/cut by tools	3R) Struck/cut by tools ▪ Cut resistant work gloves will be worn when dealing with sharp objects. ▪ All hand and power tools will be maintained in safe condition. ▪ Do not drop or throw tools. Tools shall be placed on the ground or worksurface or handed to another employee in a safe manner. ▪ Guards will be kept in place while using hand and power tools.
	3S) Caught in/on/between	3S) Caught in/on/between ▪ Workers will not position themselves between equipment and a stationary object. ▪ Workers will not wear long hair down (place in pony-tail and tuck into shirt) or jewelry if working with tools/machinery.

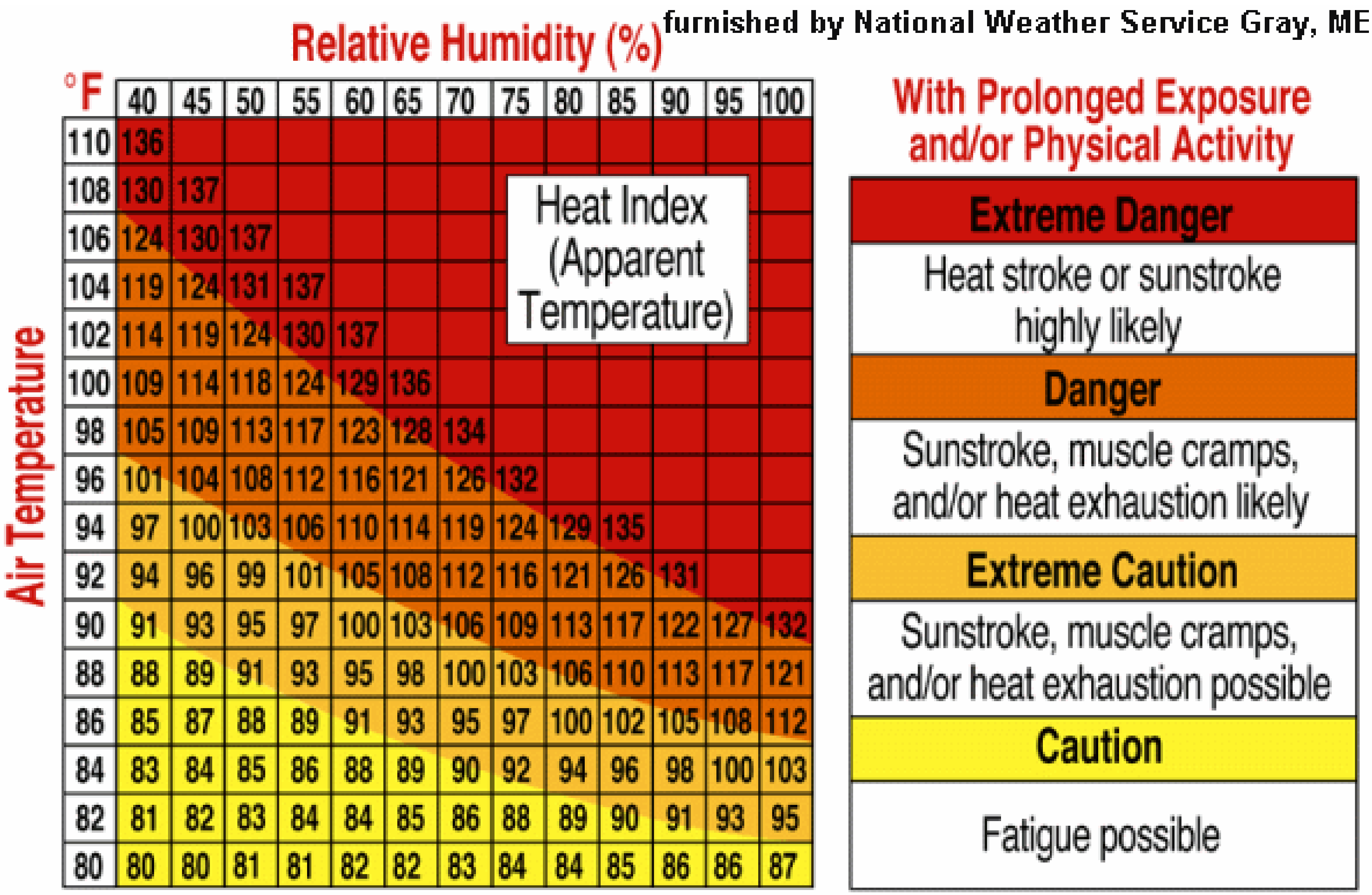
Key Work Steps	Hazards/Potential Hazards	Safe Practices
	3T) Contact with Electricity/Lightning	3T) Contact with Electricity/Lightning ▪ All electrical tools and equipment will be equipped with GFCI. ▪ Electrical extension cords will be of the “Hard” or “Extra Hard” service type. ▪ All extension cords shall have a three-blade grounding plug. ▪ Personnel shall not use extension cords with damaged outer covers, exposed inner wires, or splices. ▪ Electrical cords shall not be laid across roads where vehicular traffic may damage the cord without appropriate guarding. ▪ All electrical work will be conducted by a licensed electrician. ▪ All equipment will be locked out and tagged out and rendered in a zero energy state prior to commencing any operation that may exposed workers to electrical, mechanical, hydraulic, etc. hazards. ▪ All utilities will be marked prior to excavation activities. ▪ All equipment will stay a minimum of 10 feet from overhead energized electrical lines (50 kV). This distance will increase by 4 inches for each 10 kV above 50 kV. Rule of Thumb: Stay 10 feet away from all overhead powerlines known to be 50 kV or less and 35 feet from all others.) ▪ The SHSO shall halt outdoor site operations whenever lightning is visible, outdoor work will not resume until 30 minutes after the last sighting of lightning.
	3U) Equipment failure	3U) Equipment failure ▪ All equipment will be inspected before use. If any safety problems are noted, the equipment should be tagged and removed from service until repaired or replaced.
	3V) Hand & power tool usage.	3V) Hand & power tool usage ▪ Daily inspections will be performed. ▪ Ensure guards are in place and are in good condition. ▪ Remove broken or damaged tools from service. ▪ Use the tool for its intended purpose. ▪ Use in accordance with manufacturers instructions. ▪ No tampering with electrical equipment is allowed (e.g., splicing cords, cutting the grounding prong off plug, etc.) ▪ See JHA for Power Tool Use - Electrical and Power Tool Use - Gasoline
	3W) Fire Protection	3W) Fire Protection ▪ Ensure that adequate number and type of fire extinguishers are present at the site ▪ Inspect fire extinguishers on a monthly basis – document ▪ All employees who are expected to use fire exinguishers will have received training on an annual basis. ▪ Obey no-smoking policy ▪ Open fires are prohibited ▪ Maintain good housekeeping. Keep rubbish and combustibles to a minimum. ▪ Keep flammable liquids in small containers with lids closed or a safety can. ▪ When dispensing flammable liquids, do in well vented area and bond and ground containers.
	3X) Confined Space Entry	3X) Confined Space Entry ▪ See JHA for Confined Space Entry

Key Work Steps	Hazards/Potential Hazards	Safe Practices

4. Environmental health considerations	4A) Heat Stress	4A) Take precautions to prevent heat stress
		▪ Remain constantly aware of the four basic factors that determine the degree of heat stress (air temperature, humidity, air movement, and heat radiation) relative to the surrounding work environmental heat load.
		▪ Know the signs and symptoms of heat exhaustion, heat cramps, and heat stroke. Heat stroke is a true medical emergency requiring immediate emergency response action.
		NOTE: The severity of the effects of a given environmental heat stress is decreased by reducing the work load, increasing the frequency and/or duration of rest periods, and by introducing measures which will protect employees from hot environments.
		▪ Maintain adequate water intake by drinking water periodically in small amounts throughout the day (flavoring water with citrus flavors or extracts enhances palatability).
		▪ Allow approximately 2 weeks with progressive degrees of heat exposure and physical exertion for substantial acclimatization.
		▪ Acclimatization is necessary regardless of an employee's physical condition (the better one's physical condition, the quicker the acclimatization). Tailor the work schedule to fit the climate, the physical condition of employees, and mission requirements.
		  ▪ A reduction of work load markedly decreases total heat stress.
		  ▪ Lessen work load and/or duration of physical exertion the first days of heat exposure to allow gradual acclimatization.
		▪ Alternate work and rest periods. More severe conditions may require longer rest periods and electrolyte fluid replacement.

	4B) Wet Bulb Globe Temperature (WBGT) Index	4B) WBGT ▪ Curtail or suspend physical work when conditions are extremely severe (see attached Heat Stress Index). ▪ Compute a Wet Bulb Globe Temperature Index to determine the level of physical activity (take WBGT index measurements in a location that is similar or closely approximates the environment to which employees will be exposed).
		WBGT THRESHOLD VALUES FOR INSTITUTING PREVENTIVE MEASURES
		80-90 degrees F — Fatigue possible with prolonged exposure and physical activity. 90-105 degrees F — Heat exhaustion and heat stroke possible with prolonged exposure and physical activity. 105-130 degrees F — Heat exhaustion and heat stroke are likely with prolonged heat exposure and physical activity.
	4C) Cold Extremes	4C) Take precautions to prevent cold stress injuries ▪ Cover all exposed skin and be aware of frostbite. While cold air will not freeze the tissues of the lungs, slow down and use a mask or scarf to minimize the effect of cold air on air passages. ▪ Dress in layers with wicking garments (those that carry moisture away from the body – e.g., cotton) and a weatherproof slicker. A wool outer garment is recommended. ▪ Take layers off as you heat up; put them on as you cool down. ▪ Wear head protection that provides adequate insulation and protects the ears. ▪ Maintain your energy level. Avoid exhaustion and over-exertion which causes sweating, dampens clothing, and accelerates loss of body heat and increases the potential for hypothermia. ▪ Acclimate to the cold climate to minimize discomfort. ▪ Maintain adequate water/fluid intake to avoid dehydration.

Key Work Steps	Hazards/Potential Hazards	Safe Practices
	4D) Wind	4D) Effects of the wind ▪ Wind chill greatly affects heat loss (see attached Wind Chill Index). ▪ Avoid marking in old, defective timber, especially hardwoods, during periods of high winds due to snag hazards.
	4E) Thunderstorms	4E) Thunderstorms ▪ Monitor weather channels to determine if electrical storms are forcased. ▪ Plan ahead and identify safe locations to be in the event of a storm. (e.g., sturdy building, vehicle, etc.) ▪ Suspend all field work at the first sound of thurnder. You should be in a safe place when the time between the lightning and thunder is less than 30 seconds. ▪ Only return to work 30 minutes after the after the last strike or sound of thunder



furnished by National Weather Service Gray, ME

Heat Index (Apparent Temperature)

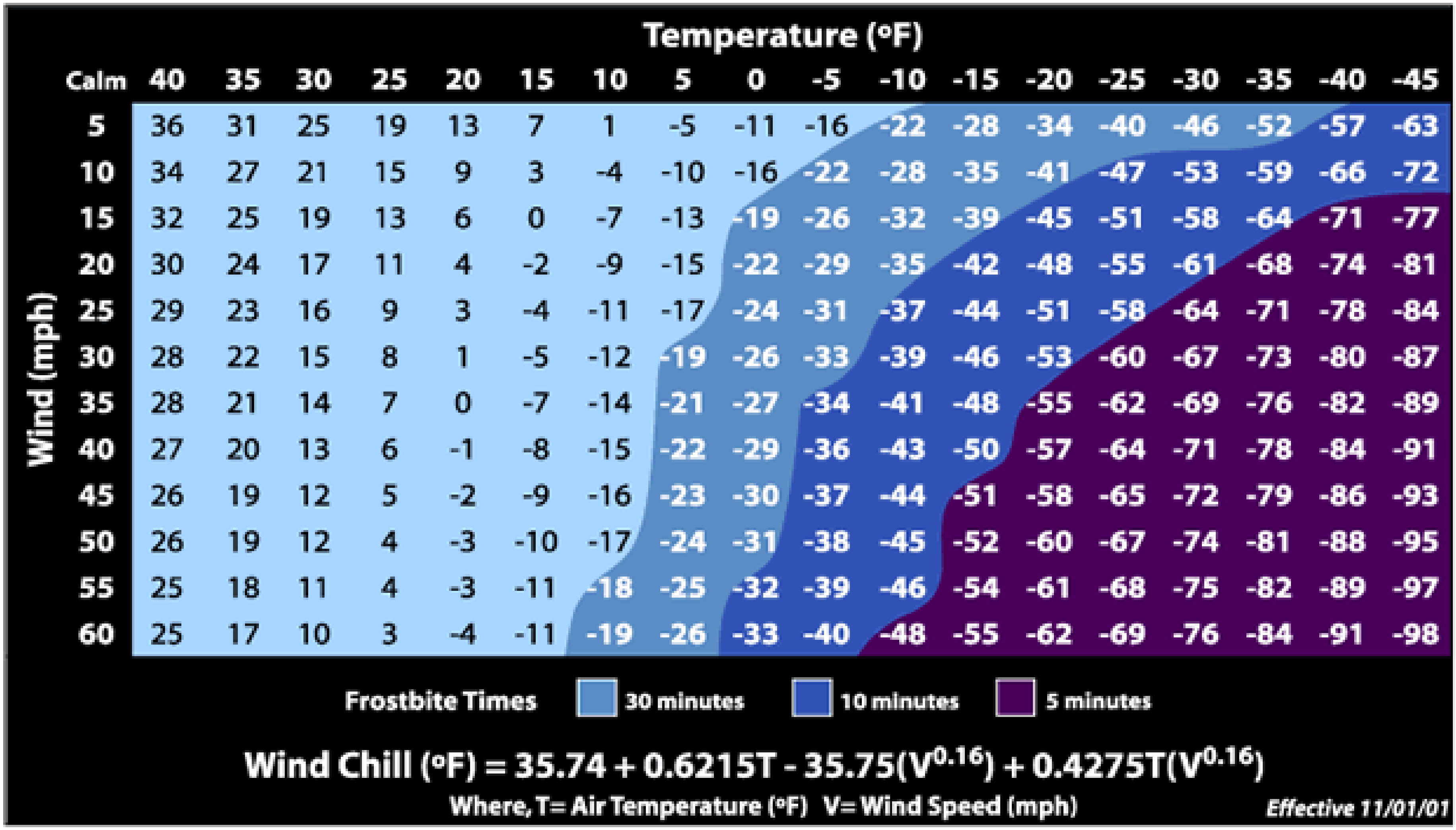
Air Temperature (°F) by Relative Humidity (%)

°F	40	45	50	55	60	65	70	75	80	85	90	95	100
110	136												
108	130	137											
106	124	130	137										
104	119	124	131	137									
102	114	119	124	130	137								
100	109	114	118	124	129	136							
98	105	109	113	117	123	128	134						
96	101	104	108	112	116	121	126	132					
94	97	100	103	106	110	114	119	124	129	135			
92	94	96	99	101	105	108	112	116	121	126	131		
90	91	93	95	97	100	103	106	109	113	117	122	127	132
88	88	89	91	93	95	98	100	103	106	110	113	117	121
86	85	87	88	89	91	93	95	97	100	102	105	108	112
84	83	84	85	86	88	89	90	92	94	96	98	100	103
82	81	82	83	84	84	85	86	88	89	90	91	93	95
80	80	80	81	81	82	82	83	84	84	85	86	86	87

With Prolonged Exposure and/or Physical Activity

🟥	**Extreme Danger** Heat stroke or sunstroke highly likely
🟧	**Danger** Sunstroke, muscle cramps, and/or heat exhaustion likely
🟧	**Extreme Caution** Sunstroke, muscle cramps, and/or heat exhaustion possible
🟨	**Caution** Fatigue possible

Wind Chill Chart



Wind (mph)	Temperature (°F)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times 🟦 30 minutes 🟦 10 minutes 🟪 5 minutes

$$\text{Wind Chill } (^\circ F) = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Job Hazard Analysis Form

JHA No.: JHA -________-_____-____-____

Job Title: Decontamination **Date of Analysis:** 5/1/07

Job Location: ______________________ **Team Leader:** ______________________

Applicable ES&H Procedures:
2.9.A - Hazardous Waste Operations and Emergency Response Program
2.9.C - Respiratory Protection Program
2.9.D - Personal Protective Equipment Program
2.9.E - Hazard Communication Program
2.5.1 - Heavy Equipment
2.9.16 - Thermal Stress
2.9.21 - Power and Hand Tools

Other Referenced JHAs:

Key Work Steps	Hazards/Potential Hazards	Safe Practices
1. Establish Decontamination Station	1A) Materials Handling	1A) Materials Handling ▪ Use proper lifting techniques ▪ Use mechanical aids, if available, to move heavy items.
2. Decontamination / Steam cleaning.	2A) Struck by steam/hot water/pressure washing	2A) Struck by steam/hot water ▪ Workers not directly engaged in steam cleaning operations must stay clear. ▪ Workers using steam cleaning equipment must be trained on operation and safety devices/procedures using the owners/operators manual. ▪ Use face shield **and** safety glasses or goggles, if steam cleaning. ▪ Stay out of the splash/steam radius. ▪ Pressure washer must have dead man switch. ▪ Do not direct steam at anyone. ▪ Do not hold objects with your feet or hands. ▪ Ensure that direction of spray minimizes spread of contaminants of concern. ▪ Use shielding as necessary.
	2B) Exposure to contaminants	2B) Exposure to contaminants ▪ Conduct air monitoring (see HASP). ▪ Wear proper PPE. ▪ See MSDSs for hazards associated with the decon solutions used (if other than water alone us used).
	2C) Slips/Trips/Falls	2C) Slips/Trips/Falls ▪ Be cautious as ground/plastic can become slippery ▪ Use boots or boot covers with good traction
3. Vehicle Decontamination	3A) Vehicle traffic in and out of the CRZ	3A) Large Vehicle Traffic ▪ Always wear a hard hat, steel toe boots, and a high visibility vest (unless Tyveks are used and are high visibility). ▪ Vehicle drivers are not to exit the vehicle in the CRZ. ▪ Identify an individual to communicate with vehicle drivers and maintain order ▪ Trucks will be lined with plastic and kept out of direct contact with any contaminated materials during loading. Wear PPE when removing plastic lining from truck beds. ▪ If not in the vehicle, obtain eye contact with the driver, so he is aware of your presence and location in the CRZ.

Key Work Steps	**Hazards/Potential Hazards**	**Safe Practices**
		▪ If you are driving the vehicle, be aware of personnel in the CRZ and maintain communication with the identified personnel.
	3B) Exposure to contaminants	3B) Exposure to contaminants ▪ Use safety glasses or goggles, Polycoated Tyvek (if level of contamination poses dermal hazard or to keep work clothes dry), high visibility vest (if high visibility Tyveks are not used) hard hats, steel toe boots, and gloves while cleaning contaminated materials. ▪ Do not doff PPE until decontamination of the vehicle is complete and a decontamination certificate has been issued by the HSO. ▪ Conduct air monitoring (see HASP). ▪ See MSDSs for hazards associated with the decon solutions (if other than water alone is used).
	3C) Slips/Trips/Falls	3C) Slips/Trips/Falls ▪ Be cautious as ground/plastic can become slippery ▪ Use boots or boot covers with good traction
4. Equipment and Sample Decontamination	4A) Chemical exposure when handling contaminated sample jars and equipment	4A) Chemical exposure ▪ Wear PPE. ▪ Refer to MSDS for specific hazards associated with decon solutions ▪ Monitor breathing zone for contaminants ▪ Monitor breathing zone for decon solutions (e.g., methanol, hexane, etc.) if appropriate (see HASP)
	4B) Materials Handling related injuries	4B) Materials Handling related injuries ▪ Use proper lifting techniques when lifting heavy equipment ▪ Use two person lift for heavy coolers

5. Personal Decontamination	5A) Exposure to contaminants	5A) Exposure to contaminants
		▪ Avoid bringing contaminated materials via shoes and clothing into the CRZ by examining such prior to exiting the EZ.
		▪ Removal of PPE will be performed by the following tasks in the listed order:
		  ▪ Gross boot wash and rinse and removal
		  ▪ Outer glove removal
		  ▪ Suit removal
		  ▪ Respirator removal (if worn).
		  ▪ Inner glove removal
		▪ Contaminated PPE is to be placed in the appropriate, provided receptacles.
		▪ Respirators will be removed and decontaminated at a specified location within the CRZ by a designated technician, then placed in storage bag.
		▪ Employees will wash hands, face, and any other exposed areas with soap and water.
		▪ Portable eyewash stations and showers will be available should employees come into direct contact with contaminated materials.
		▪ See MSDSs for hazards associated with the decontamination solutions used.
		▪ Decon solutions will be disposed of according to the work plan.

Job Hazard Analysis Form

JHA No.: JHA -_______ -_____ -____ -____

Job Title: Groundwater Sampling **Date of Analysis:** 8/20/07

Job Location: Rochester, NY **Team Leader/Project Manager:** Chuck Staples

Applicable ES&H Procedures:
2.9.A - Hazardous Waste Operations and Emergency Response Program
2.9.C - Respiratory Protection Program
2.9.D - Personal Protective Equipment Program
2.9.19 - Electrical Safety
2.14.1 - Flammable and Combustible Liquids
2.14.5 - Collection of Field Samples

Other Referenced JHAs:
- Mobilization/Demobilization and Site Preparation
- Field Work General
- Insect Stings and Bites
- Gasoline
- Working with Preservatives

Key Work Steps	Hazards/Potential Hazards	Safe Practices
1. Mobilization	1A) See JHA Mobilization/Demobilization/Site Preparation	1A) See JHA Mobilization/Demobilization/Site Preparation
2. General Site Hazards	2A) See JHA Field Work - General	2A) See JHA Field Work - General
	2B) Chemical exposure	2B) Chemical Exposure ▪ Read HASP and determine air monitoring and PPE needs.
3. Calibrate monitoring equipment	3A) Exposure to calibration gases	3A) Exposure to calibration gases ▪ Review equipment manuals ▪ Calibrate in a clean, well ventilated area
4. Opening the well cap, taking water level readings	4A) Contact with poisonous plants or the oil from poisonous plants	4A) Contact with poisonous plants or the oil from those plants: ▪ Look for signs of poisonous plants and avoid. ▪ Ensure all field workers can identify the plants. Mark identified poisonous plants with spray paint if working at a fixed location. ▪ Wear PPE as described in the HASP. ▪ Do not touch any part of your body/clothing. ▪ Always wash gloves before removing them. ▪ Discard PPE in accordance with the HASP. ▪ Use commercially available products such as Ivy Block or Ivy Wash as appropriate.

Key Work Steps	Hazards/Potential Hazards	Safe Practices
	4B) Contact with biting insects (i.e., spiders, bees, etc.) which may have constructed a nest in the well cap/well.	4B) Contact with stinging/biting insects ▪ Discuss the types of insects expected at the Site and be able to identify them. ▪ Look for signs of insects in and around the well. ▪ Wear Level of PPE as described in the HASP. At a minimum, follow guidelines in the JHA “Insects Stings and Bites.” ▪ If necessary, wear protective netting over your head/face. ▪ Avoid contact with the insects if possible. ▪ Inform your supervisor and the Site Health and Safety Supervisor if you have any allergies to insects and insect bites. Make sure you have identification of your allergies with you at all times and appropriate response kits if applicable. ▪ Get medical help immediately if you are bitten by a black widow or brown recluse, or if you have a severe reaction to any spider bite or bee sting.
	4C) Exposure to hazardous Inhalation and contact with hazardous substances (VOC contaminated groundwater/ soil); liquid splash; flammable atmospheres.	4C) Exposure to hazardous substances ▪ Wear PPE as identified in HASP. ▪ Review hazardous properties of site contaminants with workers before sampling operations begin ▪ Immediately monitor breathing zone after opening well to determine exposure and verify that level of PPE is adequate – see Action Levels in HASP ▪ Monitor headspace in well. After the initial headspace reading (if required by the Work Plan), allow the well to vent for several minutes before obtaining water level and before sampling. ▪ When decontaminating equipment wear additional eye/face protection over the safety glasses such as a face shield.
	4D) Back strain due to lifting bailers or pumps and from moving equipment to well locations	4D) Back strain ▪ Use mechanical aids when possible, if mechanical aids are not available, use two person lifts for heavy items. ▪ Use proper lifting techniques
	4E) Foot injuries from dropped equipment	4E) Foot Injuries ▪ Be aware when moving objects, ensure you have a good grip when lifting and carrying objects. ▪ Do not carry more than you can handle safely ▪ Wear Steel toed boots
5. Collecting water samples	5A) Fire/Explosion/Contamination hazard from refueling generators	5A) Fire/Explosion/Contamination hazard from refueling generators ▪ Turn the generator off and let it cool down before refueling ▪ Segregate fuel and other hydrocarbons from samples to minimize contamination potential ▪ Transport fuels in approved safety containers. The use of containers other than those specifically designed to carry fuel is prohibited ▪ See JHA for Gasoline use

Key Work Steps	**Hazards/Potential Hazards**	**Safe Practices**
	5B) Electrocution	5B) Electrocution ▪ A ground fault circuit interrupter (GFCI) device must protect all AC electrical circuits. ▪ Use only correctly grounded equipment. Never use three-pronged cords which have had the third prong broken off. ▪ Make sure that the electrical cords from generators and power tools are not allowed to be in contact with water ▪ Do not stand in wet areas while operating power equipment ▪ Always make sure all electrically-powered sampling equipment is in good repair. Report any problems so the equipment can be repaired or replaced. ▪ When unplugging a cord, pull on the plug rather than the cord. ▪ Never do repairs on electrical equipment unless you are both authorized and qualified to do so.
	5C) Exposure to contaminants	5C) Exposure to Contaminants ▪ Stand up wind when sampling ▪ Monitor breathing zone with appropriate monitoring equipment (see HASP) ▪ Wear chemical resistant PPE as identified in HASP ▪ See section 4C) under Safe Practices above
	5D) Infectious water born diseases	5D) Infectious water born diseases ▪ Wear chemical resistant gloves and other PPE – as identified in HASP ▪ Prevent water from contacting skin ▪ Wash exposed skin with soap and water ASAP after sampling event ▪ Ensure that all equipment is adequately decontaminated using a 10% bleach solution
	5E) Exposure to water preservatives	5E) Exposure to water preservatives ▪ Work in a well ventilated area, upwind of samples ▪ Wear chemical resistant PPE as identified in HASP ▪ When preserving samples always add acid to water, avoid the opposite. ▪ See JHA Working with Preservatives

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Job Hazard Analysis - HASP Format

Job Title: Environmental Drilling/Boring and Associated Soil Sampling **Date of Analysis:** 7/26/06

Minimum Recommended PPE*: Steel Toed, Slip Resistant Boots; Safety Glasses; Face Shield (if danger to face due to flying particles); Leather and/or Nitrile Gloves, Snake Chaps (if required); High visibility vest; Hard Hat; Hearing Protection; Insulated Gloves (if hand digging to identify underground electrical lines)

*See HASP for all required PPE

Key Work Steps	Hazards/Potential Hazards	Safe Practices
1. All Drilling/Boring Activities	2A) Slips, Trips, Falls	1A) Slips, Trips, Falls ▪ Keep work area free of excess material and debris ▪ Remove all trip hazards by keeping materials/objects organized and out of walkways ▪ Keep work surfaces dry when possible ▪ Wear appropriate PPE (See HASP) including non-slip rubber boots if working on wet or slick surfaces ▪ Install rough work surface covers where possible ▪ Stay aware of footing and do not run
	2B) Heat/Cold Stress	1B) Heat/Cold Stress ▪ Take breaks if feeling faint or overexerted ▪ Consume adequate food/beverages (water, sports drinks) ▪ If possible, adjust work schedule to avoid temperature extremes
	2C) Biological Hazards: Insects, Snakes, Wildlife, Vegetation	1C) Biological Hazards: Insects, Snakes, Wildlife, Vegetation ▪ Inspect work areas when arrive at site to identify hazard(s) ▪ Use insect repellant if observe mosquitoes/gnats ▪ Open enclosures slowly ▪ Survey site for presence of biological hazards and maintain safe distance ▪ Wear appropriate PPE including leather gloves, long sleeves and pants, and snake chaps as warranted by site conditions (See HASP)
	2D) Traffic (including pedestrian)	1D) Traffic (including pedestrian) ▪ Notify attendant or site owner/manager of work activities and location ▪ Use cones, signs, flags or other traffic control devices as outlined in the ▪ Traffic Control Plan ▪ Set up exclusion zone surrounding work area using cones, signs, flags or other traffic control devices ▪ Wear appropriate PPE including high visibility clothing such as reflective vest (See HASP) ▪ Inspect area behind vehicle prior to backing and use spotter
	2E) Fire/ Explosion	1E) Fire/ Explosion ▪ Post No Smoking signs around work area ▪ Establish designated smoking area away from work area ▪ Ensure type ABC, 20-lb, fully charged fire extinguisher on-site and within inspection period ▪ As site conditions/activities warrant, establish Hot Work Permit including air monitoring using direct-reading, real-time instruments such as LEL/ O2 meter (See HASP for required monitoring instruments and action limits) ▪ Stop work if hazardous conditions (explosive atmosphere) are identified
2. Ambient Air Monitoring	2A) Vapors	2A) Vapors ▪ Approach area where vapors are suspected from upwind direction and stay upwind/crosswind of from potential sources of vapors (use flagging or similar device to indicate wind direction)
	2B) Ineffective Air Monitoring	2B) Ineffective Air Monitoring ▪ Ensure personnel using have been trained on instrument use ▪ Calibrate instrument prior to use

Job Hazard Analysis - HASP Format

Job Title: Environmental Drilling/Boring and Associated Soil Sampling **Date of Analysis:** 7/26/06

Key Work Steps	Hazards/Potential Hazards	Safe Practices
3. Concrete Coring	3A) Ignition Sources	3A) Ignition Sources ▪ Ensure electrical equipment properly grounded ▪ Apply water as necessary to address surface sparking potential
	3B) High Noise Levels	3B) High Noise Levels ▪ Hearing protection required when working around operating equipment if levels are suspected to be >85 dBA (if have to yell to person at a dist of 3 ft to be heard, likely exceeding 85 dBA).
	3C) Airborne Particulates and Debris	3C) Airborne Particulates and Debris ▪ Use water as necessary to control dust in area ▪ Wear appropriate PPE including face shield or safety glasses with side shields, dust mask, leather gloves and long sleeves (See HASP)
	3D) Sharp Rough Materials	3D) Sharp Rough Materials ▪ Wear appropriate PPE including leather gloves, long sleeves and pants, and steel-toed boots (See HASP)
	3E) Impact to Subsurface Lines	3E) Impact to Subsurface Lines ▪ Ensure all underground features have been identified in area per SCP prior to start of activities
4. Drill Rig Set-Up	4A) Contact with Electric Lines and Other Overhead Obstacles	4A) Contact with Electric Lines and Other Overhead Obstacles ▪ Position rig to avoid overhead utility lines by distance defined by voltage and local regulations ▪ Use a spotter when raising mast to confirm clearance of overhead lines and other obstructions
	4B) Rig Movement	4B) Rig Movement ▪ Heavy equipment should be equipped with back-up alarm or use horn when backing - use spotter when available ▪ Stay clear of operating equipment and rig when moving
	4C) Heavy Equipment Lifting/ Carrying	4C) Heavy Equipment Lifting/ Carrying ▪ Use at least 2 people to lift and carry sections, use mechanical lift devices whenever possible, bend and lift with legs and arms, not back
	4D) Sharp or Elevated Equipment	4D) Sharp or Elevated Equipment ▪ Wear appropriate PPE including steel-toed safety boots, leather gloves and hard hat (See HASP) ▪ Establish communication system between workers involved in moving/attaching sections
5. Ground Disturbance: Auger/Boring Advancement	5A) Faulty or Inappropriate Equipment	5A) Faulty or Inappropriate Equipment ▪ Qualified driller must inspect drill rig prior to use, if faulty or inappropriate, do not proceed until repaired or replaced ▪ Inspect all hand tools prior to use, if faulty or inappropriate, do not proceed until repaired or replaced. Tag out all defective tools
	5B) Moving Equipment	5B) Moving Equipment ▪ Clear area of obstructions and communicate with all workers involved that drilling is beginning ▪ Do not exceed manufacturer's recommended speed, force, torque, or other specifications. and penetrate the ground slowly with hands on the controls for at least the first foot of soil to minimize chance of auger kick-out ▪ Stay clear of rotating auger ▪ Use long-handled shovel to clear away cuttings when auger has stopped ▪ Do not wear loose clothing ▪ Wear appropriate PPE including leather gloves and steel-toed boots (See HASP)

Job Hazard Analysis - HASP Format

Job Title: Environmental Drilling/Boring and Associated Soil Sampling **Date of Analysis:** 7/26/06

Key Work Steps	Hazards/Potential Hazards	Safe Practices
	5C) Suspended Loads	5C) Suspended Loads ▪ Do not walk under suspended loads ▪ When possible, remove overhead hazards promptly ▪ Wear appropriate PPE including hard hat and steel-toed boots (See HASP)
	5D) High Noise Levels	5D) High Noise Levels ▪ Use hearing protection if within 20 feet of active drill rig
	5E) Ground Disturbance: Auger/Boring Advancement Vapors and Airborne	5E) Ground Disturbance: Auger/Boring Advancement Vapors and Airborne ▪ Monitor air concentrations using direct-reading, real-time instruments such as OVM and Dräger tubes (See HASP for required monitoring instruments and action limits)
	5F) Particulates	5F) Particulates ▪ Stop work if hazardous conditions (explosive atmosphere, O2 deficient atmosphere) identified until precautions are taken (See HASP for required monitoring instruments and action limits) ▪ Wear appropriate PPE including face shield or safety glasses with side shields, dust masks or respirators, long sleeves and pants (See HASP) ▪ Stay upwind (use flagging or similar device to indicate wind direction)
	5G) Impact to Subsurface Lines/Tanks	5G) Impact to Subsurface Lines/Tanks ▪ Only drill in areas where underground features have been identified and cleared per Subsurface Clearance Protocol (SCP) if hole has to be moved, clear new location first ▪ Wear appropriate PPE including insulating gloves or stand on an insulating mat when in contact with drill rig ▪ Ensure first aid responders are trained to deal with electric shock and flash burns
6. Ground Intrusion: Split Spoon	6A) Faulty Equipment	6A) Faulty Equipment ▪ Inspect rope/cable/rod for wear, fraying, oils and moisture prior to use, do not use if faulty until repaired or replaced. ▪ Inspect cathead for rust and rope grooves prior to use, do not use if faulty until repaired or replaced ▪ Report any defects to your supervisor
	6B) Moving Equipment	6B) Moving Equipment ▪ Do not wrap rope around any part of the hand or body ▪ Maintain distance of at least 18-inches from in-running points on running/reciprocating equipment ▪ Eliminate excess rope ▪ Do not wear loose clothing ▪ Wear appropriate PPE including leather gloves (See HASP)
7. Soil Sampling	6C) Contaminated Materials	6C) Contaminated Materials ▪ Wear appropriate PPE including Nitrile gloves (See HASP)
	6D) Sharp Sampling Tools	6D) Sharp Sampling Tools ▪ Use correct tools for opening sleeves ▪ When opening sleeve, cut away from body ▪ Place soil core on sturdy surface prior to cutting
	6E) Vapors	6E) Vapors ▪ Wear appropriate PPE including respirator if conditions warrant
	6F) Sample Cross Contamination	6F) Sample Cross Contamination ▪ Decontaminate or dispose of sampling equipment between sampling locations ▪ Double-check sample labels to ensure accuracy and adhesion to containers

Job Hazard Analysis - HASP Format

Job Title: Environmental Drilling/Boring and Associated Soil Sampling **Date of Analysis:** 7/26/06

Key Work Steps	Hazards/Potential Hazards	Safe Practices
8. Solid/Liquid Waste Management/ Disposal	6G) Vapors and Airborne Particulates	6G) Vapors and Airborne Particulates ▪ Monitor air concentrations using direct-reading, real-time instruments such as OVM and Dräger tubes (See HASP for required monitoring instruments and action limits) ▪ Stop work if hazardous conditions (explosive atmosphere, O2 deficient atmosphere) identified until precautions are taken ▪ Wear appropriate PPE including safety glasses with side shields, dust masks and respirators (See HASP) ▪ Stay upwind (use flagging or similar device to indicate wind direction)
	6H) Contaminated Materials and Container Pinch Points	6H) Contaminated Materials and Container Pinch Points ▪ Wear appropriate PPE including Nitrile and leather gloves (See HASP) ▪ Position hands/fingers to avoid pinching/smashing/crushing when closing drum rings
	6I) Heavy Materials and Containers Lifting/ Moving	6I) Heavy Materials and Containers Lifting/ Moving ▪ Do not lift or move heavy containers without assistance ▪ Use proper bending/lifting techniques by lifting with arms and legs and not with back ▪ If possible, use powered lift truck, drum cart, or other mechanical means Take breaks if feeling faint or overexerted ▪ Spot drums in storage area prior to filling ▪ Wear appropriate PPE including leather gloves and steel-toed boots

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Job Hazard Analysis - HASP Format

Job Title: Drilling – Pre-ground Disturbance and Clearance Activities **Date of Analysis:** 7/26/06

Minimum Recommended PPE*: Steel Toed, Slip Resistant Boots; Safety Glasses; Face Shield (if danger to face due to flying particles); Leather and/or Nitrile Gloves, Snake Chaps (if required); High visibility vest; Hard Hat; Hearing Protection; Insulated Gloves (if hand digging to identify underground electrical lines)

*See HASP for all required PPE

Key Work Steps	Hazards/Potential Hazards	Safe Practices
1. All Pre-Ground Disturbance Clearance Activities including Site Inspection, Subsurface Features Mark-out, Removal of Surface Cover and Ground Clearance	1A) Slips/Trips/Falls	1A) Slips/Trips/Falls ▪ Keep work area free of excess material and debris ▪ Remove all trip hazards by keeping materials/objects organized and out of walkways ▪ Keep work surfaces dry when possible ▪ Wear appropriate PPE (see HASP) including non-slip rubber boots if working on wet or slick surfaces ▪ Install rough work surface covers where possible ▪ Stay aware of footing and do not run
	1B) Heat/Cold Stress	1B) Heat/Cold Stress ▪ Take breaks if feeling faint or overexerted ▪ Consume adequate food/beverages (water, sports drinks) ▪ If possible, adjust work schedule to avoid temperature extremes
	1C) Biological Hazards: Insects, Snakes, Wildlife, Vegetation	1C) Biological Hazards: Insects, Snakes, Wildlife, Vegetation ▪ See JHA – Insect Bites and Stings ▪ Inspect work areas when arrive at site to identify hazard(s) ▪ Use insect repellant if observe mosquitoes/gnats ▪ Survey site for presence of biological hazards and maintain safe distance ▪ Wear appropriate PPE including leather gloves, long sleeves and pants, and snake chaps as warranted by site conditions
	1D) Traffic (including pedestrian)	1D) Traffic (including pedestrian) ▪ Notify attendant or site owner/manager of work activities and location ▪ Use cones, signs, flags or other traffic control devices as outlined in the Traffic Control Plan ▪ Set up exclusion zone surrounding work area using cones, signs, flags or other traffic control devices ▪ Wear appropriate PPE including high visibility clothing such as reflective vest ▪ Inspect area behind vehicle prior to backing and use spotter
	1E) Fire/Explosion	1E) Fire/Explosion ▪ Post No Smoking signs around work area ▪ Establish designated smoking area away from work area ▪ Ensure type ABC, 20-lb, fully charged fire extinguisher on-site and within inspection period ▪ As site conditions/activities warrant, establish Hot Work Permit including air monitoring using direct-reading, real-time instruments such as LEL/O meter (see HASP) ▪ Stop work if hazardous conditions (explosive atmosphere) are identified
2. Ambient Air Monitoring	2A) Vapors	2A) Vapors ▪ Approach area where vapors are suspected from upwind direction and stay upwind/crosswind of from potential sources of vapors (use flagging or similar device to indicate wind direction) ▪ See HASP for monitoring requirements and action limits
	2B) Ineffective Air Monitoring	2B) Ineffective Air Monitoring ▪ Ensure personnel using have been trained on instrument use ▪ Calibrate instrument prior to use

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Job Hazard Analysis - HASP Format

Job Title: Drilling – Pre-ground Disturbance and Clearance Activities **Date of Analysis:** 7/26/06

Key Work Steps	Hazards/Potential Hazards	Safe Practices
3. Breaking-Up and Removing Asphalt/ Concrete Cover by Saw Cutting or with Heavy Equipment	3A) Heavy Equipment Movement	3A) Heavy Equipment Movement ▪ Heavy equipment should be equipped with back-up alarm or use horn when backing ▪ Do not allow personnel to stand within the swing radius of equipment booms/arms when equipment is in operation ▪ Stay clear of operating equipment and heavy equipment when moving ▪ When approaching heavy equipment, approach should be made from the front ensuring eye contact is made with operator
	3B) Suspended Loads	3B) Suspended Loads ▪ Do not walk under suspended loads ▪ Wear appropriate PPE including hard hat
	3C) Ignition Sources	3C) Ignition Sources ▪ Ensure electrical equipment properly grounded ▪ Apply water as necessary to address surface sparking potential ▪ Equip heavy equipment with non-sparking bucket/blade
	3D) High Noise Levels	3D) High Noise Levels ▪ Hearing protection required when working around operating equipment if levels are suspected to be >85 dBA (if have to yell to person at a dist of 3 ft to be heard, likely exceeding 85 dBA).
	3E) Airborne Particulates and Debris	3E) Airborne Particulates and Debris ▪ Use water as necessary to control dust in area ▪ Wear appropriate PPE including face shield or safety glasses with side shields, dust mask, leather gloves and long sleeves
	3F) Heavy Material Lifting	3F) Heavy Material Lifting ▪ Use heavy equipment to lift ▪ Do not lift or move heavy materials (greater than 50 lbs) without adequate assistance ▪ Bend and lift with legs and arms, keeping back straight ▪ Wear appropriate PPE including leather gloves, long sleeves and pants, and steel-toed boots
	3G) Impact to Subsurface Lines	3G) Impact to Subsurface Lines ▪ Ensure all underground features have been identified in area per Subsurface Clearance Protocol (SCP) prior to start of activities
	3H) Equipment Rollover	3H) Equipment Rollover ▪ If soil appears unstable, the soil should be assessed by a qualified professional engineer to ensure safe conditions with implementation of design control measures prior to start of work
	3I) Heavy Equipment Movement	3I) Heavy Equipment Movement ▪ Heavy equipment should be equipped with back-up alarm ▪ When approaching heavy equipment, approach should be made from the front ensuring eye contact is made with operator
	3J) Physical Injury from Managing Equipment	3J) Physical Injury from Managing Equipment ▪ Take breaks if feeling faint or overexerted
	3K) Ignition Sources	3K) Ignition Sources ▪ Ensure equipment properly bonded and grounded ▪ Use sufficient hose so that equipment does not have to be located in critical zone ▪ Apply water as necessary to address sparking potential if equipment comes in contact with rocks/buried objects ▪ Equip heavy equipment with non-sparking bucket/blade

Job Hazard Analysis - HASP Format

Job Title: Drilling – Pre-ground Disturbance and Clearance Activities **Date of Analysis:** 7/26/06

Key Work Steps	Hazards/Potential Hazards	Safe Practices
	3L) High Noise Levels	3L) High Noise Levels ▪ Hearing protection required when working around operating equipment if levels are suspected to be >85 dBA (if have to yell to person at a dist of 3 ft to be heard, likely exceeding 85 dBA).
	3M) Airborne Debris	3M) Airborne Debris ▪ Wear appropriate PPE including leather gloves, long sleeves and pants, and face shield or safety glasses with side shields (see HASP)
	3N) Vapors and Airborne Particulates	3N) Vapors and Airborne Particulates ▪ Monitor air concentrations using direct-reading, real-time instruments such as OVM and Dräger tubes (See HASP for monitoring equipment and action limits) ▪ Stop work if hazardous conditions (explosive atmosphere, O2 deficient atmosphere) identified until precautions are taken (See HASP) ▪ Wear appropriate PPE including dust masks and respirators (See HASP) ▪ Stay upwind (use flagging or similar device to indicate wind direction)
	3O) Impact to Underground Lines/Tanks	3O) Impact to Underground Lines/Tanks ▪ Ensure underground features in area have been identified to extent possible per SCP (line locators, drawing review,) ▪ Wear insulating gloves or stand on insulating mat when advancing hand tools
	3P) Open Excavation	3P) Open Excavation ▪ Personnel should stay at least two feet away from edge ▪ Install orange construction fence or temporary chain link fence around excavated area if to be left unattended
4. Solid Waste Management/ Disposal	4A) Vapors and Airborne Particulates	4A) Vapors and Airborne Particulates ▪ Monitor air concentrations using direct-reading, real-time instruments such as OVM and Dräger tubes (See HASP for required monitoring instruments and action limits) ▪ Stop work if hazardous conditions (explosive atmosphere, O2 deficient atmosphere) identified until precautions are taken (See HASP) ▪ Wear appropriate PPE including safety glasses with side shields, dust masks and respirators (See HASP) ▪ Stay upwind (use flagging or similar device to indicate wind direction)
	4B) Contaminated Materials and Container Pinch Points	4B) Contaminated Materials and Container Pinch Points ▪ Wear appropriate PPE including nitrile and leather gloves (See HASP) ▪ Position hands/fingers to avoid pinching/smashing/crushing when closing drum rings
	4C) Heavy Materials and Container Lifting/Moving	4C) Heavy Materials and Container Lifting/Moving ▪ Do not lift or move heavy containers without assistance ▪ Use proper bending/lifting techniques by lifting with arms and legs and not with back ▪ If possible, use powered lift truck, drum cart, or other mechanical means to move containers ▪ Take breaks if feeling faint or overexerted ▪ Spot drums in storage area prior to filling ▪ Wear appropriate PPE including leather gloves and steel-toed boots (See HASP)

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Job Hazard Analysis - HASP Format

Job Title: Streams and Wetlands **Date of Analysis:** 5/30/06

Minimum Recommended PPE*:
*See HASP for all required PPE

Key Work Steps	Hazards/Potential Hazards	Safe Practices
1. Walking to and from stream	1A) Insect bites/stings	2A) Insect bites/stings ▪ Avoid wearing heavy fragrances. ▪ Carry first-aid and sting relief kits. ▪ Make sure all crew members are informed about others who are allergic and what to do if they need assistance. ▪ Carry necessary emergency medication. ▪ See JHA Insect Bites and Stings
	1B) Slips and falls	2B) Slips and falls ▪ Use traction devices on shoes. ▪ Move slowly, take your time. ▪ Use a walking staff to provide a three point support.
	1C) Eye injuries	2C) Eye injuries ▪ Travel with care through heavy brush. ▪ Use eye protection in brushy areas.
	1D) Scrapes and punctures	2D) Scrapes and punctures ▪ Wear proper clothing, long sleeved shirts and pants. No shorts.
	1E) Cuts/Lacerations due to machette use	2E) Cuts/Lacerations due to machette use ▪ Wear chaps or snake legs ▪ Cut away from the body ▪ Ensure blade of machette is sharp
	1F) Blow-down / heavy debris	2F) Blow-down / heavy debris ▪ Be aware of your surroundings, including hanging or leaning debris that may be dislodged and fall.
	1G) Animal encounters	2G) Animal encounters ▪ Moose: a. Make noise to avoid encounter. b. If you do encounter a moose, put a lot of room between you and the animal by walking around him/her if necessary. c. Do not look it in the eye. d. If charged, run away or climb a tree. e. Throwing something or shouting may deter an attack.
	1H) Severe injury in remote locations	2H) Severe injury in remote locations ▪ Carry a two-way radio and know how to use it. ▪ Work in teams. ▪ Make sure someone on crew is certified in first aid. ▪ Carry a first aid kit.
2. Entering Stream	2A) Slips and falls	2A) Slips and falls ▪ Use traction devices on shoes and waders. ▪ Move slowly, take your time. ▪ Use a walking staff to provide a three point support.
	2B) Sand or Mud – knee or ankle injury	2B) Sand or Mud ▪ Use shorter steps ▪ Use walking sticks to check firmness of soils ▪ Use buddy system ▪ Snowshoes that dissipate weight may be effective ▪ If leg gets caught, use slight back and forth motion to soften mud and remove slowly. Don’t try to pull leg out with twisting or jerking motion. ▪ If possible, aeriate or bubble the mud to help releave suction.

Job Hazard Analysis - HASP Format

Job Title: Streams and Wetlands **Date of Analysis:** 5/30/06

Key Work Steps	Hazards/Potential Hazards	Safe Practices
	2C) Equipment	2C) Equipment ▪ Secure packs and hip waders with quick release straps and be ready to discard, if an emergency arises. ▪ Do not work in waders in water greater than 3 feet deep or in swift water. ▪ Wear bike or rafting helmets to protect from blows to the head.
	2D) Hypothermia	2D) Hypothermia ▪ Work in teams of two. ▪ Have warming devices available. ▪ Wear proper equipment that is in good condition. ▪ Be aware of signs of hypothermia, it's prevention, detection and treatment. ▪ Stay in tune to current weather and extended forecasts. ▪ See JHA General Field Work
	2E) High flow velocity	2E) High flow velocity ▪ Evaluate a stream before entering. ▪ Follow the "rule of 10" a. If stream is 1 foot deep and flowing @10 ft./sec, it is too hazardous to wade b. If stream is 2 feet deep and flowing at 5 ft./second, it is too hazardous to wade. c. If you do enter a stream and discover it is too dangerous to wade, back out using your wading pole for balance.
	2F) Severe weather	2F) Severe weather ▪ Suspend measurements during lightning storms or when a storm is approaching.

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Job Hazard Analysis - HASP Format

Job Title: Insect Stings and Bites **Date of Analysis:** 4/20/06

Minimum Recommended PPE*: Long sleeved shirt and pants, light colored clothing
*See HASP for all required PPE

Key Work Steps	Hazards/Potential Hazards	Safe Practices
1. Traveling/working in areas with potential Tick Bites –Example outdoor wooded areas or fields.	1. Lyme Disease, Rocky Mountain Spotted Fever, etc.	1A) Spray clothing with insect repellant as a barrier. 1B) Wear light colored clothing that fits tightly at the wrists, ankles, and waist. 1C) Each outer garment should overlap the one above it. 1D) Cover trouser legs with high socks or boots. 1E) Tuck in shirt tails. 1F) Search the body on a regular basis, especially hair and clothing; ticks generally do not attach for the first couple of hours. 1G) If a tick becomes attached, pull it by grasping it as close as possible to the point of attachment and pull straight out with gentle pressure. Wash skin with soap and water then cleanse with rubbing alcohol. Place the tick in an empty container for later identification, if the victim should have a reaction. Record dates of exposure and removal. 1H) Do not try to remove the tick by burning with a match or covering it with chemical agents. 1I) If you can not remove the tick, or the head detaches, seek propmt medical help. 1J) Watch for warning signs of illness: a large red spot on the bite area; fever, chills, headache, joint and muscle ache, significant fatigue, and facial paralysis are reactions that may appear within two weeks of the attack. Symptoms specific to Lyme disease include: confusion, short-term memory loss, and disorientation.
2. Working/traveling in areas with potential bee and wasp stings-Example wooded areas and fields	2. Allergic reactions, painful stings	2A) Be alert to hives in brush or in hollow logs. Watch for insects travelling in and out of one location. 2B) If you or anyone you are working with is known to have allergic reactions to bee stings, tell the rest of the crew and your supervisor. Make sure you carry emergency medication with you at all times. 2C) Wear long sleeve shirts and trousers; tuck in shirt.. Bright colors and metal objects may attract bees. 2D) If you are stung, cold compresses may bring relief. 2E) If a stinger is left behind, scrape it off the skin. Do not use a tweezers as this squeezes the venom sack, worsening the injury. 2F) If the victim develops hives, asthmatic breathing, tissue swelling, or a drop in blood pressure, seek medical help immediately. Give victim antihistime, (Benadryl, chlo-amine tabs).
3. Traveling/working in areas of potential Mosquito Bites- Example- Woods, fields, near bodies of water and etc.	3. Skin irritation, encephalitis	3A) Wear long sleeves and trousers. 3B) Avoid heavy scents. 3C) Use insect repellants. If using DEET, do not apply directly to skin, apply to clothing only. 3D) Carry after-bite medication to reduce skin irritation.

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Job Hazard Analysis - HASP Format

Job Title: Working with Preservatives (Acids) **Date of Analysis:** 5/30/06

Minimum Recommended PPE*: Safety glasses/goggles, nitrile gloves,
*See HASP for all required PPE

Key Work Steps	Hazards/Potential Hazards	Safe Practices
1. Opening the box of ampoules	1A) Cuts or punctures with a knife	1A) Cuts or punctures with a knife ▪ Use appropriate techniques when handling a knife. Always cut away from you.
	1B) Broken ampoules in the box. Cuts from the broken glass.	1B) Broken ampoules in the box. Cuts from the broken glass. ▪ Wear safety goggles and protective gloves. ▪ Dispose of the preservative and broken glass by approved methods.
	1C) Broken ampoules in the box. Breathing fumes.	1C) Broken ampoules in the box. Breathing fumes. ▪ Wear safety goggles and protective gloves. ▪ Always work in a well-ventilated area.
2. Breaking top of glass ampoule	2A) Cuts from the broken glass.	2A) Cuts from the broken glass ▪ Wear safety goggles and protective gloves. ▪ Use a paper towel to wrap ampoule in to snap the top or use an ampoule breaker. ▪ Always point the ampoule away from you when you snap off the top.
	2B) Skin contact chemical burns.	2B) Skin contact chemical burns. ▪ Wear safety goggles and protective gloves. ▪ Fumes may come into contact with the perspiration on your skin and rehydrate to form an acid. ▪ If your skin itches, flush affected area for 15 minutes with water.
	2C) Eye contact	2C) Eye contact ▪ Wear safety goggles. ▪ If acid splashes in the eyes, flush eyes for 15 minutes with water. Seek medical advice.
	2D) Breathing fumes	2D) Breathing fumes ▪ HNO_3 and HCL have high vapor pressure. Always work in a well-ventilated area.
3. Adding acid to sample	3A) Chemical reaction	3A) Chemical reaction ▪ Wear safety goggles and protective gloves. Acid may react with high alkaline sample and fizz (releases CO_2).
	3B) Eye contact	3B) Eye contact ▪ Wear safety goggles. ▪ If acid splashes in the eyes, flush eyes for 15 minutes with water. Seek medical advice.
	3C) Skin contact chemical burns.	3C) Skin contact chemical burns. ▪ Wear safety goggles and protective gloves.
4. Ampoule disposal	4A) Cuts from the broken glass.	4A) Cuts from the broken glass. ▪ Wear safety goggles and protective gloves. ▪ Place used ampoules in an empty, non-reactive container in the field and bring it back to the office. Dispose of the preservative and broken glass by approved methods.

Job Hazard Analysis - HASP Format

Job Title: Pore Water Sampling from the Shore **Date of Analysis:** 4/4/07

Minimum Recommended PPE*: Safety Boots/Shoes; Safety Glasses; Rubber boots; Waders; Personal Flotation Device (if over or in water);

*See HASP for all required PPE

Key Work Steps	Hazards/Potential Hazards	Safe Practices
1. Prepare for site visit	1A) Slips, trips, falls	1A) Familiarize self with site prior to visit. ▪ Complete appropriate training before going on site. ▪ Provide appropriate person in district office your itinerary. ▪ Prepare listing of emergency phone numbers, both on and offsite. ▪ Identify site/activity PPE needs. ▪ Ensure that First Aid training is current, and that tetanus booster are current.
2. Check and calibrate sampling equipment.	2A) Muscle Strain - lifting, twisting, tugging	2A) Muscle Strain - lifting, twisting, tugging ▪ Inspect all PPE and equipment and ensure that it is working properly. ▪ Get assistance from a coworker or use mechanical means to move equipment (dolly, cart, etc.)
	2B) Slips, trips, falls, strain	2B) Slips, trips, and falls ▪ Wear proper footwear. ▪ Pay attention to where walking.
3. Load/carry equipment to the site.	3A) Slips, trips, falls,	3A) Slips, trips, falls ▪ See JHA for Mobilization / Demobilization and Site Preparation ▪ Survey and clear the pathway. See JHA for Clearing Brush and Trees
	3B) Muscle Strain - lifting, twisting, tugging	3B) Muscle Strain - lifting, twisting, tugging ▪ Proper lifting, ergonomic practices and body mechanics. ▪ Share the load, move items in smaller shifts, or use cart.
4. Field parameters	4A) Falling into water	4A) Falling into water ▪ Limit access to water. ▪ Use equipment that facilitates reaching the location from a safe distance. ▪ Work using the buddy system. Wear PFD if working over or in water.
	4B) Slips trips and falls	4B) Slips trips and falls ▪ Wear appropriate footwear. ▪ Survey and clear walking area. ▪ Do not walk on slippery surfaces. ▪ Housekeeping.
	4C) Stuck in the mud or sand	4C) Stuck in the mud or sand ▪ Ensure secure footing. ▪ Provide walkways, platforms or secure walking surface. ▪ Use the buddy system and maintain communications with support staff. ▪ (See JHA for Rescue from Mud footing)

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Job Hazard Analysis - HASP Format

Job Title: Pore Water Sampling from the Shore **Date of Analysis:** 4/4/07

Key Work Steps	Hazards/Potential Hazards	Safe Practices
	4D) Vermin, leaches, Insect/animal born disease	4D) Vermin, leaches, Insect/animal born disease ▪ Survey the area for dens, nests, etc. ▪ Identify areas where biological hazards may be present. ▪ Be aware of your surroundings. ▪ Wear insect netting clothing or apply insect repellant on all exposed skin surfaces as appropriate – consider sample contamination ▪ Wear long sleeve shirt and full length pants ▪ Wear appropriate footwear (snake boots, etc.) ▪ Avoid high grass areas if possible ▪ Tuck pants leg into boot ▪ Do not put hand/arm into/under an area that you can not see into/under clearly ▪ Do not touch any suspected contaminant without appropriate hand PPE ▪ Wash hands as soon as possible upon completion of task. ▪ Perform routine inspections for ticks, leaches, etc. of yourself and co-workers. ▪ Contract vermin relocation, if applicable. ▪ Remain vigilant and respectful of wildlife. ▪ See JHA for Insects, Stings and Bites ▪ See JHA for Dog – Wildlife Safety.
	4E) Weather – temperature extremes	4E) Weather – temperature extremes ▪ Train workers about weather and appropriate precautions. ▪ Heat: o Familiarize self with signs of heat related illnesses: cramps, heat rash, dehydration, heat exhaustion, and heat stroke. ▪ Sun: o Keep body protected o Wear sunscreen, wide brimmed hat or hardhat. o Drink plenty of fluids to remain hydrated. o Schedule work for cool part of day. o Take breaks in the shade. ▪ Wind: o Wear layered clothing, gloves, hard hat with winter liner, etc. ▪ Cold: o During cold weather - layer clothing and wear wind impervious outerwear o During warm months – wear a long sleeve cotton/breathable fabric shirt and pant.
5. Sample collection	5A) Same as Item #4 above.	5A) Same as Item #4 above.
	5B) Bending, pulling, twisting	5B) Bending, pulling, twisting ▪ Use a vibrating or wiggling motion on the sample device to break the soil suction. ▪ Proper lifting technique.
	5C) Splash	5C) Splash ▪ Wear appropriate safety glasses (tinted for sun). ▪ Be aware if sampling water through a filter, if it becomes plugged with sediment it may unexpectedly “blow off” the hose and splash. ▪ Change filter prior to sedimentation back pressure.

Job Hazard Analysis - HASP Format

Job Title: Pore Water Sampling from the Shore **Date of Analysis:** 4/4/07

Key Work Steps	Hazards/Potential Hazards	Safe Practices
	5D) Chemical exposure	5D) Chemical exposure ▪ Wear PPE including protective gloves, coveralls, safety glasses as appropriate. ▪ Work upwind of the sample location. ▪ Minimize exposure using a shovel/spoon or tool to collect the sample. ▪ Review and understand MSDS for all chemicals being handled. ▪ Be careful when handling acids and caustic substances. ▪ Wear adequate PPE and wash hands after completion of task.
	5E) Vegetation, sticks, reeds, - cuts and punctures	5E) Vegetation, sticks, reeds, - cuts and punctures ▪ Clear access to site. ▪ Be familiar with toxic plants such as poison ivy. Avoid such plants. ▪ Wash thoroughly after accidental contact with toxic materials and plants.
6. Sample preparation.	6A) Lifting heavy objects (covers, pumps, sampling equipment, coolers, etc.) Muscle strain	6A) Lifting heavy objects (covers, pumps, sampling equipment, coolers, etc.) Muscle strain ▪ Use proper ergonomics when lifting heavy objects ▪ Use appropriate mechanical assistance and tools when possible.
	6B) Chemical Exposure	6B) Chemical Exposure ▪ Wear PPE including protective gloves, coveralls, safety glasses as appropriate. ▪ Wash/wipe or decontaminate exterior of sample containers and equipment. ▪ Use care handling preservatives (acids/bases.)
	6C) Sharps and knives	6C) Sharps and knives ▪ Use care handling tape dispensers, knives and sharp objects.
	6D) Extreme cold (ice preservation)	6D) Extreme cold (ice preservation) ▪ Minimize exposure to ice. ▪ Use a shovel/spoon or tool to fill bags for preserving samples in coolers.
7. Site exit and drive home or next site.	7A) Vehicle contamination	7A) Vehicle contamination ▪ Wash hands promptly. ▪ Contaminated PPE (booties, Tyvek, nitrile gloves) should be disposed on-site. ▪ Remove boots and soiled clothing for secure storage in trunk; decontaminate as soon as possible. ▪ Update exposure log.
	7B) Traffic hazards.	7B) Traffic hazards. ▪ See JHA for Mobilization / Demobilization and Site Preparation.

Job Hazard Analysis - HASP Format

Job Title: Well Development **Date of Analysis:** 8/11/06

Minimum Recommended PPE*:

*See HASP for all required PPE

Key Work Steps	Hazards/Potential Hazards	Safe Practices
1. Going to site, work preparation	1A) Mobilization / Demobilization and Site Preparation	1A) See JHA for Mobilization Demobilization and Site Preparation ▪ See HASP for required PPE and air monitoring equipment needs
2. Working at the site	2A) General Field Work – Walking and working in the field, environmental conditions, communication	2A) See JHA for General Field Work
3. Surge and Bail well	3A) Lifting/Twisting/Tugging	3A) Lifting/Twisting/Tugging ▪ Use proper lifting techniques when lifting equipment ▪ Use mechanical aids if available ▪ Use 2 person lift for heavy items
	3B) Slips/Trips/Falls	3B) Slips/Trips/Falls ▪ Ground can become wet/muddy, created by spilled water ▪ Place all purged water in drums or carboys for removal ▪ Wear good slip resistant footwear
	3C) Entanglement – Mechanical Surge	3C) Entanglement – Mechanical Surge ▪ Be aware of cords/wiring/hose location at all times. ▪ Secure all loose clothing and long hair
	3D) Exposure to Contaminated Groundwater	3D) Exposure to Contaminated Groundwater ▪ After the initial headspace reading (if required by the Work Plan), allow the well to vent for several minutes before bailing well ▪ Wear PPE as identified in HASP. ▪ Review hazardous properties of site contaminants with workers before sampling operations begin ▪ Monitor breathing zone air in accordance with HASP to determine levels of contaminants present. ▪ Wear face shield if splash hazard exists.
	3E) Poisonous Plants and Insects	3E) Poisonous Plants and Insects ▪ Look for signs of poisonous plants and avoid. ▪ Ensure all field workers can identify the plants. Mark identified poisonous plants with spray paint if working at a fixed location. ▪ Wear PPE as described in the HASP. ▪ Do not touch any part of your body/clothing. ▪ Always wash gloves before removing them. ▪ Discard PPE in accordance with the HASP. ▪ Use commercially available products such as Ivy Block or Ivy Wash as appropriate.
	3F) Contact with biting insects (i.e., spiders, bees, etc.) which may have constructed a nest in the well cap/well.	3F) Contact with biting insects ▪ Discuss the types of insects expected at the Site and be able to identify them. ▪ Look for signs of insects in and around the well. ▪ Wear Level of PPE as described in the HASP. At a minimum, follow guidelines in the JHA "Insects Stings and Bites." ▪ If necessary, wear protective netting over your head/face. ▪ Avoid contact with the insects if possible. ▪ Inform your supervisor and the Site Health and Safety Supervisor if you have any allergies to insects and insect bites. Make sure you have identification of your allergies with you at all times and appropriate response kits if applicable. ▪ Get medical help immediately if you are bitten by a black widow or brown recluse, or if you have a severe reaction to any spider bite or bee sting.

Job Hazard Analysis - HASP Format

Job Title: Well Development **Date of Analysis:** 8/11/06

Key Work Steps	Hazards/Potential Hazards	Safe Practices
4. Pump well	4A) Lifting/Twisting/Tugging	4A) Lifting/Twisting/Tugging ▪ Use proper lifting techniques when lifting equipment ▪ Use mechanical aids if available ▪ Use 2 person lift for heavy items
	4B) Using Generator/Electrical Equipment	4B) Using Generator/Electrical Equipment ▪ A ground fault circuit interrupter (GFCI) device must protect all AC electrical circuits. ▪ Use only correctly grounded equipment. Never use three-pronged cords which have had the third prong broken off. ▪ Make sure that the electrical cords from generators and power tools are not allowed to be in contact with water ▪ Do not stand in wet areas while operating power equipment ▪ Always make sure all electrically-powered equipment is in good repair. Report any problems so the equipment can be repaired or replaced. ▪ When unplugging a cord, pull on the plug rather than the cord. ▪ Never do repairs on electrical equipment unless you are both authorized and qualified to do so.
	4C) Entanglement	4C) Entanglement ▪ Be aware of cords/wiring/hose location at all times. ▪ Secure all loose clothing and long hair
	4D) Exposure to Contaminated Groundwater	4D) Exposure to Contaminated Groundwater ▪ After the initial headspace reading (if required by the Work Plan), allow the well to vent for several minutes before bailing well ▪ Wear PPE as identified in HASP. ▪ Review hazardous properties of site contaminants with workers before sampling operations begin ▪ Monitor breathing zone air in accordance with HASP to determine levels of contaminants present. ▪ Wear face shield if splash hazard exists.
	4E) Cuts to hands	4E) Cuts ▪ Be alert for sharp edges. Wear cut resistant gloves as appropriate
	4F) Poisonous Plants and Insects	4F) Poisonous Plants and Insects ▪ Look for signs of poisonous plants and avoid. ▪ Ensure all field workers can identify the plants. Mark identified poisonous plants with spray paint if working at a fixed location. ▪ Wear PPE as described in the HASP. ▪ Do not touch any part of your body/clothing. ▪ Always wash gloves before removing them. ▪ Discard PPE in accordance with the HASP. ▪ Use commercially available products such as Ivy Block or Ivy Wash as appropriate.

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Job Hazard Analysis - HASP Format

Job Title: Well Development **Date of Analysis:** 8/11/06

Key Work Steps	Hazards/Potential Hazards	Safe Practices
	4G) Contact with biting insects (i.e., spiders, bees, etc.) which may have constructed a nest in the well cap/well.	4G) Contact with biting insects ▪ Discuss the types of insects expected at the Site and be able to identify them. ▪ Look for signs of insects in and around the well. ▪ Wear Level of PPE as described in the HASP. At a minimum, follow guidelines in the JHA "Insects Stings and Bites." ▪ If necessary, wear protective netting over your head/face. ▪ Avoid contact with the insects if possible. ▪ Inform your supervisor and the Site Health and Safety Supervisor if you have any allergies to insects and insect bites. Make sure you have identification of your allergies with you at all times and appropriate response kits if applicable. ▪ Get medical help immediately if you are bitten by a black widow or brown recluse, or if you have a severe reaction to any spider bite or bee sting.
5. Dispose of developmental water	5A) Lifting, Carrying (5 gal carboys or heavy equipment)	5A) Lifting, Carrying ▪ Use proper lifting techniques when lifting equipment ▪ Use mechanical aids if available ▪ Use 2 person lift for heavy items
	5B) Slips/Trips/Falls	5B) Slips/Trips/Falls ▪ Ground can become wet/muddy, created by spilled water ▪ Place all purged water in drums or carboys for removal ▪ Wear good slip resistant footwear
	5C) Exposure to Contaminated Groundwater	5C) Exposure to Contaminated Groundwater ▪ After the initial headspace reading (if required by the Work Plan), allow the well to vent for several minutes before bailing well ▪ Wear PPE as identified in HASP. ▪ Review hazardous properties of site contaminants with workers before sampling operations begin ▪ Monitor breathing zone air in accordance with HASP to determine levels of contaminants present. ▪ Wear face shield if splash hazard exists.
	5D) Walking through woods	5D) Walking through woods ▪ Protect head agains falling objects. ▪ Wear your hardhat for protection from falling limbs and pinecones, and from tools and equipment carried by other crewmembers. ▪ Stay out of the woods during extremely high winds. ▪ Watch your footing as stepping over rocks, roots, uneven terrain, etc.

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Job Hazard Analysis - HASP Format

Job Title: Power Tools - Electrical **Date of Analysis:** 8/2/06

Minimum Recommended PPE*: Safety glasses, ear protection, dust mask or respirator,

*See HASP for all required PPE

Key Work Steps	Hazards/Potential Hazards	Safe Practices
1. Carrying tool to jobsite	1A) Back or muscle strain	1A) Back or muscle strain ▪ Use proper lifting techniques when tools or generators ▪ Use mechanical aids if available ▪ Use 2 person lift for heavy items
2. Setting up Work Area	2A) Injury due to encountering branches or debris	2A) Injury due to encountering branches or debris ▪ Inspect work area and clear away any loose wire, rope, branches or other items that may become entangled in tool or cutting head. ▪ Tool should be equipped with trigger style release switch.
	2B) Injury due to defective tool	2B) Injury due to defective tool ▪ Inspect tool prior to use to ensure it is safe to use. ▪ If found to be defective or if questionable condition, do not use the tool until serviced. Tag tool out of service
3. Using tool – Electric Saws	3A) Inexperience	3A) Inexperience ▪ Train all hand tool users in their proper use. ▪ Never allow workers to work alone until they have demonstrated an ability to handle the tool safely.
	3B) Electrical shock	3B) Electrical shock ▪ Make sure that tool is in good condition, cord is not frayed or pulling away from the plug or connection. ▪ Do not remove grounding plug or use a tool where the grounding plug has been removed ▪ Avoid working in wet areas. ▪ Ground tools when using generators. ▪ Use a GFCI ▪ Keep tools unplugged when not in use.
	3C) Cuts	3C) Cuts ▪ All electric power tools should be unplugged when changing bits, making adjustments, or changing blades. ▪ Guards must remain in place and not "pinned" back. ▪ Push sticks should be used when using jointer or ripping with table saw. ▪ Keep fingers away from cutting blades. ▪ Clamp small stock when using router, drill, saw, or sander. ▪ Check blades regularly and keep in good condition. ▪ Use blade recommended for material being cut. ▪ Never jam saw into work. ▪ Cut green, treated or wet material slowly and with caution
	3D) Ear injury	3D) Ear injury ▪ Wear ear protection if required.
	3E) Eye injury	3E) Eye injury ▪ Safety goggles (or protective glasses) should be worn at all times. ▪ Look for nails or hard knots before cutting.
	3F) Entanglement (clothing or cords)	3F) Entanglement (clothing or cords) ▪ Secure all loose clothing and long hair. ▪ Be aware of cord locations and keep away from drill, saw, or sander. ▪ Keep chuck key clear of drill or saw before plugging in. ▪ Electrical hand saws and drills must have quick release trigger.

Job Hazard Analysis - HASP Format

Job Title: Power Tools - Electrical **Date of Analysis:** 8/2/06

Key Work Steps	Hazards/Potential Hazards	Safe Practices
	3G) Electrical grinders	3G) Electrical grinders ▪ Check grinding wheels often. ▪ Do not grind soft material. ▪ Hold small objects with clamp or vise grip.
	3H) Electrical saws (dust)	3H) Electrical saws (dust) ▪ Operators exposed to dust, as when cutting concrete, tile, treated wood or stone, shall wear approved respirator (mask).
	3I) Electrical drills	3I) Electrical drills ▪ Inspect drill bits regularly and use the recommended bit for material being drilled.
	3J) Electrical sanders	3J) Electrical sanders ▪ Inspect sanding surface for nails. ▪ Check sandpaper often. Keep belt centered on belt sander. ▪ Do not sand wet material.

Job Hazard Analysis - HASP Format

Job Title: Sub-Slab-Indoor Air Sampling **Date of Analysis:** 11/1/2007

Minimum Recommended PPE*: steel-toed boots, safety glasses, chemical resistant gloves-nitrile, flashlight/lamp
*See HASP for all required PPE

Key Work Steps	Hazards/Potential Hazards	Safe Practices
1. Mobilization	1A) See JHA Mobilization/Demobilization/Site Preparation	1A) See JHA Mobilization/Demobilization/Site Preparation
2. General Site Hazards	2A) See JHA Field Work - General	2A) See JHA Field Work - General
	2B) Chemical exposure	2B) Chemical Exposure ▪ Read HASP and determine air monitoring and PPE needs.
3. Calibrate monitoring equipment	3A) Exposure to calibration gases	3A) Exposure to calibration gases ▪ Review equipment manuals ▪ Calibrate in a clean, well ventilated area
4. Access Residence	4A) Tripping hazards	4A) Observe floors/stairs for potential tripping hazards
	4B) Back strain	4B) Watch back when carrying equipment into residence
	4C) Chemical Hazard	4C) Be careful when identifying residential chemicals ▪ Wear PPE as described in the HASP.
5. Drill Hole in basement floor	5A) Electrocution	5A) Electrocution ▪ A ground fault circuit interrupter (GFCI) device must protect all AC electrical circuits. ▪ Use only correctly grounded equipment. Never use three-pronged cords which have had the third prong broken off. ▪ Make sure that the electrical cords from generators and power tools are not allowed to be in contact with water ▪ Do not stand in wet areas while operating power equipment ▪ Always make sure all electrically-powered sampling equipment is in good repair. Report any problems so the equipment can be repaired or replaced. ▪ When unplugging a cord, pull on the plug rather than the cord. ▪ Never do repairs on electrical equipment unless you are both authorized and qualified to do so.
	5B) Exposure to hazardous Inhalation and contact with hazardous substances (VOC contaminated Soil Vapor).	5B) Exposure to hazardous substances ▪ Wear PPE as identified in HASP (steel-toed boots, safety glasses, nitrile gloves and a flashlight or lamp). ▪ Review hazardous properties of site contaminants with workers before sampling operations begin ▪ Immediately monitor breathing zone using a PID after drilling hole to determine exposure and verify that level of PPE is adequate – see Action Levels in HASP
	5C) Back strain due to lifting and from moving equipment	5C) Back strain ▪ Use mechanical aids when possible, if mechanical aids are not available, use two person lifts for heavy items. ▪ Use proper lifting techniques
	5D) Foot injuries from dropped equipment/drill bit	5D) Foot Injuries ▪ Be aware when moving objects, ensure you have a good grip when lifting and carrying objects. ▪ Do not carry more than you can handle safely ▪ Watch feet when drilling and hold drill firmly ▪ Wear Steel toed boots

Job Hazard Analysis - HASP Format

Job Title: Sub-Slab-Indoor Air Sampling **Date of Analysis:** 11/1/2007

Key Work Steps	Hazards/Potential Hazards	Safe Practices
6. Collecting Sub-Slab sample	6A) Burn Hazard/fire Hazard	6A) Burn Hazard/ Fire Hazard from Melting Wax ▪ Place hot plate in safe location away from flammable material ▪ Be careful with exposed skin when working around hot plate and hot wax. ▪ Poor wax with spoon and avoid splatter.
	6B) Cutting Hazard	6B) Be careful with sharp knives when cutting tubing
	6C) Exposure to contaminants	6C) Exposure to Contaminants ▪ Monitor breathing zone with appropriate monitoring equipment (see HASP) ▪ Wear chemical resistant PPE as identified in HASP ▪ See section 5B) under Safe Practices above
7. Collecting Indoor Air sample	7A) Pinching Hazard	7A) Pinching Hazard from attaching regulators/tubing ▪ Be careful when using wrenches to attach regulator and or tubing to cans to not pinch fingers

Job Hazard Analysis - Short Form HASP

Job Title: Working in Muddy Areas **Date of Analysis:** 9/26/06

Minimum Recommended PPE*: Modified Level D – field clothing, boots
*See HASP for all required PPE

Key Work Steps	Hazards/Potential Hazards	Safe Practices
1. Prepare for site visit	1A) See JHA Mobilization/ demobilization/site preparation	1A) See JHA Mobilization/ demobilization/site preparation
2. Traveling/working in areas with potential muddy locations – Example outdoor surface water areas.	2A) Poor footing - sip, suction, entrapment or fall.	2A) Poor footing - slip, suction, entrapment or fall. ▪ Use a walking stick or probe to check footing and potietial deep holes prior to entering area. ▪ Wear appropriate foot wear such as boots. Over shoe boots provide protection to foot wear as well as a layer to remove if foot gets stuck. ▪ Be aware of surroundings. Avoid muddy areas if possible. ▪ Use the buddy system. Keep a safe distance between workers to avoid both workers getting stuck. ▪ Be prepared with rope, plywood, shovel, pole to assist “rescue” from being stuck in the mud. ▪ If walking in mud is required to reach sample area, several techniques may be employeed to limit foot suction and sinking in mud or quicksand. - Provide a walkway or elevated surface. - Use of snow fencing on the surface or snow shoes to disperse your weight. - Use a skating motion and keep moving until on location. Use a platform to stand on for sampling. - Use coolers or other means of support while walking across muddy area.
3.	3A) Allergic reactions, painful stings	3A) Allergic reactions, painful stings ▪ Be alert to hives in brush or in hollow logs. Watch for insects travelling in and out of one location. ▪ See JHA – Insect bites and stings.
4. .	4A) Skin irritation, encephalitis	4A) Skin irritation, encephalitis ▪ Wear long sleeves and trousers.

Material Safety Data Sheet
Hydrochloric Acid, Reagent ACS

ACC# 95547

Section 1 - Chemical Product and Company Identification

MSDS Name: Hydrochloric Acid, Reagent ACS
Catalog Numbers: AC423790025, AC423790250, AC423795000, NC9619320
Synonyms: Muriatic acid; Chlorohydric acid; Hydrogen chloride; Spirits of salt
Company Identification:
Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410
For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
7647-01-0	Hydrochloric acid	36.5	231-595-7
7732-18-5	Water	Balance	231-791-2

Hazard Symbols: C
Risk Phrases: 34 37

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: colorless to slight yellow clear liquid. **Danger!** Corrosive. Causes eye and skin burns. May cause severe respiratory tract irritation with possible burns. May cause severe digestive tract irritation with possible burns. May be harmful if swallowed.
Target Organs: Respiratory system, teeth, eyes, skin, circulatory system.

Potential Health Effects

Eye: May cause irreversible eye injury. Vapor or mist may cause irritation and severe burns. Contact with liquid is corrosive to the eyes and causes severe burns. May cause painful sensitization to light.
Skin: May be absorbed through the skin in harmful amounts. May cause skin sensitization, an allergic reaction, which becomes evident upon re-exposure to this material. Contact with liquid is corrosive and causes severe burns and ulceration.
Ingestion: May cause circulatory system failure. Causes severe digestive tract burns with abdominal pain, vomiting, and possible death. May cause corrosion and permanent tissue destruction of the esophagus and digestive tract. May be harmful if swallowed.
Inhalation: May cause severe irritation of the respiratory tract with sore throat, coughing,

shortness of breath and delayed lung edema. Causes chemical burns to the respiratory tract. Exposure to the mist and vapor may erode exposed teeth. Causes corrosive action on the mucous membranes.
Chronic: Prolonged or repeated skin contact may cause dermatitis. Repeated exposure may cause erosion of teeth. May cause fetal effects. Laboratory experiments have resulted in mutagenic effects. Prolonged exposure may cause conjunctivitis, photosensitization, and possible blindness.

Section 4 - First Aid Measures

Eyes: Get medical aid immediately. Do NOT allow victim to rub or keep eyes closed. Extensive irrigation with water is required (at least 30 minutes). SPEEDY ACTION IS CRITICAL!
Skin: Get medical aid immediately. Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Destroy contaminated shoes.
Ingestion: Do NOT induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately. Give milk of magnesia.
Inhalation: Get medical aid immediately. Remove from exposure and move to fresh air immediately. If breathing is difficult, give oxygen. Do NOT use mouth-to-mouth resuscitation. If breathing has ceased apply artificial respiration using oxygen and a suitable mechanical device such as a bag and a mask.
Notes to Physician: Do NOT use sodium bicarbonate in an attempt to neutralize the acid.
Antidote: Do NOT use oils or ointments in eye.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Water runoff can cause environmental damage. Dike and collect water used to fight fire. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Not flammable, but reacts with most metals to form flammable hydrogen gas. Use water spray to keep fire-exposed containers cool. Vapors may be heavier than air. They can spread along the ground and collect in low or confined areas. Reaction with water may generate much heat which will increase the concentration of fumes in the air. Containers may explode when heated.
Extinguishing Media: For large fires, use water spray, fog, or alcohol-resistant foam. Substance is nonflammable; use agent most appropriate to extinguish surrounding fire. Do NOT get water inside containers. Do NOT use straight streams of water. Most foams will react with the material and release corrosive/toxic gases. Cool containers with flooding quantities of water until well after fire is out. For small fires, use carbon dioxide (except for cyanides), dry chemical, dry sand, and alcohol-resistant foam.
Flash Point: Not applicable.
Autoignition Temperature: Not applicable.
Explosion Limits, Lower: Not available.
Upper: Not available.
NFPA Rating: (estimated) Health: 3; Flammability: 0; Instability: 0

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Large spills may be neutralized with dilute alkaline solutions of soda ash (sodium carbonate, $Na2CO3$), or lime (calcium oxide, CaO). Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the Protective Equipment section. Remove all sources of ignition. Provide ventilation. Do not get water inside containers. A vapor suppressing foam may be used to reduce vapors. Cover with dry earth, dry sand, or other non-combustible material followed with plastic sheet to minimize spreading and contact with water.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use only in a well-ventilated area. Contents may develop pressure upon prolonged storage. Do not breathe dust, vapor, mist, or gas. Do not get in eyes, on skin, or on clothing. Keep container tightly closed. Do not ingest or inhale. Discard contaminated shoes. Use caution when opening. Keep from contact with moist air and steam.
Storage: Do not store in direct sunlight. Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances. Corrosives area. Do not store in metal containers. Store protected from moisture. Do not store near flammable or oxidizing substances (especially nitric acid or chlorates).

Section 8 - Exposure Controls, Personal Protection

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

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Hydrochloric acid	2 ppm Ceiling	50 ppm IDLH	5 ppm Ceiling; 7 mg/m3 Ceiling
Water	none listed	none listed	none listed

OSHA Vacated PELs: Hydrochloric acid: No OSHA Vacated PELs are listed for this chemical. Water: No OSHA Vacated PELs are listed for this chemical.
Personal Protective Equipment
Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin: Wear neoprene or polyvinyl chloride gloves to prevent exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant a respirator's use.

Section 9 - Physical and Chemical Properties

Physical State: Clear liquid
Appearance: colorless to slight yellow

Odor: strong, pungent
pH: 0.01
Vapor Pressure: 5.7 mm Hg @ 0 deg C
Vapor Density: 1.26
Evaporation Rate:> 1.00 (N-butyl acetate)
Viscosity: Not available.
Boiling Point: 81.5-110 deg C @ 760 mmHg
Freezing/Melting Point:-74 deg C
Decomposition Temperature: Not available.
Solubility: Miscible.
Specific Gravity/Density:1.0-1.2
Molecular Formula:HCl.H2O
Molecular Weight:36.46

Section 10 - Stability and Reactivity

Chemical Stability: Stable under normal temperatures and pressures.
Conditions to Avoid: Mechanical shock, incompatible materials, metals, excess heat, exposure to moist air or water, bases.
Incompatibilities with Other Materials: Acetates, acetic anhydride, alcohols + hydrogen cyanide, 2-aminoethanol, ammonium hydroxide, calcium carbide, calcium phosphide, cesium acetylene carbide, cesium carbide, chlorosulfonic acid, 1,1-difluoroethylene, ethylene diamine, ethyleneimine, fluorine, lithium silicides, magnesium boride, mercuric sulfate, oleum, perchloric acid, potassium permanganate, beta-propiolactone, propylene oxide, rubidium acetylene carbide, rubidium carbide, silver perchlorate + carbon tetrachloride, sodium, sodium hydroxide, sulfuric acid, uranium phosphide, vinyl acetate, zinc, metal oxides, aluminum, amines, carbonates, iron, steel, copper alloys, copper, alkali metals, bases, moisture.
Hazardous Decomposition Products: Hydrogen chloride, chlorine, carbon monoxide, carbon dioxide, hydrogen gas.
Hazardous Polymerization: Will not occur.

Section 11 - Toxicological Information

RTECS#:
CAS# 7647-01-0: MW4025000; MW4031000
CAS# 7732-18-5: ZC0110000
LD50/LC50:
CAS# 7647-01-0:
Inhalation, mouse: LC50 = 1108 ppm/1H;
Inhalation, mouse: LC50 = 8300 mg/m3/30M;
Inhalation, rat: LC50 = 3124 ppm/1H;
Inhalation, rat: LC50 = 45000 mg/m3/5M;
Inhalation, rat: LC50 = 8300 mg/m3/30M;
Oral, rabbit: LD50 = 900 mg/kg;
CAS# 7732-18-5:
Oral, rat: LD50 = >90 mL/kg;
Carcinogenicity:
CAS# 7647-01-0:
ACGIH: A4 - Not Classifiable as a Human Carcinogen
IARC: IARC Group 3 - not classifiable CAS# 7732-18-5: Not listed by ACGIH, IARC, NIOSH, NTP,

or OSHA.
Epidemiology: Experimental reproductive effects have been reported.
Teratogenicity: Embryo or Fetus: Stunted fetus, Inhalation, rat TCL0=450 mg/m3/1H Specific Developmental Abnormalities: homeostatis, Inhalation, rat TCL0=450 mg/m3/1H (female 1 days pre-mating).
Reproductive Effects: No information available.
Neurotoxicity: No information available.
Mutagenicity: Cytogenetic analysis: Hamster, lung = 30 mmol/L.; Cytogenetic analysis: Hamster, ovary = 8 mmol/L.
Other Studies: No data available.

Section 12 - Ecological Information

Ecotoxicity: Fish: Bluegill/Sunfish: 3.6 mg/L; 48Hr; Lethal (unspecified) Bluegill/Sunfish: LC50; 96 Hr; pH 3.0-3.5 No data available.
Environmental: Rapidly hydrolyzes when exposed to water. Will exhibit extensive evaporation from soil surfaces. Upon transport through the soil, hydrochloric acid will dissolve some of the soil materials (especially those with carbonate bases) and the acid will neutralize to some degree.
Physical: No information available.
Other: No information available.

Section 13 - Disposal Considerations

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

Section 14 - Transport Information

	US DOT	IATA	RID/ADR	IMO	Canada TDG
Shipping Name:	HYDROCHLORIC ACID				No information available.
Hazard Class:	8				
UN Number:	UN1789				
Packing Group:	II				

Section 15 - Regulatory Information

US FEDERAL

TSCA
CAS# 7647-01-0 is listed on the TSCA inventory.

CAS# 7732-18-5 is listed on the TSCA inventory.

Health & Safety Reporting List

None of the chemicals are on the Health & Safety Reporting List.

Chemical Test Rules

None of the chemicals in this product are under a Chemical Test Rule.

Section 12b

None of the chemicals are listed under TSCA Section 12b.

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

SARA

CERCLA Hazardous Substances and corresponding RQs

CAS# 7647-01-0: 5000 lb final RQ; 2270 kg final RQ

SARA Section 302 Extremely Hazardous Substances

CAS# 7647-01-0: 500 lb TPQ

SARA Codes

CAS # 7647-01-0: acute.

Section 313

This material contains Hydrochloric acid (CAS# 7647-01-0, 36 5%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

Clean Air Act:

CAS# 7647-01-0 is listed as a hazardous air pollutant (HAP). This material does not contain any Class 1 Ozone depletors. This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

CAS# 7647-01-0 is listed as a Hazardous Substance under the CWA. None of the chemicals in this product are listed as Priority Pollutants under the CWA. None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

CAS# 7647-01-0 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.
CAS# 7732-18-5 is not present on state lists from CA, PA, MN, MA, FL, or NJ.
California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:

C

Risk Phrases:

R 34 Causes burns.
R 37 Irritating to respiratory system.

Safety Phrases:

S 1/2 Keep locked up and out of reach of children.
S 26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S 36/37/39 Wear suitable protective clothing, gloves and eye/face protection.
S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
S 9 Keep container in a well-ventilated place.

WGK (Water Danger/Protection)

CAS# 7647-01-0: 1
CAS# 7732-18-5: No information available.

Canada - DSL/NDSL

CAS# 7647-01-0 is listed on Canada's DSL List.
CAS# 7732-18-5 is listed on Canada's DSL List.

Canada - WHMIS

This product has a WHMIS classification of D1A, E.

Canadian Ingredient Disclosure List

CAS# 7647-01-0 is listed on the Canadian Ingredient Disclosure List.

Exposure Limits

CAS# 7647-01-0: OEL-AUSTRALIA:TWA 5 ppm (7 mg/m3) OEL-AUSTRIA:TWA 5 ppm (7 mg/m3) OEL-BELGIUM:STEL 5 ppm (7.7 mg/m3) OEL-DENMARK:STEL 5 ppm (7 mg/m3) OEL-FINLAND:STEL 5 ppm (7 mg/m3);Skin OEL-FRANCE:STEL 5 ppm (7.5 mg/m3) OEL-GERMANY:TWA 5 ppm (7 mg/m3) OEL-HUNGARY:STEL 5 mg/m3 OEL-JAPAN:STEL 5 ppm (7.5 mg/m3) OEL-THE NETHERLANDS:TWA 5 ppm (7 mg/m3) OEL-THE PHILIPPINES:TWA 5 ppm (7 mg/m3) OEL-POLAND:TWA 5 mg/m3 OEL-RUSSIA:STEL 5 ppm (5 mg/m3) OEL-SWEDEN:STEL 5 ppm (8 mg/m3) OEL-SWITZERLAND:TWA 5 ppm (7.5 mg/m3);STEL 10 ppm (15 mg/m3) OEL-THAILAND:TWA 5 ppm (7 mg/m3) OEL-TURKEY:TWA 5 ppm (7 mg/m3) OEL-UNITED KINGDOM:TWA 5 ppm (7 mg/m3);STEL 5 ppm (7 mg/m3) OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA check ACGIH TLV OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGI TLV

Section 16 - Additional Information

MSDS Creation Date: 7/06/1999
Revision #4 Date: 8/14/2003

MSDS Number: **N3661** * * * * * *Effective Date:* ***01/19/06*** * * * * * *Supercedes:* ***04/13/05***

MSDS **Material Safety Data Sheet**

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. And Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

J.T.Baker®

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

NITRIC ACID ULTREX II

1. Product Identification

Synonyms: Aqua Fortis; Azotic Acid
CAS No.: 7697-37-2
Molecular Weight: 63.00
Chemical Formula: HNO3
Product Codes: 6901

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Nitric Acid	7697-37-2	65 - 70%	Yes
Water	7732-18-5	29 - 35%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG AND TOOTH DAMAGE.

SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 4 - Extreme (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 3 - Severe (Oxidizer)
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White (Corrosive)

Potential Health Effects

Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison.

Inhalation:
Corrosive! Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract.
Ingestion:
Corrosive! Swallowing nitric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract.
Skin Contact:
Corrosive! Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color.
Eye Contact:
Corrosive! Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Chronic Exposure:
Long-term exposure to concentrated vapors may cause erosion of teeth and lung damage. Long-term exposures seldom occur due to the corrosive properties of the acid.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders, eye disease, or cardiopulmonary diseases may be more susceptible to the effects of this substance.

4. First Aid Measures

Immediate first aid treatment reduces the health effects of this substance.

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion:
DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition. Can react with metals to release flammable hydrogen gas.
Explosion:
Reacts explosively with combustible organic or readily oxidizable materials such as: alcohols, turpentine, charcoal, organic refuse, metal powder, hydrogen sulfide, etc. Reacts with most metals to release hydrogen gas which can form explosive mixtures with air.
Fire Extinguishing Media:
Water spray may be used to keep fire exposed containers cool. Do not get water inside container.
Special Information:
Increases the flammability of combustible, organic and readily oxidizable materials. In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRASORB® or TEAM® 'Low Na+' acid neutralizers are recommended for spills of this product.

7. Handling and Storage

Store in a cool, dry, ventilated storage area with acid resistant floors and good drainage. Protect from physical damage. Keep out of direct sunlight and away from heat, water, and incompatible materials. Do not wash out container and use it for other purposes. When diluting, the acid should always be added slowly to water and in small amounts. Never use hot water and never add water to the acid. Water added to acid can cause uncontrolled boiling and splashing. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
2 ppm (TWA), 4 ppm (STEL)
-ACGIH Threshold Limit Value (TLV):
2 ppm (TWA); 4 ppm (STEL)

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus. Nitric acid is an oxidizer and should not come in contact with cartridges and canisters that contain oxidizable materials, such as activated charcoal. Canister-type respirators using sorbents are ineffective.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Colorless to yellowish liquid.
Odor:
Suffocating, acrid.
Solubility:
Infinitely soluble.
Specific Gravity:
1.41
pH:
1.0 (0.1M solution)

% Volatiles by volume @ 21C (70F):
100 (as water and acid)
Boiling Point:
122C (252F)
Melting Point:
-42C (-44F)
Vapor Density (Air=1):
2-3
Vapor Pressure (mm Hg):
48 @ 20C (68F)
Evaporation Rate (BuAc=1):
No information found.

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10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Containers may burst when heated.
Hazardous Decomposition Products:
When heated to decomposition, emits toxic nitrogen oxides fumes and hydrogen nitrate. Will react with water or steam to produce heat and toxic and corrosive fumes.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
A dangerously powerful oxidizing agent, concentrated nitric acid is incompatible with most substances, especially strong bases, metallic powders, carbides, hydrogen sulfide, turpentine, and combustible organics.
Conditions to Avoid:
Light and heat.

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11. Toxicological Information

Nitric acid: Inhalation rat LC50: 244 ppm (NO2)/30M; Investigated as a mutagen, reproductive effector. Oral (human) LDLo: 430 mg/kg.

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--------\Cancer Lists\------------------------------------------------------
                                       ---NTP Carcinogen---
Ingredient                             Known    Anticipated    IARC Category
------------------------------------   -----    -----------    -------------
Nitric Acid (7697-37-2)                 No          No             None
Water (7732-18-5)                       No          No             None
```

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12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

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13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

---

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: NITRIC ACID (WITH NOT MORE THAN 70% NITRIC ACID)
Hazard Class: 8
UN/NA: UN2031
Packing Group: II
Information reported for product/size: 2L

International (Water, I.M.O.)

Proper Shipping Name: NITRIC ACID (WITH NOT MORE THAN 70% NITRIC ACID)
Hazard Class: 8
UN/NA: UN2031
Packing Group: II
Information reported for product/size: 2L

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15. Regulatory Information

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--------\Chemical Inventory Status - Part 1\---------------------------------
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Ingredient	TSCA	EC	Japan	Australia
Nitric Acid (7697-37-2)	Yes	Yes	Yes	Yes
Water (7732-18-5)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\--------------------------------

		--Canada--		
Ingredient	Korea	DSL	NDSL	Phil.
Nitric Acid (7697-37-2)	Yes	Yes	No	Yes
Water (7732-18-5)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

	-SARA 302-		------SARA 313------	
Ingredient	RQ	TPQ	List	Chemical Catg.
Nitric Acid (7697-37-2)	1000	1000	Yes	No
Water (7732-18-5)	No	No	No	No

--------\Federal, State & International Regulations - Part 2\----------------

		-RCRA-	-TSCA-
Ingredient	CERCLA	261.33	8(d)
Nitric Acid (7697-37-2)	1000	No	No
Water (7732-18-5)	No	No	No

Chemical Weapons Convention: No   TSCA 12(b): No   CDTA: No
SARA 311/312: Acute: Yes   Chronic: Yes Fire: Yes Pressure: No
Reactivity: No   (Mixture / Liquid)

Australian Hazchem Code: 2PE
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **4** Flammability: **0** Reactivity: **0** Other: **Oxidizer**
Label Hazard Warning:
POISON! DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG AND TOOTH DAMAGE.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe vapor or mist.
Use only with adequate ventilation.
Wash thoroughly after handling.
Keep from contact with clothing and other combustible materials.
Do not store near combustible materials.
Store in a tightly closed container.
Remove and wash contaminated clothing promptly.
Label First Aid:
In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In all cases get medical attention immediately.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 14, 16.
Disclaimer:
****

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****

Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **S8234** * * * * * *Effective Date:* ***02/04/05*** * * * * * *Supercedes:* ***11/04/04***

MSDS *Material Safety Data Sheet*

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

SULFURIC ACID, 52 - 100 %

1. Product Identification

Synonyms: Oil of vitriol; Babcock acid; sulphuric acid
CAS No.: 7664-93-9
Molecular Weight: 98.08
Chemical Formula: H_2SO_4 in H_2O
Product Codes:
J.T. Baker: 5030, 5137, 5374, 5802, 5815, 5858, 5859, 5868, 5889, 5897, 5961, 5971, 5997, 6902, 9671, 9673, 9674, 9675, 9676, 9679, 9680, 9681, 9682, 9684, 9687, 9691, 9693, 9694
Mallinckrodt: 21201, 2468, 2876, 2878, 2900, 2904, 3780, 4222, 5524, 5557, H644, H850, H976, H996, V651, XL003

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Sulfuric Acid	7664-93-9	52 - 100%	Yes
Water	7732-18-5	0 - 48%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR CONTACTED WITH SKIN. HARMFUL IF INHALED. AFFECTS TEETH. WATER REACTIVE. CANCER HAZARD. STRONG INORGANIC ACID MISTS CONTAINING SULFURIC ACID CAN CAUSE CANCER. Risk of cancer depends on duration and level of exposure.

SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 4 - Extreme (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 2 - Moderate
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White (Corrosive)

Potential Health Effects

Inhalation:
Inhalation produces damaging effects on the mucous membranes and upper respiratory tract. Symptoms may include irritation of the nose and throat, and labored breathing. May cause lung edema, a medical emergency.
Ingestion:
Corrosive. Swallowing can cause severe burns of the mouth, throat, and stomach, leading to death. Can cause sore throat, vomiting, diarrhea. Circulatory collapse with clammy skin, weak and rapid pulse, shallow respirations, and scanty urine may follow ingestion or skin contact. Circulatory shock is often the immediate cause of death.
Skin Contact:
Corrosive. Symptoms of redness, pain, and severe burn can occur. Circulatory collapse with clammy skin, weak and rapid pulse, shallow respirations, and scanty urine may follow skin contact or ingestion. Circulatory shock is often the immediate cause of death.
Eye Contact:
Corrosive. Contact can cause blurred vision, redness, pain and severe tissue burns. Can cause blindness.
Chronic Exposure:
Long-term exposure to mist or vapors may cause damage to teeth. Chronic exposure to mists containing sulfuric acid is a cancer hazard.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired respiratory function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician immediately.
Ingestion:
DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Call a physician immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Excess acid on skin can be neutralized with a 2% solution of bicarbonate of soda. Call a physician immediately.
Eye Contact:
Immediately flush eyes with gentle but large stream of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Call a physician immediately.

5. Fire Fighting Measures

Fire:
Concentrated material is a strong dehydrating agent. Reacts with organic materials and may cause ignition of finely divided materials on contact.
Explosion:
Contact with most metals causes formation of flammable and explosive hydrogen gas.
Fire Extinguishing Media:
Dry chemical, foam or carbon dioxide. Do not use water on material. However, water spray may be used to keep fire exposed containers cool.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Structural firefighter's protective clothing is ineffective for fires involving this material. Stay away from sealed containers.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRASORB® or TEAM® 'Low Na+' acid neutralizers are recommended for spills of this product.

7. Handling and Storage

Store in a cool, dry, ventilated storage area with acid resistant floors and good drainage. Protect from physical damage. Keep out of direct sunlight and away from heat, water, and incompatible materials. Do not wash out container and use it for other purposes. When diluting, always add the acid to water; never add water to the acid. When opening metal containers, use non-sparking tools because of the possibility of hydrogen gas being present. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
For Sulfuric Acid:
- OSHA Permissible Exposure Limit (PEL) -
1 mg/m3 (TWA)
- ACGIH Threshold Limit Value (TLV) -
0.2 mg/m3(T) (TWA) for sulfuric acid - A2 Suspected Human Carcinogen for sulfuric acid contained in strong inorganic mists.
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a full facepiece respirator with an acid gas cartridge and particulate filter (NIOSH type N100 filter) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P particulate filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air purifying respirators do not protect workers in oxygen-deficient atmospheres. Where respirators are required, you must have a written program covering the basic requirements in the OSHA respirator standard. These include training, fit testing, medical approval, cleaning, maintenance, cartridge change schedules, etc. See 29CFR1910.134 for details.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Clear oily liquid.
Odor:
Odorless.
Solubility:
Miscible with water, liberates much heat.
Specific Gravity:
1.84 (98%), 1.40 (50%), 1.07 (10%)
pH:
1 N solution (ca. 5% w/w) = 0.3; 0.1 N solution (ca. 0.5% w/w) = 1.2; 0.01 N solution (ca. 0.05% w/w) = 2.1.
% Volatiles by volume @ 21C (70F):
No information found.

Boiling Point:
ca. 290C (ca. 554F) (decomposes at 340C)
Melting Point:
3C (100%), -32C (93%), -38C (78%), -64C (65%).
Vapor Density (Air=1):
3.4
Vapor Pressure (mm Hg):
1 @ 145.8C (295F)
Evaporation Rate (BuAc=1):
No information found.

---

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Concentrated solutions react violently with water, spattering and liberating heat.
Hazardous Decomposition Products:
Toxic fumes of oxides of sulfur when heated to decomposition. Will react with water or steam to produce toxic and corrosive fumes. Reacts with carbonates to generate carbon dioxide gas, and with cyanides and sulfides to form poisonous hydrogen cyanide and hydrogen sulfide respectively.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Water, potassium chlorate, potassium perchlorate, potassium permanganate, sodium, lithium, bases, organic material, halogens, metal acetylides, oxides and hydrides, metals (yields hydrogen gas), strong oxidizing and reducing agents and many other reactive substances.
Conditions to Avoid:
Heat, moisture, incompatibles.

---

11. Toxicological Information

Toxicological Data:
Oral rat LD50: 2140 mg/kg; inhalation rat LC50: 510 mg/m3/2H; standard Draize, eye rabbit, 250 ug (severe); investigated as a tumorigen, mutagen, reproductive effector.
Carcinogenicity:
Cancer Status: The International Agency for Research on Cancer (IARC) has classified "strong inorganic acid mists containing sulfuric acid" as a known human carcinogen, (IARC category 1). This classification applies only to mists containing sulfuric acid and not to sulfuric acid or sulfuric acid solutions.

```
--------\Cancer Lists\------------------------------------------------------
                                          ---NTP Carcinogen---
Ingredient                                Known    Anticipated    IARC Category
------------------------------------      -----    -----------    -------------
Sulfuric Acid (7664-93-9)                  No          No             None
Water (7732-18-5)                          No          No             None
```

---

12. Ecological Information

Environmental Fate:
When released into the soil, this material may leach into groundwater. When released into the air, this material may be removed from the atmosphere to a moderate extent by wet deposition. When released into the air, this material may be removed from the atmosphere to a moderate extent by dry deposition.
Environmental Toxicity:
LC50 Flounder 100 to 330 mg/l/48 hr aerated water/Conditions of bioassay not specified; LC50 Shrimp 80 to 90 mg/l/48 hr aerated water /Conditions of bioassay not specified; LC50 Prawn 42.5 ppm/48 hr salt water /Conditions of bioassay not specified.
This material may be toxic to aquatic life.

---

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

---

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: SULFURIC ACID (WITH MORE THAN 51% ACID)
Hazard Class: 8
UN/NA: UN1830
Packing Group: II
Information reported for product/size: 440LB

International (Water, I.M.O.)

Proper Shipping Name: SULFURIC ACID (WITH MORE THAN 51% ACID)
Hazard Class: 8
UN/NA: UN1830
Packing Group: II
Information reported for product/size: 440LB

---

15. Regulatory Information

```
  --------\Chemical Inventory Status - Part 1\---------------------------------
  Ingredient                                       TSCA  EC   Japan  Australia
  -----------------------------------------------  ----  ---  -----  ---------
  Sulfuric Acid (7664-93-9)                         Yes  Yes   Yes      Yes
  Water (7732-18-5)                                 Yes  Yes   Yes      Yes

  --------\Chemical Inventory Status - Part 2\---------------------------------
                                                          --Canada--
  Ingredient                                       Korea  DSL   NDSL  Phil.
  -----------------------------------------------  -----  ---   ----  -----
  Sulfuric Acid (7664-93-9)                         Yes   Yes   No     Yes
  Water (7732-18-5)                                 Yes   Yes   No     Yes

  --------\Federal, State & International Regulations - Part 1\----------------
                                             -SARA 302-    ------SARA 313------
  Ingredient                                 RQ    TPQ     List  Chemical Catg.
  -----------------------------------------  ---   -----   ----  --------------
  Sulfuric Acid (7664-93-9)                  1000  1000    Yes        No
  Water (7732-18-5)                          No    No      No         No

  --------\Federal, State & International Regulations - Part 2\----------------
                                                        -RCRA-    -TSCA-
  Ingredient                                 CERCLA     261.33     8(d)
  -----------------------------------------  ------     ------    ------
  Sulfuric Acid (7664-93-9)                  1000       No         No
  Water (7732-18-5)                          No         No         No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  Yes
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: Yes         (Pure / Liquid)
```

Australian Hazchem Code: 2P
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **2** Other: **Water reactive**
Label Hazard Warning:
POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR CONTACTED WITH SKIN. HARMFUL IF INHALED. AFFECTS TEETH. WATER REACTIVE. CANCER HAZARD. STRONG INORGANIC ACID MISTS CONTAINING SULFURIC ACID CAN CAUSE CANCER. Risk of cancer depends on duration and level of exposure.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe mist.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Do not contact with water.
Label First Aid:
In all cases call a physician immediately. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before re-use. Excess acid on skin can be neutralized with a 2% bicarbonate of soda solution. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 8.
Disclaimer:
****
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****
Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

ORION RESEARCH INC -- ALKALINE REAGENT 10N NAOH, 951011 -- 6850-00N037887

==================== Product Identification ====================

Product ID:ALKALINE REAGENT 10N NAOH, 951011
MSDS Date:09/05/1986
FSC:6850
NIIN:00N037887
MSDS Number: BQWWT
=== Responsible Party ===
Company Name:ORION RESEARCH INC
Address:529 MAIN ST
City:BOSTON
State:MA
ZIP:02129
Country:US
Info Phone Num:617-242-3900
Emergency Phone Num:617-242-3900
Preparer's Name:MICHAEL H. SWIGNY
CAGE:30260
=== Contractor Identification ===
Company Name:ORION RESEARCH INC
Address:529 MAIN ST
Box:City:BOSTON
State:MA
ZIP:02129
Country:US
Phone:617-242-3900
CAGE:30260

============ Composition/Information on Ingredients ============

Ingred Name:SODIUM HYDROXIDE (SARA III)
CAS:1310-73-2
RTECS #:WB4900000
Fraction by Wt: 40%
OSHA PEL:2 MG/M3
ACGIH TLV:C 2 MG/M3; 9293
EPA Rpt Qty:1000 LBS
DOT Rpt Qty:1000 LBS

==================== Hazards Identification ====================

LD50 LC50 Mixture:NONE SPECIFIED BY MANUFACTURER.
Routes of Entry: Inhalation:YES Skin:YES Ingestion:YES
Reports of Carcinogenicity:NTP:NO   IARC:NO   OSHA:NO
Health Hazards Acute and Chronic:ACUTE:INHAL:MILD TO SEV IRRIT, LG DOSES-DELAYED PULM EDEMA. SKIN: SM SKIN BURNS W/DEEP ULCERATION. EYES: SEV BURNS & DISINTEGRATION OF CONJUNCTIVAL & CORNEAL EPITHELIUM. INGEST: CORR OF LIPS, MOUTH, T ONGUE & PHARYNX, VOMIT OF MUCOSA-ASPHYXIA CAN OCCUR FROM SWELLING OF THROAT. CHRONIC: BRONCHIAL IRRITANT, (SUPP DATA)
Explanation of Carcinogenicity:NOT RELEVANT
Effects of Overexposure:SORE THROAT, COUGHING, LABORED BREATHING - BURNS OF SKIN, EYES, MUCOUS MEMBRANES.
Medical Cond Aggravated by Exposure:LUNG CONDITIONS, IRRITATED OR SENSITIVE SKIN.

===================== First Aid Measures =====================

First Aid:ALL EXPOSURES: GET MEDICAL ATTENTION. INHAL: FRESH AIR, ARTIFICIAL RESPIRATION IF NECESSARY. KEEP WARM & AT REST. SKIN: WASH WITH SOAP AND LG AMOUNTS OF WATER WHILE REMOVING CONTAMINATED CLOTHING. EYE S: FLUSH W/LARGE AMOUNTS OF WATER WHILELIFTING LIDS (AT LST 15-20 MIN). INGEST: GIVE LARGE AMOUNTS OF MILK OR WATER AND ALLOW VOMITING TO OCCUR. DO NOT INDUCE VOMITING.

===================== Fire Fighting Measures =====================

Flash Point:NOT COMBUSTIBLE
Extinguishing Media:USE MEDIA SUITABLE FOR SURROUNDING FIRE .
Fire Fighting Procedures:WEAR NIOSH/MSHA APPRVD SCBA & FULL PROT EQUIP . MOVE CNTNRS AWAY IF POSS, COOL FROM SIDE, USE FLOODING QTYS OF WATER AS FOG. APPLY FROM (SUPP DATA)
Unusual Fire/Explosion Hazard:NEGLIGIBLE FIRE AND EXPLOSION HAZARD WHEN EXPOSED TO HEAT OR FLAME.

================== Accidental Release Measures ==================

Spill Release Procedures:VENTILATE AREA, WEAR IMPERVIOUS GLOVES, CLOTHING AND A FACESHIELD. PREVENT SKIN CONTACT. PICK UP, NEUTRALIZE WITH HCL, FLUSH RESULTING SODIUM CHLORIDE SOLUTION DOWN DRAIN.
Neutralizing Agent:HCL.

====================== Handling and Storage ======================

Handling and Storage Precautions:KEEP COOL AND WELL SEALED. STORE AWAY FROM ACIDS, FLAMMABLES.
Other Precautions:WILL ATTACK SOME FORMS OF PLASTICS, RUBBER AND COATINGS.

============= Exposure Controls/Personal Protection =============

Respiratory Protection:AT >100 MG/M3 WEAR NIOSH/MSHA APPROVED SCBA WITH FULL FACEPLATE.
Ventilation:LOCAL EXHAUST: TO MEET EXPOSURE LIMITS.
Protective Gloves:IMPERVIOUS GLOVES.
Eye Protection:CHEM WORK GOG & FULL LGTH FSHLD .
Other Protective Equipment:IMPERVIOUS CLOTHING. DELUGE SHOWER . EMERGENCY EYEWASH SHOULD BE AVAILABLE.
Work Hygienic Practices:NO EATING OR SMOKING WHILE USING.
Supplemental Safety and Health
FIRE FIGHT PROC: DISTANCE, STAY UPWIND. AVOID BREATHING. HLTH HAZ: COUGHING, PNEUMONIA, GI DISTURBANCES, DERMATITIS, CONJUNCTIVITIS.

================== Physical/Chemical Properties ==================

Boiling Pt:B.P. Text:>230F,>110C
Melt/Freeze Pt:M.P/F.P Text:>-4F,>-20C
Spec Gravity:1.4 (H*2O=1)
pH:14
Solubility in Water:MISCIBLE
Appearance and Odor:COLORLESS ODORLESS SOLUTION.

================= Stability and Reactivity Data =================

Stability Indicator/Materials to Avoid:YES
CONTACT WITH ACIDS, FLAMMABLE LIQUID, AND ORGANIC HALOGEN COMPOUNDS MAY

CAUSE FIRE.

Stability Condition to Avoid:CONTACT WITH WATER MAY CAUSE HEAT TO BE RELEASED.

Hazardous Decomposition Products:MAY RELEASE TOXIC FUMES OF SODIUM OXIDE WHICH CAN REACT WITH WATER OR STEAM TO PRODUCE HEAT OR FLAMMABLE H*2 GAS.

==================== Disposal Considerations ====================

Waste Disposal Methods:DISPOSE OF I/A/W FEDERAL, STATE AND LOCAL REGULATIONS .

ALCONOX MSDS

Section 1 : MANUFACTURER INFORMATION

Product name: Alconox

Supplier: Same as manufacturer.

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

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

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

Supplier MSDS date: 2005/03/09

D.O.T. Classification: Not regulated.

Section 2 : HAZARDOUS INGREDIENTS

C.A.S.	CONCENTRATION %	Ingredient Name	T.L.V.	LD/50	LC/50
25155-30-0	10-30	SODIUM DODECYLBENZENESULFONATE	NOT AVAILABLE	438 MG/KG RAT ORAL 1330 MG/KG MOUSE ORAL	NOT AVAILABLE
497-19-8	7-13	SODIUM CARBONATE	NOT AVAILABLE	4090 MG/KG RAT ORAL 6600 MG/KG MOUSE ORAL	2300 MG/M3/2H RAT INHALATION 1200 MG/M3/2H MOUSE INHALATION
7722-88-5	10-30	TETRASODIUM PYROPHOSPHATE	5 MG/M3	4000 MG/KG RAT ORAL 2980 MG/KG MOUSE ORAL	NOT AVAILABLE
7758-29-4	10-30	SODIUM PHOSPHATE	NOT AVAILABLE	3120 MG/KG RAT ORAL 3100 MG/KG MOUSE ORAL >4640 MG/KG RABBIT DERMAL	NOT AVAILABLE

Section 2A : ADDITIONAL INGREDIENT INFORMATION

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

Section 3 : PHYSICAL / CHEMICAL CHARACTERISTICS

Physical state: Solid

Appearance & odor: Almost odourless.
White granular powder.

Odor threshold (ppm): Not available.

Vapour pressure (mmHg): Not applicable.

Vapour density (air=1): Not applicable.

By weight: Not available.

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

Boiling point (°C): Not applicable.

Freezing point (°C): Not applicable.

pH: (1% aqueous solution).
9.5

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

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

Coefficient of water\oil dist.: Not available.

VOC: None

Section 4 : FIRE AND EXPLOSION HAZARD DATA

Flammability: Not flammable.

Conditions of flammability: Surrounding fire.

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

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

Auto-ignition temperature: Not available.

Flash point (°C), method: None

Lower flammability limit (% vol): Not applicable.

Upper flammability limit (% vol): Not applicable.

Not available.

Sensitivity to mechanical impact: Not applicable.

Hazardous combustion products: Oxides of carbon (COx).
Hydrocarbons.

Rate of burning: Not available.

Explosive power: None

Section 5 : REACTIVITY DATA

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

Section 6 : HEALTH HAZARD DATA

Route of entry:	Skin contact, eye contact, inhalation and ingestion.
<u>Effects of Acute Exposure</u>	
Eye contact:	May cause irritation.
Skin contact:	Prolonged contact may cause irritation.
Inhalation:	Airborne particles may cause irritation.
Ingestion:	May cause vomiting and diarrhea. May cause abdominal pain. May cause gastric distress.
Effects of chronic exposure:	Contains an ingredient which may be corrosive.
LD50 of product, species & route:	> 5000 mg/kg rat oral.
LC50 of product, species & route:	Not available for mixture, see the ingredients section.
Exposure limit of material:	Not available for mixture, see the ingredients section.
Sensitization to product:	Not available.
Carcinogenic effects:	Not listed as a carcinogen.
Reproductive effects:	Not available.
Teratogenicity:	Not available.
Mutagenicity:	Not available.
Synergistic materials:	Not available.
Medical conditions aggravated by exposure:	Not available.
<u>First Aid</u>	
Skin contact:	Remove contaminated clothing. Wash thoroughly with soap and water. Seek medical attention if irritation persists.
Eye contact:	Check for and remove contact lenses. Flush eyes with clear, running water for 15 minutes while holding eyelids open: if irritation persists, consult a physician.
Inhalation:	Remove victim to fresh air. Seek medical attention if symptoms persist.
Ingestion:	Dilute with two glasses of water. Never give anything by mouth to an unconscious person. Do not induce vomiting, seek immediate medical attention.

Section 7 : PRECAUTIONS FOR SAFE HANDLING AND USE

Leak / Spill:	Contain the spill. Recover uncontaminated material for re-use. Wear appropriate protective equipment. Contaminated material should be swept or shoveled into appropriate waste container for disposal.
Waste disposal:	In accordance with municipal, provincial and federal regulations.
Handling procedures and equipment:	Protect against physical damage. Avoid breathing dust. Wash thoroughly after handling. Keep out of reach of children. Avoid contact with skin, eyes and clothing. Launder contaminated clothing prior to reuse.
Storage requirements:	Keep containers closed when not in use. Store away from strong acids or oxidizers. Store in a cool, dry and well ventilated area.

Section 8 : CONTROL MEASURES

Precautionary Measures

Gloves / Type:	Neoprene or rubber gloves.
Respiratory / Type:	If exposure limit is exceeded, wear a NIOSH approved respirator.
Eye / Type:	Safety glasses with side-shields.
Footwear / Type:	Safety shoes per local regulations.
Clothing / Type:	As required to prevent skin contact.
Other / Type:	Eye wash facility should be in close proximity. Emergency shower should be in close proximity.
Ventilation requirements:	Local exhaust at points of emission.

AIR LIQUIDE

MATERIAL SAFETY DATA SHEET

Prepared to U.S. OSHA, CMA, ANSI and Canadian WHMIS Standards

1. PRODUCT IDENTIFICATION

CHEMICAL NAME; CLASS: NON-FLAMMABLE GAS MIXTURE

Containing One or More of the Following Components in a Nitrogen Balance Gas:
Oxygen 0-23.5%; Isobutylene, 0.0005-0.9%

SYNONYMS: Not Applicable
CHEMICAL FAMILY NAME: Not Applicable
FORMULA: Not Applicable
Document Number: 50054

Note: The Material Safety Data Sheet is for this gas mixture supplied in cylinders with 33 cubic feet (935 liters) or less gas capacity (DOT - 39 cylinders). This MSDS has been developed for various gas mixtures with the composition of components within the ranges listed in Section 2 (Composition and Information on Ingredients). Refer to the product label for information on the actual composition of the product.

PRODUCT USE:	Calibration of Monitoring and Research Equipment
SUPPLIER/MANUFACTURER'S NAME:	AIR LIQUIDE AMERICA CORPORATION
ADDRESS:	821 Chesapeake Drive Cambridge, MD 21613
EMERGENCY PHONE:	CHEMTREC: 1-800-424-9300
BUSINESS PHONE:	1-410-228-6400
General MSDS Information	1-713/868-0440
Fax on Demand:	1-800/231-1366

2. COMPOSITION and INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS #	mole %	EXPOSURE LIMITS IN AIR					
			ACGIH		OSHA			OTHER
			TLV ppm	STEL ppm	PEL ppm	STEL ppm	IDLH ppm	
Oxygen	7782-44-7	0 - 23.5%	There are no specific exposure limits for Oxygen.					
Isobutylene	115-11-7	0.0005 - 0.9%	There are no specific exposure limits for Isobutylene.					
Nitrogen	7727-37-9	Balance	There are no specific exposure limits for Nitrogen. Nitrogen is a simple asphyxiant (SA). Oxygen levels should be maintained above 19.5%.					

NE = Not Established. C = Ceiling Limit. See Section 16 for Definitions of Terms Used.

NOTE : All WHMIS required information is included. It is located in appropriate sections based on the ANSI Z400.1-1993 format.

3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: This product is a colorless, odorless gas. Releases of this product may produce oxygen-deficient atmospheres (especially in confined spaces or other poorly-ventilated environments); individuals in such atmospheres may be asphyxiated. Isobutylene, a component of this gas mixture, may cause drowsiness and other central nervous system effects in high concentrations; however, due to its low concentration in this gas mixture, this is unlikely to occur.

SYMPTOMS OF OVER-EXPOSURE BY ROUTE OF EXPOSURE: The most significant route of over-exposure for this product is by inhalation.

INHALATION: Due to the small size of an individual cylinder of this product, no unusual health effects from over-exposure to the product are anticipated under routine circumstances of use. The chief health hazard associated with this gas mixture is when this product contains less than 19.5% Oxygen and is released in a small, poorly-ventilated area (i.e. an enclosed or confined space). Under this circumstance, 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 effects associated with various levels of oxygen are as follows:

CONCENTRATION OF OXYGEN	**OBSERVED EFFECT**
12-16% Oxygen:	Breathing and pulse rate increase, muscular coordination slightly disturbed.
10-14% Oxygen:	Emotional upset, abnormal fatigue, disturbed respiration.
6-10% Oxygen:	Nausea, vomiting, collapse, or loss of consciousness.
Below 6%:	Convulsive movements, possible respiratory collapse, and death.

HAZARDOUS MATERIAL INFORMATION SYSTEM

HEALTH	(BLUE)	1
FLAMMABILITY	(RED)	0
REACTIVITY	(YELLOW)	0
PROTECTIVE EQUIPMENT		B

EYES	RESPIRATORY	HANDS	BODY
See Section 8			

For routine industrial applications

HEALTH EFFECTS OR RISKS FROM EXPOSURE: An Explanation in Lay Terms. Over-exposure to this gas mixture may cause the following health effects:

ACUTE: Due to the small size of the individual cylinder of this product, no unusual health effects from exposure to the product are anticipated under routine circumstances of use. The most significant hazard associated with this gas mixture when it contains less than 19.5% oxygen is the potential for exposure to oxygen-deficient atmospheres. Symptoms of oxygen deficiency include respiratory difficulty, ringing in ears, headaches, shortness of breath, wheezing, headache, dizziness, indigestion, nausea, unconsciousness, and death. The skin of a victim of over-exposure may have a blue color. Additionally, Isobutylene, a component of this gas mixture, may cause drowsiness or central nervous system effects in high concentrations; however, due to its low concentration in this gas mixture, this is unlikely to occur.

CHRONIC: There are currently no known adverse health effects associated with chronic exposure to this gas mixture.

TARGET ORGANS: Respiratory system.

4. FIRST-AID MEASURES

RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO THIS PRODUCT WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT. At a minimum, Self-Contained Breathing Apparatus must be worn.

No unusual health effects are anticipated after exposure to this product, due to the small cylinder size. If any adverse symptom develops after over-exposure to this product, remove victim(s) to fresh air as quickly as possible. Only trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation if necessary.

4. FIRST-AID MEASURES (Continued)

Victim(s) who experience any adverse effect after over-exposure to this product 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).

5. FIRE-FIGHTING MEASURES

FLASH POINT, (method): Not applicable.

AUTOIGNITION TEMPERATURE: Not applicable.

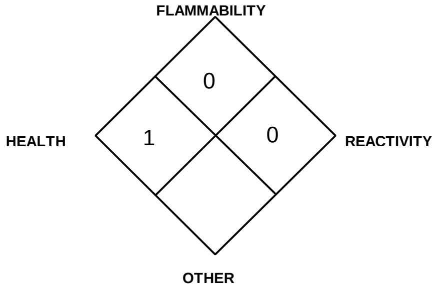
FLAMMABLE LIMITS (in air by volume, %):
Lower (LEL): Not applicable.
Upper (UEL): Not applicable.

FIRE EXTINGUISHING MATERIALS: Non-flammable gas mixture. Use extinguishing media appropriate for surrounding fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS: This gas mixture is not flammable; however, containers, when involved in fire, may rupture or burst in the heat of the fire.

Explosion Sensitivity to Mechanical Impact: Not sensitive.
Explosion Sensitivity to Static Discharge: Not sensitive.

NFPA RATING



SPECIAL FIRE-FIGHTING PROCEDURES: Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment.

6. ACCIDENTAL RELEASE MEASURES

LEAK RESPONSE: Due to the small size and content of the cylinder, an accidental release of this product presents significantly less risk of an oxygen deficient environment and other safety hazards than a similar release from a larger cylinder. However, as with any chemical release, extreme caution must be used during emergency response procedures. 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.

Allow the gas mixture to dissipate. If necessary, monitor the surrounding area (and the original area of the release) for oxygen. Oxygen levels must be above 19.5% before non-emergency personnel are allowed to re-enter area.

If leaking incidentally from the cylinder, contact your supplier.

7. HANDLING and USE

WORK PRACTICES AND HYGIENE PRACTICES: 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 product could occur without any significant warning symptoms, due to oxygen deficiency. Do not attempt to repair, adjust, or in any other way modify cylinders containing this gas mixture. If there is a malfunction or another type of operational problem, contact nearest distributor immediately.

STORAGE AND HANDLING PRACTICES: Cylinders should be firmly secured to prevent falling or being knocked-over. Cylinders must be protected from the environment, and preferably kept at room temperature (approximately 21°C; 70°F). Cylinders should be stored in dry, well-ventilated areas, away from sources of heat, ignition, and direct sunlight. Protect cylinders against physical damage.

Full and empty cylinders should be segregated. Use a first-in, first-out inventory system to prevent full containers from being stored for long periods of time. These cylinders are not refillable. **WARNING! Do not refill DOT 39 cylinders. To do so may cause personal injury or property damage.**

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS: WARNING! Compressed gases can present significant safety hazards. During cylinder use, use equipment designed for these specific cylinders. Ensure all lines and equipment are rated for proper service pressure.

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Follow practices indicated in Section 6 (Accidental Release Measures). Make certain that application equipment is locked and tagged-out safely. Always use product in areas where adequate ventilation is provided.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: No special ventilation systems or engineering controls are needed under normal circumstances of use. As with all chemicals, use this product in well-ventilated areas. If this product is used in a poorly-ventilated area, install automatic monitoring equipment to detect the levels of oxygen.

RESPIRATORY PROTECTION: No special respiratory protection is required under normal circumstances of use. Use supplied air respiratory protection if oxygen levels are below 19.5% or unknown during emergency response to a release of this product. If respiratory protection is required for emergency response to this product, follow the requirements of the Federal OSHA Respiratory Protection Standard (29 CFR 1910.134) or equivalent State standards.

EYE PROTECTION: Safety glasses.

HAND PROTECTION: No special protection is needed under normal circumstances of use.

BODY PROTECTION: No special protection is needed under normal circumstances of use.

9. PHYSICAL and CHEMICAL PROPERTIES

Unless otherwise specified, the following information is for Nitrogen, the main component of this gas mixture.

GAS DENSITY @ 32°F (0°C) and 1 atm: 0.072 lbs/ ft^3 (1.153 kg/m^3)

BOILING POINT: -195.8°C (-320.4 °F)

FREEZING/MELTING POINT @ 10 psig -210°C (-345.8°F)

SPECIFIC GRAVITY (air = 1) @ 70°F (21.1°C): 0.906 **pH**: Not applicable.

SOLUBILITY IN WATER vol/vol @ 32°F (0°C) and 1 atm: 0.023 **MOLECULAR WEIGHT:** 28.01

EVAPORATION RATE (nBuAc = 1): Not applicable. **EXPANSION RATIO**: Not applicable.

ODOR THRESHOLD: Not applicable. **SPECIFIC VOLUME (ft^3/lb)**: 13.8

VAPOR PRESSURE @ 70°F (21.1°C) psig: Not applicable.

COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.

The following information is for this gas mixture.

APPEARANCE AND COLOR: This product is a colorless, odorless gas.

HOW TO DETECT THIS SUBSTANCE (warning properties): There are no unusual warning properties associated with a release of this product.

10. STABILITY and REACTIVITY

STABILITY: Normally stable in gaseous state.

DECOMPOSITION PRODUCTS: The thermal decomposition products of Isobutylene include carbon oxides. The other components of this gas mixture do not decompose, per se, but can react with other compounds in the heat of a fire.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Titanium will burn in Nitrogen (the main component of this product). Lithium reacts slowly with Nitrogen at ambient temperatures. A component of this product (Isobutylene) are also incompatible with strong oxidizers (i.e. chlorine, bromine pentafluoride, oxygen difluoride, and nitrogen trifluoride).

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Contact with incompatible materials. Cylinders exposed to high temperatures or direct flame can rupture or burst.

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA: The following toxicology data are available for the components of this product:

NITROGEN: There are no specific toxicology data for Nitrogen. Nitrogen is a simple asphyxiant, which acts to displace oxygen in the environment.

ISOBUTYLENE:
LC_{50} (inhalation, rat) = 620,000 mg/kg/4 hours
LC_{50} (inhalation, mouse) = 415,000 mg/kg

11. TOXICOLOGICAL INFORMATION (Continued)

SUSPECTED CANCER AGENT: The components of this gas mixture are not found on the following lists: FEDERAL OSHA Z LIST, NTP, CAL/OSHA, and IARC; therefore, they are not considered to be, nor suspected to be, cancer-causing agents by these agencies.

IRRITANCY OF PRODUCT: Not applicable.

SENSITIZATION TO THE PRODUCT: This gas mixture is not known to cause sensitization in humans.

REPRODUCTIVE TOXICITY INFORMATION: Listed below is information concerning the effects of this product and its components on the human reproductive system.

Mutagenicity: No mutagenicity effects have been described for this gas mixture.
Embryotoxcity: No embryotoxic effects have been described for this gas mixture.
Teratogenicity: No teratogenicity effects have been described for this gas mixture.
Reproductive Toxicity: No reproductive toxicity effects have been described for gas mixture.

A mutagen is a chemical which causes permanent changes to genetic material (DNA) such that the changes will propagate through generation lines. An embryotoxin is a chemical which causes damage to a developing embryo (i.e. within the first eight weeks of pregnancy in humans), but the damage does not propagate across generational lines. A teratogen is a chemical which causes damage to a developing fetus, but the damage does not propagate across generational lines. A reproductive toxin is any substance which interferes in any way with the reproductive process.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Acute or chronic respiratory conditions may be aggravated by over-exposure to the components of this product.

RECOMMENDATIONS TO PHYSICIANS: Administer oxygen, if necessary; treat symptoms; eliminate exposure.

BIOLOGICAL EXPOSURE INDICES (BEIs): Currently, Biological Exposure Indices (BEIs) are not applicable for the components of this gas mixture.

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: The components of this gas mixture occur naturally in the atmosphere. The gas will be dissipated rapidly in well-ventilated areas. The following environmental data are applicable to the components of this product.

OXYGEN: Water Solubility = 1 volume Oxygen/32 volumes water at 20°C. Log K_{ow} = -0.65
NITROGEN: Water Solubility = 2.4 volumes Nitrogen/100 volumes water at 0°C. 1.6 volumes Nitrogen/100 volumes water at 20°C.

EFFECT OF MATERIAL ON PLANTS or ANIMALS: No evidence is currently available on this product's effects on plant and animal life.

EFFECT OF CHEMICAL ON AQUATIC LIFE: No evidence is currently available on this product's effects on aquatic life.

13. DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate Federal, State, and local regulations. Cylinders with undesired residual product may be safely vented outdoors with the proper regulator. For further information, refer to Section 16 (Other Information).

14. TRANSPORTATION INFORMATION

THIS MATERIAL IS HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.
PROPER SHIPPING NAME: Compressed gases, n.o.s. (Nitrogen, Oxygen)
HAZARD CLASS NUMBER and DESCRIPTION: 2.2 (Non-Flammable Gas)
UN IDENTIFICATION NUMBER: UN 1956
PACKING GROUP: Not applicable.
DOT LABEL(S) REQUIRED: Non-Flammable Gas
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (1996): 126

MARINE POLLUTANT: The components of this gas mixture are not classified by the DOT as Marine Pollutants (as defined by 49 CFR 172.101, Appendix B).

14. TRANSPORTATION INFORMATION (Continued)

SPECIAL SHIPPING INFORMATION: 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.

Note: DOT 39 Cylinders ship in a strong outer carton (overpack). Pertinent shipping information goes on the outside of the overpack. DOT 39 Cylinders do not have transportation information on the cylinder itself.

TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: THIS MATERIAL IS CONSIDERED AS DANGEROUS GOODS. Use the above information for the preparation of Canadian Shipments.

15. REGULATORY INFORMATION

SARA REPORTING REQUIREMENTS: This product is subject to the reporting requirements of Sections 302, 304, and 313 of Title III of the Superfund Amendments and Reauthorization Act, as follows:

COMPONENT	SARA 302	SARA 304	SARA 313
Oxygen	NO	NO	NO
Nitrogen	NO	NO	NO
Isobutylene	NO	NO	NO

SARA THRESHOLD PLANNING QUANTITY: Not applicable.

TSCA INVENTORY STATUS: The components of this gas mixture are listed on the TSCA Inventory.

CERCLA REPORTABLE QUANTITY (RQ): Not applicable.

OTHER U.S. FEDERAL REGULATIONS:

- No component of this product is subject to the requirements of CFR 29 1910.1000 (under the 1989 PELs).
- Isobutylene is subject to the reporting requirements of Section 112(r) of the Clean Air Act. The Threshold Quantity for this gas is 10,000 pounds.
- The regulations of the Process Safety Management of Highly Hazardous Chemicals are not applicable (29 CFR 1910.119).
- This gas mixture does not contain any Class I or Class II ozone depleting chemicals (40 CFR Part 82).
- Nitrogen and Oxygen are not listed as Regulated Substances, per 40 CFR, Part 68, of the Risk Management for Chemical Releases. Isobutylene is listed under this regulation in Table 3 as Regulated Substances (Flammable Substances), in quantities of 10,000 lbs (4,553 kg) or greater.

OTHER CANADIAN REGULATIONS: This gas mixture is categorized as a Controlled Product, Hazard Class A, as per the Controlled Product Regulations.

STATE REGULATORY INFORMATION: The components of this gas mixture are covered under the following specific State regulations:

Alaska - Designated Toxic and Hazardous Substances: No.
California - Permissible Exposure Limits for Chemical Contaminants: Nitrogen.
Florida - Substance List: Oxygen, Isobutylene.
Illinois - Toxic Substance List: No.
Kansas - Section 302/313 List: No.
Massachusetts - Substance List: Oxygen, Isobutylene.
Michigan - Critical Materials Register: No.
Minnesota - List of Hazardous Substances: No.
Missouri - Employer Information/Toxic Substance List: No.
New Jersey - Right to Know Hazardous Substance List: Oxygen, Nitrogen, Isobutylene.
North Dakota - List of Hazardous Chemicals, Reportable Quantities: No.
Pennsylvania - Hazardous Substance List: Oxygen, Nitrogen, Isobutylene.
Rhode Island - Hazardous Substance List: Oxygen, Nitrogen.
Texas - Hazardous Substance List: No.
West Virginia - Hazardous Substance List: No.
Wisconsin - Toxic and Hazardous Substances: : No.

CALIFORNIA PROPOSITION 65: No component of this product is on the California Proposition 65 lists.

16. OTHER INFORMATION

INFORMATION ABOUT DOT-39 NRC (Non-Refillable Cylinder) PRODUCTS

DOT 39 cylinders ship as hazardous materials when full. Once the cylinders are relieved of pressure (empty) they are not considered hazardous material or waste. Residual gas in this type of cylinder is not an issue because toxic gas mixtures are prohibited. Calibration gas mixtures typically packaged in these cylinders are Nonflammable n.o.s., UN 1956. A small percentage of calibration gases packaged in DOT 39 cylinders are flammable or oxidizing gas mixtures.

For disposal of used DOT-39 cylinders, it is acceptable to place them in a landfill if local laws permit. Their disposal is no different than that employed with other DOT containers such as spray paint cans, household aerosols, or disposable cylinders of propane (for camping, torch etc.). When feasible, we recommended recycling for scrap metal content. Air Liquide America will do this for any customer that wishes to return cylinders to us prepaid. All that is required is a phone call to make arrangements so we may anticipate arrival. Scrapping cylinders involves some preparation before the metal dealer may accept them. We perform this operation as a service to valued customers who want to participate.

MIXTURES: When two or more gases or liquefied gases are mixed, their hazardous properties may combine to create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an Industrial Hygienist or other trained person when you make your safety evaluation of the end product. Remember, gases and liquids have properties which can cause serious injury or death.

Further information about the handling of compressed gases can be found in the following pamphlets published by: Compressed Gas Association Inc. (CGA), 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202-4102. Telephone: (703) 412-0900.

P-1	*"Safe Handling of Compressed Gases in Containers"*
AV-1	*"Safe Handling and Storage of Compressed Gases"*
	"Handbook of Compressed Gases"

PREPARED BY:

CHEMICAL SAFETY ASSOCIATES, Inc.
9163 Chesapeake Drive, San Diego, CA 92123-1002
619/565-0302

Fax on Demand: 1-800/231-1366

AIR LIQUIDE™

AutoCal -----MATERIAL SAFETY DATA SHEET-----

AutoCal Solution
Compliance Technology Inc.
118 Starlite St.
So. San Francisco, CA 94080-6310Prepared: February 20, 1996
Revised: February 14, 2000

----- NOTICE-----

This information is believed to be accurate and represents the best information currently available to us. however, we make no warranty of merchantability, or fitness for any particular use, or any other warranty, express or implied, with respect to this information, and we assume no liability resulting from the use of this information. Users should make their own investigations to determine the suitability of the information for their particular needs and purposes. Compliance Technology Inc. will assist in this regard.

-----SUBSTANCE IDENTIFICATION-----

SUBSTANCE: AutoCal Solution Calibrating Buffer Solution
Trade names/synonyms: This material is also known by various catalog numbers.
Cercla ratings (scale 0-3): health=0 fire=0 reactivity=0 persistence=0
Nfpa ratings (scale 0-4): health=0 fire=0 reactivity=0

-----COMPONENTS AND CONTAMINANTS---

Component: potassium hydrogen phthalate CAS# 877-24-7 Percent: <2.0
Component: water CAS# 7732-18-5 percent: >98
Other contaminants: none

----- EXPOSURE LIMITS-----

No occupational exposure limits established by osha, acgih or niosh.

-----PHYSICAL DATA-----

Description:
Clear, colorless liquid.
Approx. boiling point: 212°F (100°C). Approx. melting point: 32°F (0°C)
Vapor pressure: 14 torr @20°C Evap. Rate: (ether=1) < 1
pH: 4.0 Solubility in water: complete Vapor density: 0.7 (H_2O)

-----FIRE AND EXPLOSION DATA-----

Fire and explosion hazard: No fire hazard when exposed to heat or flame.
Flash point: not applicable
Fire fighting media: dry chemical, carbon dioxide, water spray or regu-lar foam. (1990 emergency response guidebook, dot p-5800.5) For larger fires, use water spray, fog or regular foam. (1990 emergency response guidebook, dot p-5800.5)
Fire fighting: Move container from fire area if it can be done without risk. Do not scatter spilled material with high-pressure water streams. Dike fire-control water for later disposal . (1990 emergency response guidebook, dot p-5800.5 Pg. 31) Use agents suitable for the type of surrounding fire. Avoid breathing hazardous vapors, stay upwind of the fire.

-----TOXICITY-----

potassium hydrogen phthalate:
Carcinogen status: none.

Local effects: irritant - inhalation, skin, eye.
Acute toxicity level: no data available.
Target effects: no data available.
medical conditions agravated by exposure: no data available.

-----HEALTH EFFECTS AND FIRST AID-----

INHALATION

POTASSIUM HYDROGEN PHTHALATE:IRRITANT.
ACUTE EXPOSURE - MAY CAUSE IRRITATION.
CHRONIC EXPOSURE - REPEATED OR PROLONGED EXPOSURE MAY CAUSE IRRITA-TION.
FIRST AID - REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

SKIN CONTACT:

POTASSIUM HYDROGEN PHTHALATE:IRRITANT.
ACUTE EXPOSURE - MAY CAUSE IRRITATION.
CHRONIC EXPOSURE - REPEATED OR PROLONGED EXPOSURE MAY CAUSE DERMATITIS.
FIRST AID - REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY, WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:

POTASSIUM HYDROGEN PHTHALATE: IRRITANT.
ACUTE EXPOSURE-DIRECT CONTACT MAY CAUSE IRRITATION, REDNESS AND PAIN.
CRONIC EXPOSURE-REPEATED OR PROLONGED EXPOSURE MAY CAUSE CONJUNCTIVITIS
FIRST AID - WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION

POTASSIUM HYDROGEN PHTHALATE: IRRITANT.
ACUTE EXPOSURE - MAY CAUSE NAUSEA, VOMITING AND DIARRHEA.
CRONIC EXPOSURE - NOT REPORTED TO OCCUR IN HUMANS
FIRST AID - IF VICTIM IS CONSCIOUS, IMMEDIATELY GIVE 2-4 GLASSES OF WATER, AND INDUCE VOMITING BY TOUCHING FINGER TO BACK OF THROAT, GET MEDICAL ATTENTION IMMEDIATELY.

-----REACTIVITY-----

Reactivity: stable under normal temperatures and pressures.
Incompatibilities: AFFECTED BY STRONG OXIDIZERS WHEN DRY.
Decomposition: NONE KNOWN WHILE IN SOLUTION.
Polymerization: NONE KNOWN WHILE IN SOLUTION.

-----STORAGE AND DISPOSAL-----

Observe all federal, state and local regulations when storing or disposing of this substance. for assistance, contact the district director of the environmental protection agency.

-----PROTECTIVE EQUIPMENT-----

When using, wear eye protection to prevent contact.

APPENDIX B

SOLINST MULTICHANNEL WELL INSTALLATION STANDARD OPERATING PROCEDURE

Ground Water Monitoring&Remediation

A New Multilevel Ground Water Monitoring System Using Multichannel Tubing

by Murray D. Einarson and John A. Cherry

Abstract

A new multilevel ground water monitoring system has been developed that uses custom-extruded flexible 1.6-inch (4.1 cm) outside-diameter (O.D.) multichannel HDPE tubing (referred to as Continuous Multichannel Tubing™ or CMT) to monitor as many as seven discrete zones within a single borehole in either unconsolidated sediments or bedrock. Prior to inserting the tubing in the borehole, ports are created that allow ground water to enter six outer pie-shaped channels (nominal diameter = 0.5 inch [1.3 cm]) and a central hexagonal center channel (nominal diameter = 0.4 inch [1 cm]) at different depths, facilitating the measurement of depth-discrete piezometric heads and the collection of depth-discrete ground water samples. Sand packs and annular seals between the various monitored zones can be installed using conventional tremie methods. Alternatively, bentonite packers and prepacked sand packs have been developed that are attached to the tubing at the ground surface, facilitating precise positioning of annular seals and sand packs. Inflatable rubber packers for permanent or temporary installations in bedrock aquifers are currently undergoing site trials. Hydraulic heads are measured with conventional water-level meters or electronic pressure transducers to generate vertical profiles of hydraulic head. Ground water samples are collected using peristaltic pumps, small-diameter bailers, inertial lift pumps, or small-diameter canister samplers.

For monitoring hydrophobic organic compounds, the CMT tubing is susceptible to both positive and negative biases caused by sorption, desorption, and diffusion. These biases can be minimized by: (1) purging the channels prior to sampling, (2) collecting samples from separate 0.25-inch (0.64 cm) O.D. Teflon® sampling tubing inserted to the bottom of each sampling channel, or (3) collecting the samples downhole using sampling devices positioned next to the intake ports. More than 1000 CMT multilevel wells have been installed in North America and Europe to depths up to 260 feet (79 m) below ground surface. These wells have been installed in boreholes created in unconsolidated sediments and bedrock using a wide range of drilling equipment, including sonic, air rotary, diamond-bit coring, hollow-stem auger, and direct push. This paper presents a discussion of three field trials of the system, demonstrating its versatility and illustrating the type of depth-discrete data that can be collected with the system.

Introduction

Many investigations have shown that contaminant plumes are typically complex zones that exhibit large variations in concentration over small vertical distances. These variations are caused by spatial and temporal variability of the contaminant sources and heterogeneity of the geologic materials. In sand aquifers, large vertical concentration variability within plumes is enhanced by weak transverse vertical dispersion that preserves the variability over large travel distances (Reinhard et al. 1984; Robertson et al. 1991; van der Kamp et al. 1994). Weak dispersion has been documented during natural gradient tracer experiments in which the tracers were monitored intensively using multilevel depth-discrete samplers (Mackay et al. 1986a, 1986b; Garabedian et al. 1991; LeBlanc et al. 1994).

Conventional monitoring wells are often ineffective for discerning the details of the concentration distribution in plumes and particularly for locating the highest concentration zones because the well screens provide water samples that are a mixture of waters of different composition from various depths (Robbins 1989; Martin-Hayden et al. 1991; Robbins and Martin-Hayden 1991). Nested monitoring wells (i.e., two or more individual wells installed to different depths in the same borehole) can yield depth-discrete samples; however, their use is discouraged because of the difficulty in installing reliable seals between the different well screens (U.S. EPA 1986). Clusters of conventional monitoring wells (i.e., closely spaced wells installed in individual boreholes but completed to different depths) are an alternative to nested wells but commonly do not monitor more than two or three depth intervals because of the economic limitation on the number of wells used in each cluster. To overcome these limitations, multilevel monitoring systems that provide water samples from many depth-discrete levels or ports in a single monitoring hole have been used, such as those described by Pickens et al. (1978), Cherry and Johnson (1982), and Black and Patton (1986).

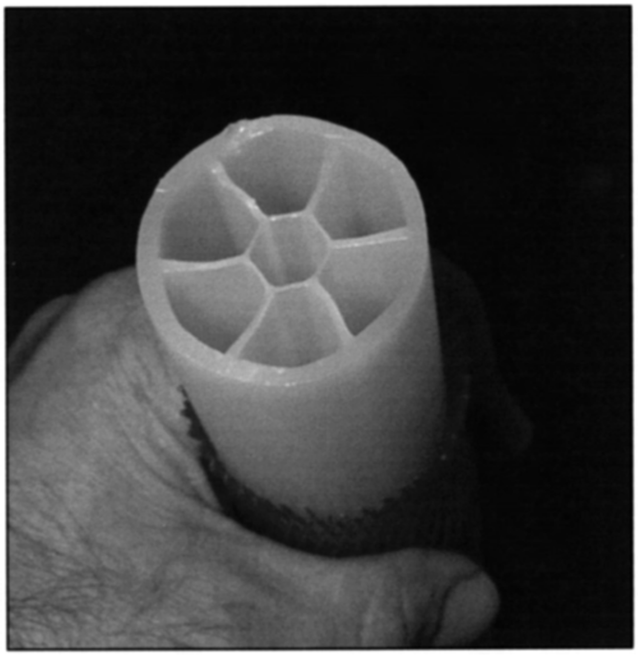


Figure 1. CMT tubing.

This paper describes a new low-cost permanent multilevel monitoring system that can be used to collect ground water samples and measure hydraulic heads from up to seven discrete zones in one borehole. The system uses a single length of custom-extruded flexible tubing, facilitating the installation of reliable annular seals between the monitoring zones using conventional well-construction methods where annular materials (e.g., sand and bentonite pellets) are added from the ground surface. Bentonite packers also have been used that allow the entire multilevel well to be constructed aboveground and then inserted into a borehole. By using the bentonite packers, seals of exact dimensions and position can be installed. A modification of the system using water-inflated rubber packers for use in rock boreholes is currently undergoing site trials.

Materials and Methods

Continuous Multichannel Tubing

The key component of the new monitoring system is custom-made, high-density polyethylene (HDPE) tubing. The 1.6-inch (4.1 cm) outside diameter (O.D.) tubing, referred to as Continuous Multichannel Tubing™ (CMT™, patent pending), is extruded with internal partitions, forming seven discrete channels within the larger tube (Figure 1). The honeycomb design creates six outer pie-shaped channels having a nominal inside diameter of ~0.5 inch (1.3 cm) and a central hexagonal channel ~0.4 inch (1 cm) in diameter. The primary advantage of the new multichannel tubing over bundles of tubes as described by Cherry et al. (1983) is that there is only one relatively large tube installed in the borehole, which simplifies the installation of annular seals placed between the tubing and the borehole wall.

The multichannel tubing can be extruded in lengths currently up to 300 feet (92 m) and is shipped in 4-foot (1.2 m) diameter coils (Figure 2). The desired length of tubing, equal to the total depth of the multilevel well, is cut from a coil, and the well is built at the job site based on the hydrogeologic data obtained from the exploratory boring or other methods (e.g., CPT or geophysical data). Having a continuous length of tubing is a key advantage of the system because it eliminates the need for strong, watertight joints in the monitoring well. No joints exist because the tubing is one piece. This increases the reliability and reduces the cost of the monitoring system. The tubing is stiff enough to be easily handled, yet light and flexible enough to allow site workers to insert the multilevel well hand-over-hand into the borehole.

Figure 2. CMT tubing coil.

A small ridge along the outside of one of the channels facilitates identification of specific channels. The collapse and tensile strengths of the tubing have not yet been tested, but are expected to be high because of the internal honeycomb structure of the tubing.

Intake Ports and Screens

Construction of the intake ports and screens is done before the CMT is inserted into the borehole. Depth-discrete intake ports are created by drilling or cutting 0.38-inch (0.95 cm) holes through the exterior wall of the tubing into each of the channels at the desired depths. Channel 1 ports correspond to the shallowest monitoring interval; channel 2 ports are drilled further down the tubing (i.e., to monitor a deeper zone), and so forth. The central channel, channel 7, is open to the bottom of the multilevel well. In this way, the ports of the various channels are staggered both vertically and around the perimeter of the multichannel tubing. Typically, each channel is hydraulically connected to only one monitoring interval. However, the well can be constructed with two channels open to the same interval: One channel can be used for measuring water levels; the other for collecting ground water samples with a dedicated sampling pump. Because two channels are used at each depth, constructing a well this way reduces the number of intervals that can be monitored. For most of the installations performed to date, an intake interval of 4 inches (10 cm) has been created by drilling four holes 1 inch (2.5 cm) apart. The depth interval of the intake ports can be increased simply by drilling more holes.

Well screens are constructed by wrapping synthetic or stainless-steel fabric mesh completely around the tubing in the interval containing the ports (Figure 3). The mesh is secured

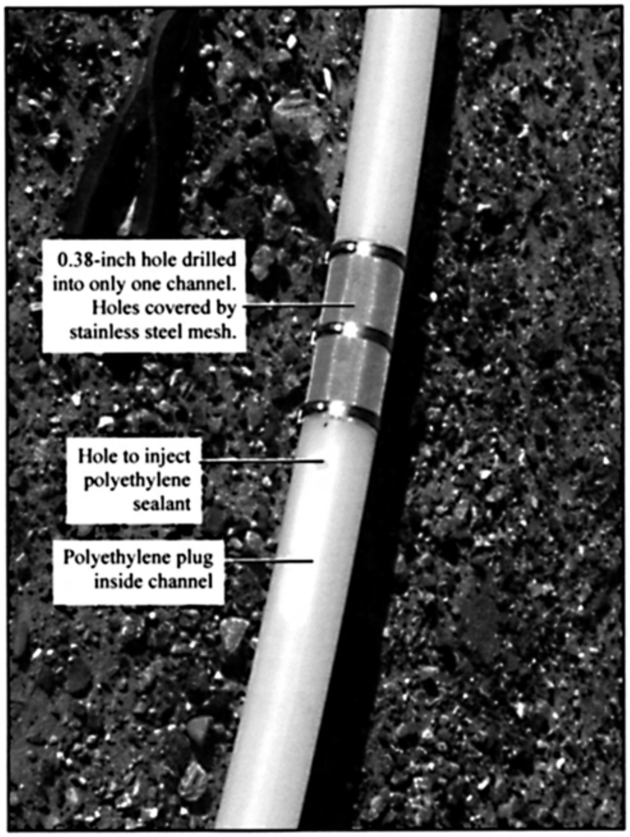


Figure 3. Typical CMT intake port.

to the tubing using stainless-steel clamps. The size of the mesh openings can be selected based on the grain-size distribution of the particular water-bearing zone being monitored. However, a 100 mesh stainless-steel screen having an open area of ~0.006 inch (0.15 mm) has been used successfully for most of the installations performed to date.

Stagnant water in the tubing below the intake ports is hydraulically isolated by plugging the channels a few inches below each intake port. This has been done by injecting a small amount of a polyethylene sealant into each channel (Figure 3). Polyethylene plugs are also injected into each of the outer six channels at the very bottom of the well. This effectively seals the various channels from just below the intake ports to the bottom of the well. (Pressure tests show that a 1-inch-long plug withstands a pressure differential of more than 80 pounds per square inch [552 Kpa; Solinst Canada Ltd. 2001]). Small vent holes are drilled directly beneath the upper polyethylene plugs (i.e., the plugs located just below the intake ports) to allow air to vent out of the sealed channels during installation. The seventh (internal) channel is open to the bottom of the well. A cap of stainless-steel mesh is attached to the bottom of the tubing to enable the central channel to be used as the deepest monitoring zone.

Installation Methods

Installation in Collapsing Sands

In loose, unconsolidated sand formations, seven-zone monitoring wells can be quickly installed by inserting the tubing (with drilled ports and well screens) into the ground through a steel drive casing and then removing the drive casing. When the drive casing is removed, the sand will collapse around the multilevel well, restoring the original permeability of the sediments between the various monitored zones. This method of installation can be very rapid (47 20-foot [6.1 m] deep multilevel wells have been installed in two days with this method) and is particularly well suited to dual-tube direct-push (DP) sampling systems (Einarson 1995) and sonic drilling equipment (Barrow 1994). However, when used without seals between sampling ports in such cohesionless deposits, the system loses its advantage over bundles of polyethylene or Teflon tubes (such as those described by Cherry et al. [1983]), which offer more ports for more detailed depth-discrete monitoring.

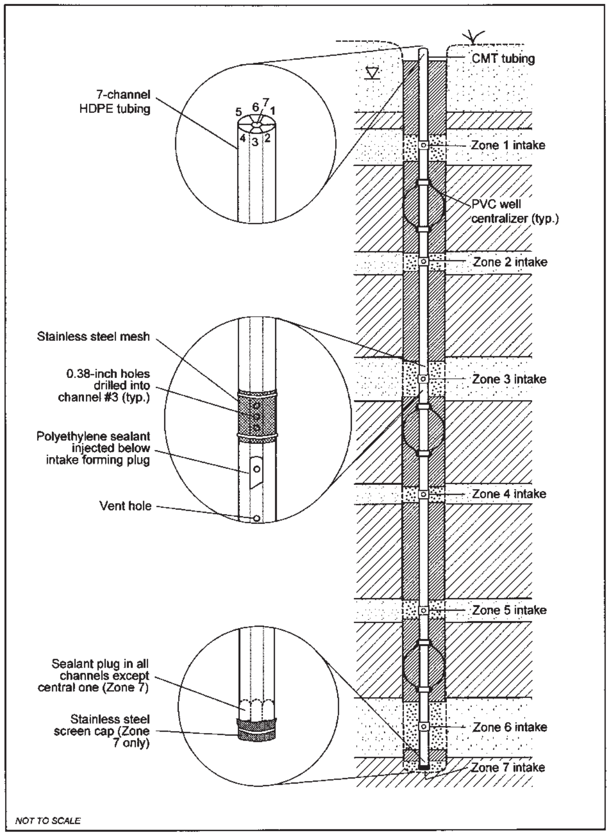


Figure 4. Installation of a CMT multilevel well where sand pack and bentonite seals are tremied from the ground surface.

Installation Using Conventional Well-Construction Techniques to Install Sand Packs and Annular Seals

In clay-rich or indurated sediments and bedrock, the borehole usually will not collapse and other methods are necessary to seal the annulus between the various intake ports. At these sites, alternating lifts of sand and bentonite have been added to the annular space from the ground surface using conventional well construction techniques (Figure 4). First, ports are created and stainless-steel screens are attached to the tubing at the ground surface, as discussed previously. Next, the CMT is lowered to the bottom of the borehole either in an open hole (if the borehole will stay open) or inside steel casing or hollow-stem augers. Alternating lifts of sand and bentonite pellets are poured into the annular space from the ground surface to specific depths according to the well design. In an open hole, materials can be added via a tremie pipe to ensure that no bridg-

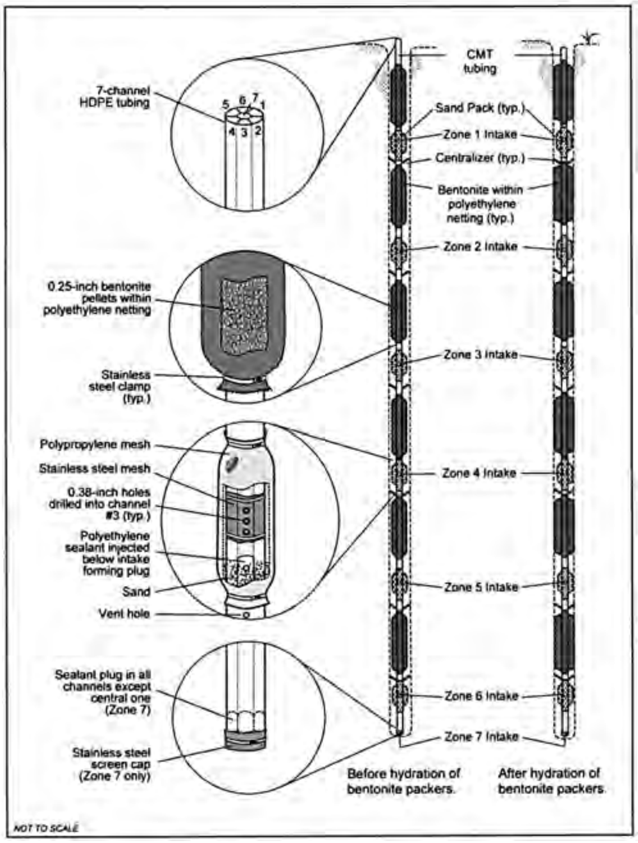


Figure 5. Installation of the CMT well with prepacked sand packs and bentonite packers.

ing occurs. In cased holes (steel drive casing or hollow-stem augers), the sand and bentonite pellets are usually poured from the surface without a tremie pipe. The casing or augers are removed incrementally as the annular materials are added. In either case, the depth of the sand and bentonite is measured frequently during construction using a weighted measuring line.

Because the tubing is flexible, closely spaced (e.g., every 15 feet [4.6 m]) steel or PVC centralizers have been attached to the CMT to ensure that the tubing is centered in the borehole during construction. The use of centralizers can be avoided by using a 2-inch (5 cm) metal or polyvinyl chloride (PVC) insertion pipe to center the CMT during well construction. The insertion pipe is placed in the borehole prior to inserting the CMT. Annular materials are poured from the surface and the insertion pipe is removed from the borehole incrementally along with the steel casing or augers (if used). Two centralizers (20 feet [6.1 m] apart) have been attached to the bottom of the insertion pipe to keep the CMT centered in the borehole during construction. In this way, the annular space between the insertion pipe and the borehole (or casing/augers) is unobstructed by centralizers, minimizing the likelihood of bridging the bentonite pellets and tangling the measuring line. For deep wells where the water table is shallow, coated bentonite pellets have been used. Coated pellets prevent the bentonite from swelling prematurely as the pellets fall through standing water. Premature hydration of the pellets can create undesirable bridging in the annulus, preventing the pellets from falling to the desired depth.

Figure 6. Stainless-steel form used to construct bentonite packers.

Installation in Noncollapsing Sediments Using Bentonite Packers and Prepacked Sand Packs

Installing seven-zone multilevel wells using the conventional well-construction techniques described requires precise placement of annular seals and sand packs, especially for shallow wells where each seal may be only a few feet thick. This degree of precision may not be possible at many sites using conventional well-construction methods where some amount of sloughing of native materials and/or overfilling of materials often occurs. Consequently, bentonite packer seals were developed that can be attached to the CMT prior to insertion into the borehole. This eliminates the need to add annular materials from the ground surface and offers greater precision in the construction of shallow multilevel wells. Sand packs can also be attached around the well screens in a similar fashion.

The bentonite packers have been constructed using commercial 0.25-inch (0.64 cm) bentonite pellets contained inside of polyethylene mesh sleeves (Figure 5). The mesh sleeves allow the ground water to freely contact and hydrate the bentonite and stretch as the bentonite swells. The bentonite packers should contain as much bentonite as possible yet be small enough to easily fit inside of the borehole.

A stainless-steel form aids in the assembly of bentonite packers and ensures a consistent diameter (Figure 6). The form is threaded over the CMT and placed inside of the polyethylene mesh sleeve. Flanges on the inside of the form ensure that the form is centered around the CMT. Bentonite pellets are then poured inside of the steel form until it is full. The form is then pulled up, leaving behind a cylinder of bentonite pellets around the multichannel tubing.

Figure 7. Bentonite packer (right) prior to insertion in a borehole. To left, bentonite packer after it has hydrated and swelled.

Openings in the mesh are sufficiently large to allow some of the bentonite to squeeze through the mesh as the bentonite swells, creating a bond with the borehole wall (Figure 7). The bentonite packers constructed to date have typically been 1 or 2 feet (31 or 61 cm) long. Annular seals of any length can be made by attaching bentonite packers to the CMT "back to back" in the entire interval where an annular seal is desired. To maximize the integrity of the annular seals, the multilevel well should be centered in the borehole. PVC well centralizers have been used to center the CMT and bentonite packers in boreholes up to 4.5 inches (11.4 cm) in diameter.

The bentonite packers constructed to date have contained enough bentonite to expand and seal an annular space up to 0.75 inch (1.9 cm). Sealing larger annular spaces requires the use of more bentonite pellets, which makes the packers deform under their own weight. Consequently, the use of this type of bentonite packer should be limited to installations where the annular space between the CMT tubing and the borehole wall is 0.75 inch (1.9 cm) or less. Also, the bentonite packers manufactured to date are easily deformed and torn during installation. For this reason, they should be limited to installations where temporary flush-threaded, thin-walled steel casing is used to keep the borehole open while the fully built CMT well is inserted. The current bentonite packers are not appropriate for installations inside of hollow-stem augers because the packers will not swell sufficiently to seal the relatively large annular space created by the auger flights.

Once all of the bentonite packers, sand packs, and centralizers have been attached to the CMT, the tubing is inserted into the steel drive casing hand-over-hand to the bottom of the borehole (Figure 8). Insertion of the tubing into a 100-foot-deep (31 m) borehole takes ~10 minutes. After the well is in place, the temporary steel casing is removed, allowing ground water to hydrate the bentonite packers. As they hydrate, the bentonite packers swell, sealing the borehole between the monitoring zones within three or four hours. More than 200 installations of the CMT multilevel system equipped with bentonite packer seals and prepacked sand packs have been successfully performed to date, including an installation to a depth of 195 feet (60 m) using a sonic drill rig.

Figure 8. Inserting a CMT multilevel well equipped with bentonite packers and prepacked sand packs.

Well Development, Measuring Hydraulic Head, Hydraulic Testing, and Collecting Ground Water Samples

Well Development

Requirements for developing the multilevel wells vary depending on the type of installation. If no foreign water is introduced to the aquifer during installation, well development can be limited to thorough purging to remove introduced fines from the borehole wall and enhance the hydraulic connection with the formation. If foreign water or other drilling fluids are used during drilling and well installation, removal of large quantities of water may be necessary.

Limited well development can be performed using small-diameter sampling pumps. However, the extraction rate of the pumps is small and extracting large volumes of water (e.g., hundreds of gallons) is not cost-effective. Also, the low extraction rates of small-diameter sampling pumps create a relatively weak hydraulic stress, resulting in a limited ability to remove introduced fines and/or smeared soil from the borehole wall, especially in large-diameter borings drilled in relatively permeable formations.

An innovative gas-lift/vacuum extraction system has been developed to simultaneously extract ground water from all seven zones. This system, which is a variation of standard air-lift well development techniques, has been used to develop 1300 gallons (4921 L) of water at a flow rate of 1.1 gallons/min (4.2 L/min) from a multilevel well where the static depth to water was 100 feet (31 m) below ground surface (bgs). The gas-lift/vacuum extraction system is described in more detail by Einarson (2001).

Measuring Hydraulic Heads

Depth to ground water measurements can be made using commercially available water level meters (e.g., well sounders). Water-level measurements >150 feet (46 m) bgs have been made inside of the CMT using a small-diameter water-level meter (Solinst Canada Ltd., Georgetown, Ontario, Canada). If continuous pressure measurements are desired, pressure transducers small enough to fit down the CMT channels (Druck Model PDCR 35D-8070) are commercially available (Solinst Canada Ltd. 2001).

Hydraulic Testing

The authors are aware of several sites where environmental consultants have performed rising- and/or falling-head tests (i.e., slug tests) in CMT wells, although the authors have not yet performed such tests themselves. The availability of small-diameter transducers connected to dataloggers facilitates the recording of rapid hydraulic responses in permeable aquifers that would not be possible with hand measurements. Calculation of formation hydraulic conductivity using conventional analytical solutions may be complicated, however, by the pie-shaped geometry of the CMT. The potential error associated with the nonradial CMT well geometry is a function of the relative difference between the sand pack and formation hydraulic conductivity, and could possibly be addressed using a skin factor applied to the analytical solution (Butler 2001). Hydraulic testing in CMT wells is the subject of ongoing research and testing by the authors and other collaborators.

Collecting Ground Water Samples

Ground water samples can be collected from the CMT multilevel system using a variety of methods including peristaltic pumps (providing that the water level is within the limits of suction lift), inertial lift pumps (e.g., Waterra® pumps [Rannie and Nadon 1985]), and small-diameter bailers. Small-diameter downhole canister samplers such as those described by Pankow et al. (1985) and Johnson et al. (1987) may also be used to collect ground water samples from the bottom of each channel directly adjacent to the intake ports. Because of the small internal diameter of the CMT channels, no commercially available submersible or bladder pumps currently exist for the system, although an innovative double-valve sampling pump is under development (Solinst Canada Ltd. 2001).

Water samples have been successfully collected from a CMT multilevel well at a flow rate of 120 mL/min using a hand-operated 0.25-inch (0.64 cm) O.D. Teflon inertial lift pump where the static depth of ground water was 100 feet (31 m) bgs. The purge volume of the internal channels is ~40 mL/foot (131 mL/m) of tubing, which minimizes the amount of purge water that needs to be removed prior to sampling.

All sampling devices can impart biases in analytical results because of the volatilization of organic contaminants, sorption/desorption of hydrophobic solutes onto/off of sample tubing, pH changes that may precipitate dissolved metals, etc. Parker (1994) offers a thorough literature review of the biases associated with various ground water sample collection methods.

Potential Chemical Biases Associated with the CMT System

Because the CMT monitoring system uses one continuous length of tubing, the tubing must be flexible enough to bend 90 degrees when it is being inserted into a borehole. This degree of flexibility requires that the system be made of polymeric tubing. A drawback of polymeric tubing as a well-construction material is that it is less resistant to sorption (adsorption and absorption) of hydrophobic organic contaminants than rigid well construction materials such as stainless steel or PVC. Chemical biases associated with polymeric tubing have been described by many authors and are therefore discussed only briefly in this paper.

Sorption/Desorption of Organic Contaminants onto/off of the Interior Walls of the CMT During Sampling

A negative sampling bias can occur if organic contaminants sorb onto the interior walls of the HDPE CMT while the water sample is pumped up from the sampling port to the ground surface. For HDPE tubing, the amount of contaminant mass lost from the sample is proportional to the residence time within the channel and the hydrophobicity of the organic solute (Hewitt 1994; Parker and Ranney 1998). Conversely, a positive bias can occur during a later sampling event if organic molecules desorb from the tubing into the subsequent ground water sample (Barcelona et al. 1985; Barker et al. 1987; Gillham and O'Hannesin 1990; Parker and Ranney 1998).

Diffusion of Organic Contaminants from the Aquifer Surrounding the CMT Well

Barker et al. (1987), Gillham (1989), and Gillham and O'Hannesin (1990) showed that in wells or piezometers constructed of polyethylene tubing, hydrophobic organic compounds can diffuse through the tubing from the aquifer into water inside the tubing in response to concentration gradients. In the case where the intake of a polyethylene well is located below a high-strength contaminant plume, hydrophobic volatile organic compounds (VOCs) detected in samples collected from the well may simply be a result of diffusion through the tubing from the shallow contaminant plume surrounding the exterior of the tubing. Such detections could lead site investigators to falsely conclude that the VOC contamination extends to a greater depth than it actually does. With the CMT system, the potential sampling bias is further complicated by the honeycomb structure of the tubing. During the time between sampling events, solutes present in one or more of the channels could diffuse into adjacent channels, resulting in the false detection of the solutes in one or more of the multilevel sampling intervals.

Leaching of Organic Compounds from HDPE Tubing and/or Polyethylene Hot-Melt Sealant

Leaching of organic compounds from the CMT well materials can result in a potential positive sampling bias. Leaching of trace organic compounds from polymer tubing has been evaluated by several researchers, including Junk et al. (1974), Curran and Tomson (1983), Barcelona et al. (1985), Parker and Ranney (1997), Parker and Ranney (1998), and Ranney and Parker (1998). Those studies indicate that polyethylene tubing, by itself, is either inert or does not impart significant amounts of common target organic compounds to water that has been in contact with the tubing. As discussed previously, however, a commercial hot-melt polyethylene adhesive (Arrow C-7 Hot-Melt Sealant, Arrow Fastener Co. Inc., Saddle Brook, New Jersey) has been used to seal the various channels below the sampling ports. The sealant is injected using a high-temperature glue gun. Leaching of trace organic compounds from the polyethylene sealant is another potential source of positive sample bias with the system. The potential bias caused by leaching of organic compounds from the polyethylene tubing and the hot-melt polyethylene sealant was investigated by performing static leaching tests on virgin materials used to construct the CMT wells. Details of the leaching tests, including analytes and detection limits, are presented by Einarson (2001). In summary, samples of distilled water that had been in contact with virgin CMT polyethylene tubing and hardened hot-melt sealant for one week were analyzed for a comprehensive suite of VOCs using gas chromatograph/mass spectrometry (GC/MS) methods in accordance with U.S. EPA Method 8260B. No VOCs were detected in the water that had been in contact with the polyethylene; however, toluene was detected at a concentration of 25.5 μg/L in the sample of water that had been in contact with the hot-melt sealant. Although the detection of toluene in the leachate sample suggests that there may be a systematic positive bias caused by leaching of the polyethylene sealant in the CMT wells, two years of field monitoring suggests otherwise. Only one anomalous detection of toluene has been measured in hundreds of analyses of ground water samples collected from CMT wells. The well in question is completed in a fine-grained formation that yields little water during sampling. Because the rate of recovery is so slow, it has not been possible to purge the well before sampling. Only a foot or two of ground water is typically present in the channel, and initial analyses of ground water collected from the channel two weeks after the well was installed contained toluene at a concentration of 5 μg/L. The fact that toluene has not been detected in other wells that are purged prior to sampling suggests that the potential sampling bias caused by leaching of the polyethylene sealant is minor because of reduced contact time under dynamic sampling conditions (Parker and Ranney [1998]) or a decrease in the amount of toluene leached from the sealant over time as the compound ages.

In any case, recent advancements in the design of the sampling ports use mechanical expansion plugs instead of the hot-melt polyethylene sealant (Solinst Canada Ltd. 2001). This will eliminate the need for the chemical sealant and potential biases associated with its use.

Sorption and Leaching of Metals and Other Inorganic Solutes

Previous studies indicate that while plastic tubing is generally inert with regard to anionic solutes, positively charged solutes are subject to cation exchange reactions (Ranney and Parker 1998). Several laboratory studies have been performed to evaluate the significance of these processes in ground water monitoring applications, however few quantitative studies have been performed using HDPE tubing. Results of the limited studies indicate that negative biases from sorption onto polymeric tubing is minor compared to stainless steel. Sorption and/or leaching of metals from the stainless-steel screens and clips used to construct the CMT wells may be of concern, however. To minimize these biases, the CMT well screens could be constructed with plastic mesh and plastic ties. Readers are referred to Parker et al. (1990), Hewitt (1992), Hewitt (1994), and Ranney and Parker (1998) for additional discussions of the applicability of using polymeric tubing for monitoring trace concentrations of dissolved metals and other ionic contaminants.

Suggested Sampling Protocol to Minimize Chemical Biases

Chemical biases caused by sorption/desorption and diffusion of dissolved hydrophobic organic contaminants through the CMT tubing can be minimized by thorough purging of each channel prior to sampling and by collecting ground water samples from separate 0.25-inch (0.64 cm) diameter Teflon sampling tubing placed inside the channels to depths corresponding to the various intake ports. That way, ground water from the formation is drawn through the ports and immediately enters the Teflon sampling tubing where the sorption/diffusion of the solutes is reduced. Similarly, contact between the ground water sample and the CMT tubing could be minimized by using downhole canister samplers similar to those described by Pankow (1985) and Johnson (1987), although those samplers have not yet been tested with the CMT system.

Trial Installations

Canadian Forces Base Borden, Ontario, Canada

Two CMT multilevel wells (ME-1 and ME-2) were installed at Canadian Forces Base (CFB) Borden in Ontario, Canada. The CMT wells were installed in a well-studied part of the base where a controlled release of tetrachloroethylene (PCE) took place in 1991 (Brewster et al. 1995). During that experiment, 771 L of PCE were injected into a shallow sand aquifer isolated within a 9 × 9 m sheet pile enclosure. Sheet piles extended through the surficial aquifer into the underlying clay till aquitard.

The hydrogeology in the vicinity of the 9 × 9 m cell is well understood as a result of detailed field studies performed by Foley (1992) and Morrison (1998). In those investigations, more than 105 boreholes were drilled in and around the 9 × 9 m cell, into which more than 50 single- or multilevel monitoring wells were installed.

The study area is underlain by a 15-foot-thick (4.6 m) surficial sandy aquifer referred to as the Borden Aquifer (Figure 9). Unconfined ground water occurs within that unit at a depth ranging seasonally from 3 to 6 feet (0.9 to 1.8 m) bgs. A 20- to 28-foot-thick (6.1 to 8.5 m) clay aquitard unconformably underlies the upper aquifer in the study area, separating it from the underlying lower aquifer (Morrison 1998).

The clay aquitard can be divided into an upper and lower unit based on lithology and post-depositional weathering. The upper unit is ~10 to 15 feet (3.1 to 4.6 m) thick and is composed of silty clay containing discontinuous sandy laminae and thin sand interbeds. Vertical cracks and fissures are common in the upper unit because of erosion and desiccation following the Late Wisconsin glacial retreat. The lower part of the aquitard is ~6 to 10 feet (2 to 3 m) thick and is composed of unweathered, unfractured silty clay and clay. The Lower Aquifer in the vicinity of the 9 × 9 m cell is relatively thin, consisting of a 6- to 10-foot-thick (2 to 3 m) continuous layer of medium- to coarse-grained sand. Piezometric heads within the lower aquifer fluctuate between ~697 and 700 feet above sea level (fasl; 212.5 and 213.4 m) in the last few years (Morrison 1998).

Detailed hydraulic head monitoring by Foley (1992) and Morrison (1998) showed a strong downward hydraulic gradient between the upper and lower aquifers. Hydraulic head profiles measured in 1996 in two piezometer clusters located near CMT wells ME-1 and ME-2 are shown in Figure 9. Piezometer cluster ML96-2 is located ~80 feet (24 m) northwest of CMT wells ME-1 and

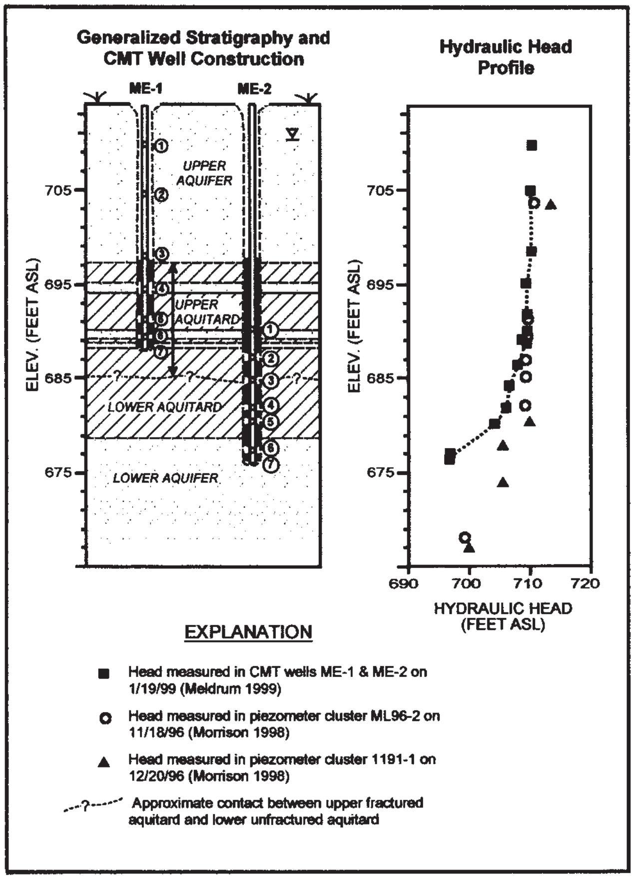


Figure 9. Generalized stratigraphy, well construction, and hydraulic head profile. CMT multilevel wells ME-1 and ME-2, Canadian Forces Base Borden, Ontario, Canada.

ME2. Piezometer cluster 1191-1 is ~40 feet (12 m) south of the two CMT wells. A head change in excess of 12 feet (3.6 m) was measured in 1996 between piezometers installed in the upper aquitard and the lower aquifer. Core logs and hydraulic head data from those and other piezometers suggest that nearly all of the head change occurs across the basal portion of the clay aquitard, where the sandy interbeds and vertical fractures are absent. The upper and middle portions of the clay aquitard are suspected of being hydraulically active (i.e., hydraulically connected to the upper aquifer) because of the abundance of coarse-grained interbeds and desiccation fractures (Morrison 1998).

CMT wells ME-1 and ME-2 were installed in June and December 1998, respectively, with a total of 14 ports in the upper and lower aquifers and in the intervening clay aquitard (Figure 9). The wells were installed in boreholes created with a dual-tube direct-push sampling system described by Einarson (1995). Continuous soil cores were collected and logged in detail prior to selecting the screened intervals of the multilevel wells. After the coring was finished, the sampling equipment was withdrawn from the boreholes, but the outer 3-inch (7.5 cm) inside- diameter (I.D.) drive casing was left in place to keep the boreholes from collapsing. The CMT wells were built aboveground according to the design, complete with sand packs and bentonite packers, and were then inserted into the boreholes inside of the steel drive casing. The steel casing was then withdrawn, allowing ground water to contact and hydrate the bentonite packers.

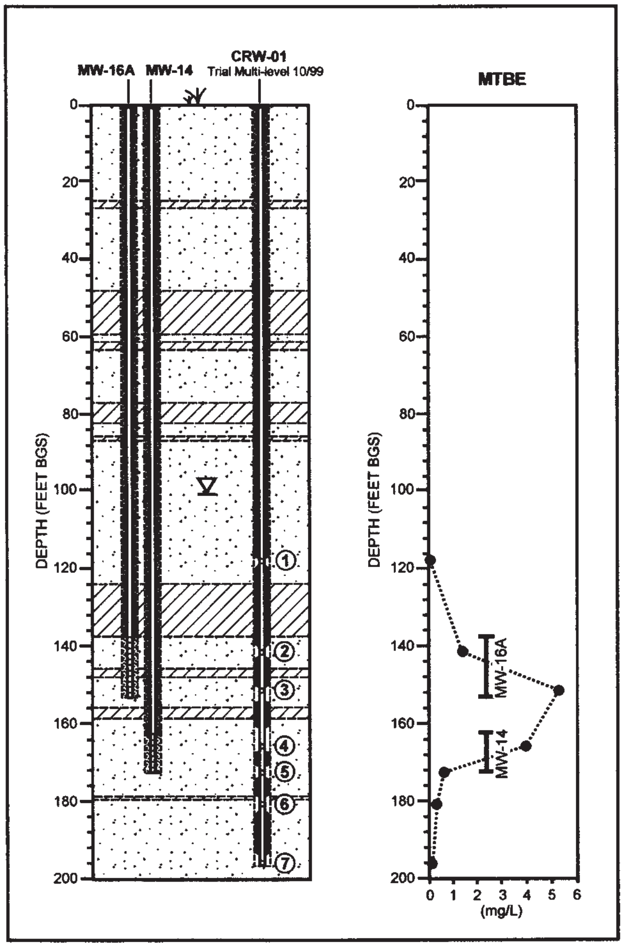


Figure 10. Construction details and MTBE concentration profile from a trial CMT multilevel well plotted next to data from two nearby conventional monitoring wells, Santa Monica, California.

As shown in Figure 9, the wells were constructed in a two-well pair with ME-1 monitoring the upper aquifer and the upper portion of the underlying clay aquitard. ME-2 was constructed to monitor the lower portion of the clay aquitard and the underlying lower aquifer. This multilevel well pair allowed measurement of the hydraulic head at 14 discrete depths, providing detailed definition of the hydraulic head distribution in the shallow geologic deposits next to the 9 × 9 m cell. After an equilibration period of one month, hydraulic heads had stabilized in the various channels.

Figure 9 shows the head distribution measured in the CMT wells on January 19, 1999, along with the CMT well construction and 1996 head measurements from the nearby piezometer clusters for comparison. Hydraulic head data from the CMT wells shows the same strong downward vertical pressure gradient measured by Morrison in the nearby piezometer clusters in 1996. As shown in Figure 9, there was a 13-foot (4 m) difference in head between the upper and lower aquifers measured in the CMT wells in early 1999, with most of the measured head change (7.3 feet [2.2 m]) occurring in the lower 3.3 feet (1 m) of the lower aquitard between the fifth and sixth sampling ports in CMT-2. The strong downward hydraulic gradient (2.2) across this thin zone supports the hypothesis that the lower unfractured portion of the lower aquitard is a strong barrier to downward ground water flow.

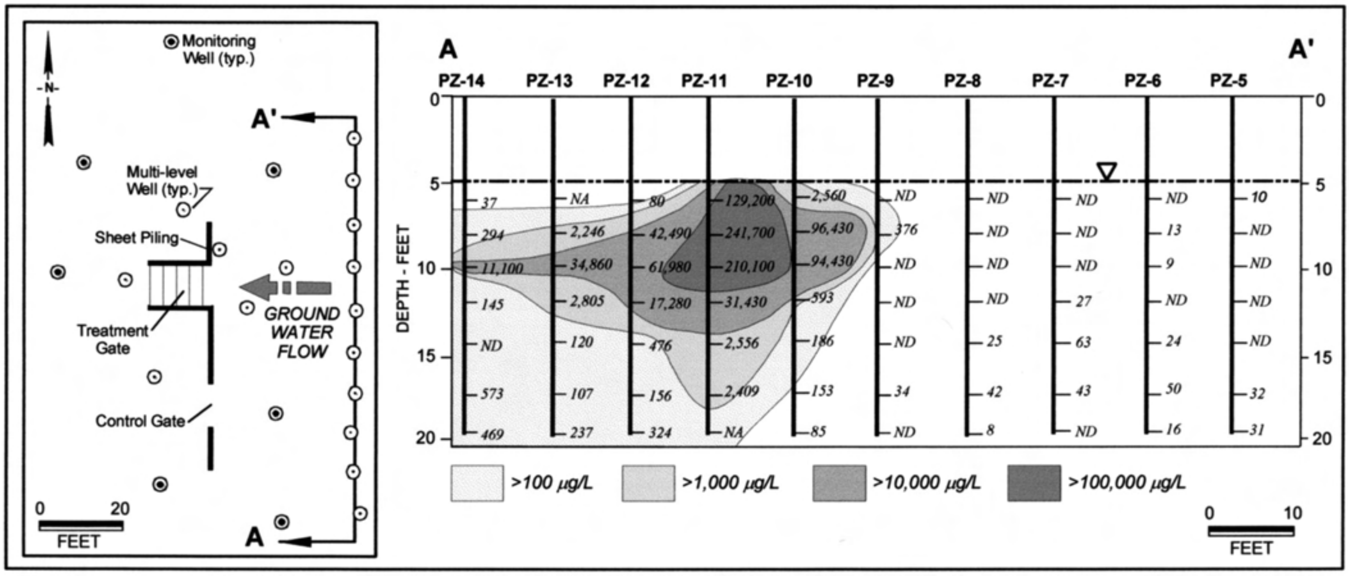


Figure 11. A stratified VOC plume at Alameda Point, California. Site plan shown on left. On right, transect A to A′ (perpendicular to the direction of ground water flow) showing concentration contours of cis-1,2 DCE across the dissolved plume.

The head data from the CMT wells is comparable to the data from the nearby piezometer nests, although there are important differences. First, the hydraulic head measured in the CMT ports completed in the lower aquifer is ~3 feet (1 m) lower than the head measured by Morrison in 1996 using piezometers reportedly completed within the same unit. This difference is likely because the measurements were made almost three years apart (three feet of head fluctuation is within the range of head values historically measured within the unit in the vicinity of the 9 × 9 m cell [Morrison 1998]). Second, the strong drop in head recorded in the CMT wells at the base of the lower aquitard occurs more abruptly and at a higher elevation than in piezometer clusters ML96-2 and 1191-1. This is likely because of natural variation in the geology in the study area. Relatively high hydraulic heads are maintained to a greater depth 40 feet (12 m) south of the CMT wells near cluster 1191-1, suggesting that the lower aquitard extends to a greater depth there than in the vicinity of the CMT wells. Variations in the depth of the base of the aquitard is not unexpected; Morrison (1998) noted that the elevation of the base of the unit varied by more than 8 feet (2.4 m) in the study area. The same condition may be true 80 feet (24 m) to the northwest in the vicinity of piezometer cluster ML96-2, although the data there are inconclusive. As shown in Figure 9, the bottom two piezometers in the ML96-2 cluster are spaced >14 feet. (4.3 m) apart vertically. Thus, there are an insufficient number of data points to show whether, and at what elevation, an abrupt drop in head (indicating the base of an unfractured aquitard) may occur or whether the pressure decrease may occur more gradually with depth, suggesting a thicker, more permeable (i.e., more extensively fractured) aquitard than in the vicinity of the CMT wells.

In summary, the much lower vertical hydraulic conductivity of the bottommost 3 feet (1 m) of the lower aquitard indicated by the detailed head profile in the CMT wells is consistent with the observed penetration of PCE down to but not through the base of the aquitard. The base of the aquitard in that area likely has few or perhaps no fractures. Only a head profile with many data points could have accurately identified this hydrogeologic condition.

In June 1998, head measurements were again made in CMT wells ME-1 and ME-2. This time, however, the measured heads in well ME-2 were much different from the earlier measurements, suggesting that one or more of the lower seals had likely failed. The potential causes of the leakage could have been from one or more of the following:

(1) A poor bond between the polyethylene sealant and the tubing caused by insufficient heating of the sealant

(2) Deformation of the bentonite packers en route to the job site from the warehouse where the wells constructed

(3) Slow dissolution of the bentonite packers when they are not completely surrounded by a porous medium (as may be the case in installations in boreholes drilled into aquitards or bedrock where the tops and bottoms of the packers contact only water in the borehole) (Einarson 2001).

Additional field testing of the bentonite packers is planned to determine which of these factors likely caused the packer failure at the Borden site.

Santa Monica, California

A trial multilevel well was installed in Santa Monica, California, in December 1999 to assess the feasibility of using CMT multilevel wells to monitor a dissolved plume of methyl tert butyl ether (MTBE) more than 120 feet (37 m) below the ground surface. The trial well was located within 20 feet (6 m) of a pair of 4-inch (10 cm) diameter conventional monitoring wells to compare the concentrations of MTBE in water samples collected from the CMT well with samples collected from the conventional wells. Continuous soil cores were first collected with a sonic drilling rig to a depth of 195 feet (60 m); 3.5-inch (9 cm) I.D. flush-threaded steel casing was advanced incrementally to keep the borehole open. The cores were logged in detail to identify preferred pathways of contaminant migration. The well was built completely aboveground and inserted into the borehole prior to removing the steel casing. The well was developed (using the gas lift/vacuum extraction method described earlier) and samples were collected at a rate of 120 mL/min using a 0.25-inch (0.64 cm) O.D. Teflon iner-

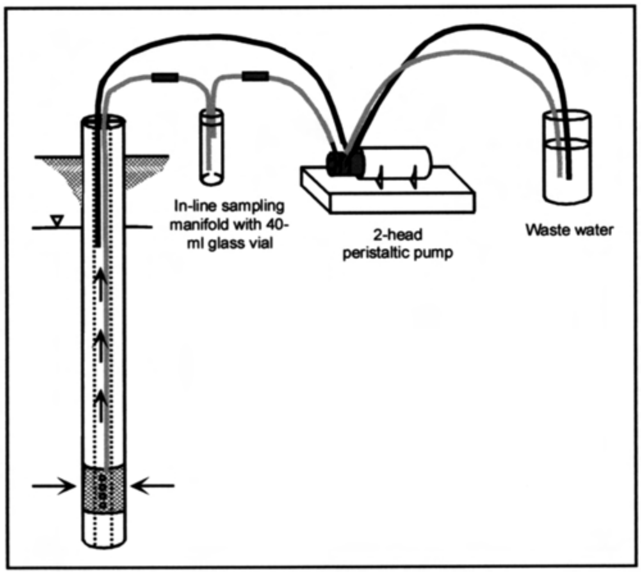


Figure 12. Dual-tube ground water sampling apparatus.

tial lift pump (Solinst Canada Ltd., Georgetown, Ontario, Canada).

A summary of the stratigraphy and construction of the CMT well and the nearby conventional monitoring wells is shown in Figure 10. A graph of MTBE concentrations versus depth for all three wells is shown on the right of the figure. Comparison of the MTBE concentrations measured in samples from the CMT well with data from the conventional wells provides an example of contaminant mixing in monitoring wells described earlier. It is clear from the figure that wells MW-14 and MW-16 yield ground water samples that are a composite of ground water within the vertical interval of the aquifer screened by the wells. Analysis of a sample from Zone 3 of the CMT well shows that MTBE is present in the aquifer at concentrations as high as 5300 µg/L. However, the concentration of MTBE measured in samples from the conventional wells is much lower (~2300 µg/L) because relatively clean water (entering the upper portion of MW-16's well screens and the lower portion of MW-14's well screens) mixes with the water containing high concentrations of MTBE when these wells are pumped.

Alameda Point, California

A transect of 10 CMT multilevel monitoring wells was installed at Site 1, Alameda Point (formerly Alameda Naval Air Station), California, during the course of a three-year University of Waterloo field experiment to treat a mixed plume of VOCs and petroleum hydrocarbons in situ using a sequential reactive barrier (Morkin et al. 1998; Fiorenza et al. 2000).

Because the aquifer consists of loose unconsolidated sand, the multilevel wells could be installed by simply inserting the CMT tubing and well screens into small-diameter steel drive casing that had been vibrated with a knockout plug to the bottom of the aquifer (22 feet [6.7 m] bgs). After each multilevel well was inserted, the drive casing was removed, allowing the native sand to collapse around the drive casing.

Figure 11 shows concentration contours of cis-1,2 DCE along the transect of monitoring wells collected in December 1998. A high-strength plume core, exhibiting concentrations of cis-1,2 DCE >300,000 µg/L, was mapped in the upper portion of the aquifer in the vicinity of well PZ-11. The plume core is surrounded by ground water having as much as three orders of magnitude lower concentrations of dissolved VOCs. The large variation in concentrations of dissolved VOCs in a single multilevel well over vertical distances of just a few feet provides evidence that there is no enhanced hydraulic interconnection between the intake ports.

The Alameda Point VOC plume provided an opportunity to test the hypothesis that sampling biases could be minimized by thoroughly purging the various channels prior to sampling and collecting ground water samples from separate Teflon sampling tubing inserted to the bottom of each CMT channel. These techniques were followed when collecting all of the samples from the multilevel wells at Alameda Point. In addition, one well (PZ-14D, located next to well PZ-14) was constructed with separate stainless-steel "control" sampling tubing to further assess potential sampling biases associated with the new CMT monitoring system. Stainless steel is much less affected by sorption/desorption of organic compounds than polymeric tubing. Therefore, it was thought that samples collected from the stainless-steel tubing would yield independent values of dissolved solute concentrations in the aquifer that were not biased by processes affecting the polymeric tubing. When constructing well PZ-14D, 0.13-inch (3.3 mm) O.D. stainless-steel tubing was secured to the outside of the multichannel tubing. Seven lengths of tubing were attached, each one extending to the depth of one of the ports of the multilevel monitoring well. The ends of the stainless steel tubing were wrapped in a fine stainless-steel mesh, allowing for the independent collection of ground water samples from the aquifer at the same depths as the ports in the CMT multilevel well.

Well PZ-14D Sampling Technique

Ground water samples were collected from the Teflon sampling tubing and the stainless-steel control tubing using a peristaltic pump. To minimize potential sampling biases caused by stagnant water in the various CMT channels, a dual-tube water sampling technique was employed. In addition to the sampling tubing described previously, separate lengths of 0.25-inch (0.64 cm) O.D. polyethylene "purge tubing" were inserted into each CMT channel 3 feet (0.9 m) below the static ground water depth (i.e., to a depth of approximately 8 feet [2.4 m] bgs). Water was then simultaneously pumped from the shallow purge tubing and the deeper sampling tubing (either the Teflon or stainless steel tubing) in each channel using a dual-head peristaltic pump (Figure 12). By doing this, stagnant water above the CMT intake ports was drawn upward, away from the intake of the Teflon or stainless-steel sampling tubing. Ground water entering the CMT sampling ports was immediately drawn into the deeper sampling tubing, thus minimizing contact with the HDPE CMT tubing.

Samples of the stagnant water in the various channels were collected from the first 40 mL of water pumped from the upper purge tubing. This was done to test the hypothesis that VOCs present at shallow depths in the aquifer may have diffused into channels monitoring deeper zones during the eight-month period since the wells were last sampled. Ground water samples were then collected from each length of the stainless-steel control tubing and the 0.25-inch (0.64 cm) Teflon sampling tubing after ~750 mL of water had been purged and elec-

Table 1
Concentrations of Select VOCs and Petroleum Hydrocarbons in Samples Collected from CMT Well PZ-14D, June 7, 1999, Alameda Point, California

CMT Port Depth		Vinyl Chloride	cis 1,2 DCE	trans 1,2 DCE	Benzene	Toluene	Ethylbenzene	p/m Xylenes
(feet bgs)	Sample ID	log Kow: 0.6[a]	1.86[b]	2.09[b]	2.13[a]	2.69[a]	3.15[a]	3.2[c]
	Pz14D-2 purge water	101.0	134.8	14.7	21.7	255.7	67.6	109.3
8	PZ14D-2 CMT channel*	<44	<5.4	67.1	58.4	106.9	167.1	443.9
	PZ14D-2 control**	<44	<5.4	62.4	54.1	109.7	131.4	444.3
	% of control	NA	NA	107.53%	107.95%	97.45%	127.17%	99.91%
	PZ14D-3 purge water	307.8	341.3	<1	25.7	171.5	11.6	31.6
10	PZ14D-3 CMT channel	1904.0	1078.0	75.1	46.2	1397.0	235.7	989.1
	PZ14D-3 control	1607.0	744.9	85.2	100.4	1338.0	227.8	970.3
	% of control	118.48%	144.72%	88.15%	46.02%	104.41%	103.47%	101.94%
	PZ14D-4 purge water	452.6	847.89	<1	26.8	243.6	11	31.4
12	PZ14D-4 CMT channel	517.7	3627.0	114.4	134.4	325.8	186.7	629.1
	PZ14D-4 control	563.7	3953.0	69.9	118.7	361.5	154.4	577.2
	% of control	91.84%	91.75%	163.66%	113.23%	90.12%	120.92%	108.99%
	PZ14D-5 purge water	466.2	862.0	<1	24.7	160.3	13.1	16.9
14.5	PZ14D-5 CMT channel	<44	<5.4	<1	<3.8	<4.0	<2.5	<5.4
	PZ14D-5 control	<44	<5.4	<1	<3.8	<4.0	<2.5	<5.4
	% of control	NA	NA	NA	NA	NA	NA	NA
	PZ14D-6 purge water	488.8	721.8	<1	25.8	165.6	<2.5	18.1
17.5	PZ14D-6 CMT channel	217.1	341.2	<1	<3.8	<4.0	<2.5	<5.4
	PZ14D-6 control	497.7	526.5	<1	<3.8	<4.0	<2.5	<5.4
	% of control	43.62%	64.81%	NA	NA	NA	NA	NA
	PZ14D-7 purge water	534.4	706.5	<1	21.1	130.2	25	50.7
20	PZ14D-7 CMT channel	3368.0	661.8	<1	<3.8	<4.0	<2.5	<5.4
	PZ14D-7 control	2143.0	1159.0	<1	<3.8	<4.0	<2.5	<5.4
	% of control	157.16%	57.10%	NA	NA	NA	NA	NA

(All concentrations in µg/L)
* = sample collected from Teflon tubing inserted to bottom of CMT channel
** = sample collected from stainless tubing secured to outside of CMT well and extending to same depth as CMT inake port
NA = Not applicable, one or both values at or below method reporting limit
a = Schwartzenbach et al. 1993
b = Mabey et al. 1982
c = Tewari et al. 1982

trical conductivity (EC) measurements had stabilized. Samples were collected in 40 mL glass vials positioned upstream of the peristaltic pump. All samples were spiked with sodium azide to minimize aerobic biodegradation of the organic compounds and were shipped on ice to the University of Waterloo analytical laboratory in Ontario, Canada.

Analytical Method

All VOCs were analyzed at University of Waterloo's analytical laboratory by the headspace technique using a Varian Genesis autosampler and a Hewlett-Packard 5890 gas chromatograph equipped with a split injection port 12:1 at 150° C, and a capillary column DB-VRX 30 m × 0.32 mm I.D., maintained isothermally at 32°C. Helium was used as the carrier gas at a flow rate of 3.5 mL/min, and a photoionization detector (PID) was used with an 11.7 eV lamp. A complete list of analytes and associated method reporting limits is presented by Einarson (2001).

Results

Table 1 presents a summary of analytical results for VOCs in samples collected from multilevel well PZ-14D in June 1999. Octanol-water partition coefficients (K_{ow}) are also listed for each compound shown. Compounds with higher K_{ow} values are more hydrophobic and would be expected to diffuse more rapidly through the walls of the CMT tubing as discussed earlier. Those compounds could also preferentially sorb to the inside walls of the CMT tubing, resulting in a potential negative bias.

As shown in Table 1, many VOCs were detected in samples of purge water from channels monitoring deeper portions of the aquifer (i.e., below the high-strength core of the VOC plume) but were not detected in samples collected from the corresponding stainless-steel or Teflon sampling tubing after purging was complete. This indicates that VOCs detected in the purge water from those channels likely resulted from diffusion of VOCs from adjacent channels or from the contaminant plume directly. This positive bias was effectively removed by purging the stagnant water from the channels prior to sampling and collecting the samples from separate sampling tubing inserted to the full depth of the various CMT channels.

No aromatic hydrocarbons were detected in samples collected from either the stainless-steel or Teflon sampling tubing below a depth of 12 feet (3.7 m). *Cis*-1,2 DCE and vinyl chloride, however, were detected in the Teflon and stainless-steel tubing near the bottom of the aquifer (i.e., the channels monitoring ground water at depths of 17.5 and 20 feet. [5.4 and 6.1 m] bgs). The fact that these compounds were detected in samples collected from the Teflon sampling tubing at concentrations higher than those measured in samples of the purge water suggests that the VOCs are present near the base of the aquifer, beneath the core of the VOC plume, and are not artifacts of diffusion through the CMT tubing. Measurement of high concentrations of *cis*-1,2 DCE and vinyl chloride in samples from the stainless-steel control tubing at the same depths supports that conclusion.

Overall, there is a reasonably good match between the concentrations of VOCs measured in most of the samples collected from the CMT channels and the stainless-steel control tubing. In some cases, concentrations of VOCs were higher in samples collected from the stainless-steel control tubing than the samples collected from the CMT channels (e.g., *cis*-1,2 DCE measured in samples from depths of 17.5 and 20 feet [5.4 and 6.1 m]). This may be evidence of a negative sampling bias caused by inadequate flushing of water through the Teflon sampling tubing prior to sample collection. As discussed previously, sorption of hydrophobic solutes onto virgin Teflon sampling tubing can decrease the concentration of organic solutes in the samples initially collected from the tubing. In several instances, the concentrations of VOCs were higher in the samples collected from the Teflon sampling tubing than the samples from the stainless-steel control tubing. This may be evidence of a negative bias in samples collected from the stainless-steel control tubing because of degassing during sample collection. The tips of the stainless-steel control tubing are wrapped with a very fine stainless-steel mesh to prevent sand from clogging the ends of the tubing. The fine mesh likely causes a significant head loss from friction when the stainless-steel tubing was being pumped. Thus, a larger vacuum was applied to collect ground water samples from the stainless-steel control tubing than the larger CMT channels. Alternatively, the differences between solute samples collected from the CMT channels (i.e., the Teflon sampling tubing) and the stainless-steel "control" tubing could be primarily a result of microscale variations in the distribution of dissolved contaminants surrounding the multilevel monitoring well. As discussed, the aquifer near well PZ-14D exhibits striking variability in the concentration and spatial distribution of dissolved VOCs. In fact, DNAPL was sampled in a CMT multilevel well 30 feet (9 m) away from well PZ-14D during a later sampling event. Therefore, because of the documented variability in the actual concentration of the various solutes in the aquifer surrounding well PZ-14D, the designation of samples from the stainless-steel tubing as "control" samples should be viewed with caution. Similar testing and comparisons performed in a laboratory setting would likely provide a more rigorous evaluation of the potential biases associated with the various methods of sampling CMT multilevel monitoring wells.

Cost

To gain widespread use, installations of multilevel monitoring systems must be less expensive than other methods for permanent depth-discrete ground water monitoring, e.g., clusters of conventional monitoring wells. The price of the CMT well materials is comparable to the materials used to construct conventional monitoring wells: The current price for the CMT tubing ranges from US$3.95 to $6.50 per linear foot. (depending on volume purchased [Solinst Canada Ltd. 2001]), a cost similar to 2-inch (5 cm) or 4-inch (10 cm) diameter slotted PVC pipe. Aside from the CMT tubing, all other components are off-the-shelf materials commonly used in environmental investigations (e.g., stainless-steel mesh, sand, and bentonite pellets).

The real cost savings, of course, are apparent when the cost of drilling and installing one CMT well is compared to the cost of drilling and installing seven individual monitoring wells. Drilling footage, well materials, and disposal of investigation-derived waste (i.e., drill cuttings) is reduced sevenfold. More time is needed to construct a seven-zone CMT well than a conventional single-zone monitoring well; however, experience shows that building a CMT well using either conventional (tremie) methods or with seals made of bentonite packers takes about twice the time as constructing a conventional monitoring well to the same depth.

Conclusions

The CMT multilevel monitoring system represents a new low-cost multilevel monitoring system that can be installed with a variety of drilling equipment to depths currently greater than 250 feet (76 m). Continuous multichannel HDPE tubing eliminates the potential for leakage at joints (because there are no joints) and contributes to the low cost of the system. Compared to nested monitoring wells, having only one tube in a borehole simplifies the installation of sand packs and annular seals, which can be installed from the surface using conventional tremie methods. Bentonite packers and prepacked sand packs have also been developed that are attached to the tubing at the ground surface. Fully built multilevel wells are then inserted into boreholes in unconsolidated sediments through steel drive casing or in open holes in bedrock in just a few minutes. Aboveground construction is feasible because the CMT tubing is flexible enough to be lowered hand-over-hand into a borehole. Aboveground construction ensures that the sand packs and seals are located at precisely the desired depths, a goal that is sometimes not met when sand and bentonite tablets are poured from the surface or via a tremie pipe. Additional field testing and monitoring of the bentonite packer seals is needed, however, to assess the long-term viability of the seals in a variety of hydrogeologic settings.

Like all ground water monitoring devices, there are biases inherent with the CMT multilevel system. The design of the system requires that the tubing be flexible so that it can be inserted hand-over-hand into a borehole. There are several types of flexible polymeric tubing, but HDPE was selected as the optimum material because of its favorable working characteristics and low cost. For many target contaminants, HDPE is susceptible to both positive and negative biases caused by sorption, desorption, and diffusion. These biases can be minimized by purging the channels prior to sampling and collecting samples from separate 0.25-inch (0.64 cm) diameter Teflon sampling tubing or canister samplers placed to the bottom of each sampling channel adjacent to the various ports. In this way, ground water samples are collected that have minimal contact with the HDPE CMT tubing. Evaluations of the CMT system performed to date have focused on VOCs, but it is expected that with appropriate sampling methods, the system can be used to collect viable samples of ground water containing other dissolved contaminants. Also, additional evaluations of other sampling methods and pumps should be undertaken, ideally in a laboratory setting. Additional studies should include evaluations of small-diameter canister samplers and other types of small-diameter pumps that are currently being developed for the system.

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Authors' Note: Since the completion of the field trials described in this paper, a number of modifications to the system have been implemented, or are pending, for the commercial versions now available on the market. These evolvements principally relate to the channel seal methodology and to the tools and sampling options available.

Editor's Note: The use of brand names in peer-reviewed papers is for identification purposes only and does not constitute endorsement by the authors, their employers, or the National Ground Water Association.

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Biographical Sketches

Murray D. Einarson *(Einarson & Associates, 3806 El Centro Ave., Palo Alto, CA 94306; [650] 494-0946) is a consulting hydrogeologist based in Palo Alto, California. His work focuses on developing innovative and more effective ways to characterize and remediate plumes of dissolved contaminants.*

John A. Cherry *is a professor at the University of Waterloo (200 University Ave. W., Waterloo, ON N2L 3G1 Canada; [519] 885-1211). His research for the last 25 years has focused on field studies of ground water contamination, including the integration of field information with laboratory and modeling studies for assessment of site contamination and remedial options.*

APPENDIX C

PHOTOVAC VOYAGER
STANDARD OPERATING PROCEDURE

PHOTOVAC GC ANALYSIS FOR SOIL, WATER, AND AIR/SOIL GAS

SOP#: 2109
DATE: 10/19/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to describe a method for a low-cost field laboratory screening tool for tentative identification and determination of concentration levels on select contaminants for site assessment and health and safety surveys.

This method describes the rapid screening of air/soil gas, water, and soil samples using a Photovac portable Gas Chromatograph (GC) Model 10S series to determine the presence of various volatile organic compounds.

Data generated allows only rapid evaluation of site conditions and is applied to, but not limited to, the following activities: extent and degree of contamination; pollutant plume definition; health and safety assessment; and tentative pollutant identification and quantitation. The data should not be used for site ranking or enforcement purposes since only limited Quality Assurance/Quality Control (QA/QC) is required, and the reported data is qualified as tentative.

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

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Air/soil gas, water, or soil samples can be analyzed by the Photovac. Brief method summaries are provided below. All methods use a Photovac 10S series GC equipped with a 10.6 eV Photoionization Detector (PID), and use external standards to tentatively identify and quantitate compounds of interest.

2.1 Air/Soil Gas Samples

Ambient air or soil gas samples are collected in one-liter Tedlar bags. An aliquot of each bag sample is withdrawn using a gas-tight syringe and directly injected into the GC. Vapor from selected samples can then be absorbed onto Tenax/CMS cartridges for confirmational GC/MS analysis.

2.2 Water Samples

Water samples are collected in 40-mL VOA vials with Teflon-lined silicone septum screw caps. A 20-mL aliquot of sample is pipetted into a second, clean VOA vial. The vial is capped, shaken vigorously for one minute, and allowed to stand at room temperature for at least 30 minutes for vapor phase equilibration. An aliquot of the water headspace is then injected into the GC using a gas-tight syringe.

2.3 Soil Samples

Soil samples are collected in VOA vials. A five gram aliquot of sample is weighed into a second, clean vial. Enough reagent water is added to bring the total volume of the soil/water extract to 20-mL. The vial is then capped, shaken vigorously for one minute, and allowed to stand at room temperature for at least one hour for vapor phase equilibration. An aliquot of the soil headspace is then injected into the GC using a gas-tight syringe.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

3.1 Air/Soil Gas Samples

Air/soil gas samples are collected and stored in one liter Tedlar gas sampling bags as per the Soil Gas Sampling SOP. Samples should be kept in a cooler out of direct light and heat. Samples should be analyzed within 48 hours of collection, preferably within 12 hours.

Alternatively, samples may be collected in Summa canisters. In this case, sample stability may extend up to two months, depending upon sample matrix.

3.2 Water Samples

Water samples are collected, in triplicate, in 40-mL VOA vials. One sample is to be analyzed by the Photovac; the two remaining vials are used for confirmation analysis by another method. All three should be completely filled, with no visible air bubbles. Samples are stored out of direct light, in a cooler packed with ice immediatly upon collection until analysis. Sample vials should be protected against breakage. Samples should be analyzed within seven days of collection.

3.3 Soil Samples

Soil samples are collected in 40-mL VOA vials, and stored out of direct light, in a cooler packed with ice. Sample containers should be protected from breakage.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

4.1 Air/Soil Gas Samples

1. High concentrations of short chain alkanes and alkenes in samples may interfere with the resolution and detector sensitivity of early-eluting chlorinated alkenes and aromatic compounds.

2. Syringe blanks should be run as necessary to ensure against carryover contamination.

3. Samples can be contaminated by diffusion of volatile organics through the septum seals and the walls of the sampling bag during shipment and storage. A field blank, a Tedlar bag filled with ultra-zero air carried through sampling and handling protocol can serve as a check on such contamination.

4. Teflon or equivalent inert fittings and tubing should be used in all procedures to prevent contamination by off-gassing.

5. Parameters are identified by retention time (RT). Samples with response at the same RTs as target compounds are assumed to be identical, which may not be the case.

4.2 Water and Soil Samples

1. Liquid samples can not be directly introduced into the GC. Direct injection of liquids, without heated injection ports, may result in damage to the GC.

2. Syringe blanks should be run as necessary to ensure against carryover contamination.

3. Samples can be contaminated by diffusion of volatile organics through the septum seal during shipment and storage. A field reagent blank, prepared from reagent water and carried through the sampling and handling protocol, can serve as a check on such contamination.

4. Some of the sample will volatilize when the vials are opened during sample preparation. This loss is minimized by proper sample handling.

5. Parameters are identified by retention time (RT). Samples with response at the same RTs as target compounds are assumed to be identical, which may not be the case.

5.0 EQUIPMENT/APPARATUS

The following equipment is required for Photovac operation and analysis.

5.1 Photovac Operation

C Photovac 10S Series Gas Chromatograph, with manual and power cord

- Extra source lamp
- Photovac lamp-tuning screwdriver
- Extra columns/fittings
- Ultra-zero-air carrier gas
- Two stage regulator, with quick-connect fitting
- One flowmeter per Photovac, either bubble-meter, rotameter, or Gilibrator
- Septa, six-mm diameter
- Syringes, gas-tight, 10 µl to 1 mL
- VOA vials filled with activated charcoal (for syringe cleaning)
- Extra Photovac integrator pens
- Extra Photovac integrator paper
- Labels
- Tools - Large adjustable wrench
  - wrenches (5/16" to 9/16")
  - screwdrivers (flat head and Phillips head)
  - nosepliers
  - jeweler's screwdrivers
  - Allen wrenches
- Duct tape
- Teflon tape
- Power strip
- Snoop
- Kimwipes
- Pelican cases

5.2 Soil Gas Analysis

- Tedlar bags, one liter
- Summa canisters for holding gas standards
- Extra-large syringe (100 mL to 500 mL) for serial dilutions

5.3 Tenax/CMS Sampling

- Tenax/CMS cartridges in sealed, glass ampoules
- Culture tubes (labeled) with glass wool to ship cartridges
- Cotton gloves or cloths for cartridge handling
- Fitting to connect syringe to cartridge
- Fitting to connect cartridge to Tedlar bag
- 1/4" silicone O-rings for a tight seal around cartridge

5.4 Water Headspace Analysis

- Headspace standards, Purgeable A and B or equivalent
- 1.8-mL vials for holding standards (either screw-cap or crimp-top vials)
- Pasteur pipettes for transferring standards
- 40-mL VOA vials (one per sample plus extras for standards and QA/QC requirements)
- 10-mL or 20-mL pipettes and pipette bulb
- Liquid standard syringes
- Surgical gloves

5.5 Soil Headspace Analysis

- Same equipment for Water Headspace Analysis, plus:
- Portable scale, accurate to ±0.1 g.
- Spatulas, or equivalent, for transferring soil

6.0 REAGENTS

6.1 Reagent List for Air Sample Analysis

1. Gas Standards - Certified to ±2% level of accuracy, commercially available through Scott Specialty Gas or equivalent. In-house laboratory preparation of calibration gas standards with confirmational GC/MS analysis is acceptable.

2. Ultra-zero air carrier gas.

6.2 Reagent List for Water and Soil Sample Analysis

1. Reagent Water - Organic-free chromatographic grade or equivalent, free of any contaminants which may interfere with the detection and resolution of target parameters.

2. Ultra zero air carrier gas.

3. Stock Standard Solutions - Stock standard solutions may be prepared from pure standard materials or purchased as certified solutions (e.g., Supelco Purgeable A or B, or equivalent). Reagents to be used as standards may be dependent upon site specific suspected volatile contaminants.

7.0 PROCEDURES

7.1 Method Detection Limits

The method detection limit (MDL) is determined just before the analysis with a serial dilution of the standard, and is the lowest concentration that can be detected at the gain setting selected for the analysis. MDLs are dependent on the type of analysis performed and the condition of the gas chromatograph. Because of the difference in matrices, air and soil gas analyses usually have MDLs an order of magnitude above headspace analyses. Factors that can vary the sensitivity of a Photovac from site to site are the age of the source lamp, detector age, column condition, shipping the GC to the site, and the location of the field lab. Typical MDLs for soil gas range from 10 ppb to 50 ppb, and headspace MDLs range from 1 ppb to 5 ppb.

If sample concentrations are high, injection volumes may be reduced to obtain on-scale response for parameters of interest, and to avoid contamination of the GC system. The method detection limit (MDL) for compounds not detected at reduced injection volumes is calculated by the following:

$$MDL = \frac{(V_{STD})(C_{STD})}{(V)} \qquad (Equation\ 1)$$

where,

V_{STD} = Lowest volume of standard headspace injected
C_{STD} = Concentration of standard
V = Volume of sample headspace injected

7.2 Calibration

Photovac analyses are calibrated by the external standard method using the standards described in Section 6. At the beginning of the analysis, a three-to-five point calibration curve is run to demonstrate linear instrument response over a specified concentration range. The development of this method has shown the best linearity of the PID response to be from 10 ppb to 1 ppm for air/soil gas analysis and from 1 ppb to 100 ppb for headspace analysis. Most PIDs will be linear above that range but eventually at high enough concentrations the PID will become saturated. The curve is verified daily by running a calibration check standard from the middle of the curve.

If the response of any parameter varies from the curve by more than ±25% RSD (relative standard deviation) indicating that the instrument response has changed, then a new calibration curve should be run.

1. Air/Soil Gas Calibration

   The concentrations needed for calibration can be prepared by a serial dilution of the gas standard. For example, adding 50 mL of a 1-ppm standard and 450 mL of ultra zero carrier gas to a new Tedlar bag gives a 100-ppb calibration standard. The 100 ppb bag can then be used to make up lower concentration standards.

Alternatively, the analyst can construct a calibration curve by varying injection volumes. By designating a 250-µL injection volume as the 1-ppm standard, a 100-ppb standard is created by injecting 25 µL of a 1-ppm standard. This method is more convenient and does not require the large syringes needed for serial dilution, but it has the limitation that the calibration curve is limited by the sizes of the available syringes.

2. Water and Soil Calibration

   Headspace standards can be created at selected concentrations by adding the appropriate volumes of stock standard into clean 40-mL VOA vials containing 20 mL of reagent water. These volumes (V) are calculated by:

$$V = \frac{20\ mL}{(Calibrant\ conc.)} \times (Stock\ conc.)$$

(*Equation* 2)

   From the 200-ppm Purgeable A and B standards, it is advisable to first prepare a 2-ppm stock solution to allow calibration standards between 1 ppb and 10 ppb to be prepared with the syringes listed in Section 5.

7.3 Operation

7.3.1 Air/Soil Gas Analysis

1. Typical columns used for this method include SE-30 (packed) and CP-Sil 19 (capillary). An example of compound separation using CP-Sil 19, with typical chromatographic conditions, is shown in Figure 1 (Appendix A).
2. Standards are injected after every 10-15 samples or every six hours, whichever is more frequent, to bracket possible parameter RT variations.
3. If sample concentrations are high, injection volumes may be reduced to obtain on-scale response. The method detection limit (MDL) for compounds not detected at reduced injection volumes is calculated according to Equation 1, in Section 7.1.
4. Identify the compounds in the sample by comparing the retention time (RT) of the peaks in the sample chromatogram with those of the peaks in the standard chromatograms. The width of the RT windows used to make identifications should be based upon measurements of actual RT variations of standards which bracket a series of sample injections. Three times the standard deviation of a RT can be used to calculate a suggested window size, however, the experience of the analyst should be a major factor in the interpretation of chromatograms.

7.3.2 Water Sample Analysis

1. Pipet a 20-mL aliquot of sample into a clean 40-mL VOA vial with Teflon-lined septum screw cap. Cap the vial.
2. Shake the capped vial vigorously by hand for one minute. Allow to stand, inverted, and undisturbed for at least 30 minutes at ambient temperature for vapor phase equilibration. Use a gas-tight syringe to extract an aliquot of headspace by inserting the syringe needle through the vial septum to a distance approximately half way between the liquid surface and the septum's Teflon face. Purge the syringe barrel three to five times by withdrawing and expelling a volume of headspace in slight excess of the volume anticipated to be used for analysis.
3. If sample concentrations are high, injection volumes may be reduced to obtain on-scale response. If sample headspace injection volume is reduced below the volume of the aqueous calibration standard used to establish the MDL, the detection limit for target compounds detected at the reduced headspace volume must be determined. This is accomplished by injecting headspace aliquots at the reduced volume into the GC, beginning with the 10-ppb calibration standard and increasing or decreasing standard concentrations as warranted until a

response has been obtained for all target compounds. The detection limit for parameters detected at the lower headspace injection volume is then calculated using Equation 1, Section 7.1.

4. Identify the compounds in the sample by comparing the RT of the peaks in the sample chromatogram with those of the peaks in standard chromatograms. The width of the RT windows used to make identifications should be based upon measurements of actual RT variations of standards over the course of a day. Three times the standard deviation of a RT can be used to calculate a suggested window size, however, the experience of the analyst should be a major factor in the interpretation of chromatograms.

7.3.3 Soil Sample Analysis

1. Place a clean, empty, 40-mL, glass vial on the balance. Zero the balance. Use a clean stainless steel spatula to add 5.0 g ±0.1 g of soil sample. Pipet enough reagent water to bring the total volume of the soil and water to 20 mL. Seal the vial with a Teflon-lined, septum screw cap.

2. Shake the capped vial vigorously for one minute to promote dispersion of the soil sample and increase surface area. Allow to stand, undisturbed, at ambient temperature for at least one hour for vapor phase equilibrium. Use a gas-tight syringe to extract an aliquot of headspace by inserting the syringe needle through the vial septum to a distance approximately half way between the slurry surface and the septum's Teflon face. Purge the syringe barrel three to five times by withdrawing and expelling a volume of headspace in slight excess of the volume anticipated to be used for analysis. Wipe the syringe needle with a kimwipe before injection into the GC.

3. Although 5g has worked the best for most soil matrices, other amounts ranging from 1-10g have also been used depending on sample concentrations and the consistency of the matrix.

4. If sample concentrations are high, the analyst can either reduce the injection volumes or analyze less soil to obtain on-scale response. If sample headspace injection volume is reduced below the volume of aqueous calibration standard used to establish the MDL, follow the procedure in Section 7.2.3 to determine the MDL for target compounds detected at the reduced headspace volume. Alternatively, the analyst can weigh out as little as 1.0 g, keeping in mind that this means a 10% error if using a portable balance accurate to ±0.1 g.

5. Identify the parameters in the sample by comparing the RT of the peaks in the sample chromatogram with those of the peaks in standard chromatograms. The width of the RT windows used to make identifications should be based upon measurements of actual RT variations of standards over the course of a day. Three times the standard deviation of a RT can be used to calculate a suggested window size, however, the experience of the analyst should be a major factor in the interpretation of chromatograms.

8.0 CALCULATIONS

8.1 Air/Soil Gas Samples

The concentration of individual compounds in each sample is determined by using the following equation:

$$[Sample] = \frac{(Area\ Sample)}{(Area\ Standard)} \times \frac{(Volume\ Standard)}{(Volume\ Sample)} \times [Standard]$$

(*Equation* 3)

"Area Standard" is the average of the areas of the standards run before and after the sample. Concentrations are reported in ppb or ppm (volume/volume).

8.2 Water Samples

Concentrations of individual compounds in the sample are determined by the following equation:

This is the same as Equation 3, except the concentration of the headspace standard is used. Concentrations are reported in µg/L (ppb).

8.3 Soil Samples

Concentrations of individual compounds in the sample are determined by the following equation:
The volume of the headspace is always 20 mL, and the weight of the sample is usually 5 g. Concentrations are reported in µg/kg (ppb).

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

In order to meet the QA2 data quality objectives, at least 10% of all field samples must be confirmed by GC/MS analysis. The following QA/QC requirements must be followed and provided in the data package submitted:

1. Chain of custody documentation.

2. Sample log, including date/time of sample collection, date/time of analysis, and run numbers.

3. Blanks

    1. Air/Soil Gas Analysis - For each day of analysis, Field Standards (Tedlar bags filled with gas standards) and Field Blanks (Tedlar bags filled with ultra-zero air) must accompany samples through collection, handling, and storage.

    2. Water Analysis - Field Blank - duplicate 40-mL VOA vials completely filled with reagent water must accompany each cooler used for sample collection, storage, and/or shipment.

    3. Soil Analysis - Reagent Blank - 20 mL of the reagent water used in the soil analysis is pipetted into a clean 40-mL VOA vial, allowed to equilibrate, and analyzed prior to sample analysis.

$$[Sample] = \frac{(Area\ Sample)}{(Area\ Standard)} \times \frac{(Volume\ Standard)}{(Volume\ Sample)} \times [Standard]$$

(*Equation* 4)

4. Instrument calibration data

$$[Sample] = \frac{(Area\ Sample)}{(Area\ Standard)} \times \frac{(Vol.\ Standard)}{(Vol.\ Sample)} \times \frac{(Vol.\ Headspace)}{(Weight\ Sample)} \times [Standard]$$

(*Equation* 5)

5. Syringe blanks - Syringe blanks are to be run prior to each sample analysis. (In practice, there is no need to run syringe blanks if the previous sample is clean).

6. Labeling of chromatograms - Each chromatogram must be clearly identified by analysis type (i.e., syringe blank, sample number, or calibrant concentration), injection volume, run number, date, and time.

7. Replicate analysis - A replicate sample analysis is to be run after every 10 samples to check method/analyst precision. The RSD of the area response of any of the compounds should be within 15%.

8. Retention time/instrument response check - Since compound identification is based upon RT matches, a calibration standard should be run after every 10-15 samples.

9. Spikes - Soil and Water Samples Only

    1. For every 20 samples, one Matrix Spike (MS) and one Matrix Spike Duplicate (MSD) must be analyzed. If there are less than 20 samples in a matrix, at least one MS/MSD must be analyzed.

    2. The spiked samples should, if possible, have moderate concentrations. The amount spiked should be equivalent to the middle of the calibration range, or one to five times the sample background concentrations, whichever is higher.

3. To calculate the percent recovery (%R) of each compound of interest:

$$\%R \text{ ' } 100\% \times \frac{(A \ \& \ B)}{S} \qquad (\textit{Equation } 6)$$

where,

A = concentration of sample and spike
B = concentration of sample
S = concentration of the spike

4. The %R should be 50-90% for a soil matrix, and 80-120% for a water matrix. Due to the complexity of the soil/water/vapor equilibria, recoveries from soil matrices are consistently below 100%.

5. After the analysis of at least three spiked water samples, calculate the average percent recovery (P_{avg}) and the standard deviation of percent recovery (S_p). Express the accuracy assessment as the percent recovery interval, from P_{avg}-(w)s_p to P_{avg}+(2)s_p. Update the accuracy assessment for each parameter at each site where at least three accuracy measurements are made. This step is optional.

10. Confirmational Analysis (Air/Soil Gas)

Depending on work plan stipulations, at least 10% of the soil gas samples analyzed by this GC method must be submitted for confirmational GC/MS analysis (according to modified methods TO-1 [Tenax absorbent] and TO-2 [Carbon Molecular Sieve (CMS) absorbent]). Each soil gas sample must be absorbed on replicate Tenax/CMS tubes. The volume absorbed on a Tenax/CMS tube is dependent on the total concentration of the compounds measured by the Photovac:

Total Concentration (ppm)	Sample Volume (mL)
>10	Use Serial Dilution
10	10-50
5	20-100
1	100-250

A range of volumes is given to account for sample variability. The low end of the range should be used for samples whose total concentrations are primarily one large peak, as too large a volume will overload the GC/MS column when that peak is confirmed. The high end of the range should be used for multi-peak samples.

10.0 DATA VALIDATION

Data should be reviewed to ensure that the QA/QC requirements listed in Section 9 have been met.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow US EPA, OSHA, and corporate health and safety practices. More specifically, it is suggested that the samples should be stored in a cooler, away from the analysis area. In addition, the analysis area should have adequate ventilation.

12.0 REFERENCES

EPA Method 601/602.

FASP Method 101, Screening for Volatile Organics in Water.

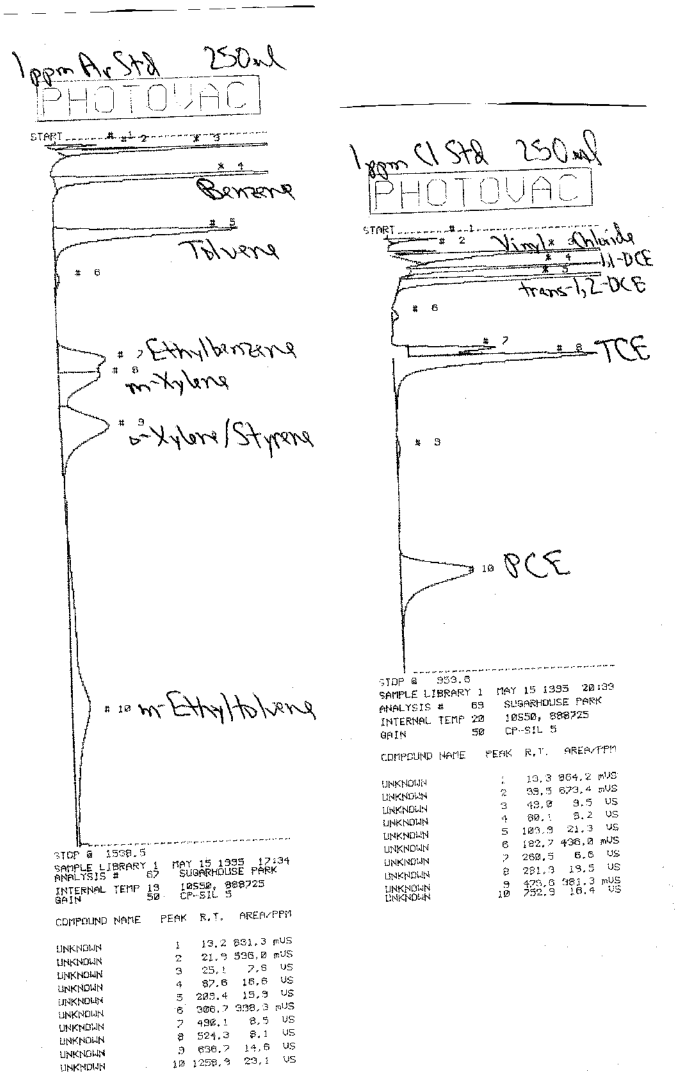
Chapman, H., Clay, P., Field Investigation Team (FIT) Screening Methods and Mobile Laboratories Complementary to Contract Laboratory Program (CLP), October 17, 1986.

APPENDIX A

Figures

FIGURE 1. Gas Chromatogram of Gas Standards Used in Air/Soil Gas Analysis

(10S50 GC Flow 10-15 cc/min Gain 50 Window 10% Min Area 100 mV/sec
Chart Speed 0.5 cm/min Slope Sens. 18, 14, 4)



```
STOP @  1538.5
SAMPLE LIBRARY 1  MAY 15 1995  17:34
ANALYSIS #    67   SUGARHOUSE PARK
INTERNAL TEMP 19   10S50, 888725
GAIN          50   CP-SIL 5

COMPOUND NAME   PEAK  R.T.   AREA/PPM

UNKNOWN           1    13.2 831.3 mVS
UNKNOWN           2    21.9 536.0 mVS
UNKNOWN           3    25.1    7.6  VS
UNKNOWN           4    87.6   16.6  VS
UNKNOWN           5   209.4   15.9  VS
UNKNOWN           6   306.7 938.3 mVS
UNKNOWN           7   490.1    8.5  VS
UNKNOWN           8   524.3    8.1  VS
UNKNOWN           9   636.7   14.6  VS
UNKNOWN          10  1258.9   29.1  VS
```

```
STOP @   953.6
SAMPLE LIBRARY 1  MAY 15 1995  20:33
ANALYSIS #    69   SUGARHOUSE PARK
INTERNAL TEMP 20   10S50, 888725
GAIN          50   CP-SIL 5

COMPOUND NAME   PEAK  R.T.   AREA/PPM

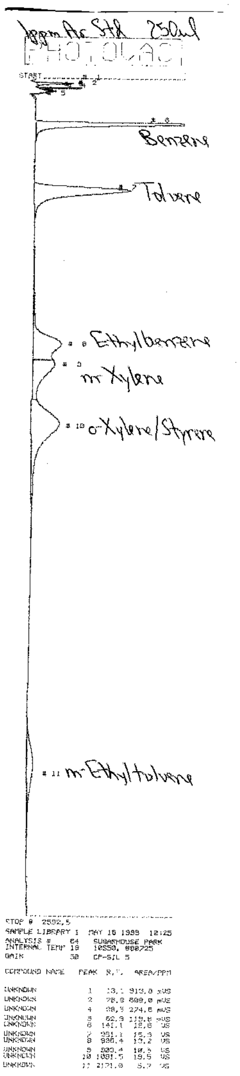
UNKNOWN           1    13.3 864.2 mVS
UNKNOWN           2    39.5 673.4 mVS
UNKNOWN           3    49.0    9.5  VS
UNKNOWN           4    80.1    5.2  VS
UNKNOWN           5   103.9   21.3  VS
UNKNOWN           6   182.7 436.0 mVS
UNKNOWN           7   260.5    6.6  VS
UNKNOWN           8   281.9   19.5  VS
UNKNOWN           9   479.6 981.3 mVS
UNKNOWN          10   752.9   16.4  VS
```

APPENDIX A (Cont'd)

Figures

FIGURE 2. Gas Chromatogram of Purgeable Standards Used in Water or Soil Analysis

(10S50 GC Flow 10-15 cc/min Gain 50 Window 10% Min Area 100 mV/sec
Chart Speed 0.5 cm/min Slope Sens. 18, 14, 4)



```
STOP @  2592.5
SAMPLE LIBRARY 1  MAY 16 1999  12:25
ANALYSIS #     64   SUGARHOUSE PARK
INTERNAL TEMP 19   10S50, 808725
GAIN           50   CP-SIL 5

COMPOUND NAME   PEAK  R.T.   AREA/PPM

UNKNOWN            1    13.1  913.0 mVS
UNKNOWN            2    28.9  808.0 mVS
UNKNOWN            4    38.9  274.6 mVS
UNKNOWN            5    62.9  119.6 mVS
UNKNOWN            6   141.1   18.6  VS
UNKNOWN            7   331.1   15.3  VS
UNKNOWN            8   835.4   13.2  VS
UNKNOWN            9   903.4   10.5  VS
UNKNOWN           10  1081.5   19.5  VS
UNKNOWN           11  2171.0    5.7  VS
```

PROVEN SOLUTIONS FOR VOC DETECTION

PHOTOVAC, Inc.

Tech Notes

Number 3

Procedure for Preparing Soil and Water Samples for Analysis by Voyager Portable GC

INTRODUCTION

When analyzing samples with a field portable Gas Chromatograph, rapid turnaround, simplicity of operation and data reproducibility are very important. Therefore, the method of injection and sample preparation must be carefully thought out.
Static headspace methods allow soil and water samples to be analyzed in the field with speed and accuracy without using expensive sample preparation equipment. "Static headspace involves a partitioning of volatile components between the aqueous and vapor phases enclosed in a gas tight vial" [1] .
The Photovac Voyager portable Gas Chromatograph is capable of analyzing static headspace above soil and water samples. Following is the procedure for preparing soil and water samples for analysis by the Voyager Portable Gas Chromatograph.

EQUIPMENT NEEDED

AQUEOUS SAMPLES
40 mL VOA vials with Teflon septum caps
Constant temperature water bath
Gas tight syringes
Spare needle
Syringe with 22 gauge needle 3.5 in. (8.9cm) in length

SOIL SAMPLES
40 mL VOA vials with Teflon septum caps
10cm^3 plastic syringes
Graduated cylinder or volumetric pipettes
Gas tight syringes
Spare needle

Constant temperature water bath
Distilled water

PROCEDURE

AQUEOUS SAMPLES

- Collect samples in clean, unpreserved 40 mL septum capped glass vials with zero headspace. Cap vials and invert to avoid loss of volatiles.
- Before samples are analyzed, the portable gas chromatograph should be calibrated with an aqueous standard containing all of the compounds of interest. See

Photovac TechTIP Volume 5, Number 2 for details on preparation of Aqueous Standards. The standard should be handled in exactly the same fashion as the sample, using the identical volume of headspace, the identical injection volume, and the identical equilibration time and temperature. The compound names and concentrations should be stored in the library for comparison against the sample.

- Refrigerate samples at 4° C if not analyzing immediately; otherwise place inverted vials into a constant temperature water bath for fifteen minutes to reach thermal equilibrium. The minimum temperature of the water bath should be 25° C and the maximum temperature 50° C. Using the maximum temperature will increase the rate of volatilization and result in greater recoveries.
- Insert a syringe needle into the septum to allow air to enter the vial, then use a second syringe with the longer needle inserted through the septa to the bottom of the vial, and withdraw 10 mL of sample. Discard the 10 mL of sample. Preliminary studies had indicated the need to use a long needle so as not to allow air bubbles to pass through the solution. These air bubbles were shown to cause significant increases of the volatile organic compounds in the headspace due to air stripping[2].
- Invert the vial with the 10 mL of headspace and shake vigorously for 2 minutes. Place the vial into the water bath for 5 minutes.
- When ready to analyze, remove a suitable amount of headspace for injection into the GC using a gas tight syringe. Typically, injection volumes of headspace range from 100-500 uL.
- During analysis, the sample is automatically compared to the library compounds; sample constituents will be identified and quantified. After the analysis is complete the results will appear on the GC screen.

SOIL SAMPLES

- Using a sharp knife cut the injection tip off a 10 cm^3 plastic syringe. See Figure 1.
- Use the $10cm^3$ tipless plastic syringe to collect 4cc of soil[3], allowing the open end to core the soil (4cc = approx. 5-7 gm).
- Clean the outside of the plastic syringe with a paper towel to remove soil particles.
- Insert the plastic syringe into a 40 mL VOA vial containing 20 mL of distilled, organic-free water. Push the plunger down to extrude all of the soil from the syringe.[3] See Figure 2.
- *Optional Step - To determine the exact concentration of the compound(s) in the soil, the soil sample will have to be weighed and the exact weight noted for use in the calculation found below. The best method of weighing the soil is to weigh the vial with the organic-free water, add the soil and reweigh. If soil weight is not known, an estimate will have to be made.*
- Immediately cap the vial and shake vigorously for two minutes.
- Before samples are analyzed the portable gas chromatograph should be calibrated with an aqueous standard containing all of the compounds of interest. See Photovac TechTIP Volume 5, Number 2 for details on preparation of Aqueous

Standards. The standard should be handled in exactly the same fashion as the samples, using the identical volume of headspace, the identical injection volume, and the identical equilibration time and temperature.

- Place the inverted vials into a constant temperature water bath for fifteen minutes for thermal equilibrium to be reached. The minimum temperature of the water bath should be 25° C and the maximum temperature 50° C. Using the maximum temperature will increase rate of volatilization and result in greater recoveries.
- When ready to analyze, remove a suitable amount of headspace to inject into the GC using a gas tight syringe. Typically, injection volumes of headspace range from 100-500 uL.
- During analysis the sample is compared to the library compounds. Sample constituents will be identified and quantified based on comparison with the library. Since the library used was created with aqueous standards (wt/vol), a calculation is required to determine the soil concentration (wt/wt).

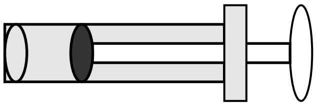


Figure 1
Tipless Syringe

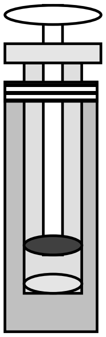


Figure 2
Dispensing soil sample
into 40 mL VOA Vial

CALCULATION

Determine the concentrations of individual compounds in the sample by using the following formula derived from the EPA SOP #2109, modified for use with the Voyager Portable Gas Chromatograph[4] :

$$\text{Sample Concentration} = \text{Voyager Reported Concentration} \times \frac{\text{Standard Volume}}{\text{Injection Volume}} \times \frac{\text{Volume Water (mL)}}{\text{Mass Soil (gm)}}$$

- Soil Sample Concentration in <u>PPM (mg/kg) or PPB (ug/kg)</u>
- Voyager GC reported Concentration in <u>PPM or PPB</u>
- Volume of Organic-Free Water Added to Sample Vial in <u>mL</u> (usually 20 mL)
- Mass of Soil Sample in <u>gm</u>

For further information contact your area representative or Photovac:

Photovac, Inc.
300 Second Avenue
Waltham, MA 02451
Phone: 781-290-0777
Fax: 781-290-4884
www.photovac.com

Last updated 11/02/2007

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[1] Manual Headspace Method to Analyze for the Volatile Aromatics of Gasoline in Groundwater and Soil Samples. Roe, V.D., M.J. Lacy and J.D. Stuart, Dept. of Chemistry, University of Conn., G.A. Robbins, Dept. of Geology and Geophysics, University of Conn. 1989 American Chemical Society.

[2] Using the Static Headspace Method To Determine Henry's Law Constants. Robbins, G.A. Dept. of Geology and Geophysics, University of Conn., S. Wang and J.D. Stuart, Dept. of Chemistry, University of Conn. 1993 American Chemical Society.

[3] Collection, handling and storage: Keys to improved data quality for volatile organic compounds in soil. Hewitt, A.D., T.F. Jenkins and C.L. Grant. American Environmental Laboratory, On-Site Analysis February 1995.

[4] Compendium of ERT Field Analytical Procedures. United States EPA, Office of Emergency and Remedial Response, Washington, DC. Publication 9360.4-04 May 1992.

Tech Notes

Number 4

Preparation of Aqueous Standards for Groundwater Analysis Using the Photovac Voyager Portable GC

INTRODUCTION

Although the Photovac Voyager Portable Gas Chromatograph is designed to accept gas samples only, it can readily be used to measure volatile organic compound (VOC) contamination in water. A volume of the headspace above a water sample can be analyzed. This Bulletin describes a method for preparing aqueous standards starting with a stock methanolic solution of VOC and serial dilution with organic-free water.

PREPARATION OF WATER STANDARDS

This is a general guideline to be used when making aqueous standards of volatile compounds. The examples given are for Benzene and TCE, two compounds commonly found as groundwater contaminants. The volumes used for generating the initial stock solution and subsequent dilutions are readily dispensable to allow the preparation of low concentration standards.

The accuracy of aqueous standards is dependent upon the precautions taking in the transfer of liquids and the prevention of headspace loss. Cross contamination by using contaminated syringes must also be avoided.

APPARATUS

The following apparatus is required, with care being taken to decontaminate the various items using only spectroscopic grade Methanol:

1. 40 mL VOA vials.
2. Liquid or gas-tight syringes (10 and 25 uL).
3. Disposable pipettes.
4. Volumetric flasks, 100 mL, with caps.

REAGENTS

1. 100 mL Methanol, purity 99.0% or better
2. Approximately 20 mL each of other desired reagents
3. Organic-free water

The densities of the desired standard compounds are used to determine the weight of known volumes (a table of densities is provided in Appendix 1). The following is an example for making aqueous standards of Benzene and TCE at a concentration of 5.0 PPB (ug/L). The procedure consists of two parts: A) Making a stock solution in Methanol (200 ug/mL or 200 PPM), and B) 1/40,000 (5 ug/L or 5 PPB) dilution in organic-free water.

A) STOCK SOLUTION IN METHANOL

1. Calculate the volume of each desired standard compound to be added to 100 mL of Methanol to produce 200 ug/mL (PPM) Stock solution.

(a) For **Benzene**: From Appendix 1, density at 20°C = **0.8794 g/mL.** Convert g/mL to mg/uL:

$$\frac{0.8794\ \text{g}}{\text{mL}} = \frac{879.4\ \text{mg}}{\text{mL}} = \frac{879.4\ \text{mg}}{1000\ \text{uL}} = \frac{\mathbf{0.8794\ mg}}{\mathbf{uL}}$$

Desired stock concentration = **200 ug/mL.** Multiply desired stock concentration by the volume of Methanol used for the dilution in order to determine the weight of Benzene necessary to achieve the stock concentration:

$$\frac{200\ \text{ug}}{\text{mL}} = \frac{20000\ \text{ug}}{100\ \text{mL}} = \frac{\mathbf{20\ mg}}{\mathbf{100\ mL}}$$

Divide this weight by the density of Benzene (in mg/uL) to determine the volume of Benzene required to achieve the stock concentration:

$$\frac{20\ \text{mg}}{0.8794\ \text{mg/uL}} = \mathbf{22.74\ uL\ Benzene}$$

(b) For **TCE**: From Appendix 1, density at 20°C = **1.4649 g/mL.** Convert gm/mL to mg/uL:

$$\frac{1.4649\ \text{g}}{\text{mL}} = \frac{1465\ \text{mg}}{\text{mL}} = \frac{1465\ \text{mg}}{1000\ \text{uL}} = \frac{\mathbf{1.465\ mg}}{\mathbf{uL}}$$

Desired stock concentration = **200 ug/mL**. Multiply desired stock concentration by the volume of Methanol used for the dilution in order to determine the weight of TCE necessary to achieve the stock concentration:

$$\frac{200\ \text{ug}}{\text{mL}} = \frac{20000\ \text{ug}}{100\ \text{mL}} = \frac{\mathbf{20\ mg}}{\mathbf{100\ mL}}$$

Divide this weight by the density of TCE (in mg/uL) to determine the volume of TCE required to achieve the stock concentration:

$$\frac{20\ \text{mg}}{1.4649\ \text{mg/uL}} = \mathbf{13.65uL\ TCE}$$

2. Using appropriate glassware, transfer approximately 99 mL of Methanol to a 100 mL volumetric flask. The meniscus (bottom of the air/liquid interface) of the liquid will be visible in the flask neck about 1 cm from the "full" line.

3. With clean 25uL liquid syringes, transfer the calculated Benzene and TCE volumes to the Methanol flask. Place the tip of the syringe needle below the surface of the liquid before expelling the contents, to prevent volatilization of the compound. Rinse the syringe thoroughly with Methanol after each use by repeatedly withdrawing the plunger and expelling the liquid onto a paper towel. <u>This syringe should be reserved for preparing only aqueous standards.</u>

4. Fill the flask to exactly 100 mL volume by dispensing Methanol droplets with a pipette until the meniscus is level with the "full" line.

5. Cap the flask and invert 2 or 3 times <u>only</u> (do not shake) to mix the contents.

6. This Methanol stock solution may now be stored in septum vials, refrigerated and used to prepare fresh standards daily for up to 3 months. To use again, bring to room temperature and remove the liquid by piercing the septum. Do not remove the cap or the contents will be useless.

B) DILUTION OF STOCK SOLUTION

1. Calculate the volume of stock solution to be added to 100 mL of organic-free water to produce **5 ug/L** (PPB):

   Stock concentration = 200 ug/mL = 200 PPM weight (w) / volume (v)

   Desired Standard concentration = 5 ug/L = 5 PPB w/v

$$\frac{5\text{ug}}{\text{L}} = \frac{.005\text{ mg}}{\text{L}} = .005\text{ PPM}$$

$$\frac{\text{Conc. desired}}{\text{Stock conc.}} = \frac{.005\text{ PPM}}{200\text{ PPM}} = \frac{\mathbf{1}}{\mathbf{40{,}000}}$$

Volume of diluent organic-free water = 100 mL

$$100\text{ mL} \times \frac{1}{40{,}000} = 0.0025\text{mL} = \mathbf{2.5\text{ uL}}$$

This is the volume of stock solution to add to 100 mL water to create a 5 ug/L standard.

2. Using a clean 10 uL liquid syringe, transfer the calculated volume to a volumetric flask containing 99 mL of organic-free water filled exactly as described previously. Again, be sure to place the syringe tip below the surface of the water prior to expelling the contents, to prevent volatilization.

3. Fill the flask to exactly 100 mL with organic-free water.

4. Cap the flask and invert 2 or 3 times only (do not shake) to mix the contents. Discard the liquid in the flask neck and immediately transfer 20 mL of the working standard to a 40 mL VOA bottle. Cap immediately. This solution must be made fresh daily.

NOTES:

- Follow chemical manufacturer's recommended safety information for the reagents used.
- As many compounds as desired may be added to the Methanol stock solution during preparation.
- The Methanol stock solution may be stored in small vials with septum caps at 4°C. Fill completely so that there is no headspace in the vial. To use, warm vials to room temperature and puncture the septum with a syringe needle, withdrawing the appropriate volume for dilution.
- When working with samples in low PPM and PPB concentration ranges, freshly prepared aqueous standards should be used on a daily basis.

- Although only a few microliters of stock solution are required for dilution into water when preparing the working standard, the relatively large volume (100 mL) of diluent liquid is used so that each standard is easily measured and dispensed. A smaller diluent volume would require measurement of extremely small microliter volumes of stock solution, which is difficult to accomplish accurately.

- Care should be taken not to inject liquid into the GC.

- Typically, injection volumes of headspace range from 100 - 500 uL.

When using a Voyager GC, use a separate file for water standard data. By storing the headspace concentration as the liquid concentration, from the standards, the GC will display results based on liquid concentration for field samples. This approach will prevent confusion with air calibration data and negates the need for using Henry's Law to calculate vapor concentrations with respect to liquid samples.

For further information contact your area representative or Photovac:

Photovac, Inc.
300 Second Avenue
Waltham, MA 02451
Phone: 781-290-0777
Fax: 781-290-4884
www.photovac.com

APPENDIX 1

Densities of Organic Compounds

Compound	Formula	Density (gm/mL)	Compound	Formula	Density (gm/mL)
Acetone	C_3H_6O	0.79	Ethylbenzene	C_8H_{10}	0.87
Acrylonitrile	C_3H_3N	0.8004	Ethyl Bromide	C_2H_5Br	1.45
Benzene	C_6H_6	0.8794	Ethyl Chloride	C_2H_5Cl	0.9214
Benzyl Chloride	C_7H_7Cl	1.1	n-Heptane	C_7H_{16}	0.68
Bromobenzene	C_6H_5Br	1.495	2-Heptanone	$C_7H_{14}O$	0.8608
Bromochloromethane	CH_2BrCl	1.991	n-Hexane	C_6H_{14}	0.66
Bromoform	$CHBr_3$	2.9	iso-Pentane	C_5H_{12}	0.692
n-Butyl Alcohol	$C_4H_{10}O$	0.81	Isoprene	C_5H_8	0.681
sec-Butyl Alcohol	$C_4H_{10}O$	0.8063	Isopropyl Alcohol	C_3H_8O	0.79
tert-Butyl Alcohol	$C_4H_{10}O$	0.7887	Isopropyl Benzene	C_9H_{12}	0.86
Carbon Tetrachloride	CCl_4	1.59	Methane	CH_4	gas
Chlorobenzene	C_6H_5Cl	1.1	Methyl Alcohol	CH_4O	0.7914
Chloroform	$CHCl_3$	1.48	Methyl Bromide	CH_3Br	gas
Cumene	C_9H1_2	0.86	Methyl Cyclohexane	C_7H_{14}	0.77
Cyclohexane	C_6H_{12}	0.81	Methyl Ethyl Ketone	C_4H_8O	0.805
Cyclohexanone	$C_6H_{10}O$	0.95	Methyl Isobutyl Ketone	$C_6H_{12}O$	0.8
Cyclopentane	C_5H_{10}	0.746	n-Nonane	C_9H_{20}	0.7176
n-Decane	$C_{10}H_{22}$	0.7025	n-Octane	C_8H_{18}	0.7025
Dibromochloromethane	$CHBr_2Cl$	2.451	n-Pentane	C_5H_{12}	0.6264
1,2-Dibromoethane	$C_2H_4Br_2$	2.18	Propane	C_3H_8	gas
1,2-Dichlorobenzene	$C_6H_4Cl_2$	1.306	Propylene	C_3H_6	gas
1,3-Dichlorobenzene	$C_6H_4Cl_2$	1.288	Styrene	C_8H_8	0.906
1,4-Dichlorobenzene	$C_6H_4Cl_2$	1.241	1,1,2,2-Tetrachloroethane	$C_2H_2Cl_4$	1.5953
Dichlorobromomethane	$CHBrCl_2$	1.98	Tetrachloroethylene	C_2Cl_4	1.63
1,1-Dichloroethane	$C_2H_4Cl_2$	1.18	Toluene	C_7H_8	0.866
1,2-Dichloroethane	$C_2H_4Cl_2$	1.256	1,1,1-Trichloroethane	$C_2H_3Cl_3$	1.339
1,1-Dichloroethylene	$C_2H_2Cl_2$	1.218	1,1,2-Trichloroethane	$C_2H_3Cl_3$	1.44
cis-1,2-Dichloroethylene	$C_2H_2Cl_2$	1.284	Trichloroethylene	C_2HCl_3	1.4649
trans-1,2-Dichloroethylene	$C_2H_2Cl_2$	1.2565	Vinyl Acetate	$C_4H_6O_2$	0.94
Dichloromethane	CH_2Cl_2	1.325	Vinyl Chloride	C_2H_3Cl	gas
1,2-Dichloropropane	$C_3H_6Cl_2$	1.156	o-Xylene	C_8H_{10}	0.8801
Epichlorohydrin	C_3H_5ClO	1.18	m-Xylene	C_8H_{10}	0.8684
Ethyl Acetate	$C_4H_8O_2$	0.9	p-Xylene	C_8H_{10}	0.8614

All densities in gm/mL at 20°C unless otherwise noted.

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