Final Work Plan

Vapor Intrusion Assessment St. Louis Ordnance Plant Former Hanley Area

St. Louis, Missouri

Prepared for

U.S. Army Corps of Engineers, Kansas City District

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Acronyms and Abbreviations

µg/m^3	microgram per cubic meter
%R	percent recovery
Army	U.S. Army Reserve 89th Regional Readiness Command
ASL	Applied Services Laboratory
BFB	bromofluorobenzene
bgs	below ground surface
CAS	Chemical Abstract Society
CLP	Contract Laboratory Program
COC	chain-of-custody
cVOC	chlorinated volatile organic compound
DCA	dichloroethane
DCE	dichloroethylene
DOT	Department of Transportation
DPT	direct push technology
EDD	electronic data deliverable
FD	field duplicate
FTL	field team lead
GPS	global positioning system
HASP	health and safety plan
HAZWOPER	hazardous waste operations and emergency response
ID	identification
IDW	investigation-derived waste
ITRC	Interstate Technology Regulatory Council
LCL	lower control limit
LCS	laboratory control sample
MCL	maximum contaminant level
MDL	method detection limit

MDNR	Missouri Department of Natural Resources
mL/min	milliliter per minute
MRBCA	Missouri risk-based corrective action
MS/MSD	matrix spike/matrix spike duplicate
NELAC	National Environmental Laboratory Accreditation Conference
ORP	oxidation-reduction potential
PCE	tetrachloroethylene
PID	photoionization detector
PPE	personal protective equipment
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
QSM	Quality Systems Manual
RI	remedial investigation
RL	reporting limit
RPD	relative percent difference
RRC	Regional Readiness Command
RRF %D	relative response factor percent drift
RSD	relative standard deviation
SA	spike concentration added
SIM	selective ion monitoring
site	former Hanley Area
SL	screening level
SLOP	St. Louis Ordnance Plant
SOP	standard operating procedure
SOW	statement of work
SR	sample result
SSC	site safety coordinator
SSR	spiked sample result
TB	trip blank

TCE	trichloroethylene
UCL	upper control limit
UHP	ultra-high-purity
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

SECTION 1

Introduction

The purpose of this work plan is to summarize the actions to be performed at the St. Louis Ordnance Plant (SLOP), Former Hanley Area (site) to assess the potential vapor intrusion pathway at residences located immediately north of the site. The site is located on the western boundary of the St. Louis, Missouri, city limits approximately 0.25 mile south of the intersection of Interstate 70 and Goodfellow Boulevard (Figure 1). The property is currently owned by the U.S. Army Reserve 89th Regional Readiness Command (RRC; Army).

1.1 Background and History

The SLOP operated from 1941 to 1945 as a small arms ammunition production facility. The ordnance plant primarily produced .30- and .50-caliber ammunition. The plant was divided into two areas designated as Plant 1, which lies east of Goodfellow Boulevard, and Plant Area 2, which lies west of Goodfellow Boulevard. The Former Hanley Area associated with this work plan consists of approximately 14 acres located at the northeastern end of former Plant Area 2 at the intersection of Stratford Avenue and Goodfellow Boulevard. The processes at former Plant Area 2 consisted of blending primary explosives, incendiary compounds, and the tracer charging of .30- and .50-caliber projectiles as part of the final product assembly.

A Phase I remedial investigation (RI), concluded in February 2005, included the collection of surface and subsurface soil samples and groundwater samples. The results confirmed localized metals contamination in the surface soil and volatile organic compound (VOC) contamination in groundwater in the vicinity of former Building 220, which is located adjacent to Stratford Avenue.

The U.S. Army Corps of Engineers (USACE) Kansas City District performed additional soil and groundwater sampling at the former Building 220 area and on public right-of-ways across Stratford Avenue in order to characterize the nature and extent of VOC contamination in groundwater. This supplemental Phase II RI fieldwork included installing groundwater monitoring wells and soil and groundwater sampling and analysis. The results of the Phase II efforts confirmed VOC contamination in soil and groundwater at the former Building 220 area above established state and federal screening levels. In addition, contaminated groundwater with VOC concentrations exceeding federal maximum contaminant levels (MCLs) was found to be moving offsite to the northeast.

1.2 Site Conditions

To gain a better understanding of site conditions that may affect the migration of vapor through the soil and potentially preferred migration pathways (such as utility corridors) into homes adjacent to the SLOP site, a site visit was conducted on January 25, 2008. Information was gathered on the location and construction of utilities, depth to groundwater at existing monitoring wells, the elevation of basement floors relative to static

groundwater levels, and the construction and condition of the basement foundations of the subject residences: 6317, 6321, 6325 and 6329 along Stratford Avenue and 4701, 4707, and 4711 along Goodfellow Boulevard based on a visual survey.

1.2.1 Site Visit Activities and Findings

Activities conducted during the site visit and the resulting findings from these activities are discussed in this section.

Utilities

The utilities that enter each subject residence were identified and located based on information from Missouri One-Call and review of utility maps. Missouri One-Call was contacted to mark the utilities and the field team met the utility representatives at the site in order to review utility maps. In addition, the utility companies were called to discuss construction material, backfill material, and depth of the utilities. Figure 3 depicts the location of the utility corridors in relation to other surface features.

According to Laclede Gas Company, the depths at which natural gas service lines are buried may vary depending on changes made to the ground surface by property owners, but when installed the lines are buried 1.5 to 2 feet below grade.

The St. Louis Water Company specifies a minimum depth at a level below the frost line and reported typical installation depths of 3 to 4 feet below grade.

According to Metropolitan St. Louis Sewer District (MSD) maps, sanitary sewer mains run along the alley behind the homes on Goodfellow Boulevard and behind the homes on Stratford Avenue, between those homes and the homes that front on Henner Avenue. Therefore, it can be assumed that sanitary sewer services exit the homes from the rear of the homes. MSD maps did not provide depths of the mains, did not mark at what point the service lines connect with the main lines, and we were unable to observe service vents or clean-outs in the yard. Based on experience with MSD in the St. Louis area, the sanitary lines are estimated to be located at a depth at least 3 to 4 feet below grade.

Backfill material used within the utility corridors may vary. St. Louis Water Company typically backfills around the pipe with gravel. Laclede Gas Company indicated that based on the date of the installation, the backfill is most likely trench cuttings. No information was obtained from MSD regarding backfill material, however, given the age of the houses it is likely that trench cuttings would have been used.

Depth to Groundwater

Water levels and total depths were measured for monitoring wells MW-107, MW-108, and MW-109 on January 25, 2008. Depth to groundwater was gauged at depths of 4 to 5 feet below street grade. The groundwater elevations were measured at 527.36, 529.79, and 531.39 North American Vertical Datum of 1988 (NAVD 88) for monitoring wells MW-107, MW-108, and MW-109, respectively. These elevations are comparable to those measured in April 2007.

Basement Elevations

Basement elevation data was collected in order to assess the depth to shallow groundwater in relation to the elevation of the basement floors and the utility corridors at the adjacent residences. The elevations of monitoring wells (MW-107, MW-108, and MW-109) were used as reference to measure the elevation at street level and the elevation of the top of the foundation of each house, and where possible, the floor of the basement. Basement floor elevations were measured at residences with garages or former garages within the basements.

Visual Foundation Survey

At each of the addresses a visual assessment was conducted to identify which residences have a basement garage and construction materials and condition (for example, cracks) of the basement structure. Five of the eight homes had poured concrete foundations, and three were stone and mortar construction. Two of the homes along Stratford Avenue had garages within the basement beneath the home (6325 and 6329) and the three homes along Goodfellow Boulevard formally had garages within the basement beneath the home.

1.2.2 Current Understanding of Site Conditions

Groundwater levels are greater than 1.5 feet and closer to 2 feet below the floor of the basements at homes along Stratford Avenue and greater than 3 feet below the floor of the basements at homes along Goodfellow Boulevard. Therefore, a sufficient thickness of unsaturated soil is present beneath the foundation depths of the homes to allow for collection of soil gas samples at the preferred collection depth.

The depth of utilities corridors are consistently above groundwater levels. Therefore, groundwater migration is not occurring through these potentially preferentially flow pathways.

Figure 2 presents a cross-sectional view running west to east along the homes on Stratford Avenue and south to north along the homes on Goodfellow Boulevard that depicts the groundwater elevation in relation to the foundation elevations. Figure 2 also depicts approximate depths at which utilities would enter at the front of the homes.

1.3 Objective

The objective of the proposed vapor intrusion investigation is to address the most immediate concern, which is the potential for vapor intrusion in residences north of the SLOP site. The contaminants of interest for the vapor intrusion assessment are those chlorinated volatile organic compounds (cVOCs) identified in groundwater at the site. These cVOCs consist of tetrachloroethylene (PCE) and its daughter products trichloroethylene (TCE), cis-1,2-dichloroethylene (cis-1,2-DCE), trans-1,2-DCE, and vinyl chloride; and 1,2-dichloroethane (1,2-DCA), also known as ethylene dichloride.

1.4 Approach

A preliminary evaluation was conducted by estimating indoor air concentration by using VOC concentrations in groundwater to estimate corresponding soil gas concentrations at the

water table and then estimating indoor air concentrations using a default attenuation factor per U.S. Environmental Protection Agency (USEPA) guidance (*USEPA Region 6 MSSL and USEPA Region 9 PRG*). The basis and calculations as well as the site conceptual model (CSM) used in the preliminary evaluation are presented in Appendix A. Note that groundwater at the locations of the residences is shallow (roughly 4 to 5 feet below ground surface [bgs] as exhibited on Figure 2).

Indoor air estimates were developed for the wells located closest to the residences (MW-107, MW-108, and MW-109) and for well MW-110, which is located on the opposite side of Stratford Avenue about 60 feet from the residences. Based on the preliminary evaluation results:

- Risk associated with vapor intrusion from groundwater concentrations observed in MW-110 is below a 1-in-10,000 lifetime cancer risk.
- Risk associated with vapor intrusion from groundwater concentrations observed in wells located closest to the residences is below a 1-in-1,000,000 lifetime cancer risk.

It can be conservatively estimated that risk might exist for residents from vapor intrusion. It should be noted there is a high probability that no risk is posed to residents.

A vapor intrusion assessment will be performed at nearby residences to measure actual soil gas, groundwater and indoor air concentrations and determine risks associated with the contaminants. Soil gas samples from multiple residential properties, groundwater samples from several residences and indoor air samples from one residence will be collected and compared with conservative risk-based screening levels based on the residential exposure scenario .

Soil gas results will be compared to screening levels from the Missouri risk-based corrective action (MRBCA) technical guidance (MDNR 2006) for clayey soils. Based on soil data reported in project boring logs, clay is the predominant soil type at the site. The soil type will be confirmed during this field event. Indoor air results will be compared to USEPA Region 6 screening levels for indoor air, and groundwater samples will be compared to federal MCLs.

If the measured soil gas, indoor air and groundwater concentrations are below the screening levels during the first round of sampling and in soil gas samples from a second round of sampling, then the exposure pathway is considered broken and no risk exists from vapor intrusion at the adjacent residences. Should soil gas values or indoor air concentrations be greater than the screening levels in samples collected from around or within a residence, sub-slab sampling will be conducted during the 2008/2009 winter season for that residence.

This overall approach to assessing the vapor intrusion pathway is consistent with the Army's policy dated October 31, 2006. That policy recommends a phased approach in which multiple lines of evidence are used to evaluate potential vapor intrusion pathways.

1.5 Project Schedule

After receiving verbal approval of the vapor intrusion assessment work plan from the Missouri Department of Natural Resources (MDNR), soil gas sampling is scheduled to begin on March 17, 2008. The schedule for completion of the VI Assessment is as follows:

- VI field activities (Round 1) - March 17 through March 21
- Sample results from laboratory - April 4, 2008
- Teleconference with Army and regulators to discuss results – by April 10, 2008
- Complete data validation – April 18, 2008
- Submit technical memorandum summarizing results (Round 1) – May 2, 2008
- Conduct meeting with residents at 89th CCR Reserve Center – May 7, 2008
- VI field activities (Round 2 – if necessary)– January 9, 2009
- Sample results from laboratory – January 23, 2009
- Teleconference with Army and regulators - by February 6, 2009
- Complete data validation – February 11, 2009
- Submit technical memorandum (Round 2) – March 13, 2009

1.6 Reporting

The results of the vapor intrusion assessment will be presented to the USACE, 89th RRC, and regulators in the form of raw, unvalidated, data with a follow-up teleconference for discussion. There will be two deliverables for the VI sampling: (1) technical memorandum for Round 1 and (2) technical memorandum for Round 2(if necessary). Field documentation, photographs, summary tables of laboratory results, and laboratory analytical data sheets will be included as attachments to the technical memorandum. Additionally, after data are collected and validated, residents and home owners will be invited to a casual meeting where the results of the VI assessment (Round 1) and the path forward will be communicated.

Each technical memorandum will be submitted as a draft to allow comment from the regulators. A final technical memorandum will be submitted that incorporates comments provided.

SECTION 2

Field Activities

This section discusses the field tasks that will be performed for the vapor intrusion assessment at the properties adjacent to the site.

2.1 Project Organization and Responsibilities

This section identifies the principal members of the project team for the vapor intrusion assessment activities. Table 2-1 specifies the team members and their contact information.

TABLE 2-1
Contact Information
St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri

Name	Organization	Telephone/FAX	E-mail	Address
Josephine Newton-Lund Project Manager	NWK - USACE, KC District	P 816-389-3912 F 816-389-2008	Josephine.M.Newton-Lund@nwk02.usace.army.mil	USACE CENWK-PM-EP 601 East 12th Street Kansas City, MO 64106
William S. (Tex) Titterington Chief, Environmental Division	89th Regional Readiness Command, U.S. Army Reserve	P 316-618-1759 F 316-652-2324 C 316-612-0350	mwilliam.titterington@us.army.mil	HQ, 89th Regional Readiness Command Attn: AFRC-CKS-ENE 3130 George Washington Blvd. Wichita, KS 67210-1598
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TABLE 2-1
Contact Information
St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri

Name	Organization	Telephone/FAX	E-mail	Address
Glynn Roberts Field Team Leader Site Safety Health Officer	CH2M HILL	P 314-421-0900 F 314-421-3927 C 314-681-1752	glynn.robertst@ch2m.com	CH2M HILL 727 North First Street, Suite 400 St. Louis, MO 63102
Dave Lee Project Chemist	CH2M HILL	P 314-335-3023 F 414-454-8707	dave.lee@ch2m.com	CH2M HILL 727 North First Street, Suite 400 St. Louis, MO 63102
Ben Thompson Laboratory Project Manager	CH2M HILL Applied Services Laboratory	P 541-768-3132 F 541-752-0276	ben.thompson@ch2m.com	CH2M HILL 2300 North West Walnut Blvd. Corvallis, OR 97330

2.2 Scheduling Sampling Activities

Prior to beginning sampling activities, reasonable attempts will be made to contact each resident by phone or in person to inform them when field activities are scheduled to occur. As part of the scheduling process each resident contacted will also be asked questions regarding specifics about their home that may have an impact on vapor intrusion and assist in interpreting the results. A sample of the questionnaire/building survey that will be used is provided in Appendix B.

2.3 Sample Locations

The focus of this investigation will be three residences on Stratford Avenue (6325, 6321, and 6317) and two residences on Goodfellow Boulevard (4701 and 4707). USACE has received signed access agreements from each of these homes on behalf of the 89th RRC. As stated in Section 1.2, utility corridors have been identified and will be re-marked prior to initiating sample activities. This information will be utilized to assist in determining sample locations.

TABLE 2-2
Residences to be Sampled
St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri

Stratford Avenue	Goodfellow Boulevard
1. 6325 Stratford Avenue	4. 4701 Goodfellow Boulevard
2. 6321 Stratford Avenue	5. 4707 Goodfellow Boulevard
3. 6317 Stratford Avenue	

2.3.1 Soil Gas

Based upon the most conservative approach outlined in Appendix D of the Interstate Technology Regulatory Council (ITRC) guidance soil gas samples will be collected from each side of the five residences (approximately four samples per residence) for up to 19 samples (Figure 2). Samples will be collected near the midpoint of each side of the house from a location within 5 feet of the building's foundation, except in those instances where a utility corridor is identified coming into the side of a residence. In such cases, the sample location has been shifted and located as close as safely possible to identified utility corridors running into the home (Figure 3). The utility corridor will be off-set by approximately 3 to 5 feet from the center-line of the corridor. No soil gas samples will be collected from within the width of the utility corridor itself (2 feet either side of the center-line of the corridor). Due to the close proximity of 6317 and 6321 Stratford Avenue (within 15 feet, only one sample will be collected from between theses residences.

Soil gas samples will be collected to assess the potential for cVOCs in groundwater to migrate through soil and affect indoor air quality in the adjacent residences. Samples will be analyzed for the six cVOCs (PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, 1,2-DCA, and vinyl chloride) identified in site groundwater in accordance with USEPA Method TO-15.

2.3.2 Groundwater

One probe (pilot hole) at each property will be advanced for soil logging and groundwater depth determination, prior to advancement of soil gas sampling probes. Grab groundwater samples will be collected from three of these pilot holes. The holes will remain open until sufficient water accumulates to allow for the collection of a sample. This may require the installation of temporary 1-inch-diameter polyvinyl chloride (PVC) pipe and screen to facilitate sampling. After sampling, the pilot holes will be abandoned according to MDNR requirements.

Groundwater samples will be collected from the following three pilot holes: south of 6321 Stratford Avenue, south of 6317 Stratford Avenue, and south of 4701 Goodfellow Boulevard (refer to Figure 2). The samples will be analyzed for cVOCs identified in groundwater at the SLOP site. These cVOCs consist of PCE and its daughter products TCE, cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride; and 1,2-DCA, also known as ethylene dichloride.

2.3.3 Indoor Air

Three indoor air samples will be collected using Summa® canisters over a 24-hour period, two from the basement of 6317 Stratford Avenue and one from the back porch of 6317 Stratford Avenue as an ambient air sample. Each 24-hour air sample will be collected using a 6-liter Summa® canister using a flow controller set for 3.75 milliliters per minute (mL/min) this will allow the Summa® canister fill over a 24-hour period.

When 6317 Stratford Avenue is entered, reasonable efforts will be made to locate a sump in the basement of the home. If a sump is located in the basement, one of the two indoor 24-hour samples will be collected immediately adjacent to the sump location with the other sample collected at the opposite corner of the basement. In addition, one grab air sample with a 1-liter Summa® canister will be taken from the sump, if water is present. The

canisters will be supplied from and returned to the CH2M HILL Applied Services Laboratory (ASL) in Corvallis, Oregon, for analysis. CH2M HILL ASL is National Environmental Laboratory Accreditation Conference (NELAC) certified and Department of Defense Quality Systems Manual (QSM) compliant.

2.3.4 Sampling Summary

Sampling being conducted in the Spring of 2008 consists of the sample quantities by media summarized in Table 2-3.

Table 2-3
Sample Quantities
St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri

Matrix	Primary Samples	Field Duplicates (1 per 10 samples)	Matrix Spike (1 per 20 samples)	Matrix Spike Duplicate (1 per 20 samples)	Trip Blanks (1 per day of shipment)
Soil Gas	Up to 19	Up to 3	0	0	Up to 5
Indoor Air	3	1	0	0	1
Groundwater	3	1	1	1	1

A second or seasonal round of indoor air sampling and collection of outdoor soil gas samples from select vapor wells (installed as part of the upcoming remedial investigation) will be conducted in winter 2008/2009 (tentatively scheduled for December).

2.4 Site Restoration

Chain-link fencing surrounds the backyards at 6317 and 6325 Startford Avenue and 4701 Goodfellow Boulevard. To allow access for the drill rig and to conduct sampling activities, some fencing will need to be taken down. The access agreement obtained by the USACE on behalf of the 89th RRC will allow for the temporary removal and re-installment of fencing where applicable. Fencing will be repaired following sample collection at a residence.

Borings will be filled with bentonite from total depth to 6 inches below grade. The top 6 inches will be filled with native surface soil removed from the probe. The surface condition will be replaced to match surrounding surficial material (for example, grass, concrete, etc.).

2.5 Sampling Procedures

2.5.1 Soil Gas

A direct push drill rig will be used to advance up to 19 probes to a depth of no more than 1.5 feet below the basement foundation to collect soil gas samples.

The standard operating procedure (SOP) for installing shallow soil gas sampling probes is described in SOP 1 in Appendix C. This method will involve using a vacuum evacuated

stainless steel canister (referred to as a Summa® canister) at each sample location. Each canister will be connected to a flow controller set at 100 to 200 mL/min by the laboratory. Based on these flow rates, it should take approximately 5 to 10 minutes to fill the 1-liter Summa® canister (SOP 2 in Appendix C).

Prior to sample collection, a helium leak test will be conducted to ensure the integrity of the sample. If after the leak test and purging procedure described in SOP 2 sufficient flow (more than 100 mL/min) is not obtained for sample collection, the probe will be pulled up an additional several inches to create a larger annular space for soil gas sampling. Once purging is completed again, if the flow rate is still too low for sample collection, the probe location will be offset and attempted again. This will be attempted a maximum of two times. If a soil gas sample cannot be collected after three attempts (borings) at a particular proposed location, the soil vapor intrusion exposure pathway will be considered broken at that location due to the low permeability of the soil. If the flow rate is adequate, sampling will continue.

Up to 19 primary samples, not including field duplicates (one duplicate per 10 samples), and trip blanks (one blank per day of shipping) will be collected (Table 2-3).

The initial pressure and final pressures will be recorded in the field logbook and on the sample canister label. Trip blank canisters stay with the field team and are shipped with each delivery of samples to the laboratory. The purpose of the trip blanks is to monitor ambient field conditions in the event of a canister leak.

2.5.2 Groundwater

Groundwater samples will be collected using a Geoprobe® Screen Point® groundwater sampling device using a Geoprobe® direct push technology (DPT) rig. The Screen Point® groundwater sampling device will be advanced to the greatest depth interval to be sampled. The 4-foot stainless steel screen will then be exposed to the formation, and groundwater will be purged and sampled from the midpoint of the sampler screen using low-flow sampling techniques. Field observations were recorded in a project-dedicated field logbook.

A groundwater confirmation sample will be collected and analyzed for the sample analyte list detailed in Section 2.6. If the probe is purged dry, groundwater will be allowed to recover and a groundwater sample collected. If groundwater recovery takes more than 2 hours, the Geoprobe® Screen Point® will be removed, and 1-inch-diameter PVC well screen and riser will be temporarily installed to collect the groundwater samples. Following sample collection, the Screen Point® sampling device will be removed from the borehole. Clean polyethylene tubing will be used at each sample interval to minimize cross contamination.

The groundwater sampling device will be decontaminated between groundwater pilot boring locations using a non-phosphate detergent wash and potable water rinse. Following completion of sampling, the soil boring will be abandoned in accordance with Missouri regulations. Groundwater sampling SOP 3 is provided in Appendix C.

2.5.3 Indoor and Ambient Air

Each indoor and ambient air sample will be collected using a 6-liter Summa® canister using a flow controller set for 3.75 mL/min this will allow the Summa® canister fill over a 24-hour period.

The grab indoor air sample collected from the sump, if present, will be collected using a 1-liter Summa® canister with a flow controller set for 150 mL/min allowing the canister to fill over a 5-minute sample period. Indoor air sampling will follow the procedure described in SOP 4 (Appendix C). The canisters will be supplied from and returned to the CH2M HILL ASL in Corvallis, Oregon, for analysis.

2.6 Sample Analysis

Air samples will be analyzed by the CH2M HILL ASL in Corvallis, Oregon, via USEPA Method TO-15 (Appendix E). Scan mode will be utilized for the soil gas samples. Selective ion mode (SIM) will be used for the indoor air samples. Groundwater samples will be analyzed by PEL Laboratories in Tampa, Florida, utilizing USEPA Method SW8260B.

The following cVOCs will be analyzed for:

- PCE
- TCE
- cis-1,2-DCE
- trans-1,2-DCE
- 1,2-DCA
- Vinyl chloride

Turnaround time for the analysis is 10 days.

2.7 Sample Identification System

A sample numbering system will be used to uniquely identify each sample, including duplicates and blanks. Each analytical sample will be assigned a number as follows:

Sample Identification: SLOP-WWWW- XX-Y-ZZ

- Site name or identifier – SLOP.
- Sample identification number (ID) – House Address Number, WWWW.
- Sample matrix – XX (SG for soil gas, GW for groundwater , IA for indoor air and AA for ambient air).
- Sample location– Y (N, S, E, and W for direction of sample location, and G for grab sample at the sump).
- Sample depth – ZZ feet for soil gas and groundwater samples

- Quality control (QC) samples will receive: TB (trip blank); MS (matrix spike); SD (matrix spike duplicate); or FD (field duplicate) designation at the end of the sample identification.

An example of the sample ID for a soil gas sample collected in the front yard (south sample) of 6321 Stratford Avenue at a depth of 7 feet would be: SLOP-6321-S-07. A field duplicate at this locations would have the sample identification SLOP-6329-S-05-FD.

In addition to the sample ID, the label and chain-of-custody (COC) form will also contain the following information as applicable:

- Date and time of sample collection – MM/DD/YY - HHMM
- Sample matrix or matrix identifier – Soil gas, groundwater, indoor air
- Type of analyses to be conducted – TO-15, 8260B

The label, affixed to samples sent to the laboratory for analysis, and the COC form will be written in indelible ink.

2.8 Sample Packing, Shipping, and Custody

The field team lead (FTL) is responsible for the care and custody of samples until they are shipped or otherwise delivered to the laboratory custodian. Samples are considered to be under the field team's custody if the samples are in their possession, locked in a secure location to prevent tampering, or in a designated secure area.

The sampling activities are expected to be completed within 5 working days. Samples will be shipped on a daily basis to arrive at the laboratory the morning after sampling (priority overnight). The laboratory will be contacted prior to shipping on Friday for Saturday delivery to make sure that samples will be received and appropriately managed.

Samples will be packed in a rigid wall shipping container; a cooler for groundwater samples and heavy duty cardboard box for Summa® canisters containing air samples. Summa® canisters will not be packed with other objects or materials that could cause them to puncture.

Completed COC forms will be inserted into a waterproof cover and taped to the inside lid of each shipping container. The shipping container will be sealed with strapping tape for extra security during shipping. The custody seal will be placed over the openings of the shipping container.

The FTL will notify the laboratory of the field sampling activities and the subsequent transfer of samples to the laboratory. This notification will include information concerning the number and type of samples to be shipped and the expected date of arrival.

The laboratory custodian will verify that the custody seals on the sample shipment or the containers are intact and that the information on the COC form matches the actual contents. The vacuum of each canister will be checked upon receipt by the laboratory to ensure that vacuum was not lost in transport. The laboratory custodian also will note anomalies.

2.9 Field Documentation

The field team will document field activities in a bound field logbook with water-resistant and consecutively numbered pages. Entries will be logged with waterproof ink. The individual making the entry will date each page and will sign the page with the last entry at the end of each day. Corrections must be marked with a single line, dated, and initialed.

The field logbook should contain the following information.

- Date, time of specific activities, and physical location
- Weather conditions, including barometric pressure.
- Names, titles, and organization of personnel onsite; names and titles of visitors; and times of visits
- Health and safety briefing
- Field observations, including specific details on sampling activities; a description of instrument calibration and field tests and their results; and references to field forms used and type of document generated
- A detailed description of samples collected and duplicates or blanks that were prepared
- A list of sample ID numbers, packaging numbers, and COC record numbers pertinent to each sample
- Specific problems, including equipment malfunctions and their resolutions
- Detailed description of and rationale for deviations from the approved work plan

2.10 Field Instruments

Field instrumentation required for use during the vapor intrusion investigation consists of a photoionization detector (PID), low-flow groundwater sampling pump, and water level indicator. The PID will be calibrated at the beginning of each day using the method described by the manufacturer's instructions, and then checked periodically during the day and at the end of the measurement period. Instrument calibration activities will be documented in the field logbooks. If an instrument needs modification because of specific site or sample conditions, such modification will be documented in the field logbooks.

2.11 Health and Safety Plan

A health and safety plan (HASP) was prepared for this field effort and is attached as Appendix D. In general, work will be performed in Level D personal protective equipment (PPE), which includes safety glasses and safety-toed boots. Optional PPE includes the use of Tyvek® coveralls as necessary. Upgrades to higher PPE are discussed in the HASP. A site safety coordinator (SSC) will be onsite during hazardous waste operations and emergency response (HAZWOPER) regulated tasks.

2.12 Mobilization and Demobilization

Field mobilization and demobilization will be performed in accordance with the applicable SOPs described in Appendix C. Mobilization activities specific to this work plan include coordination with USACE and Army personnel for access agreements, coordination with subcontractors, and preparation of field equipment. Before fieldwork begins, personnel onsite must sign the HASP (Appendix D). Since work will be conducted within a high-crime area, all work will be conducted during daylight hours. At a minimum, two field personnel will be onsite at all times.

Demobilization activities will include restoring the site to normal conditions as close as possible, reviewing COC forms to ensure that the analytical samples were collected as planned and submitted for the appropriate analysis, packaging and shipment of rental equipment for return to the appropriate vendors, and the staging of field equipment within SLOP property behind a locked fence.

2.13 Utility Locate

CH2M HILL will conduct an additional utility locate to remark the lines by contacting the Missouri One-Call at least 2 days prior to beginning field activities. The phone number is 1-800-DIG-RITE (344-7483).

The color codes to be identified in the field are as follows:

Red	ELECTRIC
Yellow	GAS-OIL-STEAM
Orange	COMMUNICATION-CATV
Blue	WATER
Green	SEWER
Fluorescent Pink –	TEMPORARY SURVEY MARKINGS
White	PROPOSED EXCAVATION
Purple	RECLAIMED WATER

2.14 Decontamination

The probes used in collecting soil gas samples will be decontaminated with Alconox™ and deionized or distilled water. Decontamination water will be stored in Department of Transportation (DOT)-approved 55-gallon drums.

The groundwater sampling device will be decontaminated between groundwater pilot boring locations using a non-phosphate detergent wash and potable water rinse.

2.15 Investigation-Derived Waste Management

Soil and decontamination water will be collected during the installation of soil gas probes and collection of the groundwater samples. Soil and liquid will be segregated by media and

containerized in DOT-approved 55-gallon drums. The waste will be stored on the former Hanley Area of the SLOP site and characterized prior to disposal at an approved facility. If investigation-derived waste (IDW) is characterized as hazardous waste and is to be associated with the 89th RRC's USEPA waste generator identification number, all draft waste manifests will be submitted to the 89th RRC Environmental Department for review and approval prior to the waste being transported offsite.

2.16 Surveying

Sampling locations at the site will be horizontally located using a global positioning system (GPS) with submeter accuracy. The survey data will be tied into the Missouri State Plane coordinate system.

SECTION 3

Quality Assurance and Quality Control Plan

3.1 Quality Control Samples

Field QC samples (including trip blanks, duplicate samples and matrix spike pairs for groundwater) and laboratory QC samples (including method blanks and laboratory control samples) will be collected and analyzed to provide a measure of the internal consistency of the samples and to provide an estimate of the components of variance and the bias in the sampling and analytical processes. Trip blanks and duplicate samples will be packed and shipped with the primary samples. Descriptions of the QC samples proposed for this project are included below.

3.1.1 Method Blank

Method blanks are used to monitor each preparation or analytical batch for interference and/or contamination from glassware, reagents, and other potential contaminant sources within the laboratory. Method blanks for air samples will be prepared with ultra-high-purity (UHP) air or Grade 5 nitrogen in a certified canister every day that samples are to be analyzed. Method blanks for water samples will be prepared with laboratory reagent water. If a target analyte is found at a concentration that exceeds the reporting limit (RL), corrective action must be performed to identify and eliminate the contamination source. Associated samples must be reanalyzed, if appropriate, after the contamination source has been eliminated. No analytical data may be corrected for the concentration found in the blank.

3.1.2 Laboratory Control Sample

The laboratory control sample (LCS) for air samples will be prepared with Grade 5 nitrogen in a certified canister spiked with known amounts of target analytes. LCS for water samples will be prepared with laboratory reagent water spiked with known amounts of target analytes. The spike levels should be as specified in the method, or less than or equal to the midpoint of the calibration range. If LCS results are outside the specified control limits, corrective action must be taken, including sample reanalysis, if appropriate. If more than one LCS is analyzed in a preparation or analytical batch, the results of all the LCSs must be reported.

3.1.3 Matrix Spike/Matrix Spike Duplicate

A sample matrix fortified with known quantities of specific compounds is called a matrix spike. It is subjected to the same preparation and analytical procedures as the native sample. For this project, project-specific MS/MSDs will only be collected for method SW8260B and the target analytes specified in the work plan will be spiked into the sample. Matrix spike recoveries are used to evaluate the effect of the sample matrix on the recovery of the analytes of interest. An MSD is a second fortified sample matrix. A matrix duplicate may be used in place of an MSD for inorganic analyses. The RPD between the results of the duplicate matrix spikes measures the precision of sample results. Only project-specific

samples designated on the COC form will be spiked. The spike levels will be less than or equal to the midpoint of the calibration range. MS/MSD pairs will be analyzed at a frequency of one pair for every 20 samples. QC precision and accuracy criteria are those stated in Tables 3-1, 3-2, and 3-3.

3.1.4 Trip Blank

One trip blank will be collected per day of shipping. Trip blanks will be handled like other samples and analyzed in the same manner as the primary samples. The trip blank will be analyzed from similar containers as the primary samples. The trip blank will be given a sample number and will be listed on the COC form according to methods described in Section 2.5. At the laboratory, the trip blank sample will be retrieved in the same manner as the actual samples by adding nitrogen to create positive pressure in the canister and extracting the contents.

3.1.5 Field Duplicate

Field duplicates will be collected at a frequency of 1 per 10 field samples per matrix. The duplicate sample will be submitted for analysis as an independent sample and, therefore, duplicate samples will have a unique sample identification number and will be listed separately on the COC form according to methods described in Section 2.5.

3.2 Sample Containers, Volume, and Holding Times

gas samples will be collected into a 1-liter Summa® canister using a flow controller set at 100 to 200 mL/min. The canister should fill in approximately 5 to 10 minutes. The indoor air and ambient air samples designated for 6317 Stratford Avenue will be collected into 6-liter Summa® canisters using flow controllers set for 3.75 mL/min allowing the canister to fill in approximately 24 hours. The procedure specified in Method TO-15, *Compendium of Methods for Toxic Organic Air Pollutants* (USEPA 1999a), will be followed (Appendix E). Groundwater samples to be analyzed by SW8260B will be collected into three 40-mL vials pre-preserved with hydrochloric acid.

The analytical laboratory will provide the required Summa® canisters, including QC samples. Soil gas Summa® canisters will be batch certified by the laboratory as pre-cleaned before usage. Indoor air Summa® canisters will be individually certified. An identification tag, indicating the analysis to be performed (SCAN or SIM mode), sample number, station number, date and time of sample collection, and the name of the responsible sampling team member, will be attached to each sample container. Initial and final pressures also will be recorded either in the field logbook or on the identification tag. Labels will not be taped to the Summa® canisters. Air samples will be analyzed within 30 days of collection. Groundwater samples will be analyzed within 14 days of collection.

3.3 Laboratory Documentation and Data Reporting

When the samples arrive at the laboratory, they will be cross-referenced against the COC form. Mislabeling will be identified, investigated, and corrected prior to admitting the samples into the laboratory. As the samples are processed, they will be logged in at each

storage area and work station required by the designated analyses. The laboratory sample receiving SOP is provided as Attachment F.

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

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

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

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

Deviations from stated guidelines must be addressed through corrective action. Deviations caused by factors outside the laboratory's control, such as matrix interference, will be noted with an explanation in the report narrative. The laboratory will contact the project chemist to discuss deviations before the final data are sent out. Calculations will be checked and reports reviewed for errors, oversights, or omissions. The hard copy and electronic laboratory reports for the samples and analyses will contain the information necessary to perform data evaluation.

3.4 Laboratory Instruments

Laboratory instruments will be calibrated in accordance with manufacturers' directions and applicable method specifications. Laboratory instrument calibration, inspection, and

maintenance procedures will be summarized in the laboratory QA plan, which will be reviewed and approved by the laboratory QA officer before samples are submitted for analysis. Documentation of these activities will be made available during QA audits.

3.5 Analytical Method and Laboratory Requirements

It is expected that the analytical data will meet the contract-required detection limits; however, because of dilutions, matrix interference, or other factors, some laboratory quantitation limits may at times exceed the required reporting levels. The analytical laboratory will be required to notify the project chemist if elevated laboratory quantitation limits are being achieved and must make every attempt to minimize this problem.

Soil gas samples will be analyzed for volatile organics by TO-15 SCAN method. This method was chosen because the detection limits meet the screening levels listed in Table 1-1 and the lower detection limits provided by method TO-15 SIM were not required. Indoor and ambient air samples will be analyzed by TO-15 SIM in order to reach lower detection limits. The air laboratory's SOP is attached in Appendix E. Groundwater samples will be analyzed by USEPA Method SW8260B. The analytical laboratories are NELAC certified and Department of Defense QSM compliant. Certification will be provided upon request.

3.6 Reporting Limits

The target RLs, screening levels, and QC limits for the VOCs associated with the soil vapor , indoor air, and groundwater sampling are included in Tables 3-1, 3-2, 3-3, respectively.

3.7 Preventative Maintenance

Preventative maintenance of both field and laboratory equipment is essential to ensuring the quality of the data obtained during an investigation.

3.7.1 Field Equipment

The field personnel operating the field equipment and appropriate offsite laboratory chemists are responsible for the maintenance of their respective instruments. Preventive maintenance will be provided on a scheduled basis to minimize downtime and the potential interruption of analytical work. Instruments will be maintained in accordance with the manufacturer's recommendations and normal approved laboratory practice.

Scheduled periodic calibration of testing equipment does not relieve field personnel of the responsibility of using properly functioning equipment. If a project team member suspects an equipment malfunction, the device will be removed from service, tagged so that it is not inadvertently used, and the appropriate personnel notified so that a recalibration can be performed or a substitute piece of equipment can be obtained.

3.7.2 Laboratory Equipment

Designated laboratory personnel will be trained in routine maintenance procedures for all major instrumentation. When repairs become necessary, they will be made by either trained

staff or trained service engineers/technicians employed by the instrument manufacturer. The laboratory will have multiple instruments that will serve as backup to minimize the potential for downtime.

Preventive maintenance will be performed according to the procedures delineated in the manufacturer's instrument manuals, including lubrication, source cleaning, detector cleaning, and the frequency of such maintenance. Procedures should be listed in greater detail in the laboratory's QA plan.

Precision and accuracy data will be examined for trends and excursions beyond control limits to identify evidence of instrument malfunction. Maintenance will be performed when an instrument begins to degrade, as evidenced by the degradation of peak resolution, shift in calibration curves, decrease in sensitivity, or failure to meet one or more of the QC criteria. Instrument downtime will be minimized by keeping adequate supplies of all expendable items (that is, an expected lifetime of less than 1 year).

TABLE 3-1
Reporting Limits and Quality Control Limits for TO-15 SCAN-Soil Gas

Contaminant of Interest	CAS	MDL ($\mu g/m^3$)	RL ($\mu g/m^3$)	MRBCA Target Soil Vapor Concentrations for Residential Clayey Soils ($\mu g/m^3$)	RL > 3x MDL	RL < SL	Accuracy (%)	Precision (%)
1,2-Dichloroethane	107-06-2	0.77	4	103,000	Y	Y	70-130	30
cis-1,2-Dichloroethylene	156-59-2	0.71	4	3,100,000	Y	Y	70-130	30
Tetrachloroethylene	127-18-4	1.4	6.8	648,000	Y	Y	70-130	30
trans-1,2-Dichloroethylene	156-605	0.99	4	6,450,000	Y	Y	70-130	30
Trichloroethylene	79-01-6	1.2	5.4	1,770,000	Y	Y	70-130	30
Vinyl chloride	75-01-4	0.54	2.6	300,000	Y	Y	70-130	30

CAS – Chemical Abstract Society
MDL – method detection limit
RL – reporting limit
$\mu g/m^3$ – micrograms per cubic meter

TABLE 3-2
Reporting Limits and Quality Control Limits for TO-15 SIM-Indoor Air

Contaminant of Interest	CAS	MDL ($\mu g/m^3$)	RL ($\mu g/m^3$)	USEPA Region 6 ($\mu g/m^3$)	RL > 3x MDL	RL < SL	Accuracy (%)	Precision (%)
1,2-Dichloroethane	107-06-2	0.0015	0.0081	0.074	Y	Y	70-130	30
cis-1,2-Dichloroethylene	156-59-2	0.0022	0.0079	37	Y	Y	70-130	30
Tetrachloroethylene	127-18-4	0.0028	0.014	0.33	Y	Y	70-130	30
trans-1,2-Dichloroethylene	156-605	0.0015	0.0079	63	Y	Y	70-130	30
Trichloroethylene	79-01-6	0.003	0.011	0.017	Y	Y	70-130	30
Vinyl chloride	75-01-4	0.00054	0.0051	0.16	Y	Y	70-130	30

CAS – Chemical Abstract Society
MDL – method detection limit
RL – reporting limit
$\mu g/m^3$ – micrograms per cubic meter

TABLE 3-3
Reporting Limits for Method SW8260B-Water Samples

Analyte	CAS Number	MDL (µg/L)	RL (µg/L)	USEPA MCL (µg/L)	RL ≤ 3x MDL	RL ≤ SL	Accuracy (%)	Precision (%)
1,2-Dichloroethane	107-06-2	0.44	2	5	Y	Y	70-130	20
cis-1,2-Dichloroethene	156-59-2	0.34	2	70	Y	Y	70-130	20
Tetrachloroethene	127-18-4	0.57	2	5	Y	Y	70-130	20
trans-1,2-Dichloroethene	156-60-5	0.39	2	100	Y	Y	70-130	20
Trichloroethene	79-01-6	0.38	2	5	Y	Y	70-130	20
Vinyl chloride	75-01-4	0.46	2	2	Y	Y	70-130	20

µg/L – microgram per kilogram
CAS – Chemical Abstract Service
MDL – method detection limit
RL – reporting limit

Maintenance will be documented in permanent logs that will be available for review. Both scheduled and unscheduled maintenance required by operational failures will be recorded. The designated laboratory operations coordinator will review maintenance records regularly to ensure that required maintenance is occurring.

Instrument maintenance logbooks are maintained in laboratories. The logbooks, in general, contain a schedule of maintenance and a complete history of past routine and non-routine maintenance.

3.8 Data Management Tasks

Proper sample collection and documentation, and maintaining control of the records is essential for tracking and oversight of data.

3.8.1 Data Collection

This work plan will include collection of definitive data, which refers to the analytical data generated by the contracted offsite laboratory. These data will undergo an extensive QC system of data review and data validation.

3.8.2 Sample Documentation

Unique sample IDs will be assigned to samples to prevent sample ID duplication in the database. A record of the unique sample ID and the corresponding sample location, time, and date will be kept in the field notebook. The sampling team shall record field analytical data in bound field logbooks or on organized data sheets. Sample labels and COC forms will list the unique sample ID as well as the appropriate sample location, date, time, samplers, and other relevant information. The nomenclature for station and sample IDs is provided in Section 2.5.

Field team members will keep a daily record of significant events, observations, and measurements during sampling. Such information is to be recorded in real time as these events, observations, measurements, or activities occur. A bound field logbook with numbered pages will be initiated at the start of the first onsite activity and maintained to record onsite activities during sampling events. The field logbook will be supplemented by sampling COC forms and/or notes recorded onto site maps or maps of adjoining properties. Documents generated during the field effort are controlled documents that become part of the project file.

3.8.3 Records

The hard copy data will be presented in the Contract Laboratory Program (CLP) format or equivalent to facilitate the data review effort and to ensure that all QC information is presented. The data package will include raw data and other information necessary to recalculate analytical results. Hard copy data will be unbound for the purpose of data review and evaluation. Each sample delivery group will include a summary package containing the Form Is, case narratives, COC forms, and the tentatively identified compounds.

Deviations from the analytical method will shall be fully detailed in the case narrative, along with a description of corrective actions taken. The case narrative will address the following aspects of the analysis at a minimum:

- Holding times
- Initial and continuing calibration
- Blank samples
- Matrix spike/matrix spike duplicates (MS/MSDs)
- LCSs
- Surrogate recovery
- Internal standard results

The analytical laboratory will submit a Microsoft Excel file containing the EDD. The EDD will follow CH2M HILL's format, LabSpec7. Specific instructions regarding the file will be communicated to the laboratory in the laboratory contract and in the procurement statement of work (SOW).

Each project team member will provide the project manager with the project information. The project manager will provide project information to the project file room following project completion.

3.9 Assessment and Oversight

The purpose of the assessment and oversight process is to verify that the data quality is adequate for its intended use and to ensure the appropriate responses are in place to address nonconformances and deviations from the work plan.

3.9.1 Data Review Methods

Data review will be conducted to assess the effect of sampling and analytical processes on the data usability. There are two areas of review: laboratory proficiency testing, and the effect of matrix interference or sampling error. Evaluating laboratory performance determines whether or not the laboratory met the QC requirements for the analytical methods and other stated protocol requirements. The assessment of potential matrix effects and sampling error consists of evaluating the analytical results for the samples, as well as a number of QC measures such as blank samples, duplicates, MS/MSDs, surrogates, etc., and then assessing if this interference could affect the usability of the data.

CH2M HILL will review the analytical results of the data collection effort as part of the data quality assessment for this project. Personnel involved in the data validation function will be independent of data generation effort. The project chemist will oversee the data review effort. Data review will be carried out when the data packages are received from the laboratory. It will be performed on an analytical batch basis using the summary results of calibration and laboratory QC, as well as those of the associated field samples. Data validation procedures will include the following:

- Review of the data package for completeness
- Review of COC records for discrepancies that might degrade data quality

- Review for compliance with holding time and QC frequency requirements
- Evaluation of calibration and QC summary results against the project requirements
- Qualification of the data using appropriate qualifier flags, as necessary, to reflect data usability limitations
- Initiation of corrective actions, as necessary, based on the data review findings

Data validation will be patterned after the *USACE Kansas City Data Quality Evaluation Guidance* (USACE-KC 2006) and *Contract Laboratory National Functional Guidelines for Organic Data Review* (USEPA 1999b), substituting the calibration and QC requirements specified in this work plan for those specified in the guidelines (Appendix G). The flagging conventions in Tables 3-4 and 3-5 will be used. The qualifier flags are defined in Table 3-6.

Qualifier flags, if required, will be applied to the electronic sample results. If multiple flags are required for a result, the most severe flag will be applied to the electronic result. The hierarchy of flags from the most severe to the least severe will be as follows: R, UJ, U, J.

A validation report will be generated for each method and sample delivery group. A copy of the validation report will be submitted to project management, and a copy will be retained with the data package in the project file. Significant data quality problems will be brought to the project chemist's attention.

TABLE 3-4
Method Quality Objectives for Method TO-15

Quality Control Check	Frequency	Evaluation	Laboratory Corrective Action	Validation Flag	Samples Affected
Holding Time	Samples analyzed within 30 days of collection.	Holding time exceeded for analysis	Contact project chemist	J positive results; UJ nondetects	Sample
		Holding time exceeded by a factor of two	Contact project chemist	J positive results; R nondetects	
BFB tune (SCAN mode analysis only)	Every 24 hours prior to sample analysis	Per Method TO-15	Correct the problem and re-tune instrument	J positive results, UJ nondetects	All associated samples in analysis batch
Initial Calibration	Prior to sample analysis, or when calibration verification fails	Analyte >30 % RSD, or linear/non-linear regression with coefficient of correlation/determination<0.99	Correct the problem and repeat the initial calibration	J positive results, UJ nondetects	All associated samples in analysis batch
Calibration Verification	At the start of each analytical sequence, after every 24 hours	RRF %D <30%	Correct the problem, then recalibrate and reanalyze all samples since the last acceptable continuing calibration verification	J positive results, UJ nondetects	All associated samples in analysis batch
		RRF %D >30%	Correct the problem, then recalibrate and reanalyze all samples since the last acceptable continuing calibration verification	J positive results	
Method Blank	At least one per analytical batch	No analytes detected at or above the RL	Correct the problem, and reanalyze the blank and all samples in the analytical batch; flag data	U positive sample results < 5 times highest blank concentration	All samples in analysis batch
Laboratory Control Sample	At least one per analytical batch	Analyte recoveries < LCL or > UCL	Correct the problem, and reanalyze the LCS and all samples (if appropriate) in the analytical batch; flag data	See Appendix F	All samples in analysis batch
Surrogates	Every QC and field sample	Analyte recoveries < LCL or > UCL	Correct the problem and reanalyze; flag results	See Appendix F	Sample results

TABLE 3-4
Method Quality Objectives for Method TO-15

Quality Control Check	Frequency	Evaluation	Laboratory Corrective Action	Validation Flag	Samples Affected
Internal Standards	Every QC and field sample	Recovery < LCL but not <10%	Correct the problem, and reanalyze the LCS and all samples in the analytical batch; flag data	J positive results, UJ nondetects	Sample results
		Recovery > UCL		J positive results	
		Recovery <10%		J positive results, R nondetects	
Field duplicate	Every 10 samples	Concentration ≥5 times the RL in either sample and RPD > UCL	NA	J positive results	Associated primary sample
		Concentration in both samples < 5 times the RL and absolute difference between the two concentrations greater than 2 times the RL		J positive result; UJ nondetect	
Lab duplicate	Every 20 samples	Concentration ≥5 times the RL in either sample and RPD > UCL	Correct the problem and reanalyze (if appropriate); flag results	J positive results	Associated primary sample
		Concentration in both samples < 5 times the RL and absolute difference between the two concentrations greater than 2 times the RL		J positive result; UJ nondetect	

LCL = lower control limit
RL = reporting limit
RPD = relative percent difference
RSD = relative standard deviation
UCL = upper control limit

TABLE 3-5

Method Quality Objectives for Method 8260

Quality Control Element	Description of Element	Frequency of Implementation	Acceptance Criteria	Corrective Action	Flagging Criteria for Validator
BFB tuning	Ion abundance relative to m/z 95 base peak.	Every 12 hours	Method criteria	Correct problem and rerun.	No flagging criteria – MUST RETUNE before analysis of samples. Reject data.
Initial calibration	Minimum five-point curve.		SPCC: minimum RF values per method requirements. CCCs: verify RSD ≤ 30% And analytes: r ≥ 0.99, RSD ≤ 15%. r2 ≥ 0.99, mean RSD ≤ 15% with a maximum RSD ≤ 20%, for up to 5% for a noncontaminant of concern).	Correct problem and rerun.	Qualify with R when less than five std. were used. When RSD exceeds 15% or correlation is less than 0.99 -J/R. Manual integration is NOT acceptable for initial calibrations, except for the low level calibration concentrations (1st and 2nd point of the calibration curve).
Initial calibration verification	Mid-level (2nd source) verification.	After initial calibration	75–125%	Correct problem and repeat.	For results greater than the 125%, apply J to positives. For a result < 75% and > 60%, apply J to positives and UJ to nondetects. For recovery < 60%, apply J to positives and R to nondetects.
Continuing calibration verification	Mid-level verification.	At the beginning of every 12 hours	Instrument Evaluation: SPCC: minimum RF values per method requirements CCC: verify %D ≤ 20%.	Correct the problem, reanalyze CCV, if problem continues repeat initial calibration.	If %D > 20% for each target analyte with a negative bias -J/R. or for each target analyte with a positive bias -J positives only.

TABLE 3-5

Method Quality Objectives for Method 8260

Quality Control Element	Description of Element	Frequency of Implementation	Acceptance Criteria	Corrective Action	Flagging Criteria for Validator
Internal standards	Analytically spiked nontarget compounds used to calculate the concentration of target compounds present.	Every sample	Retention time ≤ 30 seconds from retention time of the mid-point std. in the CCC for the sequence. EICP area within –50% to +100% of the CCC mid-point std.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.	See Appendix F
Method blank	Reagent blank to assess method contamination.	1 per sample batch	No analytes > ½ reporting limit.	Contact project chemist for approval to report data that do not conform to acceptance criteria.	See Appendix F
Laboratory control sample	Interference-free matrix containing all target analytes.	1 per sample batch	70-130%	Correct problem and repeat.	See Appendix F
Matrix spike and matrix spike duplicate	Sample matrix spiked with alltarget analytes prior to analysis.	1 pair per sample batch	Accuracy = 70-130%; Precision = 20%	Verify that there is not a laboratory error. Inform project chemist of recovery outliers.	See Appendix F
Surrogates		Per sample	See Appendix F.	Rerun samples when < LL unless project chemist approves no reanalysis.	See Appendix F

EICP = extraction ion current profile
RF = response factor
SPCC = system performance check compound

TABLE 3-6
Qualifier Flag Definitions

Flag	Definition
R	This result has been rejected.
UJ	The analyte was not detected above the detection limit; however, the reported detection limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
J	Analyte was present but reported value may not be accurate or precise.
U	This analyte was analyzed for but not detected at the specified detection limit.

3.9.2 Usability Assessment

Following the completion of the data validation and verification, the usability of the data will be assessed to evaluate if data meet the project quality objectives for the decision being made.

3.9.3 Data Quality Indicators

Data are evaluated for precision and accuracy against the analytical protocol requirements. Nonconformance or deficiencies that could affect the precision or accuracy of the reported result are identified and noted. The effect on the result is then considered when assessing whether the result is of sufficient quality to achieve data objectives.

Precision

Precision is a measure of the agreement or reproducibility of a set of replicate results obtained from duplicate analyses made under identical conditions. Precision is estimated from analytical data and cannot be measured directly. The precision of a duplicate determination can be expressed as the relative percent difference (RPD), as calculated as

$$RPD = \{(|X_1 - X_2|)/(X_1 + X_2)/2\} \times 100$$

where X_1 is the result from the native sample, and X_2 is the result from the duplicate sample.

Accuracy

Accuracy is a measure of the agreement between an experimental determination and the true value of the parameter being measured. Accuracy is estimated through the use of known reference materials or matrix spikes. It is calculated from analytical data and is not measured directly. Spiking of reference materials into a sample matrix is the preferred technique because it provides a measure of the matrix effects on analytical accuracy. Accuracy, defined as percent recovery (%R), is calculated as

$$\%R = \left[\frac{(SSR - SR)}{SA}\right] x\,100$$

where SSR is the spiked sample result, SR the sample result (native), and SA the spike concentration added to the spiked sample.

Completeness

The completeness of the field and laboratory-generated analytical data will be assessed for compliance with the amount of data required for decision making. The calculation for determining completeness is:

$$\% \text{ Completeness} = \frac{\text{Valid Data Obtained}}{\text{Total Data Obtained}} \times 100$$

The completeness goal for the project data is 90 percent. Because all data have some value, some of the data rejected in the data validation process, or questionable field screening data, may be used on the project.

Representativeness

Representativeness describes the extent of which a sampling design reflects the environmental conditions at the site. It considers the size of the site represented by a single sample and the reasonableness of the rationale for sample collection. It also takes into account the ability for the sampling team to collect samples and the ability of the laboratory to appropriately analyze the samples. Sample homogeneity and sampling variability should be considered when developing criteria for representativeness. The use of statistical sampling design and standardized SOPs for sample collection and analysis help to ensure that samples are representative of site conditions.

Comparability

Comparability is the degree to which different methods or data agree or are similar. Split samples or blind samples may be distributed to more than one analytical laboratory to assess comparability of subcontracted lab protocols. Additionally, field screening data may undergo laboratory analysis for correlation and comparability of field collection activities.

Sensitivity and Quantitation Limits

Sensitivity is the ability of the method or instrument to detect the analytes of concern at specified concentrations of interest. Contract-required quantitation limits are the minimum concentrations that the analytes may be identified.

3.9.4 Reconciliation with Data Objectives

The final data evaluation task is to assess whether the data meet the project data objectives. The final validated analytical results, which may have been modified during the data validation process and an assessment will be made as to whether or not the data are of sufficient quality to support the objectives. If the data are sufficient to achieve project objectives, the project manager will release the data and work may proceed; if not, corrective action will be required.

3.9.5 Corrective Action

Corrective action is required for analytical or equipment problems, and for noncompliance problems. Analytical and equipment problems are those that occur during sampling, sample handling, sample preparation, laboratory instrumental analysis, and data review. If an analytical or equipment problem is identified, the problem will be promptly communicated

to the project manager, FTL, and project chemist. Implementation of corrective action will be confirmed in writing through the same channels.

For either field or laboratory noncompliance problems, a formal corrective action program will be determined and implemented at the time the problem is identified. The person who identifies the problem will notify the project manager, project chemist, or FTL and will begin the documentation of the corrective action.

Sample Collection and Field Measurements

Technical staff and project personnel will be responsible for reporting suspected technical nonconformances or deficiencies of an activity or document by reporting the situation to the FTL, project manager, or project chemist. The project manager will be responsible for assessing the suspected problems in consultation with the project chemist and for making a decision based upon the potential for the situation to affect the quality of the data.

Field corrective actions will be implemented and documented in the field logbook. No staff member will initiate a corrective action without prior communication of findings through the proper channels. Corrective action for field measurements may include the following:

- Repeating the measurement to check the error
- Checking for proper adjustments for ambient conditions such as temperature
- Checking the batteries
- Checking the calibration
- Recalibrating
- Replacing the instrument or measurement devices
- Stopping work (only if necessary)

The project manager is responsible for site activities and may revise the site activities to accommodate site-specific needs. The FTL is responsible for controlling, tracking, and implementing the identified changes.

Laboratory Analyses

Laboratory corrective actions will be required whenever an out-of-control event is noted or foreseen. The corrective action taken will be dependent on the analysis and the event. Some examples of situations that may require corrective action include the following:

- QC data are outside the control limit ranges for precision and accuracy established for laboratory samples
- Blanks contain target analytes above acceptable levels
- Deficiencies are detected by the laboratory QA director during internal or external audits, or from the results of proficiency testing samples
- Undesirable trends are detected in QC data
- There are unusual changes in detection limits
- Inquiries concerning data quality are received

Corrective action procedures are often handled at the bench level by the analyst who performed the analysis. The analyst will review the preparation or extraction procedure for possible errors and check instrument calibration, standards, instrument sensitivity, etc., to investigate the problem. If the problem cannot be solved, the analyst will immediately notify the laboratory supervisor, manager, or QA department for further investigation.

Laboratory QC problems that will affect the final data will be discussed with the contractor project chemist as part of the corrective action process. Once resolved, full documentation of the corrective action will be filed with the laboratory's QA department and included in the case narrative of the analytical report. Some examples of laboratory corrective actions include the following:

- Reanalyzing suspect samples
- Recalibrating with new standards
- Eliminating blank contamination
- Resampling and analyzing new samples
- Evaluating and amending sub-sampling or analytical procedures
- Qualifying or rejecting the data

Following the implementation of the required corrective action measures, data that are deemed unacceptable may not be accepted by the project manager, and follow-up corrective actions may be explored. Details of laboratory corrective actions are provided in the laboratory's QA plan.

3.9.6 Reports to Management

Status reports to the management team will, at a minimum, discuss current activities, problems encountered and their resolution, and planned work. The analytical laboratory will provide sample acknowledgment letters and sample status updates by phone or e-mail. These requirements will be specified in each laboratory statement of work.

SECTION 4

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Figures

N

0 300 600 Feet

LEGEND

Site Boundary

FIGURE 1
SITE LOCATION MAP
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

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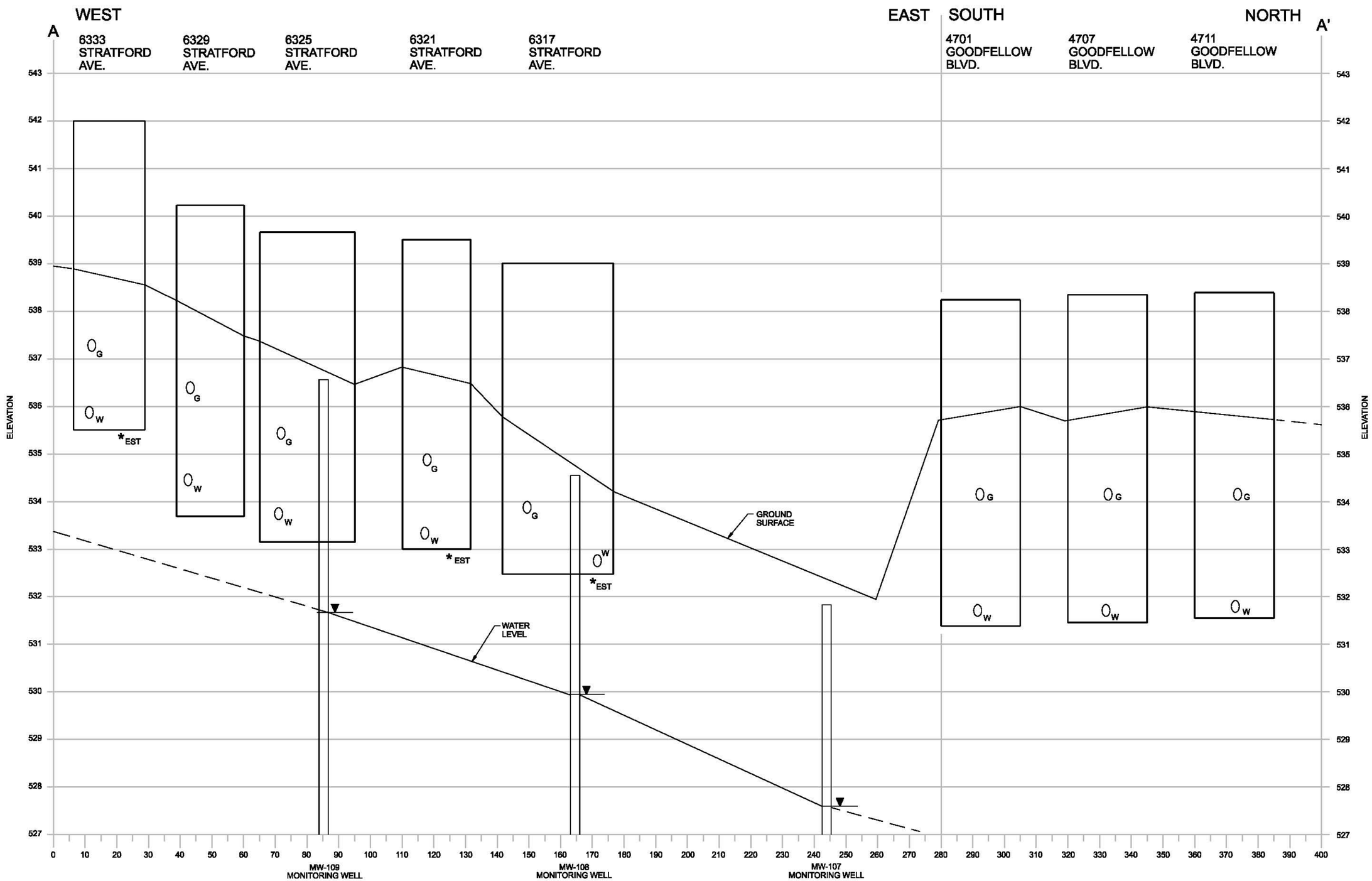

LEGEND:
G = GAS LINE
W = WATER LINE
*EST = NOT MEASURED, ESTIMATED VALUE

FIGURE 2
CROSS SECTION OF RESIDENCES
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

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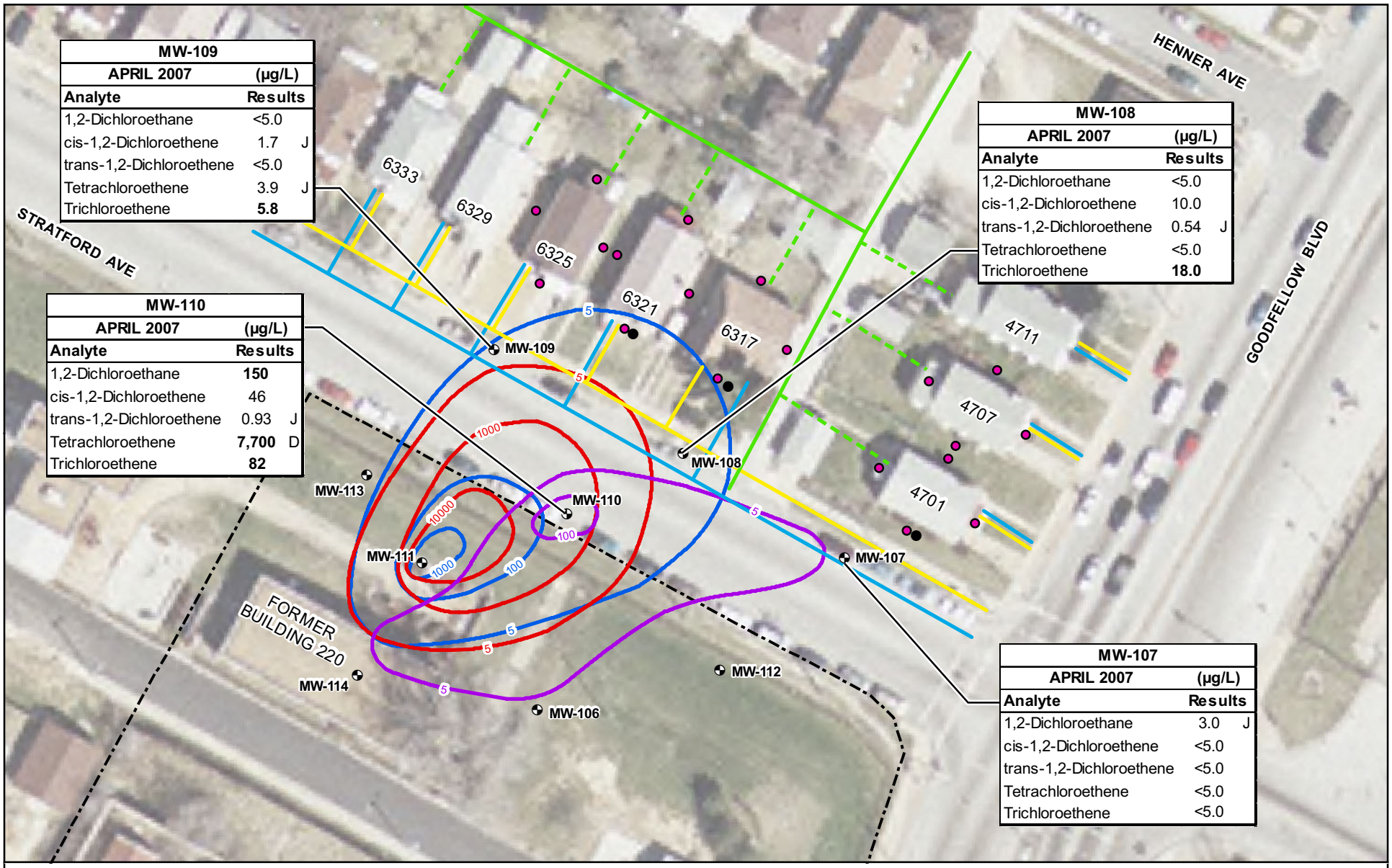

LEGEND

- Proposed Groundwater Sample Point
- Proposed Soil Gas Boring
- Monitoring Well
- Site Boundary
- DCA Plume (µg/L)
- PCE Plume (µg/L)
- TCE Plume (µg/L)

Approximate Utilities

- Natural Gas
- Sanitary Sewer
- Sewer Location Unknown
- Water

N

0 30 60 Feet

FIGURE 3
LOCATION OF UTILITIES AND PROPOSED SAMPLING POINTS
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

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Appendix A
Preliminary Evaluation of Indoor Air Calculations

Table 2
Concentrations in Groundwater Based on Equilibrium Partitioning from Soil

Attachment 1

$$C_w = \frac{C_s \; p_s}{\left[qw + k_s p_s + Hq_a\right]}$$

Universal Gas Constant	R =	0.000082	atm-m^3/mole-k
Temperature	TEMP =	298	K
Fraction organic carbon	foc =	0.002	
Bulk density	Ps	1.38	g/cm3
Soil moisture	M	0.216	
Total porosity	QT =	0.48	
Air-filled porosity	QA	0.18	
Water-filled porosity	QW	0.29808	

Chemical Constituent	Concentration in Soil (mg/kg)	Concentration in Soil (g/g)	Henry's Law (atm-m^3/mole-K)	Koc (mL/g)	Henry's Law (dimensionless)	Kd	Concentration in Pore Water (g/cm3)	Concentration in Pore Water (mg/L)	Concentration in Pore Water (ug/L)
1,2-Dichloroethane (EDC)	0.0071	7.1E-09	0.001200	14.0	0.049108	0.028	2.83E-08	2.83E-02	28.3
1,2-Dichloroethylene (trans)	0.043	0.000000043	0.006600	59.0	0.270093	0.118	1.16E-07	1.16E-01	116.3
1,2-Dichloroethylene (cis)	0.0068	6.8E-09	0.006600	59.0	0.270093	0.118	1.84E-08	1.84E-02	18.4
Tetrachloroethylene (PCE)	0.92	0.00000092	0.023000	660.0	0.941234	1.32	5.54E-07	5.54E-01	554.0
Trichloroethylene (TCE)	0.18	0.00000018	0.008920	130.0	0.365035	0.26	3.43E-07	3.43E-01	343.3

Note: soil parameters consistent with a silty clay

	ATTACHMENT A				
PHYSICAL-CHEMICAL CONSTANTS USED IN CALCULATING SOIL PRGs FOR VOLATILE ORGANIC CHEMICALS					
	Henry's Law	Water Solubility	Koc	Diffusivity in	MW
	(atm-m^3/mol)	(mg/l)	(ml/g)	Air (cm^2/s)	(g/mol)
Acetone	0.000021	1000000	2.2	0.100	58
Acrylonitrile	0.000088	79000	0.9	0.110	53
Ammonia	0.000320	530000	3.1	0.260	17
Benzene	0.005500	1800	65.0	0.088	78
Benzyl chloride	0.000051	3300	50.0	0.067	130
Bis(2-chloroethyl)ether	0.000290	10000	14.0	0.070	140
Bis(2-chloroisopropyl)ether	0.000110	1700	61.0	0.063	170
Bis(chloromethyl)ether	0.000200	22000	1.2	0.089	120
Bromodichloromethane	0.001600	4700	100.0	0.080	160
Bromoethene (Surrogate = Bromomethane)	0.006200	18000	130.0	0.100	108
Bromomethane	0.006200	18000	130.0	0.100	95
1,3-Butadiene	0.180000	740	120.0	0.098	54
Carbon disulfide	0.012000	2900	54.0	0.110	76
Carbon tetrachloride	0.024000	760	110.0	0.080	150
Chlorine dioxide					
Chloroacetaldehyde					
2-Chloroacetophenone (Surrogate = Chlorobenzene)	0.003500	470	160.0	0.072	150
Chlorobenzene	0.003500	470	160.0	0.072	110
2-Chloro-1,3-butadiene	0.032000	660	50.0	0.110	88
1-Chlorobutane (Surrogate = 2-Chloro-1,3-butadiene)	0.032000	660	50.0	0.110	93
Chlorodifluoromethane (Surrogate = Dichlorodifluoromethane)	0.100000	280	58.0	0.080	120
1-Chloroethyl vinyl ether					
Chloroform	0.003800	8200	31.0	0.089	120
Chloromethane	0.024000	8200	35.0	0.110	51
2-Chloropropane	0.002300	2700	51.0	0.080	79
o-Chlorotoluene	0.003500	470	160.0	0.072	127
Crotonaldehyde (Surrogate = Methyl methacrylate)	0.240000	20	840.0	0.091	70
Cumene (Surrogate = Ethylbenzene)	0.006400	150	220.0	0.075	120
1,2-Dibromoethane	0.000320	3400	28.0	0.073	190
1,2-Dichlorobenzene	0.001900	100	1100.0	0.130	150
1,3-Dichlorobenzene	0.001900	120	1200.0	0.130	150
1,4-Dichlorobenzene	0.001600	79	1200.0	0.130	150
1,4-Dichloro-2-butene (Surrogate = 2-Chloro-1,3-butadiene)	0.032000	660	50.0	0.110	122
Dichlorodifluoromethane	0.100000	280	58.0	0.080	120
1,1-Dichloroethane	0.004300	5500	30.0	0.091	99
1,2-Dichloroethane (EDC)	0.001200	8700	14.0	0.091	99
1,1-Dichloroethylene	0.150000	400	65.0	0.079	97
1,2-Dichloroethylene (trans)	0.006600	6300	59.0	0.079	97
1,2-Dichloroethylene (cis)	0.006600	6300	59.0	0.079	97
1,2-Dichloropropane	0.003600	2700	51.0	0.080	110
1,3-Dichloropropane	0.001300	2800	48.0	0.080	110
1,3-Dichloropropene	0.001300	2800	48.0	0.081	110
Dicyclopentadiene					
Dimethylamine	0.000090	1000000	2.2	0.120	45
1,4-Dioxane	0.000011	430000	3.5	0.085	88
Epichlorohydrin	0.000032	60000	3.5	0.088	93
Ethyl acrylate (Surrogate = Methyl methacrylate)	0.240000	20	840.0	0.091	100
Ethylbenzene	0.007900	680	220.0	0.075	110
Ethylene oxide	0.000076	1000000	2.2	0.130	44
Ethyl chloride	0.011000	5700	15.0	0.100	65
Ethyl ether	0.000013	10000	14.0	0.070	74
Ethyl methacrylate (Surrogate = Methyl methacrylate)	0.240000	20	840.0	0.091	120
Hydrogen sulfide					
Methacrylonitrile (Surrogate = Acrylonitrile)	0.000088	79000	0.9	0.110	93
Methyl acetate (Surrogate = Acetone)	0.000021	1000000	2.2	0.100	74
Methyl acrylate (Surrogate = Methyl methacrylate)	0.240000	20	840.0	0.091	100
Methylene chloride	0.002600	13200	8.8	0.100	85
Methyl ethyl ketone	0.000027	270000	4.5	0.090	72
Methyl styrene (mixture) (Surrogate = Styrene)	0.002300	300	360.0	0.071	119
Methyl styrene (alpha) (Surrogate = Styrene)	0.002300	300	360.0	0.071	119
Nitrogen dioxide					
2-Nitropropane					
Polynuclear aromatic hydrocarbons					
Acenaphthene	0.001200	4	4600.0	0.064	150
Anthracene	0.000034	0	13000.0	0.058	180
Fluorene	0.000064	2	7900.0	0.061	170
Naphthalene	0.001300	31	1300.0	0.069	130
Phenanthrene	0.000040	1	14000.0	0.058	180
Propylene oxide					58
Styrene	0.002300	300	360.0	0.071	100
1,1,1,2-Tetrachloroethane	0.000380	2900	54.0	0.073	170
1,1,2,2-Tetrachloroethane	0.000500	2900	220.0	0.073	170
Tetrachloroethylene (PCE)	0.023000	150	660.0	0.072	170
Tetrahydrofuran	0.000110			0.089	72
Toluene	0.006600	520	260.0	0.078	92
1,2,4-Trichlorobenzene	0.002300	30	9200.0	0.062	180

1,1,1-Trichloroethane	0.002800	950	150.0	0.080	130
1,1,2-Trichloroethane	0.001200	4500	56.0	0.080	130
Trichloroethylene (TCE)	0.008920	1000	130.0	0.081	130
Trichlorofluoromethane	0.097000	1100	160.0	0.087	137
1,1,2-Trichloropropane (Surrogate = 1,2-Dichloropropane)	0.003600	2700	51.0	0.080	147
1,2,3-Trichloropropane (Surrogate = 1,2-Dichloropropane)	0.003600	2700	51.0	0.080	147
1,2,3-Trichloropropene (Surrogate = 1,3-Dichloropropene)	0.001300	2800	48.0	0.081	146
1,1,2-Trichloro-1,2,2-trifluoroethane (S = Trichlorofluoromethan	0.058000	1100	160.0	0.087	186
Triethylamine (Surrogate = Dimethylamine)	0.000090	1000000	2.2	0.120	86
Vinyl chloride	0.700000	1100	57.0	0.110	63
m-Xylene	0.006900	200	240.0	0.087	110
o-Xylene	0.004900	200	240.0	0.087	110
p-Xylene	0.007000	200	240.0	0.087	110
Xylene (mixed)	0.005300	200	240.0	0.087	110

Table 1
Groundwater Data Summary
Former St. Louis Ordnance Plant

Monitoring Well	Depth to Water Table (ft)	Depth to Top of Screen (ft)	Concentrations (ug/L)					
			PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC	1,2-DCA
MW-107	3.5	12	ND	ND	ND	ND	ND	3
MW-108	2.2	10	ND	18	10	0.54	ND	ND
MW-109	3.5	10	3.9	5.8	1.7	ND	ND	ND
MW-110	1.2	10	7700	82	46	0.93	ND	150

Note:
For vapor intrusion calculation purposes, not detected (ND) values are assumed to be present at 0.5 ug/L

Table 2
Groundwater Vapor Intrusion Summary
Former St. Louis Ordnance Plant

Monitoring	Depth to Water Table (ft)	Depth to Top of Screen (ft)	Modeled Concentration in Soil Gas (ug/m^3)						Modeled Concentration in Indoor Air (ug/m^3)					
			PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC	1,2-DCA	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC	1,2-DCA
MW-107	3.5	12	0.02	0.02	0.03	0.03	0.02	0.10	0.002	0.002	0.003	0.003	0.002	0.010
MW-108	2.2	10	0.06	0.46	0.34	0.02	0.01	0.01	0.006	0.046	0.034	0.002	0.001	0.001
MW-109	3.5	10	0.16	0.23	0.09	0.03	0.02	0.02	0.016	0.023	0.009	0.003	0.002	0.002
MW-110	1.2	10	149.08	1.61	1.20	0.03	0.01	2.43	14.908	0.161	0.120	0.003	0.001	0.243
								EPA Region 6 MSSL	0.33	0.017	37	73	0.22	0.074

Assumptions:
ND values were assumed to be present at 0.5 ug/L
Soil gas concentrations modeled assuming one dimensional steady-state transport in groundwater and equilibrium partitioning with Henry's Law
Modeled concentrations in indoor air calculated using an attenuation factor of 0.1
EPA Region 6 MSSLs are based on a 1 in 1,000,000 cancer risk or a noncancer hazard quotient of one.

Table 3
Steady-State Diffusion Modeling in Groundwater for Estimation of Soil Gas Concentrations

Steady-State Diffusion Modeling in Groundwater for Estimation of Soil Gas Concentrations:

This is a calculation of the maximum soil gas concentration that may be derived from a specified groundwater concentration. This calculation uses the steady-state analytical solution provided by Barber et al., 1990. It is based on a concentration in groundwater located at a depth below the soil gas-water interface. It is based on Fick's Law of diffusion and uses equilibrium Henry's Law partitioning at the soil gas-water interface.

Sources: Barber et al., 1990; Rivett, 1995; CSIRO, 2004

$$C_{gi} = C_{go} + \left(\frac{L_g \times D_w \times C_o}{X_w \times D_g} \right)$$

For Henry's Law values greater than 0.01

Description	Symbol	Units	Comments
Gas-phase concentration immediately adjacent to the air-water interface	Cgi	ug/cm^3	
Gas-phase concentration near the ground surface	Cgo	ug/cm^3	May be assumed to be zero, if this cannot be estimated
Depth of the unsaturated zone	Lg	cm	
Groundwater concentration at depth below water table	Co	ug/cm3	
Depth below water table	Xw		
Liquid-phase diffusion coefficient	Dw	cm^2/s	
Gas-phase diffusion coefficient	Dg	cm^2/s	

Chemical	Co (ug/L)	Cgo (ug/m^3)	Dg (cm^2/s)	Dw (cm2/s)	Lg (cm)	Xw (cm)	Co (ug/cm^3)	Cgo (ug/cm3)	Cgi (ug/cm^3)	Cgi (ug/m^3)	Comparison with Equilibrium Partitioning (water to air)	Henry's Law Constant	Cgi-EQ (ug/cm^3)	Cgi-EQ (ug/m^3)
MW-107														
Tetrachloroethylene	0.5	0	0.072	0.0000082	106.68	304.8	0.0005	0	1.99E-08	1.99E-02		0.75250285	0.00037625	3.76E+02
Trichloroethylene	0.5	0	0.079	0.0000091	106.68	304.8	0.0005	0	2.02E-08	2.02E-02		0.42123801	0.00021062	2.11E+02
cis-1,2-dichloroethylene	0.5	0	0.0736	0.0000113	106.68	304.8	0.0005	0	2.69E-08	2.69E-02		0.16685933	8.343E-05	8.34E+01
trans-1,2-dichloroethylene	0.5	0	0.0707	0.0000119	106.68	304.8	0.0005	0	2.95E-08	2.95E-02		0.38361287	0.00019181	1.92E+02
Vinyl chloride (chloroethene)	0.5	0	0.106	0.0000123	106.68	304.8	0.0005	0	2.03E-08	2.03E-02		1.10421614	0.00055211	5.52E+02
1,2-Dichloroethane	3	0	0.104	0.0000099	106.68	304.8	0.003	0	1E-07	1.00E-01		0.04003806	0.00012011	1.20E+02
MW-108														
Tetrachloroethylene	2.5	0	0.072	0.0000082	67.056	304.8	0.0025	0	6.26E-08	6.26E-02		0.75250285	0.00188126	1.88E+03
Trichloroethylene	18	0	0.079	0.0000091	67.056	304.8	0.018	0	4.56E-07	4.56E-01		0.42123801	0.00758228	7.58E+03
cis-1,2-dichloroethylene	10	0	0.0736	0.0000113	67.056	304.8	0.01	0	3.38E-07	3.38E-01		0.16685933	0.00166859	1.67E+03
trans-1,2-dichloroethylene	0.54	0	0.0707	0.0000119	67.056	304.8	0.00054	0	2E-08	2.00E-02		0.38361287	0.00020715	2.07E+02
Vinyl chloride (chloroethene)	0.5	0	0.106	0.0000123	67.056	304.8	0.0005	0	1.28E-08	1.28E-02		1.10421614	0.00055211	5.52E+02
1,2-Dichloroethane	0.5	0	0.104	0.0000099	67.056	304.8	0.0005	0	1.05E-08	1.05E-02		0.04003806	2.0019E-05	2.00E+01
MW-109														
Tetrachloroethylene	3.9	0	0.072	0.0000082	106.68	304.8	0.0039	0	1.55E-07	1.55E-01		0.75250285	0.00293476	2.93E+03
Trichloroethylene	5.8	0	0.079	0.0000091	106.68	304.8	0.0058	0	2.34E-07	2.34E-01		0.42123801	0.00244318	2.44E+03
cis-1,2-dichloroethylene	1.7	0	0.0736	0.0000113	106.68	304.8	0.0017	0	9.14E-08	9.14E-02		0.16685933	0.00028366	2.84E+02
trans-1,2-dichloroethylene	0.5	0	0.0707	0.0000119	106.68	304.8	0.0005	0	2.95E-08	2.95E-02		0.38361287	0.00019181	1.92E+02
Vinyl chloride (chloroethene)	0.5	0	0.106	0.0000123	106.68	304.8	0.0005	0	2.03E-08	2.03E-02		1.10421614	0.00055211	5.52E+02
1,2-Dichloroethane	0.5	0	0.104	0.0000099	106.68	304.8	0.0005	0	1.67E-08	1.67E-02		0.04003806	2.0019E-05	2.00E+01
MW-110														
Tetrachloroethylene	7700	0	0.072	0.0000082	51.816	304.8	7.7	0	0.000149	1.49E+02		0.75250285	5.79427197	5.79E+06
Trichloroethylene	82	0	0.079	0.0000091	51.816	304.8	0.082	0	1.61E-06	1.61E+00		0.42123801	0.03454152	3.45E+04
cis-1,2-dichloroethylene	46	0	0.0736	0.0000113	51.816	304.8	0.046	0	1.2E-06	1.20E+00		0.16685933	0.00767553	7.68E+03
trans-1,2-dichloroethylene	0.93	0	0.0707	0.0000119	51.816	304.8	0.00093	0	2.66E-08	2.66E-02		0.38361287	0.00035676	3.57E+02
Vinyl chloride (chloroethene)	0.5	0	0.106	0.0000123	51.816	304.8	0.0005	0	9.86E-09	9.86E-03		1.10421614	0.00055211	5.52E+02
1,2-Dichloroethane	150	0	0.104	0.0000099	51.816	304.8	0.15	0	2.43E-06	2.43E+00		0.04003806	0.00600571	6.01E+03

Chemical Properties Lookup Table

Chemical	CAS No.	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant H' (unitless)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)
Carbon tetrachloride	56235	7.80E-02	8.80E-06	1.24E+00	3.03E-02	25
Chlordane	57749	1.18E-02	4.37E-06	1.99E-03	4.85E-05	25
gamma-HCH (Lindane)	58899	1.42E-02	7.34E-06	5.73E-04	1.40E-05	25
Ethyl ether	60297	7.82E-02	8.61E-06	1.35E+00	3.29E-02	25
Dieldrin	60571	1.25E-02	4.74E-06	6.18E-04	1.51E-05	25
Acetone	67641	1.24E-01	1.14E-05	1.59E-03	3.87E-05	25
Chloroform	67663	1.04E-01	1.00E-05	1.50E-01	3.66E-03	25
Hexachloroethane	67721	2.50E-03	6.80E-06	1.59E-01	3.88E-03	25
Benzene	71432	8.80E-02	9.80E-06	2.27E-01	5.54E-03	25
1,1,1-Trichloroethane	71556	7.80E-02	8.80E-06	7.03E-01	1.72E-02	25
Methoxychlor	72435	1.56E-02	4.46E-06	6.46E-04	1.58E-05	25
DDE	72559	1.44E-02	5.87E-06	8.59E-04	2.09E-05	25
Methyl bromide	74839	7.28E-02	1.21E-05	2.55E-01	6.22E-03	25
Methyl chloride (chloromethane)	74873	1.26E-01	6.50E-06	3.61E-01	8.80E-03	25
Hydrogen cyanide	74908	1.93E-01	2.10E-05	5.44E-03	1.33E-04	25
Methylene bromide	74953	4.30E-02	8.44E-06	3.52E-02	8.59E-04	25
Chloroethane (ethyl chloride)	75003	2.71E-01	1.15E-05	3.61E-01	8.80E-03	25
Vinyl chloride (chloroethene)	75014	1.06E-01	1.23E-05	1.10E+00	2.69E-02	25
Acetonitrile	75058	1.28E-01	1.66E-05	1.42E-03	3.45E-05	25
Acetaldehyde	75070	1.24E-01	1.41E-05	3.23E-03	7.87E-05	25
Methylene chloride	75092	1.01E-01	1.17E-05	8.96E-02	2.18E-03	25
Carbon disulfide	75150	1.04E-01	1.00E-05	1.24E+00	3.02E-02	25
Ethylene oxide	75218	1.04E-01	1.45E-05	2.27E-02	5.54E-04	25
Bromoform	75252	1.49E-02	1.03E-05	2.41E-02	5.88E-04	25
Bromodichloromethane	75274	2.98E-02	1.06E-05	6.54E-02	1.60E-03	25
2-Chloropropane	75296	8.88E-02	1.01E-05	5.93E-01	1.45E-02	25
1,1-Dichloroethane	75343	7.42E-02	1.05E-05	2.30E-01	5.61E-03	25
1,1-Dichloroethylene	75354	9.00E-02	1.04E-05	1.07E+00	2.60E-02	25
Chlorodifluoromethane	75456	1.01E-01	1.28E-05	1.10E+00	2.70E-02	25
Trichlorofluoromethane	75694	8.70E-02	9.70E-06	3.97E+00	9.68E-02	25
Dichlorodifluoromethane	75718	6.65E-02	9.92E-06	1.40E+01	3.42E-01	25
1,1,2-Trichloro-1,2,2-trifluoroethar	76131	7.80E-02	8.20E-06	1.97E+01	4.80E-01	25
Heptachlor	76448	1.12E-02	5.69E-06	6.05E+01	1.48E+00	25
Hexachlorocyclopentadiene	77474	1.61E-02	7.21E-06	1.10E+00	2.69E-02	25
Isobutanol	78831	8.60E-02	9.30E-06	4.83E-04	1.18E-05	25
1,2-Dichloropropane	78875	7.82E-02	8.73E-06	1.15E-01	2.79E-03	25
Methylethylketone (2-butanone)	78933	8.08E-02	9.80E-06	2.29E-03	5.58E-05	25
1,1,2-Trichloroethane	79005	7.80E-02	8.80E-06	3.73E-02	9.11E-04	25
Trichloroethylene	79016	7.90E-02	9.10E-06	4.21E-01	1.03E-02	25
Methyl acetate	79209	1.04E-01	1.00E-05	4.84E-03	1.18E-04	25
1,1,2,2-Tetrachloroethane	79345	7.10E-02	7.90E-06	1.41E-02	3.44E-04	25
2-Nitropropane	79469	9.23E-02	1.01E-05	5.03E-03	1.23E-04	25
Methylmethacrylate	80626	7.70E-02	8.60E-06	1.38E-02	3.36E-04	25
Acenaphthene	83329	4.21E-02	7.69E-06	6.34E-03	1.55E-04	25
Fluorene	86737	3.63E-02	7.88E-06	2.60E-03	6.34E-05	25
Hexachloro-1,3-butadiene	87683	5.61E-02	6.16E-06	3.33E-01	8.13E-03	25
o-Nitrotoluene	88722	5.87E-02	8.67E-06	5.11E-04	1.25E-05	25
Naphthalene	91203	5.90E-02	7.50E-06	1.98E-02	4.82E-04	25
2-Methylnaphthalene	91576	5.22E-02	7.75E-06	2.12E-02	5.17E-04	25
Biphenyl	92524	4.04E-02	8.15E-06	1.23E-02	2.99E-04	25
o-Xylene	95476	8.70E-02	1.00E-05	2.12E-01	5.18E-03	25
1,2-Dichlorobenzene	95501	6.90E-02	7.90E-06	7.77E-02	1.90E-03	25
2-Chlorophenol	95578	5.01E-02	9.46E-06	1.60E-02	3.90E-04	25
1,2,4-Trimethylbenzene	95636	6.06E-02	7.92E-06	2.52E-01	6.14E-03	25
1,2,3-Trichloropropane	96184	7.10E-02	7.90E-06	1.67E-02	4.08E-04	25
Methyl acrylate	96333	9.76E-02	1.02E-05	7.68E-03	1.87E-04	25
Ethylmethacrylate	97632	6.53E-02	8.37E-06	3.44E-02	8.40E-04	25
tert-Butylbenzene	98066	5.65E-02	8.02E-06	4.87E-01	1.19E-02	25
Cumene	98828	6.50E-02	7.10E-06	4.74E+01	1.46E-02	25
Acetophenone	98862	6.00E-02	8.73E-06	4.38E-04	1.07E-05	25
Nitrobenzene	98953	7.60E-02	8.60E-06	9.82E-04	2.39E-05	25
Ethylbenzene	100414	7.50E-02	7.80E-06	3.22E-01	7.86E-03	25
Styrene	100425	7.10E-02	8.00E-06	1.12E-01	2.74E-03	25
Benzylchloride	100447	7.50E-02	7.80E-06	1.70E-02	4.14E-04	25
Benzaldehyde	100527	7.21E-02	9.07E-06	9.73E-04	2.37E-05	25
n-Propylbenzene	103651	6.01E-02	7.83E-06	4.37E-01	1.07E-02	25
n-Butylbenzene	104518	5.70E-02	8.12E-06	5.38E-01	1.31E-02	25
p-Xylene	106423	7.69E-02	8.44E-06	3.13E-01	7.64E-03	25
1,4-Dichlorobenzene	106467	6.90E-02	7.90E-06	9.82E-02	2.39E-03	25
1,2-Dibromoethane (ethylene dibr	106934	2.17E-02	1.19E-05	3.04E-02	7.41E-04	25
1,3-Butadiene	106990	2.49E-01	1.08E-05	3.01E+00	7.34E-02	25
Acrolein	107028	1.05E-01	1.22E-05	4.99E-03	1.22E-04	25
1,2-Dichloroethane	107062	1.04E-01	9.90E-06	4.00E-02	9.77E-04	25
Acrylonitrile	107131	1.22E-01	1.34E-05	4.21E-03	1.03E-04	25
Vinyl acetate	108054	8.50E-02	9.20E-06	2.09E-02	5.10E-04	25
Methylisobutylketone (4-methyl-2-	108101	7.50E-02	7.80E-06	5.64E-03	1.38E-04	25
m-Xylene	108383	7.00E-02	7.80E-06	3.00E-01	7.32E-03	25
1,3,5-Trimethylbenzene	108678	6.02E-02	8.67E-06	2.41E-01	5.87E-03	25
Methylcyclohexane	108872	7.35E-02	8.52E-06	4.22E+00	1.03E-01	25
Toluene	108883	8.70E-02	8.60E-06	2.72E-01	6.62E-03	25
Chlorobenzene	108907	7.30E-02	8.70E-06	1.51E-01	3.69E-03	25
1-Chlorobutane	109693	8.26E-02	1.00E-05	6.93E-01	1.69E-02	25
Furan	110009	1.04E-01	1.22E-05	2.21E-01	5.39E-03	25
Hexane	110543	2.00E-01	7.77E-06	6.82E+01	1.66E+00	25
Bis(2-chloroethyl)ether	111444	6.92E-02	7.53E-06	7.36E-04	1.80E-05	25

Endosulfan	115297	1.15E-02	4.55E-06	4.58E-04	1.12E-05	25
Hexachlorobenzene	118741	5.42E-02	5.91E-06	5.40E-02	1.32E-03	25
1,2,4-Trichlorobenzene	120821	3.00E-02	8.23E-06	5.81E-02	1.42E-03	25
Crotonaldehyde (2-butenal)	123739	9.56E-02	1.07E-05	7.99E-04	1.95E-05	25
Chlorodibromomethane	124481	1.96E-02	1.05E-05	3.20E-02	7.81E-04	25
Methacrylonitrile	126987	1.12E-01	1.32E-05	1.01E-02	2.46E-04	25
2-Chloro-1,3-butadiene (chloropre	126998	8.58E-02	1.03E-05	4.91E-01	1.20E-02	25
Tetrachloroethylene	127184	7.20E-02	8.20E-06	7.53E-01	1.84E-02	25
Pyrene	129000	2.72E-02	7.24E-06	4.50E-04	1.10E-05	25
Dibenzofuran	132649	2.38E-02	6.00E-06	5.15E-04	1.26E-05	25
sec-Butylbenzene	135988	5.70E-02	8.12E-06	5.68E-01	1.39E-02	25
Ethylacetate	141786	7.32E-02	9.70E-06	5.64E-03	1.38E-04	25
cis-1,2-Dichloroethylene	156592	7.36E-02	1.13E-05	1.67E-01	4.07E-03	25
trans-1,2-Dichloroethylene	156605	7.07E-02	1.19E-05	3.84E-01	9.36E-03	25
Benzo(b)fluoranthene	205992	2.26E-02	5.56E-06	4.54E-03	1.11E-04	25
Chrysene	218019	2.48E-02	6.21E-06	3.87E-03	9.44E-05	25
Aldrin	309002	1.32E-02	4.86E-06	6.95E-03	1.70E-04	25
alpha-HCH (alpha-BHC)	319846	1.42E-02	7.34E-06	4.34E-04	1.06E-05	25
1,3-Dichlorobenzene	541731	6.92E-02	7.86E-06	1.27E-01	3.09E-03	25
1,3-Dichloropropene	542756	6.26E-02	1.00E-05	7.24E-01	1.77E-02	25
1,1,1,2-Tetrachloroethane	630206	7.10E-02	7.90E-06	9.90E-02	2.41E-03	25
MTBE	1634044	1.02E-01	1.05E-05	2.56E-02	6.23E-04	25
Mercury (elemental)	7439976	3.07E-02	6.30E-06	4.40E-01	1.07E-02	25

Table 3
Vapor Intrusion Summary Based on Soil Sampling Data
Former St. Louis Ordnance Plant

Monitoring	Depth to Water Table (ft)	Depth to Top of Screen (ft)	Modeled Concentration in Soil Gas (ug/m^3)					Modeled Concentration in Indoor Air (ug/m^3)				
			PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	1,2-DCA	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	1,2-DCA
SB-031	3.5	5	44.17	27.68	1.98	13.70	1.89	4.417	2.768	0.198	1.370	0.189
								0.33	0.017	37	73	0.074
									0.96			

Assumptions:
Soil gas concentrations modeled assuming one dimensional steady-state transport in groundwater and equilibrium partitioning with Henry's Law
Modeled concentrations in indoor air calculated using an attenuation factor of 0.1
EPA Region 6 MSSLs are based on a 1 in 1,000,000 cancer risk or a noncancer hazard quotient of one.
EPA Region 9 PRG also presented for TCE - this value is based on Cal-EPA toxicity values and is consistent with DOD policy on TCE

Chemical Properties Lookup Table

Chemical	CAS No.	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant H' (unitless)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)
Carbon tetrachloride	56235	7.80E-02	8.80E-06	1.24E+00	3.03E-02	25
Chlordane	57749	1.18E-02	4.37E-06	1.99E-03	4.85E-05	25
gamma-HCH (Lindane)	58899	1.42E-02	7.34E-06	5.73E-04	1.40E-05	25
Ethyl ether	60297	7.82E-02	8.61E-06	1.35E+00	3.29E-02	25
Dieldrin	60571	1.25E-02	4.74E-06	6.18E-04	1.51E-05	25
Acetone	67641	1.24E-01	1.14E-05	1.59E-03	3.87E-05	25
Chloroform	67663	1.04E-01	1.00E-05	1.50E-01	3.66E-03	25
Hexachloroethane	67721	2.50E-03	6.80E-06	1.59E-01	3.88E-03	25
Benzene	71432	8.80E-02	9.80E-06	2.27E-01	5.54E-03	25
1,1,1-Trichloroethane	71556	7.80E-02	8.80E-06	7.03E-01	1.72E-02	25
Methoxychlor	72435	1.56E-02	4.46E-06	6.46E-04	1.58E-05	25
DDE	72559	1.44E-02	5.87E-06	8.59E-04	2.09E-05	25
Methyl bromide	74839	7.28E-02	1.21E-05	2.55E-01	6.22E-03	25
Methyl chloride (chloromethane)	74873	1.26E-01	6.50E-06	3.61E-01	8.80E-03	25
Hydrogen cyanide	74908	1.93E-01	2.10E-05	5.44E-03	1.33E-04	25
Methylene bromide	74953	4.30E-02	8.44E-06	3.52E-02	8.59E-04	25
Chloroethane (ethyl chloride)	75003	2.71E-01	1.15E-05	3.61E-01	8.80E-03	25
Vinyl chloride (chloroethene)	75014	1.06E-01	1.23E-05	1.10E+00	2.69E-02	25
Acetonitrile	75058	1.28E-01	1.66E-05	1.42E-03	3.45E-05	25
Acetaldehyde	75070	1.24E-01	1.41E-05	3.23E-03	7.87E-05	25
Methylene chloride	75092	1.01E-01	1.17E-05	8.96E-02	2.18E-03	25
Carbon disulfide	75150	1.04E-01	1.00E-05	1.24E+00	3.02E-02	25
Ethylene oxide	75218	1.04E-01	1.45E-05	2.27E-02	5.54E-04	25
Bromoform	75252	1.49E-02	1.03E-05	2.41E-02	5.88E-04	25
Bromodichloromethane	75274	2.98E-02	1.06E-05	6.54E-02	1.60E-03	25
2-Chloropropane	75296	8.88E-02	1.01E-05	5.93E-01	1.45E-02	25
1,1-Dichloroethane	75343	7.42E-02	1.05E-05	2.30E-01	5.61E-03	25
1,1-Dichloroethylene	75354	9.00E-02	1.04E-05	1.07E+00	2.60E-02	25
Chlorodifluoromethane	75456	1.01E-01	1.28E-05	1.10E+00	2.70E-02	25
Trichlorofluoromethane	75694	8.70E-02	9.70E-06	3.97E+00	9.68E-02	25
Dichlorodifluoromethane	75718	6.65E-02	9.92E-06	1.40E+01	3.42E-01	25
1,1,2-Trichloro-1,2,2-trifluoroethar	76131	7.80E-02	8.20E-06	1.97E+01	4.80E-01	25
Heptachlor	76448	1.12E-02	5.69E-06	6.05E+01	1.48E+00	25
Hexachlorocyclopentadiene	77474	1.61E-02	7.21E-06	1.10E+00	2.69E-02	25
Isobutanol	78831	8.60E-02	9.30E-06	4.83E-04	1.18E-05	25
1,2-Dichloropropane	78875	7.82E-02	8.73E-06	1.15E-01	2.79E-03	25
Methylethylketone (2-butanone)	78933	8.08E-02	9.80E-06	2.29E-03	5.58E-05	25
1,1,2-Trichloroethane	79005	7.80E-02	8.80E-06	3.73E-02	9.11E-04	25
Trichloroethylene	79016	7.90E-02	9.10E-06	4.21E-01	1.03E-02	25
Methyl acetate	79209	1.04E-01	1.00E-05	4.84E-03	1.18E-04	25
1,1,2,2-Tetrachloroethane	79345	7.10E-02	7.90E-06	1.41E-02	3.44E-04	25
2-Nitropropane	79469	9.23E-02	1.01E-05	5.03E-03	1.23E-04	25
Methylmethacrylate	80626	7.70E-02	8.60E-06	1.38E-02	3.36E-04	25
Acenaphthene	83329	4.21E-02	7.69E-06	6.34E-03	1.55E-04	25
Fluorene	86737	3.63E-02	7.88E-06	2.60E-03	6.34E-05	25
Hexachloro-1,3-butadiene	87683	5.61E-02	6.16E-06	3.33E-01	8.13E-03	25
o-Nitrotoluene	88722	5.87E-02	8.67E-06	5.11E-04	1.25E-05	25
Naphthalene	91203	5.90E-02	7.50E-06	1.98E-02	4.82E-04	25
2-Methylnaphthalene	91576	5.22E-02	7.75E-06	2.12E-02	5.17E-04	25
Biphenyl	92524	4.04E-02	8.15E-06	1.23E-02	2.99E-04	25
o-Xylene	95476	8.70E-02	1.00E-05	2.12E-01	5.18E-03	25
1,2-Dichlorobenzene	95501	6.90E-02	7.90E-06	7.77E-02	1.90E-03	25
2-Chlorophenol	95578	5.01E-02	9.46E-06	1.60E-02	3.90E-04	25
1,2,4-Trimethylbenzene	95636	6.06E-02	7.92E-06	2.52E-01	6.14E-03	25
1,2,3-Trichloropropane	96184	7.10E-02	7.90E-06	1.67E-02	4.08E-04	25
Methyl acrylate	96333	9.76E-02	1.02E-05	7.68E-03	1.87E-04	25
Ethylmethacrylate	97632	6.53E-02	8.37E-06	3.44E-02	8.40E-04	25
tert-Butylbenzene	98066	5.65E-02	8.02E-06	4.87E-01	1.19E-02	25
Cumene	98828	6.50E-02	7.10E-06	4.74E+01	1.46E-02	25
Acetophenone	98862	6.00E-02	8.73E-06	4.38E-04	1.07E-05	25
Nitrobenzene	98953	7.60E-02	8.60E-06	9.82E-04	2.39E-05	25
Ethylbenzene	100414	7.50E-02	7.80E-06	3.22E-01	7.86E-03	25
Styrene	100425	7.10E-02	8.00E-06	1.12E-01	2.74E-03	25
Benzylchloride	100447	7.50E-02	7.80E-06	1.70E-02	4.14E-04	25
Benzaldehyde	100527	7.21E-02	9.07E-06	9.73E-04	2.37E-05	25
n-Propylbenzene	103651	6.01E-02	7.83E-06	4.37E-01	1.07E-02	25
n-Butylbenzene	104518	5.70E-02	8.12E-06	5.38E-01	1.31E-02	25
p-Xylene	106423	7.69E-02	8.44E-06	3.13E-01	7.64E-03	25
1,4-Dichlorobenzene	106467	6.90E-02	7.90E-06	9.82E-02	2.39E-03	25
1,2-Dibromoethane (ethylene dibr	106934	2.17E-02	1.19E-05	3.04E-02	7.41E-04	25
1,3-Butadiene	106990	2.49E-01	1.08E-05	3.01E+00	7.34E-02	25
Acrolein	107028	1.05E-01	1.22E-05	4.99E-03	1.22E-04	25
1,2-Dichloroethane	107062	1.04E-01	9.90E-06	4.00E-02	9.77E-04	25
Acrylonitrile	107131	1.22E-01	1.34E-05	4.21E-03	1.03E-04	25
Vinyl acetate	108054	8.50E-02	9.20E-06	2.09E-02	5.10E-04	25
Methylisobutylketone (4-methyl-2-	108101	7.50E-02	7.80E-06	5.64E-03	1.38E-04	25
m-Xylene	108383	7.00E-02	7.80E-06	3.00E-01	7.32E-03	25
1,3,5-Trimethylbenzene	108678	6.02E-02	8.67E-06	2.41E-01	5.87E-03	25
Methylcyclohexane	108872	7.35E-02	8.52E-06	4.22E+00	1.03E-01	25
Toluene	108883	8.70E-02	8.60E-06	2.72E-01	6.62E-03	25
Chlorobenzene	108907	7.30E-02	8.70E-06	1.51E-01	3.69E-03	25
1-Chlorobutane	109693	8.26E-02	1.00E-05	6.93E-01	1.69E-02	25
Furan	110009	1.04E-01	1.22E-05	2.21E-01	5.39E-03	25
Hexane	110543	2.00E-01	7.77E-06	6.82E+01	1.66E+00	25
Bis(2-chloroethyl)ether	111444	6.92E-02	7.53E-06	7.36E-04	1.80E-05	25

Endosulfan	115297	1.15E-02	4.55E-06	4.58E-04	1.12E-05	25
Hexachlorobenzene	118741	5.42E-02	5.91E-06	5.40E-02	1.32E-03	25
1,2,4-Trichlorobenzene	120821	3.00E-02	8.23E-06	5.81E-02	1.42E-03	25
Crotonaldehyde (2-butenal)	123739	9.56E-02	1.07E-05	7.99E-04	1.95E-05	25
Chlorodibromomethane	124481	1.96E-02	1.05E-05	3.20E-02	7.81E-04	25
Methacrylonitrile	126987	1.12E-01	1.32E-05	1.01E-02	2.46E-04	25
2-Chloro-1,3-butadiene (chloropre	126998	8.58E-02	1.03E-05	4.91E-01	1.20E-02	25
Tetrachloroethylene	127184	7.20E-02	8.20E-06	7.53E-01	1.84E-02	25
Pyrene	129000	2.72E-02	7.24E-06	4.50E-04	1.10E-05	25
Dibenzofuran	132649	2.38E-02	6.00E-06	5.15E-04	1.26E-05	25
sec-Butylbenzene	135988	5.70E-02	8.12E-06	5.68E-01	1.39E-02	25
Ethylacetate	141786	7.32E-02	9.70E-06	5.64E-03	1.38E-04	25
cis-1,2-Dichloroethylene	156592	7.36E-02	1.13E-05	1.67E-01	4.07E-03	25
trans-1,2-Dichloroethylene	156605	7.07E-02	1.19E-05	3.84E-01	9.36E-03	25
Benzo(b)fluoranthene	205992	2.26E-02	5.56E-06	4.54E-03	1.11E-04	25
Chrysene	218019	2.48E-02	6.21E-06	3.87E-03	9.44E-05	25
Aldrin	309002	1.32E-02	4.86E-06	6.95E-03	1.70E-04	25
alpha-HCH (alpha-BHC)	319846	1.42E-02	7.34E-06	4.34E-04	1.06E-05	25
1,3-Dichlorobenzene	541731	6.92E-02	7.86E-06	1.27E-01	3.09E-03	25
1,3-Dichloropropene	542756	6.26E-02	1.00E-05	7.24E-01	1.77E-02	25
1,1,1,2-Tetrachloroethane	630206	7.10E-02	7.90E-06	9.90E-02	2.41E-03	25
MTBE	1634044	1.02E-01	1.05E-05	2.56E-02	6.23E-04	25
Mercury (elemental)	7439976	3.07E-02	6.30E-06	4.40E-01	1.07E-02	25

Appendix B

Questionnaire/Building Survey

Building Survey - Indoor Air

Project Information

Project Name: _____ Project # : _____

Survey Completed By: _____ Date: _____

Building Address: _____ Residence ID: _____

Resident and Contact Information

Name of Occupant: _____ Owner / Tenant / Other: _____

Occupant Phone #s: Home: _____ Work: _____ Cell: _____

Duration at Current Residence: _____ Best Time To Call / Visit: _____

Number of Building Occupants: Children (list ages): _____ Adults: _____

(If Rental) Property Owner Name: _____ *Owner Phone #s: Home:* _____

Owner Address: _____ *Work:* _____

Name of Interviewee for Building Survey: _____ Notes: _____

Building Construction Characteristics

Building Type: (Check box for all that apply)

- ☐ Single Family Residential
- ☐ Multi Family Residential
- ☐ Commercial
- ☐ Ranch
- ☐ Two-story
- ☐ Other (specify): _____
- ☐ Split Level
- ☐ Tri Level
- ☐ Duplex (# of other half of duplex): _____
- ☐ Apartment (# of units in Building): _____

Describe Building: (General Description, Construction Materials, etc.) _____

Approximate Age: _____ years **Approximate Area:** Total Living Space: _____ sq.ft. First Floor: _____ sq.ft.

Floors: # Floors at or above grade: _____

Which floors of the residence are utilized as living space / occupied? _____

Foundation Type: Foundation Description: (Split Foundation or Multiple Types)

Crawl Space: Yes / No _____

Slab on Grade: Yes / No _____

Basement: Yes / No Slab & Crawl Space Construction: _____

Basement or Crawl Space Details: (if applicable)

Finished Basement: Yes / No Basement Finished When: _____ Approximate Area: _____ sq.ft.

Basement or Crawl Space Floor: (Check box for all that apply)

- ☐ Concrete
- ☐ Dirt
- ☐ Floating
- ☐ Other (specify): _____

Foundation Walls: (Check box for all that apply)

- ☐ Poured Concrete
- ☐ Block
- ☐ Stone
- ☐ Other (specify): _____

Does the basement or crawl space have a moisture problem - dampness? (Check only one)

- ☐ Yes, frequently (3 or more times/year)
- ☐ Yes, occasionally (1-2 times/year)
- ☐ Yes, rarely (less than 1 time/year)
- ☐ No

Is the basement or crawl space ever wet - flooded? (Check only one)

- ☐ Yes, frequently (3 or more times/year)
- ☐ Yes, occasionally (1-2 times/year)
- ☐ Yes, rarely (less than 1 time/year)
- ☐ No

Building Address: ..... Date: .....

Basement or Crawl Space Details Continued: (if applicable)

Does the basement have any of the following? (Check all that apply)

☐ Floor cracks ☐ Wall cracks ☐ Floor Drain ☐ Sump pump

☐ Other hole / opening in floor (describe): .....

Is the sump pump used? Yes / No Depth of sump? ..... ft Where does the sump pump drain? .....

Describe ventilation of crawl space: .....

.....

Description of ground cover outside of building: ☐ Grass ☐ Concrete ☐ Asphalt ☐ Other: .....

Heating & Ventilation Systems

Heating System - Fuel Type: (Check box for all that apply)

☐ Natural Gas ☐ Electric ☐ Coal ☐ Fuel Oil

☐ Wood ☐ Other (specify): .....

Heating - Conveyance System: (Check box for all that apply)

☐ Forced Hot Air ☐ Electric Baseboard ☐ Wood Stove ☐ Fireplace

☐ Forced Hot Water ☐ Hot Water Radiation ☐ Heat Pump ☐ Kerosene Heater

☐ Other (specify): .....

Type of Ventilation System: (Check box for all that apply)

☐ Central air handler / blower ☐ Mechanical / ceiling fans ☐ Bathroom ventilation fans ☐ Air-to-air heat exchanger

☐ Kitchen range hood fan ☐ Other (specify): .....

Does the Residence have Air Conditioning: (Check box for all that apply)

☐ Central Air Conditioning ☐ Window Air Conditioners ☐ Other (specify): .....

Miscellaneous Information

Does the Residence have any of the following?

Septic System? Yes / Yes (but not used) / No Irrigation / Private Well? .....

Existing subsurface depressurization (radon) system in place? Yes / No Is it running? Yes / No

Is there standing water outside the residence (pond, ditch, swale)? Yes / No If so, describe: .....

Has the residence been retrofitted / weatherized with any of the following? (Check box for all that apply)

☐ Insulation ☐ Storm Windows ☐ Energy-efficient windows ☐ Other (specify): .....

Does the building have an attached garage? Yes / No If so, is a car usually parked in the garage? Yes / No

Chemicals

Have any pesticides / herbicides been applied around the building foundation or in the yard / gardens? Yes / No

If so, when - and which chemicals? .....

Has the residence had a pesticide treatment inside? Yes / No When / by whom? .....

Do the occupants of the building have their clothes dry-cleaned? Yes / No

When were dry-cleaned clothes last brought into the building? .....

Have the occupants ever noticed any unusual odors in the buidling? Yes / No

Describe (with location): .....

Building Address: ..... Date: .....

Miscellaneous Information Continued:

Have there been any known spills of a chemical immediately outside or inside the building? Yes / No

Describe (with location): .....

Do any of the occupants smoke inside the building? Yes / No How often? .....

Do any of the occupants use solvents at work? Yes / No Are their clothes washed at home? Yes / No

If so, when - and what rooms? .....

Within the last 6 months, has there been any painting or remodeling in the residence? Yes / No If so, when .....

What rooms, and what specifically was done? .....

Within the last 6 months, has any new carpeting been installed? Yes / No Have the carpets or rugs been cleaned? Yes / No

If so, when, what rooms, and what cleaners? .....

Consumer Products Inventory

Check consumer products that are present in the residence.

		Storage Location	Frequency of Usage	Date of Last Use
☐	Paint or Wood Finishes (spray or can)			
☐	Paint stripper / remover / thinner			
☐	Solvent cleaners (eg. spray-on oven cleaner)			
☐	Metal degreaser / cleaner			
☐	Gasoline / diesel fuel			
☐	Glues or adhesives (super glue, etc)			
☐	Air fresheners & scented candles			
☐	Laundry / carpet spot removers			
☐	Pesticides / Insecticides			
☐	Nail polish remover (acetone)			
☐	Aerosols (deodorizers, polish, cleaners)			
☐	Other:			
☐	Other:			
☐	Other:			

Describe any products that are containerized during sampling event:

.....

.....

.....

Provide any additional information that is provided by interviewee:

.....

.....

.....

.....

Appendix C
Standard Operating Procedures

STANDARD OPERATING PROCEDURE 1

Shallow Soil Gas Sampling Probe Installation

Purpose

To provide general guidelines for the installation of shallow soil gas sampling probes. Scope and Applicability

This procedure is recommended for installation of soil gas probes in outdoor locations. Please refer to SOP 2, *Soil Gas Sampling*, for information pertaining to the collection of samples from the soil gas probes.

Technical Practice Details

Equipment/Materials

Provided by the Direct Push Operator

- Direct push rig

Sampling (as appropriate)

- Soil gas sampling probes
- Tubing
- Fittings
- Sampling interface assembly
- Hydrated powdered bentonite

Health and Safety

- Photoionization detector (PID) and/or flame ionization detector (FID)

Decontamination

- Deionized or distilled water and soap mixture

Procedures/Guidelines

Gas Probe System Setup

1. Obtain soil gas sampling probes, such as direct-push technology or those manufactured by Geoprobe® Systems, in sufficient quantity to carry out the assessment without delay to the sampling effort. Note: these systems and their installation can be obtained from geotechnical firms that provide direct push installation (Figure 1). Manufactured soilgas probes that are specifically manufactured for soil gas collection, such as Geoprobe® Systems post-run tubing (PRT), facilitate installation, improve sampling, are easily decontaminated between each use, and offer ease of use. Coordinate the hardware (that is, size of tubing, fittings, sampling interface assembly, etc.) that mates the soil gas probe

sampling line to the sampling system (that is, Summa® canisters). This step is critical to achieve a leak-free system. Connections should be inert gas tight compression fittings (such as Swagelok® or equal) and sample transfer lines should be made of Teflon® tubing.

2. Prior to installing gas probes at a given location, a utility survey must be completed and the necessary permits acquired.

3. The soil gas probes must be decontaminated prior to use. This equipment may be decontaminated using a deionized water and soap mixture. Once decontaminated, the probes must be shown to be free of contaminants. As a minimum, a suitably sensitive organic vapor meter should be used for this purpose. A probe that does not pass decontamination should not be used.

4. To minimize decontamination efforts and the potential for cross contamination, when it is practical, gas probe sampling lines will be replaced between uses. Alternatively, a decontamination procedure for cleaning and purging sampling lines will be carried out. Handle and store decontaminated soil gas probes in a manner that prevents contamination. Inspect each gas probe assembly for wear and faulty parts. Replace probe tips, o-rings, adapters, and probe rods as needed.

5. Place the drive head on one end of the probe rod, and the PRT expendable point holder on the other end. Put the assembled PRT probe system in the hammer assembly. Place the expendable drive point in the PRT point holder, but do not use an o-ring to hold it in place. The tip is held in place by positioning it between the ground and the drive rod prior to pushing the probe. Use of an o-ring can cause the tip to not come loose when retracted at the targeted depth

Soil Gas Probe Installation and Removal at Other Locations

1. Advance the soil gas probe to the targeted depth (must be at least 18 inches below ground surface) in a manner that creates a leak free seal between the above ground atmosphere and the probe tip while minimizing the impact on ground surface cover materials (for example, asphalt, concrete, drive ways, lawns, etc.). Pull the probe back several inches to create the annular space for soil gas sampling.

2. Install an o-ring on the PRT adapter and push the adapter into the Teflon® tubing. Using a small piece of electrical tape to join the tubing and adapter can be helpful in maintaining the integrity of the connection. Feed the tubing down the length of the probe and tighten. To achieve a leak-free seal, place hydrated powdered bentonite at the point where the probe penetrates into the ground surface as shown in Figure 2. Allow the direct push rods to remain undisturbed for a minimum of 30 minutes before collecting a soil gas sample.

3. In the event the direct push installation technique does not work or is not deemed feasible, pre-drill a pilot hole prior to insertion of the soil probe. Fill the annular space around the soil probe with sand pack that extends 6 inches above and below the targeted sampling interval. Apply at least 1 foot of dry granular bentonite on top of the sand pack. Grout the remainder of the borehole with hydrated bentonite. If a hollow-

stem auger is used to advance the boring, wait at least 48 hours after probe installation before collecting the soil gas sample.

4. After the sample has been collected, remove the probe in a manner that minimizes disruption of ground surface covers (for example, asphalt, concrete, drive ways, lawns, etc.). Fill the boring with bentonite and cover the top 6 inches with soil and cover with surrounding like material.

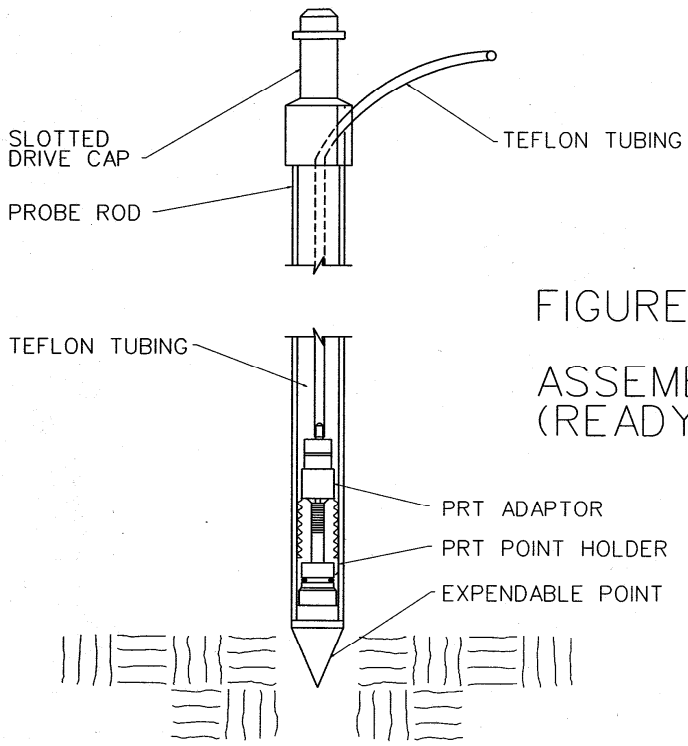


FIGURE 1

ASSEMBLED SOIL/GAS PROBE
(READY FOR INSTALLATION)

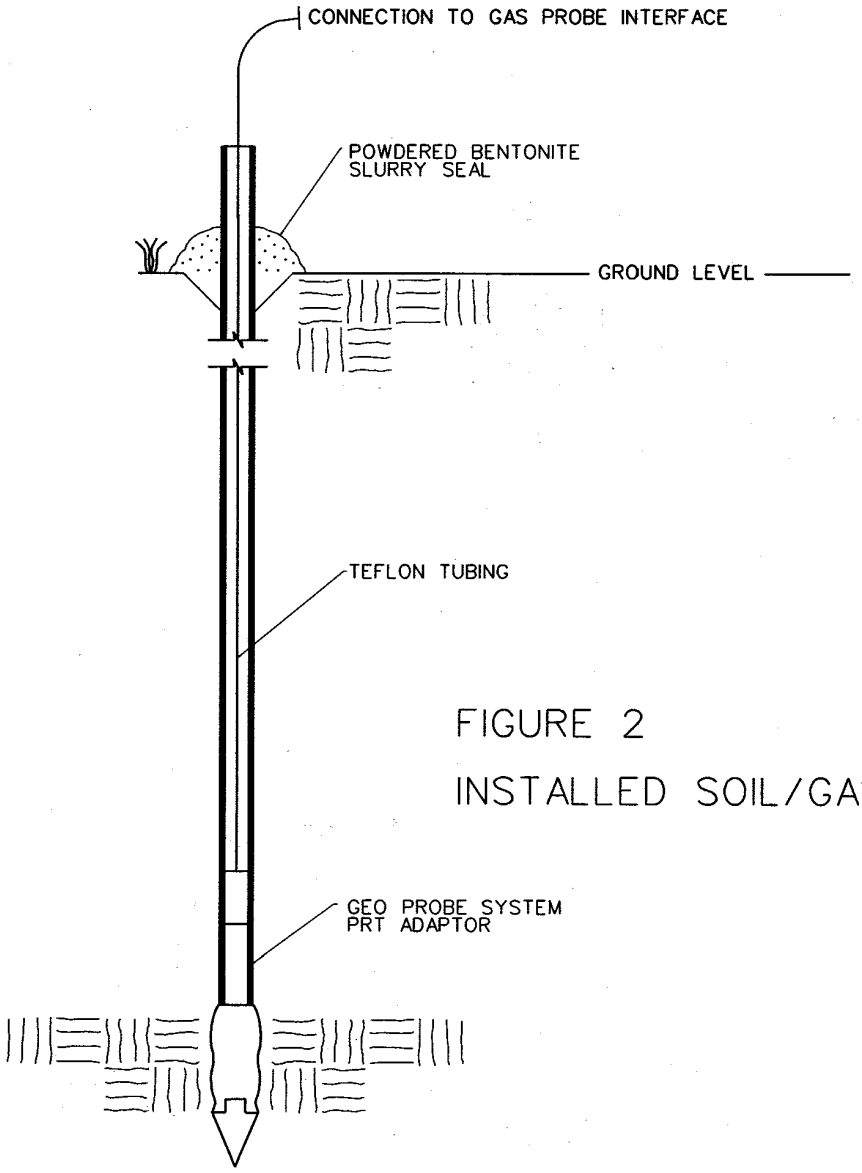


FIGURE 2

INSTALLED SOIL/GAS PROBE

STANDARD OPERATING PROCEDURE 2

Soil Gas Sampling

Purpose and Scope

This SOP describes the methods and procedures involved in conducting soil gas sampling.

Procedures

This procedure offers a practical approach for the collection of soil vapor samples from Geoprobe® Systems (or equal) direct push soil gas probes (with post-run tubing [PRT] adapters) into Summa® canisters. Soil gas sample integrity is verified by using a real-time helium leak checking procedure. This SOP should be used in conjunction with SOP 1, *Shallow Soil Gas Sampling Probe Installation*, and when its application is consistent with the projects data quality objectives. It is the project team's responsibility to make sure this procedure meets all applicable regulatory standards and receives approval/concurrence from the leading regulatory agency for the project. Only persons trained in the collection of soil gas samples should attempt this procedure. Before selecting sample locations, an underground utility search in accordance with the field sampling plan is required.

Probe Placement

- A clean probe is placed in the jaws of hydraulic pusher/puller mechanism.
- A sampling point is put on the bottom of the probe.
- The hydraulic pushing mechanism is used to push the probe into the ground. Then the probe is retracted several inches to create an annular space from which to draw a soil gas sample.
- If the pusher mechanism will not push the probe into the ground a sufficient depth for sampling, the hydraulic hammer is used to pound the probe into the ground. Concrete cutting may be required before probe placement, pending sampling point location.
- Soil gas sampling shall not begin until at least 30 minutes after the soil gas probe has been installed in accordance with SOP 1, *Shallow Soil Gas Sampling Probe Installation*.

Procedures / Guidelines

System Set-up

1. Acquire all the necessary hardware and sampling equipment shown in Figure 1.
2. Assemble or obtain the necessary fittings and vacuum gauge to create a soil gas probe and sampling manifold shown in Figure 1. This manifold must be clean, free of oils, and flushed free of volatile organic compounds (VOCs) prior to use. Note: use only gas tight fittings such as Swagelok® or equivalent. Be sure to place the helium leak check

enclosure over the probe, and push the sample tubing through the hole in the cap before attaching the sampling manifold.

3. Adjust the purge system evacuation pump sampling rate to achieve the desired flow rate of 150 milliliters per minute (mL/min). This should be performed at the outlet of the vacuum pump prior to purging, either by use of a suitable flow meter or determining the amount of time required to fill a 1 liter Tedlar® bag.
4. Summa® canisters are pre-evacuated by the laboratory. In some cases (that is, project-specific QA), the vacuum will need to be verified in the field prior to use. This is accomplished with a vacuum gauge and instructions supplied by the laboratory.
5. Flow controllers (if used) should come pre-set by the laboratory to sample at a predetermined rate based on specific project requirements (see Table 1 for the most common options). Verify the flow controller flow rate setting (indicated on the tag). In some cases (that is, project-specific QA), the flow rate will need to be verified in the field prior to use. This is accomplished with a bubble meter, vacuum source, and instructions supplied by the laboratory.

System Leak Test and Purging

1. Make sure the sampling system is assembled (as shown in Figure 1). The leak check enclosure is placed over the sample probe prior to connection of the sample line to the sampling manifold and the purge system. ***Do not connect the canister at this time***.

2. ***Physical Leak Check*** - Perform a leak check of the sample manifold system by:

   a. Making sure the gas probe valve (valve #1) is closed and the sample valve (valve #2) is open.
   b. Open the purge valve (valve #3) and start the purge pump. Verify that the flow is set to 150 mL/min.
   c. Close the sample valve (valve #2) and achieve a vacuum gauge reading of 10 inches of mercury or to a vacuum that will be encountered during sampling, which ever is greater.
   d. A leak free system will be evident by closing off the purge valve (valve #3), turning of the purge pump, and observing no loss of vacuum within the sampling manifold system for a period of 30 seconds. Repair any leaks prior to use.
   e. Record the leak check date and time on the field sampling log.
   f. ***System Purge and Helium Leak Check*** -A purge of the soil gas probe and sampling manifold system is required. The helium leak check procedure also is performed during this step. This is accomplished by:
      - 2.f.1 Where the ground surface is soft, the helium leak check enclosure is pressed down slightly into the ground surface. In situations where the ground surface is hard (such as asphalt), apply a slight downward pressure to achieve a build up of helium in the leak check enclosure.
      - 2.f.2 Start the flow of helium into the side of the leak check enclosure at 200 mL/min. Let the helium fill the enclosure for a couple of minutes.

2.f.3 Turn the helium leak detector on and make sure that the detector is not giving a helium reading before starting the purge. Place the probe of the helium detector in the exhaust port of the flow meter.

2.f.4 Purging is carried out by pulling soil gas through the system at a rate of between 150 mL/min for a time period sufficient to achieve a purge volume that equals at least 3 dead volumes (internal volume of the in ground annular space, sample line, and sampling manifold system).

2.f.5 Open the sample valve (valve #2) and the purge valve (valve #3) and start the purge pump. Verify that the flow rate is still 150 mL/min.

2.f.6 To start the soil gas probe purge, open the gas probe valve (valve #1) and close the sample valve (valve #2) at the same time, and start timing.

2.f.7 During the purge, observe the helium detector for indication of soil gas probe leakage (e.g. infiltration of ambient air into the probe). If a helium reading of more than 1 percent is observed, then the probe leak check has failed and corrective action should be taken. This includes first checking the fittings and connections and trying another purge and leak check. It may also result in removing the soil gas probe and re-installing it in a nearby location.

2.f.8 If the vacuum gauge reads greater than 15 inches during the purge, then close the purge valve (valve #3) and monitor the vacuum in the manifold and probe. If there is no significant change after a minute, then there is the lack of a significant amount of soil gas and the vacuum is too great to take a soil gas sample. Several things can cause this. Consult with the project manager and take corrective action.

2.f.8.1 The soil formation is too 'tight' (that is, high clay or moisture content). Try a different depth or location

2.f.8.2 With a Geoprobe® style probe system, the expendable tip may not have released when the probe was retracted. Try retracting the probe a little further, or using a long thin rod to poke the tip loose.

2.f.8.3 If water is visible in the flexible soil gas tubing, stop the purging immediately. It is not possible to take a soil gas sample at that depth or location.

2.f.9 At the end of the predetermined purge time (usually around a couple minutes) and after the system is verified to be leak free, close the purge valve (valve #3). Do not open it again. Doing so will result in loss of the purge integrity and requires re-purging. Turn off the helium leak detector.

2.f.10 Record the purge date, time, purge rate, leak check result, and purge volume on the field sampling log.

Immediately move on to the sampling phase. Little to no delay should occur between purging and sampling.

Summa® Canister Sampling

1. The Summa® canisters are certified clean and evacuated by the laboratory to near absolute zero pressure. Care should be used at all times to prevent inadvertent loss of canister vacuum. ***Never open the canister's valve unless the intent is to collect sample.***
2. Attach the canister to the flow controller and then connect the flow controller to the sample valve (valve #2) on the sampling manifold.
3. Before taking the sample, confirm that the sampling system valves are set as follows: 1) the purge valve (valve #3) is confirmed to be closed, gas probe valve (valve #1) is open, and 2) the sample valve is (valve #2) is open.
4. Slowly open the canister's valve approximately one full turn.
5. After sampling for the appropriate amount of time (determined from project instructions, see Table 1), close the sample valve (valve #2) and the canister's valve. Remove the canister from the sampling manifold.
6. Record the sampling date, time, canister ID, flow controller ID, and any other observation pertinent to the sampling event on the field sampling log.
7. Fill out all appropriate documentation (sampling forms, sample labels, chain of custody, sample tags, etc.).
8. Disassemble the sampling system.

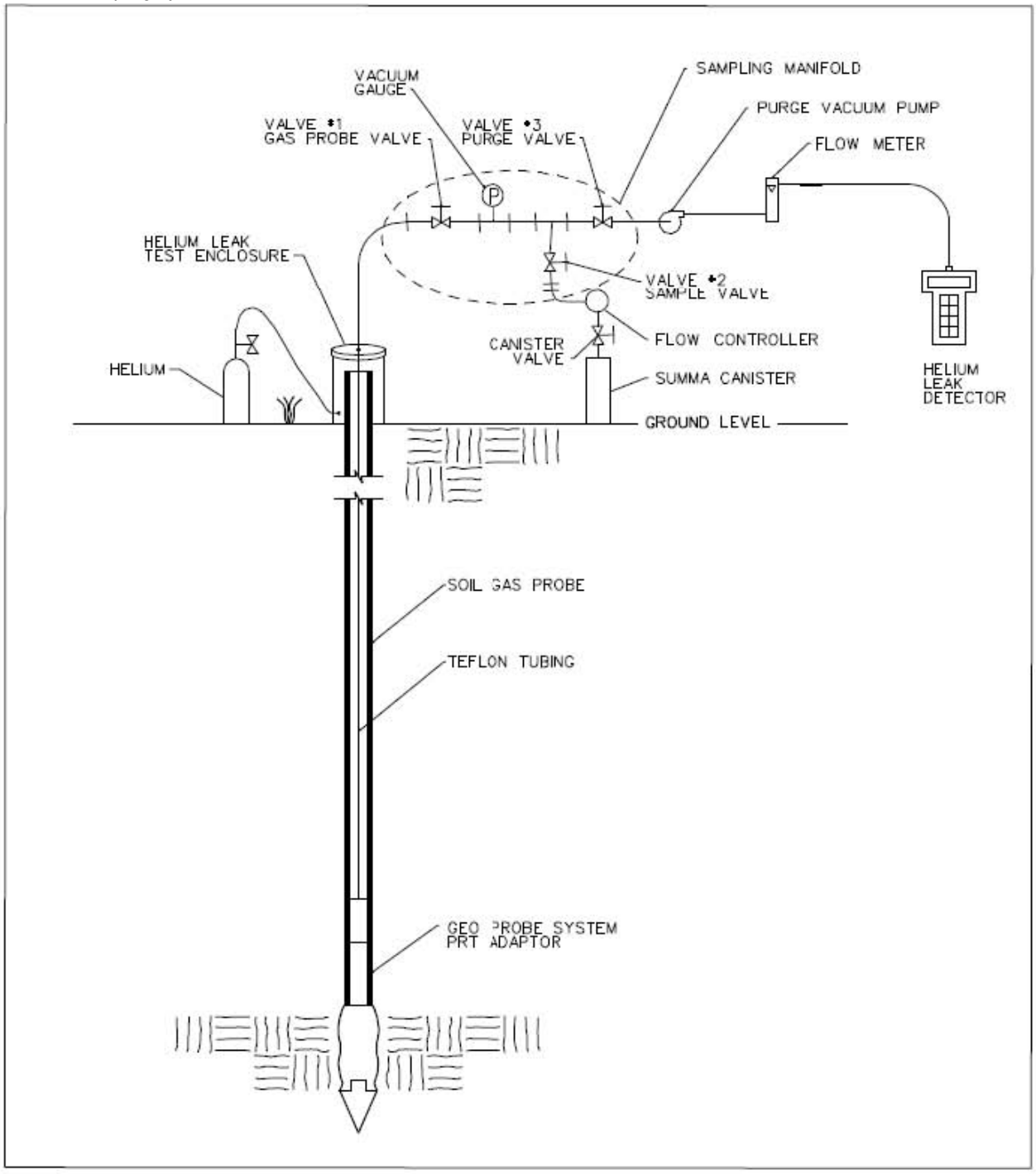
Sample Handling and Shipping

1. If shipping is required, pack the sample canisters in a rigid wall shipping container such as a cooler or heavy duty cardboard box (ice is not required). Never pack the cans with other objects or materials that could cause them to be punctured or damaged.
2. Place a custody seal over the openings to the shipping container.
3. Ship immediately to the laboratory for analysis.

TABLE 1
Common Sampling Rates for Soil Gas Sampling

Can Size	Length of Sampling Time	Sampling Flow Rate (mL/min)
6 Liter	1 hour	90
6 Liter	8 hours	11.25
6 Liter	24 hours	3.75
1 Liter	5 minutes	180
1 Liter	1 hour	15
850 ml	5 minutes	150
850 ml	1 hour	12

FIGURE 1
Soil Gas Sampling System



STANDARD OPERATING PROCEDURE 3

Groundwater Sampling using Geoprobe® Screen Point Method

Purpose and Scope

This SOP describes the methods and procedures involved in conducting groundwater sampling using Geoprobe® Screen Point Method.

Procedures

This procedure offers a convenient approach for the collection of groundwater samples from Geoprobe® Systems (or equal) screen point groundwater sampler. The screen point groundwater sampler is threaded onto the leading end of a Geoprobe® probe rod and advanced into the subsurface with a Geoprobe® direct push machine. Additional probe rods are added incrementally and advanced until the desired sampling interval is reached. While the sampler is advanced to depth, O-ring seals at each rod joint, the drive head, and the expendable drive point provide a watertight system. This system eliminates the threat of formation fluids entering the screen before deployment and assures sample integrity.

Once at the desired sampling interval, extension rods are sent downhole until the leading rod contacts the bottom of the sampler screen. The tool string is then retracted approximately 44 inches while the screen is held in place with the extension rods. As the tool string is retracted, the expandable point is released from the sampler sheath. The tool string and sheath may be retracted the full length of the screen or as little as a few inches if a small sampling interval is desired.

The screens are constructed such that flexible tubing, a mini-bailer, or a small-diameter bladder pump can be inserted into the screen cavity. This makes direct sampling possible from anywhere within the saturated zone. A removable plug in the lower end of the screens allows the user to grout as the sampler is extracted for further use.

Before selecting sample locations, an underground utility search in accordance with the Field Sampling Plan is required.

Procedures / Guidelines

Equipment and Materials

- Truck-mounted hydraulic percussion hammer.
- Direct-push (e.g., Geoprobe®) sampling rods and Screen Point
- Polyethylene sampling tubing
- Pre-cleaned sample containers
- Clean latex or surgical gloves.

- Water-level indicator
- Adjustable-rate peristaltic pump
- Generator
- Plastic sheeting
- Well-construction information
- Calibrated bucket or other container and watch with second indicator to determine flow rate
- Shipping supplies (labels, coolers, and ice)
- Field book

Groundwater Sampling

To collect groundwater samples, a small-diameter polyethylene or Teflon tubing is inserted into the probe rods until the desired depth is reached. A peristaltic pump is attached to the tubing to bring the groundwater to the surface for sample collection.

1. The sample location ID, site, date, and condition are recorded in the field logbook.
2. Plastic sheeting is placed on the ground underneath the peristaltic pump and sampling collection location. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed. To avoid cross-contamination, do not let any downhole equipment touch the ground.
3. All sampling equipment and any other equipment to be placed in the probe rods is cleaned and decontaminated before sampling in accordance with SOP Decontamination of Personnel and Equipment.
4. Water level measurements are collected prior to any equipment being placed inside the probe rods.
5. Attach and secure the polyethylene tubing to the peristaltic pump. Lower the tubing slowly into the well and set it at approximately the middle of the screen. Place the tubing intake at least 2 feet above the bottom of the sampler to avoid mobilization of any sediment present in the bottom. Preferably, the tubing should be in the middle of the screen.

Sample Collection

Once the tubing insertion has been completed, the sample location is ready to be sampled. The elapsed time between tubing insertion and collection of the groundwater sample from the sample location should be minimized. Typically, the sample is collected immediately after the tubing has been inserted.

Samples will be placed in bottles that are appropriate to the respective analysis and that have been cleaned to laboratory standards. Each bottle typically will have been previously prepared with the appropriate preservative, if any.

The following information, at a minimum, will be recorded in the logbook:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; whether the sample is filtered or not; time and date; sampler's identity)

2. Sample source and source description
3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), number of tubing volumes purged, and field parameter measurements
4. Sample disposition (preservatives added; laboratory sent to, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)

The steps to be followed for sample collection are as follows:

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 mL per minute when sampling VOCs.
3. Samples may be field filtered before transfer to the sample bottle. Filtration must occur in the field immediately upon collection. Inorganics, including metals, are to be collected and preserved in the filtered form as well as the unfiltered form. The recommended method is through the use of a disposable in-line filtration module (0.45-micron filter) using the pressure provided by the pumping device for its operation.
4. Samples for analysis for volatile organic compounds should be collected first, if such samples are required.
5. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to overflowing and capped.
6. The bottle is capped, then labeled clearly with sample ID, date, time, and analysis.
7. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.

Sample Handling and Shipping

- If shipping is required, pack the sample canisters in a cooler with double bagged ice.
- Include chain of custody in shipping container.
- Place a custody seal over the openings to the shipping container.
- Ship immediately to the laboratory for analysis.

References

Geoprobe Systems. 2001. Geoprobe Screen Point 15 and Screen Point 16 Groundwater Samplers: Technical Bulletin No. 95-1500, April.

STANDARD OPERATING PROCEDURE 4

Indoor Air Sampling

Purpose and Scope

This SOP describes the methods and procedures involved in conducting indoor air sampling.

Procedures

This procedure offers a convenient approach for the collection of indoor air samples into SUMMA® canisters. A sample of indoor air is withdrawn into a certified clean and evacuated SUMMA® canister by virtue of a certified clean flow controller. Sample collection will last up to 24 hours.

Procedures / Guidelines

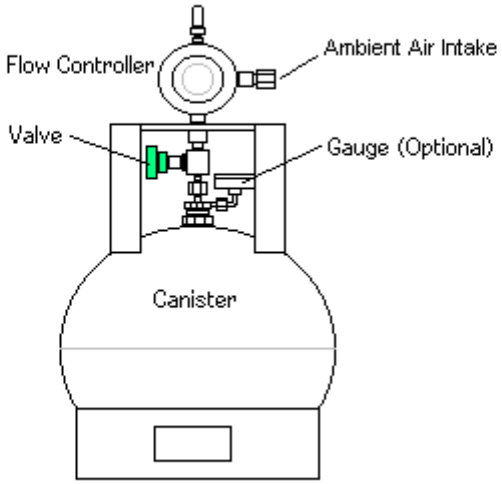
- 'Clean' sampling protocols must be followed at times when handling and collecting samples. This requires care in the shipping, storage, and use of sampling equipment. Cleanliness of personnel who come in contact with the sampling equipment, no smoking, eating, or drinking, no perfumes, deodorants, clean clothing (not dry cleaned) and clean over-garments.
- Inspect the canister for damage. Do not use a canister that has visible damage.
- Verify that the vacuum pressure of the canister is equal to that indicated on the laboratory's evacuation tag. Do not use a canister that has leaked.
    - Remove the protective cap from the valve on the canister.
    - If using an external gauge, attach the gauge to the canister and open the valve. After taking the reading, close the canister and remove the gauge.
- Verify that the flow controller is set at the desired sampling rate. If not pre-set, see the appropriate instructions for flow controller adjustment.
- In the field log record the canister ID, flow controller ID, initial vacuum, desired flow rate, sample location information, and all other information pertinent to the sampling effort.
- Connect the flow controller to the canister. The flow controller fitting denoted "LP" or "OUT" is connected to the canister. Tighten the fitting as to be leak free but <u>do not over tighten</u>. (A ¼ turn past snug is usually enough.)
- Remove all work articles from the sampling area.
- To begin sampling, slowly open the canister valve one full turn.
- For canisters with built in pressure gauges, monitor the vacuum pressure change several times during the course of the selected sample period to ensure the canister is filling at the desired rate.

- At the end of the sample period, close the canister valve finger tight.
- Remove the flow controller and replace the protective cap on the canister valve fitting.
- If using an external vacuum gauge, re-attach it, open the canister valve, and record the pressure. Then close the valve, remove the vacuum gauge, and replace the protective cap.
- If the flow controller is going to be used for more than one sample collection, be sure to purge it between uses. To do this, attach the flow controller to a vacuum source and draw clean air or gas (UHP) through it for several minutes before attaching it to the canister.
- Fill out all appropriate documentation (chain of custody, sample tags) and return canisters and all equipment to the laboratory in the shipping containers provided.
- When packing the canisters for shipment, verify that the valve (just past finger tight) and valve caps are snug (1/4 turn past finger tight), and use sufficient clean packing to prevent the valves from rubbing against any hard surfaces.
- Do not place sticky labels or tape on any surface of the canister.

Quality Control

- Canister supplied by the laboratory must follow the performance criteria and quality assurance prescribe in US EPA Method TO-14/15 for canister cleaning, certification of cleanliness, and leak checking. Standard operating procedures are required.
- Flow controllers supplied by the laboratory must follow the performance criteria and quality assurance prescribed in US EPA Method TO-14/15 for flow controller cleaning and adjustment. Standard operating procedures are required.

FIGURE 1
Assembled Canister Sampler for Integrated Sample Collection



System Leak Test and Purging

1. Make sure the sampling system is assembled (as shown in Figure 1) by connecting the sampling interface to the soil gas probe, the SUMMA® canister, and the purge system.
2. *Physical Leak Test*—Perform a leak test of the sample interface system as follows:
   a. Make sure that the gas probe valve (valve #1) is closed.
   b. Make sure that the sample valve (valve #2) leading to the SUMMA® canister is closed. Caution – never open the valve a fixed to the canister during purging. Doing so results in loss of vacuum and sample integrity.
   c. Open the purge valve (valve #3).
   d. Now operate the purge pump to achieve a vacuum gauge reading of 10 inches of Hg or to a vacuum that will be encountered during sampling, whichever is greater.
   e. A leak free system will be evident by closing off the purge valve and observing no loss of vacuum within the sampling interface system. Repair any leaks prior to use.
   f. Record the leak test date and time on the field sampling log.
   g. Close valves #1, 2, & 3 and turn off the vacuum pump prior to proceeding on to the system purge.

Sample Handling and Shipping

- If shipping is required, pack the sample canisters in a rigid wall shipping container such as a cooler or heavy duty cardboard box. Never pack the cans with other objects or materials that could cause them to be punctured.
- Place a custody seal over the openings to the shipping container.
- Ship immediately to the laboratory for analysis.

Appendix D
Health and Safety Plan

Draft Final Health and Safety Plan

Vapor Intrusion Assessment and Remedial Investigation St. Louis Ordnance Plant Former Hanley Area

St. Louis, Missouri

Prepared for

U.S. Army Corps of Engineers, Kansas City District

Contract No. W912DQ-05-D-0002
Delivery Order No. 0007

November 2007

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Prepared by

Conti

and

CH2MHILL

Approval

This site-specific Health and Safety Plan has been written for use by CH2M HILL only. CH2M HILL claims no responsibility for its use by others unless that use has been specified and defined in project or contract documents. The plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if those conditions change.

DRAFT Final Review

Written By: Michelle Hughes **Date: October 3, 2007**

Approved By: Brian Parsley/CSP **Date: October 8, 2007**

Approved By: Bill Berlett/CIH **Date: November 16, 2007**

Approved By: Daniel Price/Vice President **Date: November 16, 2007**

CH2M HILL Health and Safety Plan

This Health and Safety Plan (HSP) will be kept onsite during investigation field activities and will be reviewed as necessary. It will be amended or revised as project activities or conditions change or when supplemental information becomes available. Note, this HSP covers field activities included in the Vapor Intrusion Assessment and the upcoming Remedial Investigation (RI). The current CH2M HILL Health, Safety, Environment, and Quality Policy, Experience Modification Rates (EMRs), and OSHA 300 forms for the past 3 years are included in Attachment 1. The plan adopts, by reference, the Standards of Practice (SOPs) in the CH2M HILL *Corporate Health and Safety Program, Program and Training Manual*, as appropriate. In addition, it adopts procedures in the project Work Plan. The site safety and health officer (SSHO) is to be familiar with the contents of this plan. CH2M HILL's personnel and subcontractors must sign Attachment 2.

Project Information and Description

PROJECT NO: 364298

CLIENT: U.S. Army Corps of Engineers (USACE)-Kansas City District

PROJECT/SITE NAME: Saint Louis Ordnance Plant (SLOP)

SITE ADDRESS: Saint Louis, MO

CH2M HILL PROJECT MANAGER: Chris English

CH2M HILL OFFICE: STL

DATE HEALTH AND SAFETY PLAN PREPARED: October 3, 2007

DATE OF SITE WORK: December 2007 to July 2008

SITE ACCESS: Coordination via telephone with onsite property owner point of contact prior to access. The site is enclosed by a fence. Private property access agreements for access to offsite private residential properties. Access agreements will be obtained from the USACE.

SITE SIZE: 14 acres

SITE TOPOGRAPHY: Relatively flat on site. The topography drops to the east towards a residential area.

PREVAILING WEATHER: Humid continental climate, extreme temperatures ranging from below freezing conditions in the winter and hot/humid summers..

SITE DESCRIPTION AND HISTORY: The former St. Louis Ordnance Plant operated from 1941 to 1945 as a small arms ammunition production facility. The ordnance plant primarily produced 30 and 50-caliber ammunition. The plant was divided into two areas designated as Plant No. 1, which lies east of Goodfellow Avenue and Plant Area No. 2, which lies west of Goodfellow Avenue. The Hanley Area associated with this work plan consists of approximately 14 acres located at the northeastern end of the former Plant Area No. 2 at the intersection of Stratford Avenue and Goodfellow Boulevard. The processes at former Plant

Area No. 2 consisted of the blending of primary explosives, incendiary compounds and the tracer charging of 30 and 50-caliber projectiles as part of the assembly of the final product.

A Phase I RI, concluded in February 2005, included the collection of surface and sub-surface soil samples and groundwater samples. The results confirmed localized metals contamination in the surface soil and volatile organic compounds (VOC) contamination in an onsite and up gradient well and in the vicinity of former Building 220, which is located adjacent to Stratford Avenue.

The USACE, Kansas City District performed additional soil and groundwater sampling at the former Building 220 area and on public right-of-ways across Stratford Avenue in order to characterize the nature and extent of VOC contamination in groundwater. This supplemental Phase II RI field work included installation of groundwater monitoring wells and soil and groundwater sampling and analysis. The results of the Phase II efforts confirmed VOC contamination in soil and groundwater at the former Building 220 area above established cleanup levels. In addition, contaminated groundwater with VOC concentrations exceeding Federal Maximum Contaminant Levels (MCLs) was found to be moving off-site to the northeast.

DESCRIPTION OF SPECIFIC TASKS TO BE PERFORMED: Direct push technology and hollow-stem auger and air rotary drilling, membrane interface probing (MIP)/cone penetrometer testing (CPT), hand augering, soil sampling, shallow and deep monitoring well installation and groundwater sampling, and soil gas sampling. The specific tasks listed above require activity hazard analysis (AHA) sheets, which are provided in Attachment 9.

Site Map

This page is reserved for a Site Map.

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Attachments

1 CH2M HILL Health, Safety, Environment, and Quality Policy
2 Employee Signoff Form
3 Project-Specific Chemical Product Hazard Communication Form
4 Chemical-Specific Training Form
5 Emergency Contacts
6 Project H&S Forms/Permits
7 Project Activity Self-Assessment Checklists
8 Applicable Material Safety Data Sheets
9 Behavioral Based Loss Prevention Field Forms
10 Biological Hazards and Controls
11 Certified Industrial Hygienist Resume

1. Tasks to be Performed Under This Plan

1.1 Description of Tasks

(Reference Field Project Start-up Form)

Refer to Section 3 of the project work plan for detailed task information. A health and safety risk analysis (Section 1.2) has been performed for each task and is incorporated in this plan through task-specific hazard controls and requirements for monitoring and protection. Tasks other than those listed below require an approved amendment or revision to this plan before tasks begin. Refer to Section 8.2 for procedures related to "clean" tasks that do not involve hazardous waste operations and emergency response (Hazwoper).

1.1.1 Hazwoper-Regulated Tasks

- Drilling (air rotary, hollow-stem auger)
- Direct push technology boring
- Groundwater monitoring
- Hand augering
- Soil sampling
- Soil gas sampling
- Investigation-derived waste (drum) disposal
- Observation of material loading for offsite disposal

1.1.2 Non-Hazwoper-Regulated Tasks

Under specific circumstances, the training and medical monitoring requirements of federal or state Hazwoper regulations are not applicable. It must be demonstrated that the tasks can be performed without the possibility of exposure in order to use non-Hazwoper-trained personnel. **Prior approval from the health and safety manager (HSM) is required before these tasks are conducted on regulated hazardous waste sites.**

TASKS	CONTROLS
• Surveying	• Brief on hazards, limits of access, and emergency procedures
• General Site Entry	

2. Hazard Controls

This section specifies safe work practices and control measures to reduce or eliminate potential hazards. These practices and controls are to be implemented by the party in control of the site or of the particular hazard. CH2M HILL employees and subcontractors must remain aware of the hazards affecting them regardless of who is responsible for controlling the hazards. CH2M HILL employees and subcontractors who do not understand these provisions should contact the site safety and health officer (SSHO) for clarification.

2.1 Health and Safety Plans

CH2M HILL requires HSPs for field projects. Subcontractors are required to submit detailed Activity Hazard Analyses (AHAs) for their activities as well. HSPs provide a risk analysis of each task and identifies the potential hazards and control measures (including personal protective equipment [PPE] and air monitoring requirements) for each task.

2.2 Task Hazard Analysis

(Refer to Section 2 for hazard controls)

Potential Hazards	Hand Augering	Drilling, Direct Push Technology boring, and Well Installation	Soil Gas Sampling	Ground-water Sampling	General Site Entry Surveying	Disposal of Drums with Investigation-Derived Waste	Observation of Loading Material for Offsite Disposal
Working in a high crime area	X	X	X	X	X	X	X
Flying debris/objects	X	X				X	X
Noise > 85dBA		X					X
Electrical	X	X					
Suspended loads		X					X
Buried utilities, drums, tanks	X	X	X				
Slip, trip, fall	X	X	X	X	X	X	X
Back injury	X	X	X	X	X	X	
Visible lightning	X	X	X	X	X	X	X
Vehicle traffic							X
Elevated work areas/falls							X
Fires		X				X	
Entanglement	X	X					
Drilling		X					
Heavy equipment		X		X			X
Working near water							
Sampling of drums of investigation-derived waste						X	X

2.3 Activity Hazard Analyses

AHAs are required by CH2M HILL for tasks unless the HSM specifically determines they are unnecessary. AHAs provide a step-by-step analysis of the activity being performed and identify the equipment and control measures necessary to conduct the work safely. AHAs must be reviewed by the work team immediately before conducting the work. The AHAs can be a source of information for the daily safety meeting. Contractors and subcontractors must develop AHAs for their site activities. These must be reviewed by the HSM prior to initiating site activities. Blank copies of AHA forms to be filled out by subcontractors prior to arriving onsite are provided in Attachment 6. Completed AHAs for activities that will be performed by CH2M HILL are provided in Attachment 9.

2.3 Safety Meetings

CH2M HILL requires that the SSHO conduct daily safety meetings to discuss with the field team the tasks to be performed that day and the potential hazards and control measures. The safety meeting can be used to review the AHA with the team. As part of CH2M HILL's Behavioral Based Loss Prevention System, a Pre-task Safety Plan must be developed each day before performing specific work tasks. Each member of the team performing the task must be included in the planning so all are aware of the task hazards and controls. Attachment 9 contains a copy of a Pre-task Safety Plan.

2.4 Self-Assessments

Attachment 7 contains Project Activity Self-Assessment Checklists. The checklists provide a method of verifying compliance with established safe work practices, regulations, and industry standards pertaining to hazardous activities. They can be used by CH2M HILL employees who may be exposed to a hazardous activity or by the SSHO when providing oversight of a subcontractor performing a hazardous activity. Self-assessments must be completed before subjecting CH2M HILL staff to hazardous operations. Self-assessment checklists should be completed daily for the first week or until such time that the contractor is exhibiting appropriate work methods, then weekly thereafter.

If hazardous conditions exist or are apparent during the self-assessment, immediately notify the employees in the area and do not continue work in that area until the conditions are safe. If an imminent danger situation (immediately life threatening or would cause serious injury) exists, immediately stop work, when personnel in danger and notify the appropriate safety representative and the CH2M HILL SSHO. Non-compliance issues identified during the self-assessment shall be immediately rectified. If corrective action assistance is required, the HSM should be contacted for guidance.

Site-specific requirements outlined in this HSP that are more stringent than those contained in the self-assessment checklists are to take precedence. The self–assessment checklists are based upon minimum regulatory compliance and some site-specific requirements may be more stringent. The self-assessment checklists, including documented corrective actions, shall be made part of the permanent project records and maintained by the SSHO.

2.5 Site Compliance/Audits

In order to ensure compliance with requirements contained in this HSP, audits will be conducted by a health and safety professional as follows: The project should be audited at least once during the duration of the field activities.

2.6 Interventions

CH2M HILL is required to intervene whenever observing someone exhibiting an unsafe behavior or working in unsafe conditions. When such a situation is observed, an intervention is performed by talking to the person about how the task could be done more safely. CH2M HILL will establish a safety and occupational health deficiency tracking system that lists and monitors the status of safety and health deficiencies in chronological order. The list will be maintained onsite, will be updated daily, and will provide the date the deficiency was identified, a description of the deficiency, the name of the person

responsible for correcting the deficiency, and the resolution date. Additionally, each deficiency will be discussed with the entire field crew during the next day's safety tailgate meeting.

As part of the Behavioral Based Loss Prevention System program in place at the site, Safe Work Observation forms must be completed on a weekly basis, at a minimum, by the SSHO or field team leader (FTL). Each completed form must be maintained with the HSP field documents, and then transferred to project files upon the completion of the field work. A copy of a Safe Work Observation form is included in Attachment 9.

2.7 Project-Specific Hazards

2.7.1 Vinyl Chloride

- Vinyl chloride is considered a "confirmed human carcinogen."
- A short-term exposure limit of 15 minutes exists for this material.
- Vinyl chloride has a mild, sweet, chloroform-like odor.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.
- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by SSHO have been met.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.

2.7.2 Arsenic

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- Avoid skin and eye contact with liquid and particulate arsenic or arsenic trichloride.
- Arsenic is considered a "Confirmed Human Carcinogen."
- Arsenic particulates (inorganic metal dust) are odorless. Vapor and gaseous odor varies depending upon specific organic arsenic compound.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.

2.7.3 Lead

- Surfaces suspected of containing lead shall be treated as lead unless documentation or testing results indicate otherwise.
- Regulated areas are those where airborne exposure to lead is above the PEL, without regard to the use of respirators. Personnel shall not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met.

- Personnel shall not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- Personnel shall not launder work clothes with ordinary clothes.
- Respiratory protection and other exposure controls selection shall be based on the most relevant exposure monitoring results obtained from, or by the direction of, the lead competent person.
- Work performed in lead contaminated soil shall progress in a sequence from less contaminated to more contaminated areas.
- Water should be added to lead-contaminated soils prior to and during excavation, air rotary drilling, and other activities that create or have the potential to create airborne lead contaminated dust. For air rotary drilling operations, water can be added to the boring to reduce dust generation from the cyclone. Depending upon soil type, watering of soil may be required several days prior to beginning ground intrusive activities.
- Personnel working in the vicinity of lead-contaminated soil shall wear disposable coveralls and exercise enhanced personal hygiene (for example, frequent hand washing prior to eating, drinking, and smoking; separation of work and street clothing and footwear).

2.8 General Hazards

2.8.1 General Practices and Housekeeping

- Site is located in a high crime area, therefore work should be completed during daylight hours, be aware of your surroundings, do not work alone and be equipped with a cell phone to ensure communication with other field team members.
- Maintain good housekeeping in project work areas.
- Establish common paths of travel, and kept them free from accumulation of materials.
- Keep access to aisles, exits, ladders, stairways, scaffolding, and emergency equipment free from obstructions.
- Provide slip-resistant surfaces, ropes, or other devices to be used.
- Specific areas should be designated for the proper storage of materials.
- Tools, equipment, materials, and supplies shall be stored in an orderly manner.
- As work progresses, store or remove scrap and unessential materials neatly from the work area.
- Provide containers for collecting trash and other debris, and remove them at regular intervals.
- Clean up spills quickly. Clean oil and grease from walking and working surfaces.

2.8.2 Hazard Communication

The SSHO is to perform the following:

- Complete an inventory of chemicals brought onsite by CH2M HILL using Attachment 4.
- Confirm that an inventory of chemicals brought onsite by CH2M HILL subcontractors is available.
- Request or confirm locations of material safety data sheets (MSDSs) from the client, contractors, and subcontractors for chemicals to which CH2M HILL employees might be exposed.
- Obtain an MSDS for each hazardous chemical before or as it arrives onsite.
- Label chemical containers with the identity of the chemical and with hazard warnings, and store properly.
- Give employees required chemical-specific hazard communication (HAZCOM) training using Attachment 3.
- Store materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

2.8.3 Shipping and Transportation of Chemical Products

(Reference CH2M HILL's *Procedures for Shipping and Transporting Dangerous Goods)*

Chemicals brought to the site might be defined as hazardous materials by the U.S. Department of Transportation. Staff who ship the materials or transport them by road must receive CH2M HILL training in shipping dangerous goods. Hazardous materials that are shipped (by Federal Express, for example) or transported by road must be properly identified, labeled, packed, and documented by trained staff. Contact the HSM or equipment coordinator for additional information.

2.8.4 Lifting

- Use proper lifting techniques when lifting objects.
- Plan storage and staging to minimize lifting or carrying distances.
- Split heavy loads into smaller loads.
- Use mechanical lifting aids whenever possible.
- Have someone assist with the lift, especially heavy or awkward loads.
- Make sure the path of travel is clear prior to the lift.

2.8.5 Fire Prevention

- Provide fire extinguishers so that the travel distance from work areas to the nearest extinguisher is less than 100 feet. When 5 gallons or more of a flammable or combustible liquid are being used, an extinguisher must be within 50 feet. Extinguishers must:
  - be maintained in a fully charged and operable condition
  - be visually inspected each month
  - undergo a maintenance check each year
- Keep the area in front of extinguishers clear.

- Post "Exit" signs over exiting doors and "Fire Extinguisher" signs over extinguisher locations.
- Keep combustible materials stored outside at least 10 feet from buildings.
- Keep solvent waste and oily rags in a fire-resistant, covered container until removed from the site.
- Keep flammable/combustible liquids in approved containers, and store them in an approved storage cabinet.

2.8.6 Electrical

- Only qualified personnel are permitted to work on unprotected energized electrical systems.
- Only authorized personnel are permitted to enter high-voltage areas.
- Do not work on electrical wiring and equipment unless qualified to do so. Electrical wiring and equipment must be considered energized until lockout/tagout procedures are implemented.
- Inspect electrical equipment, power tools, and extension cords for damage before use. Do not use defective electrical equipment; instead, remove it from service.
- Make sure that temporary wiring, including extension cords and electrical power tools have ground fault circuit interrupters installed.
- Extension cords must be:
  - equipped with third-wire grounding
  - covered, elevated, or protected from damage when passing through work areas
  - protected from pinching if routed through doorways
  - not fastened with staples, hung from nails, or suspended with wire
- Make sure that electrical power tools and equipment are effectively grounded or double-insulated, UL approved.
- Operate and maintain electric power tools and equipment according to manufacturers' instructions.
- Maintain safe clearance distances between overhead power lines and any electrical conducting material unless the power lines have been de-energized and grounded, or where insulating barriers have been installed to prevent physical contact. Maintain at least 10 feet from overhead power lines for voltages of 50 kV or less, and 10 feet plus ½ inch for every 1 kV over 50 kV.
- Do not suspend temporary lights by their electric cord unless they are designed for suspension. Protect lights from accidental contact or breakage.
- Protect electrical equipment, tools, switches, and outlets from environmental elements.

2.8.7 Heat Stress

- Drink 16 ounces of water before beginning work. Disposable cups and water maintained at 50°F to 60°F should be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons per day. Do not use alcohol in place of water or other nonalcoholic fluids. Decrease your intake of coffee and caffeinated soft drinks during working hours.
- Acclimate yourself by slowly increasing workloads (e.g., do not begin with extremely demanding activities).
- Use cooling devices, such as cooling vests, to aid natural body ventilation. These devices add weight, so their use should be balanced against efficiency.
- Use mobile showers or hose-down facilities to reduce body temperature and cool protective clothing.
- Conduct field activities in the early morning or evening and rotate shifts of workers, if possible.
- Avoid direct sun whenever possible, which can decrease physical efficiency and increase the probability of heat stress. Take regular breaks in a cool, shaded area. Use a wide-brim hat or an umbrella when working under direct sun for extended periods.
- Provide adequate shelter/shade to protect personnel against radiant heat (sun, flames, hot metal).
- Maintain good hygiene standards by frequently changing clothing and showering.
- Observe one another for signs of heat stress. Persons who experience signs of heat syncope, heat rash, or heat cramps should consult the SSHO/DSC to avoid progression of heat-related illness.

Symptoms and Treatment of Heat Stress

Heat Syncope	Heat Rash	Heat Cramps	Heat Exhaustion	Heat Stroke
Signs and Symptoms				
Sluggishness or fainting while standing erect or immobile in heat.	Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure.	Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours.	Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid thready pulse and low blood pressure; oral temperature normal or low	Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature.
Treatment				
Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.	Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.	Remove to cooler area. Rest lying down. Increase fluid intake.	Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.	Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!

Monitoring Heat Stress

These procedures should be considered when the ambient air temperature exceeds 70°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress. The heart rate should be measured by the radial pulse for 30 seconds, as early as possible in the resting period. The heart rate at the beginning of the rest period should not exceed 100 beats/minute, or 20 beats/minute above resting pulse. If the heart rate is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. If the pulse rate still exceeds 100 beats/minute at the beginning of the next rest period, the work cycle should be further shortened by 33 percent. The procedure is continued until the rate is maintained below 100 beats/minute, or 20 beats/minute above resting pulse.

2.8.8 Cold Stress

- Be aware of the symptoms of cold-related disorders, and wear proper, layered clothing for the anticipated fieldwork. Don appropriate rain gear in cool weather.
- Consider monitoring the work conditions, and adjusting the work schedule using guidelines developed by the U.S. Army (wind-chill index) and the National Safety Council.
- Wind-chill index is used to estimate the combined effect of wind and low air temperatures on exposed skin. The wind-chill index does not take into account the body part that is exposed, the level of activity, or the amount or type of clothing worn. For those reasons, it should only be used as a guideline to warn workers when they are in a situation that can cause cold-related illnesses.
- Use National Safety Council Guidelines for work and warmup schedules along with the wind-chill index to estimate work and warmup schedules for fieldwork. The guidelines are not absolute. Monitored workers for symptoms of cold-related illnesses. If symptoms are not observed, the work duration can be increased.
- Persons who experience initial signs of immersion foot, frostbite, or hypothermia should consult the SSHO to avoid progression of cold-related illness.
- Observe one another for initial signs of cold-related disorders.
- Obtain and review weather forecast. Be aware of predicted weather systems along with sudden drops in temperature, increase in winds, and precipitation.

Symptoms and Treatment of Cold Stress

	Signs and Symptoms	Treatment
Immersion (Trench) Foot	Feet discolored and painful; infection and swelling present.	Seek medical treatment immediately.
Frostbite	Blanched, white, waxy skin, but tissue resilient; tissue cold and pale.	Remove victim to a warm place. Rewarm area quickly in warm—but not hot—water. Have victim drink warm fluids, but not coffee or alcohol. Do not break blisters. Elevate the injured area, and get medical attention.
Hypothermia	Shivering, apathy, sleepiness; rapid drop in body temperature; glassy stare; slow pulse; slow respiration.	Remove victim to a warm place. Have victim drink warm fluids, but not coffee or alcohol. Get medical attention.

2.8.9 Compressed Gas Cylinders

- Valve caps must be in place when cylinders are transported, moved, or stored.
- Close cylinder valves when cylinders are not being used and when moved.
- Secure cylinders in an upright position.
- Shield cylinders from welding and cutting operations, and position them to avoid being struck or knocked over, contacting electrical circuits, or exposed to extreme heat sources.
- Secure cylinders on a cradle, basket, or pallet when hoisting. They may not be hoisted by choker slings.

2.8.10 Procedures for Locating Buried Utilities

Local Utility Mark-Out Service
Name: Missouri One Call System, Inc.
Phone: 1-800-Dig-Rite

- Where available, obtain utility diagrams for the facility.
- Review locations of sanitary and storm sewers, electrical conduits, water supply lines, natural gas lines, and fuel tanks and lines.
- Review proposed locations of intrusive work with facility personnel knowledgeable of locations of utilities. Check locations against information from utility mark-out service.
- Where necessary (e.g., uncertainty about utility locations), excavate or drill the upper depth interval manually.
- Monitor for signs of utilities during intrusive work (e.g., sudden change in advance of auger or split spoon).
- When the client or other onsite party is responsible for determining the presence and locations of buried utilities, the SSHO should confirm that arrangement.

2.8.11 Drilling

- Only authorized personnel are permitted to operate drill rigs.
- Stay clear of areas surrounding drill rigs during every startup.
- Stay clear of the rotating augers and other rotating components of drill rigs.
- Stay as clear as possible of hoisting operations. Loads shall not be hoisted overhead of personnel.
- Do not wear loose-fitting clothing or other items such as rings or watches that could get caught in moving parts. Long hair should have it restrained.
- If equipment becomes electrically energized, personnel shall be instructed not to touch any part of the equipment or attempt to touch any person who may be in contact with the electrical current. The utility company or appropriate party shall be contacted to have line de-energized prior to approaching the equipment.

- Smoking around drilling operations is prohibited.
- H&S Self-Assessment Checklist—Drilling (see Attachment 7) should be used to evaluate excavations prior to entry.

2.9 Excavation

- Do not enter the excavations unless completely necessary, and only after the competent person has completed the daily inspection and has authorized entry.
- Follow excavation entry requirements established by the competent person.
- Do not enter excavations where protective systems are damaged or unstable.
- Do not enter excavations where objects or structures above the work location may become unstable and fall into the excavation.
- Do not enter excavations with the potential for a hazardous atmosphere until the air has been tested and found to be at safe levels.
- Do not enter excavations with accumulated water unless precautions have been taken to prevent excavation cave-in.
- H&S Self-Assessment Checklist—Drilling (see Attachment 7) should be used to evaluate excavations prior to entry.

2.10 Biological Hazards and Controls

2.10.1 Snakes

Snakes typically are found in underbrush and tall grassy areas. If you encounter a snake, stay calm and look around; there may be other snakes. Turn around and walk away on the same path you used to approach the area. If a person is bitten by a snake, wash and immobilize the injured area, keeping it lower than the heart if possible. Seek medical attention immediately. **DO NOT** apply ice, cut the wound, or apply a tourniquet. Try to identify the type of snake: note color, size, patterns, and markings.

2.10.2 Poison Ivy and Poison Sumac

Poison ivy, poison oak, and poison sumac typically are found in brush or wooded areas. They are more commonly found in moist areas or along the edges of wooded areas. Become familiar with the identity of these plants. Wear protective clothing that covers exposed skin and clothes. Avoid contact with plants and the outside of protective clothing. If skin contacts a plant, wash the area with soap and water immediately. If the reaction is severe or worsens, seek medical attention.

2.10.3 Ticks

Ticks typically occur in wooded areas, bushes, tall grass, and brush. Ticks are black, black and red, or brown and can be up to one-quarter inch in size. Wear tightly woven light-colored clothing with long sleeves and pant legs tucked into boots. Spray **only outside** of clothing with permethrin or permanone and spray skin with only DEET. Check yourself frequently for ticks.

If bitten by a tick, grasp it at the point of attachment and remove it carefully. After removing the tick, wash your hands and disinfect and press the bite areas. Save the removed tick. Report the bite to human resources. Look for symptoms of Lyme disease or Rocky Mountain spotted fever. Lyme disease: a rash might appear that looks like a bull's-eye with a small welt in the center. Rocky Mountain spotted fever: a rash of red spots under the skin 3 to 10 days after the tick bite. In both cases, chills, fever, headache, fatigue, stiff neck, and bone pain may develop. If symptoms appear, seek medical attention.

2.10.4 Bees and Other Stinging Insects

Bee and other stinging insects may be encountered almost anywhere and may present a serious hazard, particularly to people allergic to them. Watch for and avoid nests. Keep exposed skin to a minimum. Carry a kit if you have had allergic reactions in the past, and inform the SSHO or a buddy. If a stinger is present, remove it carefully with tweezers. Wash and disinfect the wound, cover it, and apply ice. Watch for allergic reaction. Seek medical attention if a reaction develops.

2.10.5 Bloodborne Pathogens

Exposure to bloodborne pathogens may occur when rendering first aid or CPR, or when coming into contact with landfill waste or waste streams containing potentially infectious material. Exposure controls and PPE are required. Hepatitis B vaccination must be offered before the person participates in a task where exposure is a possibility.

2.10.6 Other Anticipated Biological Hazards

Additional information on biological hazards can be found in Attachment 10.

2.11 Contaminants of Concern

TABLE 2-1
Site Specific Contaminants of Concern

Contaminant	Location and Maximum Concentration[a]	Exposure Limit[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[d] (eV)
Tetrachloroethylene (PCE)	GW: 3000 micrograms per liter (µg/L)/ DP-122	25 ppm	150 ppm Ca	Eye, skin, and respiratory irritation; nausea; flushed face and neck; vertigo; dizziness; sleepiness; skin redness; headache; liver damage	9.32
Trichloroethylene (TCE)	GW:50 (µg/L)/ DP-122	50 ppm	1,000 Ca	Headache, vertigo, visual disturbance, eye and skin irritation, fatigue, giddiness, tremors, sleepiness, nausea, vomiting, dermatitis, cardiac arrhythmia, paresthesia, liver injury	9.45
cis-1,2-Dichloroethene (cDCE)	GW:45 µg/L / DP-111	200 ppm	NA		9.65

TABLE 2-1
Site Specific Contaminants of Concern

1,2-Dichloroethane (Ethylene Dichloride)	GW: 88 µg/L/ DP-122	10 ppm	50 ppm Ca	CNS depression, nausea, vomiting, dermatitis, eye irritation, liver, kidney, and CNS damage; corneal opacity	11.05
Vinyl Chloride (VC)	GW:0.28J µg/L / DP-122	1 ppm	NL Ca	Weakness, abdominal pain, gastrointestinal bleeding, enlarged liver, pallor or cyanosis of extremities	9.99
Arsenic	GW: 47.8 µg/L/ MW-101 SB: 13.27 milligrams per kilogram (mg/kg)/ SLOP-006	0.01 mg/m^3	5 Ca	Ulceration of nasal septum, respiratory irritation, dermatitis, gastrointestinal disturbances, peripheral neuropathy, hyperpigmentation	NA
Lead	GW: 20.2 µg/L/ MW-106 SB: 983.26 mg/kg/ SLOP-SB-020	0.05 mg/m^3	100	Weakness lassitude, facial pallor, pal eye, weight loss, malnutrition, abdominal pain, constipation, anemia, gingival lead line, tremors, paralysis of wrist and ankles, encephalopathy, kidney disease, irritated eyes, hypertension	NA

[a] Specify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), S (Surface Soil), SL (Sludge), SW (Surface Water).
[b] Appropriate value of PEL, REL, or TLV listed.
[c] IDLH = immediately dangerous to life and health (units are the same as specified "exposure limit" units for that contaminant); NL = no limit found in reference materials; Ca = potential occupational carcinogen.
[d] PIP = photoionization potential; NA = Not applicable/available; UK = Unknown.

2.12 Potential Routes of Exposure

TABLE 2-2
Potential Routes of Exposure

Dermal	Contact with contaminated media. This route of exposure is minimized through proper use of PPE, as specified in Section 4.
Inhalation	Vapors and contaminated particulates. This route of exposure is minimized through proper respiratory protection and monitoring, as specified in Sections 4 and 5, respectively.
Other	Inadvertent ingestion of contaminated media. This route should not pose a concern if good hygiene practices are followed (for example, if wash hands and face before drinking or smoking).

3. Project Organization and Personnel

3.1 CH2M HILL Employee Medical Surveillance and Training

The employees listed below are enrolled in CH2M HILL's Comprehensive Health and Safety Program and meet state and federal hazardous waste operations requirements for

40-hour initial training, 3-day on-the-job experience, and 8-hour annual refresher training. Employees designated "SSHO" have completed a 12-hour site safety coordinator course, and have documented requisite field experience. An SSHO with a level designation (D, C, B) equal to or greater than the level of protection being used must be present during tasks performed in exclusion or decontamination zones. Employees designated "FA-CPR" are currently certified by the American Red Cross, or equivalent, in first aid and CPR. At least two FA-CPR and First Aid trained employees must be present during tasks performed in exclusion or decontamination zones. The employees listed below are currently active in a medical surveillance program that meets state and federal regulatory requirements for hazardous waste operations. Certain tasks (e.g., confined-space entry) and contaminants (e.g., lead) may require additional training, medical monitoring, and PPE requirements established by the competent person have been met.

Pregnant employees are to be informed of and are to follow procedures, including obtaining a physician's statement of the employee's ability to perform hazardous activities before being assigned fieldwork.

Employee Name	Office	Responsibility	SSHO / FA-CPR
Dan Price	STL	Task Manager	No/No
Glynn Roberts	STL	Field Team Lead/SSHO	Yes/Yes
Wayne Conway	STL	Field Team Member	Yes/Yes
Bill Berlett	CHI	Health and Safety Manager	No/No

3.2 Field Team Chain of Command and Communication Procedures

3.2.1 Client

Contact Name: Josephine Newton-Lund, PMP
Phone: 816-389-3912
Facility Contact Name: George Pugh
Phone: 314-382-9013 ext. 2373

3.2.2 CH2M HILL

Project Manager: Chris English
Health and Safety Manager: Bill Berlett
Field Team Leader: Glynn Roberts
Site Safety and Health Officer: Glynn Roberts

The SSHO is responsible for contacting the FTL and project manager. In general, the project manager will contact the client. The HSM should be contacted as appropriate.

3.2.3 CH2M HILL Subcontractors

Subcontractor: TBD
Subcontractor Contact Name: TBD
Telephone: TBD

The subcontractors listed above are covered by this HSP and must be provided a copy of this plan. However, this plan does not address hazards associated with the tasks and

equipment in which the subcontractor has expertise (e.g., drilling, excavation work, electrical). Subcontractors are responsible for the health and safety procedures specific to their work and are required to submit those procedures to CH2M HILL for review before the start of field work. Subcontractors must comply with the established health and safety plans. The CH2M HILL SSHO should verify that subcontractor employee training, medical clearance, and fit test records are current and must monitor and enforce compliance with the established plans. CH2M HILL's oversight does not relieve subcontractors of their responsibility for effective implementation and compliance with the established plans.

CH2M HILL should continuously endeavor to observe subcontractors' safety performance. That endeavor should be reasonable and include hazards or unsafe practices that are both readily observable and occur in common work areas. CH2M HILL is not responsible for exhaustive observation for hazards and unsafe practices. In addition to this level of observation, the SSHO is responsible for confirming CH2M HILL subcontractor performance against both the subcontractor's safety plan and applicable self-assessment checklists. The SSHO will use the self-assessment checklists contained in Attachment 7 to review subcontractor performance.

Health and safety related communications with CH2M HILL subcontractors should be conducted as follows:

- Brief subcontractors on the provisions of this plan, and require them to sign the Employee Signoff Form included in Attachment 2.
- Request subcontractors to brief the project team on the hazards and precautions related to their work.
- When apparent non-compliance/unsafe conditions or practices are observed, notify the subcontractor safety representative and require corrective action. The subcontractor is responsible for determining and implementing necessary controls and corrective actions.
- When repeat noncompliance/unsafe conditions are observed, notify the subcontractor safety representative and stop affected work until adequate corrective measures are implemented.
- When an apparent imminent danger exists, immediately remove affected CH2M HILL employees and subcontractors, notify subcontractor safety representative, and stop affected work until adequate corrective measures are implemented. Notify the project manager and HSM as appropriate.
- Document oral health and safety related communications in project field logbook, daily reports, or other records.

3.2.4 Contractors

Contractor: Conti Environment & Infrastructure, Inc.
Contractor Contact Name: Luis Seijido
Telephone: 978-318-9095

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

advising on health and safety issues). In addition to this plan, CH2M HILL staff should review contractor safety plans to be apprised of appropriate precautions that apply to us. Except in unusual situations when conducted by the HSM, CH2M HILL must never comment on or approve contractor safety procedures. Self-assessment checklists contained in Attachment 7 are to be used by the SSHO to review the contractor's performance only as it pertains to evaluating our exposure and safety.

Health and safety–related communications with contractors should be conducted as follows:

- Request the contractor to brief CH2M HILL employees and subcontractors on the precautions related to the contractor's work.
- When an apparent contractor non-compliance/unsafe condition or practice poses a risk to CH2M HILL employees or subcontractors:
  - Notify the contractor safety representative.
  - Request that the contractor determine and implement corrective actions.
  - If needed, stop affected CH2M HILL work until contractor corrects the condition or practice. Notify the client, project manager, and HSM as appropriate.
- If apparent contractor noncompliance/unsafe conditions or practices are observed, inform the contractor safety representative. Our obligation is limited strictly to informing the contractor of our observation. The contractor is solely responsible for determining and implementing necessary controls and corrective actions.
- If an apparent imminent danger is observed, immediately warn the contractor employees in danger and notify the contractor safety representative. Our obligation is limited strictly to immediately warning the affected individuals and informing the contractor of our observation. The contractor is solely responsible for determining and implementing necessary controls and corrective actions.
- Document oral health and safety-related communications in project field logbook, daily reports, or other records.

4. Personal Protective Equipment

Personal Protective Equipment Specifications[a]

Task	Level	Body	Head	Respirator[b]
General site entry Surveying Observation of material loading for offsite disposal Oversight of remediation and construction	D	Work clothes; steel-toe, leather work boots; work glove.	Hardhat [c] Safety glasses Ear protection [d]	None required.

Personal Protective Equipment Specifications[a]

Task	Level	Body	Head	Respirator[b]
Groundwater sampling Surface soil sampling Hand augering Excavation	D	Work clothes or cotton coveralls. **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers when handling or exposed to potentially contaminated materials **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Safety glasses Ear protection [d]	None required.
Groundwater sampling Direct Push Technology Soil boring Investigation-derived waste (drum) sampling and disposal	D	**Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Splash shield [c] Safety glasses Ear protection [d]	None required.
Tasks requiring upgrade Not anticipated – contact HSM for approval	C	**Coveralls:** Polycoated Tyvek **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat[c] Splash shield[c] Ear protection[d] Spectacle inserts	APR, full face, MSA Ultratwin or equivalent; with GME-H cartridges or equivalent[e].
Tasks requiring upgrade Not anticipated – contact HSM for approval	B	**Coveralls:** Polycoated Tyvek **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile and outer chemical-resistant nitrile gloves.	Hardhat[c] Splash shield[c] Ear protection[d] Spectacle inserts	Positive-pressure demand self-contained breathing apparatus (SCBA); MSA Ultralite, or equivalent.

Reasons for Upgrading or Downgrading Level of Protection

Upgrade[f]	Downgrade
Tyvek and boot coverings would be additional PPE for surface water and groundwater sampling if air monitoring in the field indicates an additional level of protection is required or if splashing/falling of contaminated materials cannot be controlled or effectively handled without risk of contacting unprotective clothing/boots. Hand protection is required at all times.	

[a] Modifications are as indicated. CH2M HILL will provide PPE only to CH2M HILL employees.
[b] No facial hair that would interfere with respirator fit is permitted.
[c] Hardhat and splash-shield areas are to be determined by the SSHO.
[d] Ear protection should be worn when conversations cannot be held at distances of 3 feet or less without shouting.
[e] Cartridge change-out schedule is at least every 8 hours (or one work day), except if relative humidity is > 85%, or if organic vapor measurements are > midpoint of Level C range (refer to Section 5)—then at least every 4 hours. If encountered conditions are different than those anticipated in this HSP, contact the HSM.
[f] Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level C) is permitted only when the PPE requirements have been approved by the HSM, and an SSHO qualified at that level is present.

5. Air Monitoring/Sampling

5.1 Air Monitoring Specifications

Instrument	Tasks	Action Levels[a]		Frequency [b]	Calibration
PID: OVM with 10.6eV lamp or	For tasks listed in	0 - 1 ppm	Level D	Initially and periodically	Daily

equivalent	Section 1.1.1	1 - 10 ppm	Level D if VC test < 0.5 ppm; if VC test > 0.5 ppm stop work, contact HSM.	during task	
		10-20 ppm	Level C if VC test < 0.5 ppm; if VC test > 0.5ppm stop work, contact HSM.		
Colormetric Tube: Dräger vinyl chloride specific (0.5 to 30 ppm range) with pre-tube, or equivalent		<0.5 ppm >0.5 ppm	Level D Stop work and contact HSM	Initially and periodically when PID/FID >1 ppm	
Noise-Level Monitor [c]:	For tasks listed in Section 1.1.1	<85 dB(A) 85–120 dB(A) 120 dB(A)	No action required Hearing protection required Stop; re-evaluate	Initially and periodically during task	Daily
Dust	For tasks in Section 1.1.1	Visual	Implement dust suppression for visual dust control. Stop work, contact HSM if suppression controls ineffective.		

[a] Action levels apply to sustained breathing-zone measurements above background.

[b] The exact frequency of monitoring depends on field conditions and is to be determined by the SSC; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate. Monitoring results should be recorded. Documentation should include instrument and calibration information, time, measurement results, personnel monitored, and place/location where measurement is taken (e.g., "Breathing Zone/MW-3," "at surface/SB-2," etc.).

[c] Noise monitoring and audiometric testing may be required. If noise levels are elevated such that having to raise your voice for a conversation with someone less than 3 feet then hearing protection is required.

5.2 Calibration Specifications

(Refer to the respective manufacturer's instructions for proper instrument-maintenance procedures)

Instrument	Gas	Span	Reading	Method
PID: OVM, 10.6 or 11.7 eV bulb	100 ppm isobutylene	RF = 1.0	100 ppm	1.5 lpm reg T-tubing
PID: MiniRAE, 10.6 eV bulb	100 ppm isobutylene	CF = 100	100 ppm	1.5 lpm reg T-tubing
PID: TVA 1000	100 ppm isobutylene	CF = 1.0	100 ppm	1.5 lpm reg T-tubing
FID: OVA	100 ppm methane	3.0 ± 1.5	100 ppm	1.5 lpm reg T-tubing
FID: TVA 1000	100 ppm methane	NA	100 ppm	2.5 lpm reg T-tubing

5.3 Air Sampling

Sampling, in addition to real-time monitoring, may be required by other Occupational Safety and Health Administration (OSHA) regulations where there may be exposure to certain contaminants. Air sampling typically is required when site contaminants include lead, cadmium, arsenic, asbestos, and certain volatile organic compounds. Contact the HSM immediately if these contaminants are encountered.

5.3.1 Personnel and Areas

Results must be sent immediately to the HSM. Regulations may require reporting to monitored personnel. Report results to:

HSM: Steve Beck
Other: Chris English

6. Decontamination

The SSHO must establish and monitor decontamination procedures and their effectiveness. Decontamination procedures found to be ineffective will be modified by the SSHO. The SSHO must ensure that procedures are established for disposing of materials generated on the site.

6.1 Decontamination Specifications

The SSHO must include appropriate decontamination procedures depending upon site conditions. Procedures may include those listed below.

Personnel	Sample Equipment	Heavy Equipment
Boot wash/rinse	Wash/rinse equipment	Power wash
Glove wash/rinse	Solvent-rinse equipment	Steam clean
Outer-glove removal	Contain solvent waste for offsite disposal	Dispose of equipment rinse water to facility or sanitary sewer, or contain for offsite disposal
Body-suit removal		
Inner-glove removal		
Respirator removal		
Hand wash/rinse		
Face wash/rinse		
Shower ASAP		
Dispose of PPE in municipal trash, or contain for disposal		
Dispose of personnel rinse water to facility or sanitary sewer, or contain for offsite disposal		

6.2 Diagram of Personnel-Decontamination Line

Eating, drinking, and smoking are not permitted in contaminated areas or in exclusion or decontamination zones. The SSHO should establish areas for eating, drinking, and smoking. Contact lenses are not permitted in exclusion or decontamination zones. Figure 6-1 illustrates a conceptual establishment of work zones, including the decontamination line. Work zones are to be modified by the SSHO to accommodate task-specific requirements.

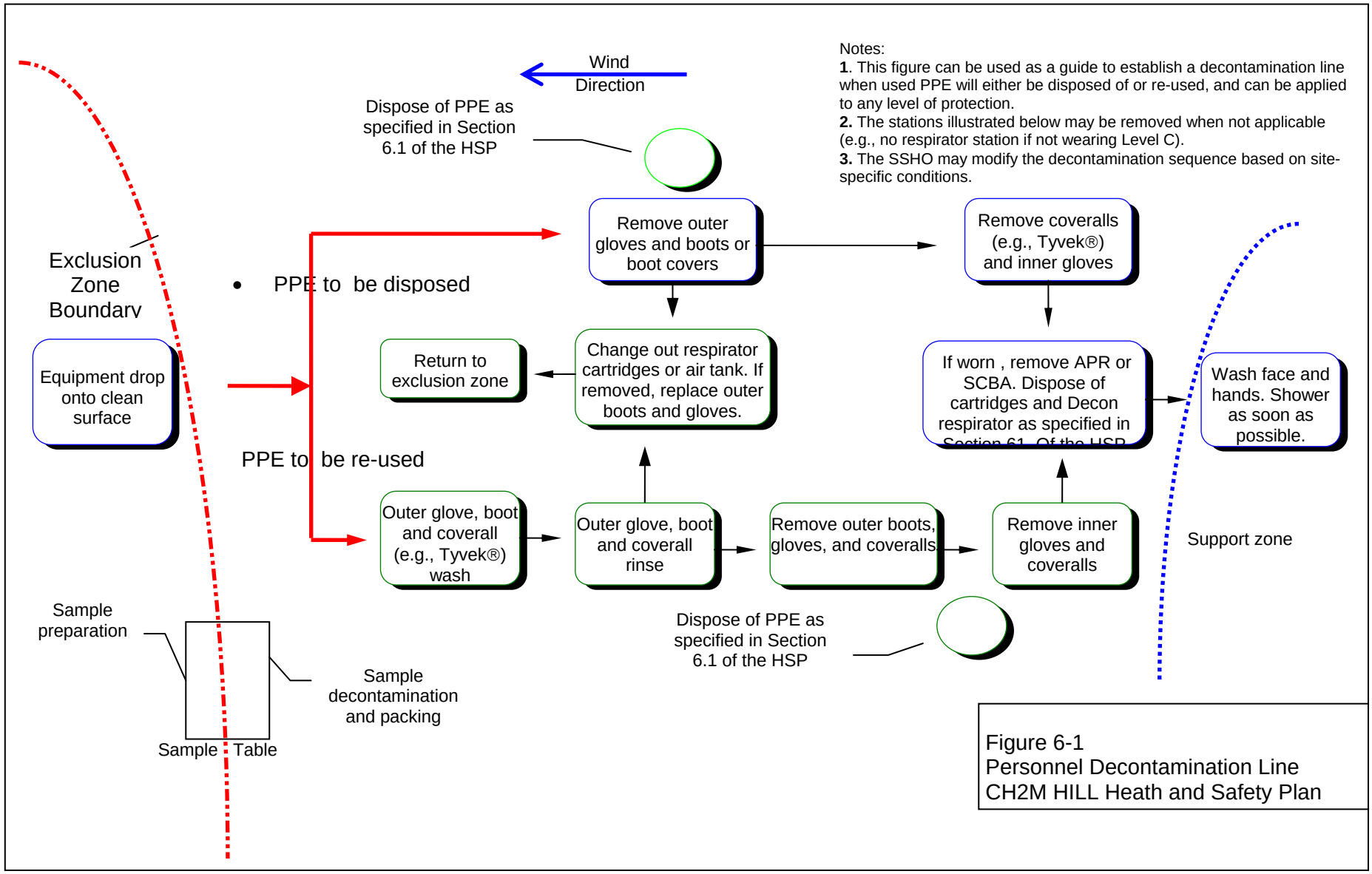
7. Spill-Containment Procedures

Onsite personnel shall be trained to follow the procedures described in this section.

- **Equipment—**Obtain client prior approval for use of client-owned spill containment equipment. If client equipment is not available, the table below provides typical spill

equipment that shall be available in the project's support zone. Consult the regional environmental coordinator and MSDS for more information.

- **Minimum Spill Kit Equipment List**
  - Neutralizers (for chemical spills)
    - Sodium Carbonate (acid spills)
    - Citric Acid (base spills)
  - Absorbent socks and pads
  - Safety goggles
  - Protective gloves
  - Tyvek suit
  - Waste containers and labels



Notes:
1. This figure can be used as a guide to establish a decontamination line when used PPE will either be disposed of or re-used, and can be applied to any level of protection.
2. The stations illustrated below may be removed when not applicable (e.g., no respirator station if not wearing Level C).
3. The SSHO may modify the decontamination sequence based on site-specific conditions.

Figure 6-1
Personnel Decontamination Line
CH2M HILL Heath and Safety Plan

- **Emergency Spill Event—**The release of an unknown hazardous material is considered an emergency spill event, for which the following procedures should be implemented:

  1. Evacuate the area and go upwind.
  2. Warn others and direct them upwind.
  3. Immediately contact the onsite safety coordinator, who will contact the HSM for direction.

- **Non-emergency Spill Event—**A non-emergency spill event includes incidental releases that do not pose a significant safety or health hazard where chemical hazards are known and CH2M HILL personnel can safely implement the following procedures as a first responder:

  1. Stop the source of the spill.
  2. Contain the spill material. If there is a chance the spill will reach nearby drains or waterways, block them to keep the spill away.
  3. Contact the SSHO.

- **Cleanup—**Clean up the spilled material wearing the proper PPE identified in the HSP equipment table if the spilled material is less than 5 gallons and hazards are known. Spills larger than 5 gallons must be cleaned up by a qualified subcontractor since CH2M HILL personnel are not trained to implement OSHA spill response requirements. Dispose of spill debris according to the Waste Management Plan or as directed by the SSHO.

- **Notification and Reporting—**All spills are considered an "incident" and shall be reported internally. Since many spills may require agency reporting within 24 hours, it is very important that internal notification occur immediately. The following summarizes required actions:

  1. Notify the SSHO ***immediately.***
  2. SSHO notifies the HSM.
  3. HSM notifies the Project Manager, who notifies the client.
  4. HSM notifies the Legal Department of a serious incident.
  5. HSM, ECC, and client shall determine if the incident is reportable to an agency.

8. Site-Control Plan

8.1 Site-Control Procedures

- The SSHO is to conduct a site safety briefing (see below) before starting field activities or as tasks and site conditions change.
- Topics for briefing onsite safety include general discussion of HSP, site-specific hazards, locations of work zones, PPE requirements, equipment, special procedures, and emergencies.
- The SSHO records attendance at safety briefings in a logbook and documents the topics discussed.
- Post the OSHA job-site poster in a central and conspicuous location,

- Establish support, decontamination, and exclusion zones. Delineate with flags or cones as appropriate. Support zone should be upwind of the site. Use access control at entry and exit from each work zone.
- Establish onsite communication consisting of the following:
  - Line-of-sight and hand signals
  - Air horn
  - Two-way radio or cellular telephone if available
- Establish offsite communication.
- Establish and maintain the "buddy system."
- Initial air monitoring is conducted by the SSHO in appropriate level of protection.
- The SSHO is to conduct periodic inspections of work practices to determine the effectiveness of this plan. Refer to Sections 2 and 3. Deficiencies are to be noted, reported to the HSM, and corrected.
- All site visitors must sign in with the SSHO and go through a site orientation briefing. Site visitors will not be allowed into the Exclusion Zone unless proof of HAZWOPER training can be demonstrated. Site visitors shall be given appropriate personal protection equipment by the SSHO as necessary.

8.2 Hazwoper Compliance Plan

Certain parts of the site work are covered by state or federal Hazwoper standards and therefore require training and medical monitoring. Anticipated Hazwoper tasks (Section 1.1.1) might occur consecutively or concurrently with respect to non-Hazwoper tasks. This section outlines procedures to be followed when approved activities specified in Section 1.1.2 do not require 24- or 40-hour training. Non–Hazwoper trained personnel also must be trained in accordance with other state and federal OSHA requirements.

- In many cases, air sampling, in addition to real-time monitoring, must confirm that there is no exposure to gases or vapors before non-Hazwoper-trained personnel are allowed on the site, or while non-Hazwoper-trained staff are working in proximity to Hazwoper activities. Other data (e.g., soil) also must document that there is no potential for exposure. The HSM must approve the interpretation of these data. Refer to subsections 2.5 and 5.3 for contaminant data and air sampling requirements, respectively.
- When non–Hazwoper trained personnel are at risk of exposure, the SSHO must post the extent of the exclusion zone and inform non–Hazwoper trained personnel of the:
  - nature of the existing contamination and its locations
  - limitations of their access
  - emergency action plan for the site
- Periodic air monitoring with direct-reading instruments conducted during regulated tasks also should be used to ensure that non-Hazwoper-trained personnel (e.g., in an adjacent area) are not exposed to airborne contaminants.

- When exposure is possible, non-Hazwoper-trained personnel must be removed from the site until it can be demonstrated that there is no longer a potential for exposure to health and safety hazards.
- Once a treatment system begins to pump and treat contaminated media, the site is, for the purposes of applying the Hazwoper standard, considered a treatment, storage, and disposal facility, and only Hazwoper-trained personnel (minimum of 24 hour of training) will be permitted to enter the site. Non–Hazwoper trained personnel must not enter the treatment, storage, and disposal area of the site.

9. Emergency Response Plan

9.1 Pre-emergency Planning

The SSHO performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with CH2M HILL onsite parties, the facility, and local emergency-service providers as appropriate.

- Review the facility emergency and contingency plans where applicable.
- Determine what onsite communication equipment is available (e.g., two-way radio, air horn).
- Determine what offsite communication equipment is needed (e.g., nearest telephone, cell phone).
- Confirm and post emergency telephone numbers, evacuation routes, assembly areas, and route to hospital; communicate the information to onsite personnel.
- Post “Exit” signs above exit doors of field trailers, and post “Fire Extinguisher” signs above locations of extinguishers. Keep areas near exits and extinguishers clear.
- Review changed site conditions, onsite operations, and personnel availability in relation to emergency response procedures.
- Where appropriate and acceptable to the client, inform emergency room and ambulance and emergency response teams of anticipated types of site emergencies.
- Designate one vehicle as the emergency vehicle. Place hospital directions and map inside. Keep keys in ignition during field activities.
- Inventory and check site emergency equipment, supplies, and potable water.
- Communicate emergency procedures for personnel injury, exposures, fires, explosions, and releases.
- Rehearse the emergency response plan before site activities begin, including driving the route to the hospital.
- Brief new workers on the emergency response plan.
- The SSHO will evaluate emergency response actions and initiate appropriate follow-up actions.

9.2 Emergency Equipment and Supplies

The SSHO should mark the locations of emergency equipment on the site map and post it.

Emergency Equipment and Supplies	Location
20 lb (or two 10-lb) fire extinguisher (A, B, and C classes)	Support zone/heavy equipment
First aid kit	Support zone/field vehicle
Eye wash	Support and decon zone/field vehicle
Potable water	Support and decon zone/field vehicle
Bloodborne-pathogen kit	Support zone/field vehicle

9.3 Incident Response

In fires, explosions, or chemical releases, the following actions are to be taken:

- Shut down CH2M HILL operations and evacuate the immediate work area.
- Notify appropriate response personnel.
- Account for personnel at the designated assembly areas.
- Assess the need for site evacuation, and evacuate the site as warranted.

Instead of implementing a work-area evacuation, note that small fires or spills posing minimal safety or health hazards may be controlled.

9.4 Emergency Medical Treatment

The procedures listed below may also be applied to non-emergency incidents. Injuries and illnesses (including overexposure to contaminants) must be reported to Human Resources. If there is doubt about whether medical treatment is necessary, or if the injured person is reluctant to accept medical treatment, contact the CH2M HILL medical consultant. During non-emergencies, follow these procedures as appropriate.

- Notify appropriate emergency response authorities listed in Attachment 5.
- The SSHO will assume charge during a medical emergency until the ambulance arrives or until the injured person is admitted to the emergency room.
- Prevent further injury.
- Initiate first aid and CPR where feasible.
- Get medical attention immediately.
- Perform decontamination where feasible. However, lifesaving and first aid or medical treatment take priority.
- Make certain that the injured person is accompanied to the emergency room.
- When contacting the medical consultant, state that the situation is a CH2M HILL matter, and give your name and telephone number, the name of the injured person, the extent of the injury or exposure, and the name and location of the medical facility where the injured person was taken.

9.5 Evacuation

- Evacuation routes and assembly areas (and alternative routes and assembly areas) are specified on the site map.
- The SSHO will designate evacuation routes and assembly areas before work begins.
- Personnel will assemble at the assembly areas upon hearing emergency signal for evacuation.
- The SSHO and a buddy will remain on the site after the site has been evacuated (if safe) to assist local responders and advise them of the nature and location of the incident.
- The SSHO will account for personnel in the onsite assembly area.
- A designated person will account for personnel at alternate assembly areas.
- The SSHO will write up the incident as soon as possible after it occurs and submit a report to the Corporate Director of Health and Safety.

9.6 Evacuation Signals

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

9.7 Incident Notification and Reporting

- If a CH2M HILL employee is injured immediately notify their group leader.
- Call the CH2M HILL Occupational Health Nurse: **1-800-756-1130**
- In case of emergency call 911.
- Report any injury to the Government Designated Authority (GDA) within 24 hours.

If the incident is serious and the HSM cannot be reached, immediately call the 24-hour CH2M HILL emergency beeper number (720-286-4911).

Incident communications regarding serious incidents (regardless of the party involved) shall be considered sensitive in nature and must be controlled in a confidential manner. Internal communications regarding a serious incident may be conducted with affected project, regional, and Business Group staff but must be kept to a minimum. Communication should be oral whenever possible. If e-mail communications are necessary they shall be sent as confidential emails. A legal representative shall direct internal and external communications, including internal incident reporting, agency reporting, client notification, and incident investigations.

The PM shall ensure that the CH2M HILL Incident Report Form (IRF) is completed within 24 hours of any incident. CH2M HILL's requirements can be met by entering an electronic IRF directly into the IRF database. The electronic IRF is found on the CH2M HILL HSE web page under Tools and Forms>Electronic Tools and Forms. If unable to submit an IRF electronically, the SSHO shall complete the hardcopy IRF provided in Attachment 9 and fax

the IRF to the human resources representative (for CH2M HILL employee injuries) or the HSM (for other incidents) for database entry **An IRF for a serious incident shall not be initiated until directed by a representative of the LID.**

When additional or updated information becomes available that was not included in the original IRF the SSHO shall forward such information to the human resources representative (for CH2M HILL employee injuries) or the HSM (for other incidents) so that the IRF may be updated. Updates to IRF reports should also be sent to HSM.

CH2M HILL staff shall comply with applicable statutory incident reporting requirements such as those required by Federal agencies (EPA, OSHA, etc.) and local authorities (police).

10. Behavioral Based Loss Prevention

A Behavior-Based Loss Prevention System (BBLPS) has been implemented on this project. BBLPS is a system to prevent or reduce losses using behavior-based tools and proven management techniques to focus on behaviors or acts that could lead to losses.

The four basic loss prevention tools that will be used to implement the BBLPS on this project include:

- Activity Hazard Analysis (AHA)
- Pre-Task Safety Plans (PTSP)
- Safe Work Observations (SWO)
- Loss and Near Loss Investigations (NLI)

The Field Team Leader (FTL) is responsible for implementing the BBLPS on the project site. The Field Team Leader delegates authority to the Site Safety Coordinator (SSC) for the implementation of the BBLPS on the project site, but the FTL remains accountable for its implementation. The SSC shall only oversee the subcontractor's implementation of their AHAs and PTSPs processes on the project.

10.1 Activity Hazard Analysis

An AHA defines the activity being performed, the hazards posed, and control measures required to perform the work safely. Workers are briefed on the AHA before doing the work and their input is solicited before, during and after the performance of work to further identify the hazards posed and control measures required.

AHAs will be prepared before beginning each project activity posing health and safety hazards to project personnel using the AHA form provided in **Attachment 9.** The AHA shall identify the work tasks required to perform each activity, along with potential H&S hazards and recommended control measures for each work task. In addition, a listing of the equipment to be used to perform the activity, inspection requirements and training requirements for the safe operation of the equipment listed must be identified.

An AHA shall be prepared for field activities performed by CH2M HILL and subcontractors during the course of the project and should be reviewed and accepted by the Health and Safety Manager. The Project-Specific, General and Biological Hazards (the Hazard Analysis Table) should be used as a basis for preparing these AHAs.

CH2M HILL subcontractors will be required to provide AHAs specific to their scope of work on the project for acceptance by the Site Safety Coordinator (SSC). Each subcontractor shall submit AHAs for their field activities, as defined in their work plan/scope of work, along with their project-specific HASP. Additions or changes in CH2M HILL or subcontractor field activities, equipment, tools or material to perform work or additional/different hazard encountered that require additional/different hazard control measures requires either a new AHA to be prepared or an existing AHA to be revised.

10.2 Pre-Task Safety Plans

Daily safety meetings are held with project personnel in attendance to review the hazards posed and required health and safety procedures/AHAs that apply for each day's project activities. The PTSPs serve the same purpose as these general assembly safety meetings, but the PTSPs are held between the crew supervisor and their work crews to focus on those hazards posed to individual work crews. At the start of each day's activities, the crew supervisor completes the PTSP, provided in **Attachment 9**, with input from the work crew, during their daily safety meeting. The day's tasks, personnel, tools and equipment that will be used to perform these tasks are listed, along with the hazards posed and required health and safety procedures, as identified in the AHA. The use of PTSPs better promotes worker participation in the hazard recognition and control process, while reinforcing the task-specific hazard and required health and safety procedures with the crew each day. The use of PTSPs is a common safety practice in the construction industry.

10.3 Safe Work Observations

Safe work loss prevention observations (SWOs) shall be conducted by Site Superintendent/SSC for specific work tasks or operations comparing the actual work process against established safe work procedures identified in the project-specific health and safety plan and AHAs. SWOs are a tool to be used by supervisors to provide positive reinforcement for work practices performed correctly, while also identifying and eliminating deviations from safe work procedures that could result in a loss. Site Superintendent/SSC shall perform at least one SWO each week for tasks/operations addressed in the project-specific HASP or AHA. The Site Superintendent/SSC shall complete the SWO form in **Attachment 9** for the task/operation being observed, following the process below.

10.4 Loss/Near-Loss Investigations

Loss/near-loss investigations shall be performed for the CH2M HILL and subcontractor incidents involving:

- Person injuries/illnesses and near-miss injuries
- Equipment/property damage
- Spills, leaks, regulatory violations
- Motor vehicle accidents

The causes of loss and near-loss incidents are similar, so by identifying and correcting the causes of near-loss incidents, future loss incidents may be prevented. The following is the loss/near-loss investigation process:

- Gather relevant facts, focusing on fact-finding, not fault-finding, while answering the who, what, when, where, and how questions.
- Draw conclusions, pitting facts together into a probable scenario.
- Determine incident root causes, which are basic causes on why an unsafe act/condition existed.
- Develop and implement solutions, matching identified root causes with solutions.
- Communicate incident as a lesson learned to project personnel.
- File follow-up on implemented corrective active action to confirm solution is appropriate.

Site Supervisors/SSO shall perform an incident investigation, as soon as practical after incident occurrence during the day of the incident, for loss and near-loss incidents that occur on the project. Loss and near-loss incident investigations shall be performed using the following incident investigation forms provided in **Attachment 9**:

- Incident Report Form (IRF)
- Incident Investigation Form
- Root Cause Analysis Form
- Accident Investigation Report

Loss and near-loss incidents involving personal injury, property damage in excess of $1,000 or near-loss incidents that could have resulted in serious consequences shall be investigated by completing the incident investigation forms and submitting them to the Project Manager and HSM within 24 hours of incident occurrence. A preliminary Incident Investigation and Root Cause Analysis shall be submitted to the Project Manager and HSM within 24 hours of incident occurs. The final Incident Investigation and Root Cause Analysis shall be submitted after completing a comprehensive investigation of the incident.

11. Attachments

Attachment 1: CH2M HILL Health, Safety, Environment, and Quality Policy
Attachment 2: Employee Signoff Form
Attachment 3: Project-Specific Chemical Product Hazard Communication Form
Attachment 4: Chemical-Specific Training Form
Attachment 5: Emergency Contacts
Attachment 6: Project H&S Forms/Permits
Attachment 7: Project Activity Self-Assessment Checklists
Attachment 8: Applicable Material Safety Data Sheets
Attachment 9: Behavioral Based Loss Prevention Field Forms
Attachment 10: Biological Hazards and Controls
Attachment 11: Certified Industrial Hygienist Resume

Attachment 1
CH2M HILL Health, Safety, Environment, and Quality Policy

CH2MHILL ENTERPRISE

HEALTH, SAFETY, ENVIRONMENT, AND QUALITY POLICY

Protection of people and the environment, while delivering quality products and services is a CH2M HILL core value. It is our vision to create a culture within CH2M HILL that empowers employees to drive this value into all global CH2M HILL operations and achieve excellence in health, safety, environment, and quality (HSE&Q) performance. CH2M HILL deploys an integrated, enterprise-wide behavior-based HSE&Q management system to fulfill our mission and the expectations of our clients, staff, and communities based on the following principles:

- We require all management and supervisory personnel to provide the leadership and resources to inspire and empower our employees to take responsibility for their actions and for the actions of their fellow employees to create a safe, healthy, secure, and environmentally-responsible workplace.
- We provide value to clients by tailoring HSE&Q processes to customer needs and requiring all CH2M HILL personnel and subcontractors to deliver projects with agility, personal service, and responsiveness and in compliance with HSE&Q requirements and company standards to achieve health, safety, quality, and pollution prevention excellence. Our performance will aspire to influence others and continually redefine world-class HSE&Q excellence.
- We systematically evaluate our design engineering and physical work environment to verify safe and secure work conditions and practices are established, consistently followed, and timely corrected.
- We continually assess and improve our HSE&Q program to achieve and maintain world-class performance by setting and reviewing objectives and targets, reporting performance metrics, and routinely reviewing our progress.
- We care about the safety and security of every CH2M HILL employee and expect all employees to embrace our culture, share our core value for the protection of people and the environment, understand their obligations, actively participate, take responsibility, and "walk the talk" on and off the job.

The undersigned pledge our leadership, commitment, and accountability for making this policy a reality at CH2M HILL.

Dated the 1st day of June 2006.

Robert C. Allen, SENIOR VP, HUMAN RESOURCES LTD

Garry M. Higdem, PRESIDENT & CHIEF EXECUTIVE, EPC

Robert G. Card, PRESIDENT & CHIEF EXECUTIVE, INTERNATIONAL

Samuel H. Iapalucci, EXECUTIVE VP CFO LTD

R. Keith Christopher, SENIOR VP, CHIEF HSE&Q OFFICER

Lee A. McIntire, PRESIDENT AND CHIEF OPERATING OFFICER

Don S. Evans, PRESIDENT & GROUP CHIEF EXECUTIVE, CIVIL INFRASTRUCTURE

Ralph R. Peterson, CHAIRMAN, CHIEF EXECUTIVE OFFICER

James J. Ferris, PRESIDENT & GROUP CHIEF EXECUTIVE, FEDERAL & INDUSTRIAL

Nancy Tuor, VICE CHAIRMAN

MARSH

CH2M HILL Companies, Ltd. Experience Rating Modifications since May 1, 2000

Policy Term	State	Modification	Actual (A) or Tentative (T)
05/01/06-05/01/07	Interstate	0.77	(A)
	California	0.82	(A)
	Michigan	0.86	(A)
	New Jersey	0.773	(A)
	Pennsylvania	0.779	(A)
05/01/05-05/01/06	Interstate	0.84	(A)
	California	1.01	(A)
	Michigan	0.81	(A)
	New Jersey	0.913	(T)
	Pennsylvania	0.681	(A)
05/01/04-05/01/05	Interstate	0.80	(A)
	California	0.87	(A)
	Michigan	0.81	(A)
	New Jersey	1.097	(A)
	Pennsylvania	0.685	(A)
05/01/03-05/01/04	Interstate	0.82	(A)
	California	0.99	(A)
	Michigan	0.81	(A)
	New Jersey	0.948	(A)
	Pennsylvania	0.744	(A)
05/01/02-05/01/03	Interstate	0.76	(A)
	California	1.16	(A)
	Michigan	0.78	(A)
	New Jersey	1.121	(A)
	Pennsylvania	1.040	(A)
05/01/01-05/01/02	Interstate	0.61	(A)
	California	0.87	(A)
	Michigan	0.76	(A)
	New Jersey	1.072	(A)
	Pennsylvania	1.038	(A)
05/01/00-05/01/01	Interstate	0.45	(A)
	California	0.57	(A)
	Michigan	TBD	
	New Jersey	1.064	(A)
	Pennsylvania	0.838	(A)

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OSHA 300 Log for the calendar year: 2003

Form Approved
O.M.B. No. 1218-0176

You must record information about every work-related death and about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR Part 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an injury and illness Incident Report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Company Name: **CH2M HILL, Inc. (INC)**

Establishment Name: **WORLD HEADQUARTERS DENVER**

Establishment Address **9191 S Jamaica St.**
Englewood, CO, 80112-5946

Case or File Number	Employee's Name	Occupation	Date of injury or onset of illness	Where the event occurred	Description of Injury or Illness (Injury Nature - Body Part), parts of body affected, and object/substance that directly injured or made person ill	Using these four categories, check ONLY the most serious results for each case				Enter the number of days the injured or ill worker was:		Check the injury column or choose one type of illness:				
						Death	Days away from work	Remained at work		On job transfer or restriction	Away from work	Injury	Skin disorder	Respiratory conditio	Poisoning	All other illnesses
								Job Transfer or restriction	Other recordable							
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(1)	(2)	(3)	(4)	(5)
954		Project Scientist	01/07/03	AFCEE-Landfill Site LF-05	Cut/Laceration-Finger(s)			1		14	0	1				
960		Associate Engineer	01/09/03	LAS	Carpal Tunnel-Wrist(s)				1	0	0					1
956		Graphic Designer - Lead	01/13/03	RDD	Wrist Pain-Wrist(s)				1	0	0					1
969		Project Consultant	01/24/03	SFO	Carpal Tunnel-Wrist(s)				1	0	0					1
982		Project Engineer	02/03/03	Westside Interceptor	Epicondylitis-Elbow(s)				1	0	0					1
978		Office Serv Asst 4	02/18/03	SEA	Strain/Sprain-Back		1			0	3	1				
996		Staff Engineer 1	03/18/03	SFO	Carpal Tunnel-Multiple (Specify)				1	0	0					1
995		Res Proj Rep 4	03/27/03	Additional Inspection	Strain/Sprain-Back			1		6	0	1				
1002		Admin Asst 2	03/28/03	SEA	Strain/Sprain-Ankle(s)				1	0	0	1				
1006		Office Serv Asst 2	04/01/03	MGM	Cut/Laceration-Finger(s)				1	0	0	1				
1022		Project Planner	04/02/03	SCO	Carpal Tunnel-Hand (s)				1	0	0					1
1010		Environmental Technologist 3	04/06/03	AFP 6/O&M Operations	Strain/Sprain-Ankle(s)			1		35	0	1				
1016		Human Resource Senior Generalist	04/17/03	SCO	Strain/Sprain-Back				1	0	0	1				
997		Associate Consultant	04/23/03	SFO	Carpal Tunnel-Multiple (Specify)				1	0	0					1
1037		Staff Planner 1	05/02/03	SFO	Carpal Tunnel-Hand (s)				1	0	0					1
1036		Engineer Tech 3	05/12/03	CS.WB.RI	Muscle Spasms-Back				1	0	0	1				
1064		Office Serv Asst 3	05/24/03	CLT	Strain/Sprain-Back				1	0	0	1				
1053		Project Manager (PM)	05/30/03	Site Visit	Insect bite -- possible tick bite-Ankle(s)				1	0	0	1				
1063		PC Systems Specialist	07/07/03	COR	Cut/Laceration-Finger(s)				1	0	0	1				
1065		Is Web Designer	07/07/03	SLC	Strain/Sprain-Multiple (Specify)				1	0	0					1
1070		Associate Consultant	07/10/03	Air Force Plant #6	Poison Ivy-Multiple (Specify)				1	0	0		1			
1066		Scientific Specialist	07/11/03	Kelly AFB Semiannual CP /	Cut/Laceration-Elbow(s)				1	0	0	1				

OSHA 300 Log for the calendar year: 2003

Form Approved
O.M.B. No. 1218-0176

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								Job Transfer or restriction	Other recordable							
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(1)	(2)	(3)	(4)	(5)
1067		Office Serv Asst 4	07/14/03	SAC	Tendonitis-Wrist(s)				1	0	0					1
1068		Resident Project Representative 4	07/16/03	VA288/RIC	Strain/Sprain-Hand (s)			1		7	0	1				
1074		Associate Engineer	07/21/03	SAC	Tendonitis-Wrist(s)				1	0	0					1
1080		PC Systems Specialist	07/21/03	RDD	Strained Back				1	0	0	1				
1076		Cor Accounts Payable Specialist	07/22/03	COR	-Finger(s)		1			0	2	1				
1085		Project Consultant	07/29/03	GNV	Fracture-Toe(s)				1	0	0	1				
1102		Associate Engineer	08/06/03	In Transit	Strain/Sprain-Multiple (Specify)				1	0	0	1				
1096		Staff Planner 2	08/14/03	WBS	Allergic reaction-Multiple (Specify)				1	0	0		1			
1095		Environmental Technologist 2	08/19/03	Delta Energy Center	Fracture-Arm(s) Multiple		1			0	5	1				
1110		Designer 5	09/18/03	ASA	Strain/Sprain-Ankle(s)			1		14	0	1				
1117		Office Serv Asst 6	10/02/03	CHI	Strain/Sprain-Back				1	0	0	1				
1128		Project Consultant 2	10/07/03	Aerial Mapping	Cut/Laceration-Finger(s)				1	0	0	1				
1134		Senior HR Assistant	10/10/03	SFO	Tendonitis-Hand (s)				1	0	0					1
1126		Resident Project Representative 5	10/15/03	2003 Waste Water Recycling Project	Strain/Sprain-Knee(s)				1	0	0	1				
1144		Cor Accounts Payable Specialist	10/31/03	COR	Muscle Spasms-Abdomen		1			0	2	1				
1140		Project Assistant 3	10/31/03	HOU	Bruised both knees and left arm-Multiple (Specify)				1	0	0	1				
1142		Environmental Technologist 3	11/04/03	HYDRO INVESTIGATION	Muscle Spasms-Back				1	0	0	1				
1156		Designer 5	11/21/03	Pier T	Concussion-Hand (s)				1	0	0	1				
1160		Office Serv Asst 5	12/04/03	COR	Hernia-Groin				1	0	0	1				
1164		Graphic Designer 3	12/15/03	DEN	Strain/Sprain-Back				1	0	0	1				
1165		Lead Purchasing Specialist	12/24/2003	SEA	Strain/Sprain-Back		1			1	4	1				

OSHA 300 Log for the calendar year: 2003

Form Approved
O.M.B. No. 1218-0176

You must record information about every work-related death and about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR Part 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an injury and illness Incident Report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Company Name: **CH2M HILL, Inc. (INC)**

Establishment Name: **WORLD HEADQUARTERS DENVER**

Establishment Address **9191 S Jamaica St.**
Englewood, CO, 80112-5946

Case or File Number	Employee's Name	Occupation	Date of injury or onset of illness	Where the event occurred	Description of Injury or Illness (Injury Nature - Body Part), parts of body affected, and object/substance that directly injured or made person ill	Using these four categories, check ONLY the most serious results for each case				Enter the number of days the injured or ill worker was:		Check the injury column or choose one type of illness:				
						Death	Days away from work	Remained at work		On job transfer or restriction	Away from work	Injury	Skin disorder	Respiratory conditio	Poisoning	All other illnesses
								Job Transfer or restriction	Other recordable							
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(1)	(2)	(3)	(4)	(5)
					TOTALS:	**0**	**5**	**5**	**33**	**77**	**16**	**29**	**2**	**0**	**0**	**12**
									43							**43**

Certification of Summary Totals By _____ Title _____ Date _____

OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

Year 2004

U.S. Department of Labor
Occupational Safety & Health Administration

You must record information about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an injury and illness incident report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Form approved OMB no. 1218-0176

Establishment name	**CH2M HILL, Inc. (INC)**

City	**Englewood**	State	**CO**

Identify the person			**Describe the case**			**Classify the case** (CHECK ONLY ONE box for each case based on the most serious outcome for that case:)				Enter the # of days the worker was:		Check the "injury" column or choose one type of illness:					
								Remained at work									
(A) Case No.	(B) Employee's Name	(C) Job Title (e.g., Welder)	(D) Date of injury/ illness (mo./day)	(E) Where the event occurred (e.g. Loading dock N. end)	(F) Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill	(G) Death	(H) Days away from work	(I) Job transfer or restriction	(J) Other record-able cases	(K) Away From Work (days)	(L) On job transfer or restriction (days)	(1) Injury	(2) Skin Disorder	(3) Respiratory Condition	(4) Poisoning	(5) Hearing Loss	(6) All other illnesses
1171		Associate Engineer	Jan-04	UOSA Project 54	Knee Damage-Knee(s)				1	0	0	1					
1175		Project Scientist 1	Feb-04	SCO	Receive 2 Diagnosis: 1) lumbar strain 2)slipped disk & pinched nerve-Back				1	0	0	1					
1186		Project Assistant 2	Feb-04	SCO	Strain/Sprain-Back			1		0	7	1					
1190		Project Assistant 3	Mar-04	SEA	Strain/Sprain-Back		1			5	0	1					
1196		Staff Engineer 2	Mar-04	Johnston Atoll Revegitation	Cut/Laceration-Finger(s)				1	0	0	1					
1191		Sr. Help Desk Coordinator	Mar-04	SAC	Strain/Sprain-Multiple (Specify)				1	0	0	1					
1208		Office Serv Asst 1	Mar-04	Other	Pain in lower back-Back		1			40	0	1					
1202		Assoc. Resident Rep.	Mar-04	Redlands Water Recycle	Cut/Laceration-Leg(s)		1			180	0	1					
1207		Project Accountant 3	Mar-04	ASW	Strain/Sprain-Arm(s) Multiple				1	0	0						1
1215		Accounting Support 2	Apr-04	WDC	Multiple (Specify)-Multiple (Specify)				1	0	0	1					
1224		Staff Engineer 1	May-04	MKE	Wrist Pain-Wrist(s)				1	0	0						1
1246		Project Accountant 3	Jun-04	ASW	Wrist Pain-Wrist(s)				1	0	0						1
1259		Project Accountant 3	Jul-04	WDC	Tendonitis-Shoulder(s)				1	0	0						1
1258		Administrative Assistant 2	Jul-04	CSG	Was diagnosed as a pinched nerve-Back				1	0	0	1					
1267		IS Consultant	Jul-04	Other	Fracture-Shoulder(s)		1			39	0	1					
1274		Environmental Technologist 2	Jul-04	TO 147 GW HYDRO INVE	Strain/Sprain-Elbow(s)			1		0	6	1					
1284		Associate GIS Developer	Aug-04	G O Base	Torn Achilles Tendon-Ankle(s)				1	0	0	1					
1280		Staff Scientist 1	Aug-04	Performance Samples	Burn (Chemical)-Arm(s) Multiple				1	0	0	1					
1281		Technical Aide 3	Aug-04	USEPA Penta Wood Superfund Site	Tendonitis-Elbow(s)			1		0	119						1
1287		Survey Technician 1	Aug-04	Raw Water Pipeline	Allergic reaction-ankles, eyelids, forearms				1	0	0	1					
1303		Staff Engineer 2	Aug-04	SFO	Left arm-Arm(s) Multiple				1	0	0						1
1301		Staff Engineer 2	Sep-04	SFO	Strain/Sprain-Multiple (Specify)				1	0	0	1					
1289		Cor Accounts Payable	Sep-04		Multiple (Specify)-Back				1	0	0						1

OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

Year 2004

U.S. Department of Labor
Occupational Safety & Health Administration

Form approved OMB no. 1218-0176

You must record information about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an injury and illness incident report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Establishment name	CH2M HILL, Inc. (INC)		
City	Englewood	State	CO

Identify the person			Describe the case			Classify the case											
						CHECK ONLY ONE box for each case based on the most serious outcome for that case:				Enter the # of days the worker was:		Check the "injury" column or choose one type of illness:					
(A)	(B)	(C)	(D)	(E)	(F)			Remained at work									
Case No.	Employee's Name	Job Title (e.g., Welder)	Date of injury/ illness (mo./day)	Where the event occurred (e.g. Loading dock N. end)	Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill	Death	Days away from work	Job transfer or restriction	Other record-able cases	Away From Work (days)	On job transfer or restriction (days)	Injury (M	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other illnesses
						(G)	(H)	(I)	(J)	(K)	(L)	(1)	(2)	(3)	(4)	(5)	(6)
1300		Senior Project Mgr	Sep-04	Other	Bruised buttocks				1	0	0	1					
1304		Employee Relations Mgr	Sep-04	Other	Multiple (Specify)-Wrist(s)				1	0	0						1
1307		Admin Asst 3	Sep-04	IDF	Strain/Sprain-Back			1		0	13	1					
1312		Project Engineer 1	Oct-04	Sloan Channel CM	Wrist Pain-Wrist(s)				1	0	0	1					
1335		Office Tech. Coordinator	Nov-04	SAN	Hernia-groin area				1	0	0	1					
1327		Project Manager (PM)	Nov-04	Engineering Support	Irritation to eye-Eye(s)				1	0	0	1					
1329		Associate Engineer	Nov-04	SCO	Pain in shoulders and neck from time working on the computer.				1	0	0	1					
1338		Senior Project Manager	Nov-04	Red Beach Wetland Delineation	Allergic reaction-Multiple (Specify)				1	0	0		1				
1340		Associate Resident Rep.	Nov-04	Inspection	Fracture-Ankle(s)		1			1	0	1					
1341		Telecom Tech Director	Nov-04	COR	Fracture-Wrist(s)			1		0	7	1					
1342		Project Consultant 1	Dec-04	In Transit	Multiple (Specify)-Back		1			14	14	1					
1348		Staff Inspector 1	Dec-04	DEN	Muscle Spasms-Back				1	0	0	1					
					Page totals:	0	6	5	24	279	166	26	1	0	0	0	8
												Injury	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other illnesses
												(1)	(2)	(3)	(4)	(5)	(6)

Public reporting burden for this collection of information is estimated to average 14 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistics, Room N-3644, 200 Constitution Ave, NW, Washington, DC 20210. Do not send the completed forms to this office.

Be sure to transfer these totals to the Summary page (Form 300A) before you post it.

OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

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Year 2005

U.S. Department of Labor
Occupational Safety & Health Administration

Form approved OMB no. 1218-0176

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Establishment name	CH2M HILL,INC		
City	Englewood	State	CO

Identify the person			Describe the case			Classify the case				Enter the # of days the worker was:		Check the "injury" column or choose one type of illness:					
						CHECK ONLY ONE box for each case based on the most serious outcome for that case:											
(A)	(B)	(C)	(D)	(E)	(F)			Remained at work									
Case No.	Employee's Name	Job Title (e.g., Welder)	Date of injury/ illness (mo./day)	Where the event occurred (e.g. Loading dock N. end)	Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill	Death	Days away from work	Job transfer or restriction	Other record-able cases	Away From Work (days)	On job transfer or restriction (days)	Injury (M	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other Illnesses
						(G)	(H)	(I)	(J)	(K)	(L)	(1)	(2)	(3)	(4)	(5)	(6)
1384		Facilities Ops Supv 2	2/7	Facilities rental	Strain/Sprain-Back				1	0	0	1					
1382		Staff Engineer 2	2/11	Geotechnical Investigation	Allergic reaction-Face				1	0	0		1				
1383		Associate Proj. Mgr	2/23	SCO	Wrist Pain-Wrist(s)				1	0	0						1
1400		Regional BD & Planning Mgr	3/9	In Transit	Multiple (Specify)-Chest/Ribs				1	0	0	1					
1399		Facilities Ops. Lead	3/14	SAC	Strain/Sprain-Multiple (Specify)		1			2	3	1					
1392		Project Gis Developer	3/15		Wrist Pain-Wrist(s)				1	0	0						1
1401		Project Manager	3/17	Microturbine & Gas	Cut/Laceration-Finger(s)				1	0	0	1					
1398		Corp. Accounts	3/17	COR	Strain/Sprain-Body System				1	0	0						1
1414		HR Assistant	4/5	COR	Numbness, tingling, hottness-Hand (s)				1	0	0						1
1427		Administrative Assistant 3	4/20	PDX	Fracture-Leg(s)		1			40	10	1					
1438		Facilities Ops. Assist. 3	4/26	COR	possible hernia-Abdomen		1			12	0	1					
1433		Senior Help Desk Coord.	4/26	SAC	Strain/Sprain-Wrist(s)				1	0	0	1					
1432		Accounting Support 1	4/28	COR	Wrist Pain-Wrist(s)				1	0	0						1
1495		Project Scientist	5/13	SWMU 5 Ecorisk Assessment	Strain/Sprain-Knee(s)				1	0	0	1					
1439		Regional Contracts Mgr	5/24	In Transit	Broke fingers & R kneecap			1		0	21	1					
1458		Recruiting Specialist	6/1	RDD	Wrist Pain-Wrist(s)				1	0	0						1
1465		Contracts Specialist	6/14	VBO	Bruise/Contusion/Abrasion-Knee(s)				1	0	0	1					
1469		Project Assistant	6/15	KNX	Strain/Sprain-Ankle(s)				1	0	0	1					
1476		Project Manager	6/16	SAN	Carpal Tunnel-Hand (s)				1	0	0						1
1472		Accounting Support	6/21	COR	Wrist Pain-Wrist(s)				1	0	0						1
1477		Project Engineer	6/22	In Transit	Multiple (Specify)-Multiple (Specify)		1			12	0	1					
1481		Staff Scientist	6/30	Upper Columbia River	Strain/Sprain-Back				1	0	0	1					
1488		Associate Surveyor	7/6	LF-05 Wetland Surveying and Work Plan	Cut/Laceration-Finger(s)				1	0	0	1					

OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

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Year 2005

U.S. Department of Labor
Occupational Safety & Health Administration

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Form approved OMB no. 1218-0176

Establishment name	CH2M HILL,INC		
City	Englewood	State	CO

Identify the person			Describe the case			Classify the case											
						CHECK ONLY ONE box for each case based on the most serious outcome for that case:				Enter the # of days the worker was:		Check the "injury" column or choose one type of illness:					
(A)	(B)	(C)	(D)	(E)	(F)			Remained at work									
Case No.	Employee's Name	Job Title (e.g., Welder)	Date of injury/ illness (mo./day)	Where the event occurred (e.g. Loading dock N. end)	Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill	Death	Days away from work	Job transfer or restriction	Other record-able cases	Away From Work (days)	On job transfer or restriction (days)	Injury (M	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other Illnesses
						(G)	(H)	(I)	(J)	(K)	(L)	(1)	(2)	(3)	(4)	(5)	(6)
1485		Software Architect	7/7	DEN	Wrist Pain-Multiple (Specify)				1	0	0	1					
1519		Project Consultant	8/10	SDO	Pain L arm & R wrist				1	0	0	1					
1518		Staff Consultant	8/10	PI-7 site reconnaissance	Allergic reaction-Arm(s) Multiple				1	0	0	1					
1526		Staff Scientist	8/15	City of Alexandria Stream Assessment Project	Cut/Laceration-Leg(s)				1	0	0	1					
1547		Administrative Assistant	8/18	DEN	Strain/Sprain-Upper Arm(s)		1			25	180	1					
1525		HS&E Professional	8/18	PI-7 Site Survey (East Vieques)	Allergic reaction-Face				1	0	0		1				
1630		Facilities Ops. Assist.	9/1	WDC	Sever Lower Back Pains-Back		1			23	0	1					
1542		Staff Engineer	9/10	BAO	Wrist Pain-Wrist(s)		1			30	0	1					
1594		Staff Scientist	9/23	Groundwater Monitoring	Allergic reaction-Arm(s) Multiple				1	0	0		1				
1572		Facilities Ops. Assist.	9/27	PDX	Foreign Body in Eye-Eye(s)				1	0	0	1					
1571		Administrative Assistant	9/29	SDO	Strain/Sprain-Multiple (Specify)			1		0	7	1					
1588		Senior HR Assistant	10/10	WDC	Irritation to eye-Eye(s)				1	0	0	1					
1621		EP02	11/1	Detail manhole inspection	Strain/Sprain-Back		1			3	0	1					
1629		Corp. Accounts	11/14	DEN	Tendonitis-Wrist(s)				1	0	0						1
1634		PC Systems Support	11/14	BAO	Cut/Laceration-Wrist(s)				1	0	0	1					
1600		Intern	11/15	ASW	Strain/Sprain-Shoulder(s)			1		0	1	1					
1614		Staff Engineer	11/18	BAO	Wrist Pain-Multiple (Specify)			1		0	24	1					
1702		Project Tech. Leader	11/19	In Transit	Sprained tendon-Hand (s)				1	0	0	1					
1643		Associate Scientist	11/20	Katrina & Rita Debris Removal QA	Neck pain				1	0	0	1					
1685		Environmental Technologist	12/21	GW Investigation	Puncture-Knee(s)				1	0	0	1					
1689		Facilities Ops. Assist.	12/22	DEN	Wrist Pain-Wrist(s)				1	0	0						1
					Page totals:	0	8	4	32	147	246	31	3	0	0	0	10

OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

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Year 2005

U.S. Department of Labor
Occupational Safety & Health Administration

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Form approved OMB no. 1218-0176

Establishment name	**CH2M HILL,INC**		
City	**Englewood**	State	**CO**

Identify the person			**Describe the case**			**Classify the case**											
						CHECK ONLY ONE box for each case based on the most serious outcome for that case:				Enter the # of days the worker was:		Check the "injury" column or choose one type of illness:					
(A)	(B)	(C)	(D)	(E)	(F)			**Remained at work**									
Case No.	Employee's Name	Job Title (e.g., Welder)	Date of injury/ illness (mo./day)	Where the event occurred (e.g. Loading dock N. end)	Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill	Death	Days away from work	Job transfer or restriction	Other record-able cases	Away From Work (days)	On job transfer or restriction (days)	Injury (M	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other illnesses
						(G)	(H)	(I)	(J)	(K)	(L)	(1)	(2)	(3)	(4)	(5)	(6)

Public reporting burden for this collection of information is estimated to average 14 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistics, Room N-3644, 200 Constitution Ave, NW, Washington, DC 20210. Do not send the completed forms to this office.

Be sure to transfer these totals to the Summary page (Form 300A) before you post it.

	Injury	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other illnesses
Page 2 of 2	(1)	(2)	(3)	(4)	(5)	(6)

CH2MHILL

Attachment 2: EMPLOYEE SIGNOFF FORM

Health and Safety Plan

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

Project Name: Former St. Louis Ordnance Plan **Project Number:** 364298

EMPLOYEE NAME (Please print)	EMPLOYEE SIGNATURE	COMPANY	DATE

CH2MHILL

Attachment 3: Project-Specific Chemical Product Hazard Communication Form

This form must be completed prior to performing activities that expose personnel to hazardous chemicals products. Upon completion of this form, the SSHO shall verify that training is provided on the hazards associated with these chemicals and the control measures to be used to prevent exposure to CH2M HILL and subcontractor personnel. Labeling and MSDS systems will also be explained.

Project Name: Former St. Louis Ordnance Plan **Project Number:** 364298

MSDSs will be maintained at the following locations: Field Vehicle

Hazardous Chemical Products Inventory

Chemical	Quantity	Location	MSDS Available	Container labels	
				Identity	Hazard
Methane	1 liter, compressed	Support Zone			
Isobutylene	1 liter, compressed	Support Zone			
Pentane	1 liter, compressed	Support Zone			
Hydrochloric acid	< 500 ml	Support Zone / sample bottles			
Nitric acid	< 500 ml	Support Zone / sample bottles			
Sulfuric Acid	< 500 ml	Support Zone / sample bottles			
Sodium hydroxide	< 500 ml	Support Zone / sample bottles			
Methanol	< 1 Gallon	Support/Decon Zones			
Hexane	< 1 Gallon	Support/Decon Zones			
pH buffers	< 500 ml	Support Zone			
MSA Sanitizer	< 1 liter	Support/Decon Zones			
Alconox/Liquinox	< 1liter	Support/Decon Zones			

CH2MHILL

Attachment 4: CHEMICAL-SPECIFIC TRAINING FORM

Location:	Project #: 364298
HCC:	Trainer:

TRAINING PARTICIPANTS:

NAME	SIGNATURE	NAME	SIGNATURE

REGULATED PRODUCTS/TASKS COVERED BY THIS TRAINING:

The HCC shall use the product MSDS to provide the following information concerning each of the products listed above.

☐ Physical and health hazards

☐ Control measures that can be used to provide protection (including appropriate work practices, emergency procedures, and personal protective equipment to be used)

☐ Methods and observations used to detect the presence or release of the regulated product in the workplace (including periodic monitoring, continuous monitoring devices, visual appearance or odor of regulated product when being released, etc.)

Training participants shall have the opportunity to ask questions concerning these products and, upon completion of this training, will understand the product hazards and appropriate control measures available for their protection.

Copies of MSDSs, chemical inventories, and CH2M HILL's written hazard communication program shall be made available for employee review in the facility/project hazard communication file.

Attachment 5: Emergency Contacts

24-hour CH2M HILL Emergency Beeper – 720-286-4911
CH2M HILL Occupational Health Nurse – 800-756-1130

Medical Emergency **911**
Facility Medical Response #: 911
Local Ambulance #: 911

Fire/Spill Emergency **911**
Facility Fire Response #: 911
Local Fire Dept #: 911

Local Occupational Physician
N/A

Security & Police **911**
Facility Security #: 911
Local Police #: 911

Corporate Director Health and Safety
Name: Andy Strickland/COR
Phone: 303-771-0952

Utilities Emergency
Water: 1-800-DIG-RITE
Gas: 1-800-DIG-RITE
Electric: 1-800-DIG-RITE

Regional Health and Safety Manager (HSM)
Name: Steve Beck
Phone: 414-272-1052 x277

Regional Environmental Manager
Linda Hickok/SYR
315-422-7250 x229

Designated Safety Coordinator
Name: TBD
Phone: TBD

Corporate Human Resources Department
Name: John Monark/COR
Phone: 303-771-0900

Project Manager
Name: Chris English
Phone: 314-335-3012

Worker's Compensation and Auto Claims
Contact Local HR Dept – After hours contact Albert Jerman 303-741-5927

Federal Express Dangerous Goods Shipping
Phone: 800-238-5355

CH2M HILL Emergency Number for Shipping Dangerous Goods
Phone: 800-255-3924

Automobile Accidents
Rental: Linda Anderson/DEN 720-286-2401
CH2M HILL Vehicle:
Zurich American Insurance 800-987-3373

Contact the project manager. Generally, the project manager will contact relevant government agencies.

Facility Alarms: None

Evacuation Assembly Area: Fleet Vehicle

Facility/Site Evacuation Route(s): TBD onsite

Hospital Name/Address:
Kindred Hospital-St. Louis
4930 Lindell Blvd
Saint Louis, MO 63018

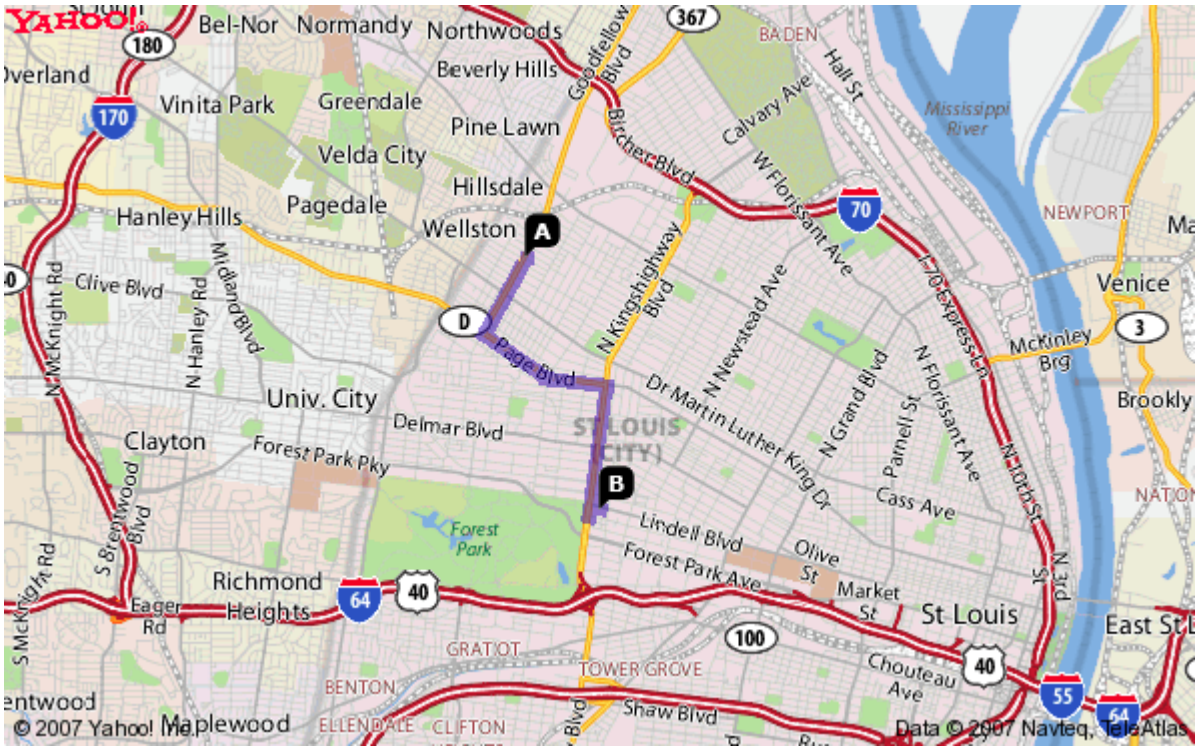
Hospital Phone #: 314-361-8700

Directions to Hospital

[2701-2729] GOODFELLOW BLVD, ST LOUIS, MO

1.	Start at **[2701-2729] GOODFELLOW BLVD, ST LOUIS** going toward **KENNERLY AVE**	go **0.8** mi	0.8 mi
2.	Turn **LEFT** on **PAGE BLVD(MO-D)**	go **1.3** mi	2.1 mi
3.	Turn **RIGHT** on **N KINGSHIGHWAY BLVD**	go **1.2** mi	3.3 mi
4.	Make a U-Turn at **W PINE BLVD** onto **N KINGSHIGHWAY BLVD**	go **0.1** mi	3.4 mi
5.	Turn **RIGHT** on **LINDELL BLVD**	go **< 0.1** mi	3.4 mi
6.	Arrive at **4930 LINDELL BLVD, ST LOUIS,** on the **RIGHT**		

4930 LINDELL BLVD, ST LOUIS, MO



Attachment 6
Project H&S Forms and Permits

CH2MHILL

Activity Hazard Analysis

Activity:	**Date:**
	Project:
Description of the work:	**Site Supervisor:**
	Site Safety Officer:
	Review for latest use: **Before the job is performed.**

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	Potential Health and Safety Hazards (Analyze each principal step for potential hazards)	Hazard Controls (Develop specific controls for each potential hazard)

Activity Hazard Analysis

Equipment to be used (List equipment to be used in the work activity)	Inspection Requirements (List inspection requirements for the work activity)	Training Requirements (List training requirements including hazard communication)

Activity Hazard Analysis

	PRINT NAME	SIGNATURE	
Supervisor Name:	_____	_____	**Date/Time:**_____
Safety Officer Name:	_____	_____	**Date/Time:**_____
Employee Name(s):	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____

CH2MHILL

Initial Medical Treatment Form

To be completed by CH2M HILL Supervisor – Send with employee visiting medical facility or forward within 24 hours.

Employee name: _____Date of Injury:_____

Supervisor: _____ HS Representative:_____

Visit Authorized by: _____Phone #;_____

CH2M HILL Workers Compensation Administrator: Cambridge

Send Bills to: CH2M HILL
Attn: Jennifer Rindahl
P.O. Box 22508
Denver, Colorado 80222-0508

To be completed by medical provider:

Physician's name: _____ Phone #: _____

Address: _____

CH2M HILL employee: _____ has been treated for:_____

It is the policy of CH2M HILL to provide temporary modified duty whenever possible for employees with physical restrictions resulting from an occupational injury or illness.

☐ Released to full duty

☐ Released to restricted duty only (list restrictions below)

☐ Out of work until _____(date)

Please list any physical restrictions:
_____
_____

Expected duration of restricted duty? _____

CH2M HILL would like the best and most efficient care extended to all our employees. Please recommend over-the-counter (OTC) medication as a suitable alternative when medically feasible.

☐ Prescribed medication:_____

☐ Recommended OTC alternative:_____

Date of follow-up appointment:_____

Physician's signature: _____ Date: _____

Please return this form to the injured employee and FAX to Health Resources at 1-800-853-2641. If you want to discuss the employee's work restrictions, please call the person listed in the "Visit Authorized by" field

Attachment 7
Project Activity Self-Assessment Checklists

CH2MHILL

HS&E Self-Assessment Checklist - DRILLING

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

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

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

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

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

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

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

SECTION 1 - SAFE WORK PRACTICES (4.1)

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

SECTION 2 - SUPPORT FUNCTIONS (4.2)

FORMS/PERMITS (4.2.1)

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

UTILITY LOCATING (4.2.2)

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

SECTION 2 (Continued)

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

SECTION 4

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

Item #	Corrective Action Planned/Taken	Date Corrected

HS&E Self-Assessment Checklist – EXCAVATIONS

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

This checklist is to be used at locations where: (1) CH2M HILL employees enter excavations (complete Sections 1 and 3), and/or (2) CH2M HILL oversight of an excavation subcontractor is required (complete entire checklist).

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

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposures to excavation hazards
☐ Evaluate a CH2M HILL subcontractor's compliance with excavation HS&E requirements
Subcontractor Name: _____

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

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HSE-32.

SECTION 1	Yes	No	N/A	N/O
EXCAVATION ENTRY REQUIREMENTS (4.1)				
1. Personnel have completed excavation safety training	☐	☐	☐	☐
2. Competent person has completed daily inspection and has authorized entry	☐	☐	☐	☐
3. Personnel are aware of entry requirements established by competent person	☐	☐	☐	☐
4. Protective systems are free from damage and in stable condition	☐	☐	☐	☐
5. Surface objects/structures secured from falling into excavation	☐	☐	☐	☐
6. Potential hazardous atmospheres have been tested and found to be at safe levels	☐	☐	☐	☐
7. Precautions have been taken to prevent cave-in from water accumulation in the excavation	☐	☐	☐	☐
8. Personnel wearing appropriate PPE, per HSP/FSI	☐	☐	☐	☐

SECTION 2	Yes	No	N/A	N/O
GENERAL (4.2.1)				
9. Daily safety briefing/meeting conducted with personnel	☐	☐	☐	☐
10. Excavation and protective systems adequately inspected by competent person	☐	☐	☐	☐
11. Defective protective systems or other unsafe conditions corrected before entry	☐	☐	☐	☐
12. Guardrails provided on walkways over excavation 6' (1.8m) or deeper	☐	☐	☐	☐
13. Barriers provided at excavations 6' or deeper when excavation not readily visible	☐	☐	☐	☐
14. Barriers or covers provided for wells, pits, shafts, or similar excavation 6' (1.8 m) or deeper	☐	☐	☐	☐
15. Earthmoving equipment operated safely (use earthmoving equipment checklist in HS-27)	☐	☐	☐	☐
PRIOR TO EXCAVATING (4.2.2)				
16. Dig permit obtained where required by client/facility	☐	☐	☐	☐
17. Location of underground utilities and installations identified	☐	☐	☐	☐
18. Excavation area evaluated for OE/UXO hazards	☐	☐	☐	☐
19. Soils characterized prior to excavation where contamination may be present	☐	☐	☐	☐
20. USDA (or local equivalent) soil permit obtained for soil transport, where required	☐	☐	☐	☐
21. Excavation area checked for wetlands, endangered species, cultural/historic resources	☐	☐	☐	☐
22. ACOE/CWA 404 (or local equivalent) permit obtained for wetlands, where required	☐	☐	☐	☐
23. Stockpile management plan prepared	☐	☐	☐	☐
24. Waste discharge/NPDES (or local equivalent) permit obtained for excavation dewatering	☐	☐	☐	☐
25. Stormwater pollution prevention or erosion & sediment control plan prepared, where required)	☐	☐	☐	☐
EXCAVATING ACTIVITIES (4.2.3)				
26. Rocks, trees, and other unstable surface objects removed or supported	☐	☐	☐	☐
27. Exposed underground utility lines supported	☐	☐	☐	☐
28. Undermined surface structures supported or determined to be in safe condition	☐	☐	☐	☐
29. Warning system used to remind equipment operators of excavation edge	☐	☐	☐	☐
30. Stockpile, excavation covers, liners, silt fences in place, where required	☐	☐	☐	☐
31. Fugitive dust suppressed	☐	☐	☐	☐
EXCAVATION ENTRY (4.2.4)				
32. Trenches > 4' (1.2 m) deep provided with safe means of egress within 25' (7.6 m)	☐	☐	☐	☐
33. Structure ramps designed and approved by competent person	☐	☐	☐	☐
34. Potential hazardous atmospheres tested prior to entry	☐	☐	☐	☐
35. Rescue equipment provided where potential for hazardous atmospheres exists	☐	☐	☐	☐
36. Ventilation used to control hazardous atmospheres and air tested frequently	☐	☐	☐	☐
37. Appropriate respiratory protection used when ventilation does not control hazards	☐	☐	☐	☐
38. Precautions taken to prevent cave-in from water accumulation in excavation	☐	☐	☐	☐
39. Precautions taken to prevent surface water from entering excavation	☐	☐	☐	☐
40. Protection provided from falling/rolling material from excavation face	☐	☐	☐	☐
41. Spoil piles, equipment, materials restrained or kept at least 2' (61 cm) from excavation edge	☐	☐	☐	☐
EXCAVATION PROTECTIVE SYSTEMS (4.2.5)				
42. Protective systems used for excavations 5' (1.5 m) or deeper, unless stable rock	☐	☐	☐	☐
43. Protective systems for excavation deeper than 20' (6.1 m) designed by registered PE	☐	☐	☐	☐
44. If soil unclassified, maximum allowable slope is 34 degrees	☐	☐	☐	☐
45. Protective systems free from damage	☐	☐	☐	☐
46. Protective system used according to manufacturer's recommendations and not subjected to loads exceeding design limits	☐	☐	☐	☐
47. Protective system components securely connected to prevent movement or failure	☐	☐	☐	☐
48. Cave-in protection provided while entering/exiting shielding systems	☐	☐	☐	☐
49. Personnel removed from shielding systems when installed, removed, or vertical movement	☐	☐	☐	☐

SECTION 2 (Continued)	Yes	No	N/A	N/O
PROTECTIVE SYSTEM REMOVAL AND BACKFILLING (4.2.6)				
50. Protective system removal starts and progresses from excavation bottom	☐	☐	☐	☐
51. Protective systems removed slowly and cautiously	☐	☐	☐	☐
52. Temporary structure supports used if failure of remaining components observed	☐	☐	☐	☐
53. Backfilling taking place immediately after protective system removal	☐	☐	☐	☐
54. Backfill certified clean when required by client or local regulation	☐	☐	☐	☐
EXCAVATING AT HAZARDOUS WASTE SITES (4.2.7)				
55. Waste disposed of according to HSP and RCRA regulations	☐	☐	☐	☐
56. Appropriate decontamination procedures being followed, per HSP	☐	☐	☐	☐
EXCAVATING AT POTENTIAL ORDNANCE EXPLOSIVES SITES (4.2.8)				
57. OE plan prepared and approved	☐	☐	☐	☐
58. OE/UXO avoidance provided, routes and boundaries cleared and marked	☐	☐	☐	☐
59. Personnel remain inside the marked boundary	☐	☐	☐	☐
60. Earthmoving equipment does not excavate closer than 1’ (30.5 cm) to anomalies	☐	☐	☐	☐

SECTION 3

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

Item #	Corrective Action Planned/Taken	Date Corrected

CH2MHILL

H&S Self-Assessment Checklist - FORKLIFTS

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

This checklist is to be used at locations where: 1) CH2M HILL employees are potentially exposed to hazards associated with forklift operations, 2) CH2M HILL employees are operating forklifts, and/or 3) CH2M HILL provides oversight of a subcontractor operating forklifts.

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

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposures to forklift hazards (Complete Section 1).
☐ Evaluate CH2M HILL employees operating forklifts (Complete entire checklist).
☐ Evaluate a CH2M HILL subcontractor's compliance with forklift safety requirements (Complete entire checklist).
Subcontractor's Name: _____

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

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HS-48.

SAFE WORK PRACTICES (3.1) **SECTION 1**	**Yes**	**No**	**N/A**	**N/O**
1. Personnel maintaining safe distance from operating forklifts.	☐	☐	☐	☐
2. Positioning personnel in proximity to operating forklifts is avoided.	☐	☐	☐	☐
3. Personnel wearing high-visibility vests when close to operating forklifts.	☐	☐	☐	☐
4. Personnel approach operating forklifts safely.	☐	☐	☐	☐
5. Personnel only riding in seats equipped with seat belts.	☐	☐	☐	☐
6. Personnel not lifted or lowered by forklift unless approved for such use.	☐	☐	☐	☐
7. Personnel not positioned under elevated loads or forks.	☐	☐	☐	☐
8. Personnel do not place body between mast uprights or outside running lines during operation.	☐	☐	☐	☐
9. Personnel do not touch or approach forklift that has become electrically energized.	☐	☐	☐	☐

FORKLIFT SAFETY REQUIREMENTS SECTION 2	Yes	No	N/A	N/O
PRIOR TO OPERATING FORKLIFT (3.2.1)				
10. Only certified personnel operating forklifts.	☐	☐	☐	☐
11. Daily safety briefing/meeting conducted with forklift operators.	☐	☐	☐	☐
12. Daily inspection of forklift conducted and documented.	☐	☐	☐	☐
13. Rated capacity of forklift visible to operator.	☐	☐	☐	☐
14. Modifications and attachments used approved by forklift manufacturer.	☐	☐	☐	☐
15. High-lift forklifts have load backrest and overhead guard.	☐	☐	☐	☐
16. Seat belts are provided and used.	☐	☐	☐	☐
17. Backup alarm or spotter used when backing forklift.	☐	☐	☐	☐
18. Operational horn provided and used as necessary.	☐	☐	☐	☐
19. Braking system capable of stopping capacity load.	☐	☐	☐	☐
20. Forklifts equipped with lights for low-light operations.	☐	☐	☐	☐
21. Carbon monoxide concentrations below PEL (50 ppm).	☐	☐	☐	☐
22. At least one fire extinguisher available at the forklift operating area.	☐	☐	☐	☐
DESIGNATIONS AND LOCATIONS (3.2.2)				
23. Atmosphere/locations classified as hazardous or non-hazardous.	☐	☐	☐	☐
24. Only properly designated forklifts used in hazardous locations.	☐	☐	☐	☐
FORKLIFT LOADING/UNLOADING (3.2.3)				
25. Operator handles only loads within rated capacity, adjusts for long or tall loads.	☐	☐	☐	☐
26. Loads are stabilized before forklift travel.	☐	☐	☐	☐
27. Operator using proper tilt to stabilize load, uses caution when tilting elevated loads.	☐	☐	☐	☐
28. When two forklifts lift a load in unison, operators stay in close communication.	☐	☐	☐	☐
29. Trucks, trailers, railroad cars secured from movement before entering with forklift.	☐	☐	☐	☐
30. Dockplates/bridgeplates secured before use; capacity not exceeded.	☐	☐	☐	☐
31. Truck, trailer, railroad car flooring checked for weakness before forklift boarding.	☐	☐	☐	☐
32. Personnel platforms secured to forklift and shut off means provided on platform.	☐	☐	☐	☐
FORKLIFT TRAVEL (3.2.4)				
33. Forklift operated on safe roadways and grades.	☐	☐	☐	☐
34. Grades ascended/descended properly.	☐	☐	☐	☐
35. Forklift operated at safe speed, kept under control at all times	☐	☐	☐	☐
36. Operators slow down and use horn at areas with obstructed vision.	☐	☐	☐	☐
37. Forklifts operating in reverse when load obstructs vision.	☐	☐	☐	☐
38. Operator keeping clear view of path of travel.	☐	☐	☐	☐
39. Forklifts do not pass other stopped vehicles at areas with obstructed vision.	☐	☐	☐	☐
40. Operators maintain safe distance from edge of ramps and platforms.	☐	☐	☐	☐
41. Overhead clearance maintained from installations.	☐	☐	☐	☐
42. Forklifts not parked within 8 feet of center of railroad tracks. Tracks crossed diagonally.	☐	☐	☐	☐
43. Forklift parked correctly when operator is dismounted.	☐	☐	☐	☐
FORKLIFT MAINTENANCE (3.2.5)				
44. Forklifts with unsafe conditions removed from service and tagged as such to prevent use.	☐	☐	☐	☐
45. Forklifts repaired in designated, non-hazardous locations by authorized personnel.	☐	☐	☐	☐
46. Battery disconnected when repairing electrical systems.	☐	☐	☐	☐
47. Additions or omissions of parts not performed without manufacturer's approval.	☐	☐	☐	☐
48. Good housekeeping maintained on and around forklift.	☐	☐	☐	☐
49. Water mufflers checked daily, kept at 75% full.	☐	☐	☐	☐
50. Forklifts removed from service if sparks, flames, or elevated operating temperatures occur.	☐	☐	☐	☐
51. Suspended forklifts or components are supported prior to work under or between.	☐	☐	☐	☐
52. Fueling/battery charging conducted in designated, well-ventilated area.	☐	☐	☐	☐
53. Fueling/battery charging areas properly equipped for task.	☐	☐	☐	☐
54. No smoking in fueling/battery charging areas.	☐	☐	☐	☐
55. Spillage of fuel properly cleaned up before starting forklift.	☐	☐	☐	☐

SECTION 3

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

Item #	Corrective Action Planned/Taken	Date Corrected

CH2MHILL

HS&E Self-Assessment Checklist - HAZARDOUS WASTE MANAGEMENT

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

This checklist is to be used at locations where: 1) CH2M HILL employees are potentially exposed to hazards associated with waste management operations (complete Sections 1 and 3), and/or 2) CH2M HILL oversight of a hazardous waste management subcontractor is required (complete entire checklist).

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

Completed checklists shall be sent to the Health and Safety Manager for review.

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposure to hazardous waste.
☐ Evaluate a CH2M HILL subcontractor's compliance with the hazardous waste management requirements.
Subcontractors Name: _____

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

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HS-80.

SECTION 1

	Yes	No	N/A	N/O
PERMITS AND NOTIFICATIONS (7.0)				
1. Client site has an EPA ID Number or RCRA permit.	☐	☐	☐	☐
2. CH2M activities comply with client's RCRA permit.	☐	☐	☐	☐
ACCUMULATION (8.0)				
3. LQG — accumulates hazardous waste for up to 90 days.	☐	☐	☐	☐
4. SQG — accumulates hazardous waste for up to 180 days.	☐	☐	☐	☐
5. CESQGs — no limit on accumulation unless it exceeds 1,000kg.	☐	☐	☐	☐
CONTAINERS (8.1)				
6. Hazardous wastes are packaged according to DOT requirements.	☐	☐	☐	☐
7. Container inspections are documented in writing using the Container Inspection Checklist.	☐	☐	☐	☐

SECTION 2	Yes	No	N/A	N/O
MARKING AND LABELING (8.2)				
Uncharacterized Waste (8.2.1)				
8. Containers of unknown wastes are marked with a description of the contents.	☐	☐	☐	☐
9. The accumulation start date is marked on the container.	☐	☐	☐	☐
10. Containers are marked with a unique identifier.	☐	☐	☐	☐
11. Non-classified label used for unclassified waste.	☐	☐	☐	☐
Non-Hazardous Waste (8.2.2)				
12. All containers must be marked an labeled, including non-regulated waste.	☐	☐	☐	☐
13. Non-Hazardous Waste label includes generator name, address, and description of waste.	☐	☐	☐	☐
Hazardous Waste (8.2.3)				
14. Hazardous waste identified with yellow Hazardous Waste label.	☐	☐	☐	☐
15. The accumulation start date marked and visible on the container.	☐	☐	☐	☐
16. Containers labeled according to DOT requirements.	☐	☐	☐	☐
Building/Storage Area Marking (8.2.4)				
17. Hazardous waste storage areas labeled.	☐	☐	☐	☐
ACCUMULATION AREAS (8.3)				
Satellite Accumulation Area (8.3.1)				
18. Up to 55 gal. of hazardous waste or 1 qt. of acutely haz. waste accumulated for unlimited time.	☐	☐	☐	☐
19. Accumulation area at or near the point of generation.	☐	☐	☐	☐
20. Area under control of waste generator.	☐	☐	☐	☐
90-Day Accumulation Area (8.3.2)				
21. Hazardous waste >55 gal. stored for 90 days in managed accumulation area.	☐	☐	☐	☐
22. Accumulation area is used only for storage of waste.	☐	☐	☐	☐
23. Container requirements have been followed.	☐	☐	☐	☐
24. Emergency spill response procedures posted and spill kit available.	☐	☐	☐	☐
25. Fire extinguisher, water supply, telephone, and alarm are located in accumulation area.	☐	☐	☐	☐
26. Emergency shower/eyewash station available, tested and functioning.	☐	☐	☐	☐
27. Accumulation area is locked when authorized personnel are not available.	☐	☐	☐	☐
28. Appropriate signs posted at the entrance.	☐	☐	☐	☐
29. Secondary containment provided for liquid hazardous waste.	☐	☐	☐	☐
30. Weekly inspections logged into book using Accumulation Area Inspection Log Sheet.	☐	☐	☐	☐
31. "NO SMOKING OR OPEN FLAME" signs posted.	☐	☐	☐	☐
32. Prior to closure all containers, liners, or containment devices removed or decontaminated.	☐	☐	☐	☐
CONTINGENCY PLAN AND EMERGENCY PROCEDURES (9.0)				
33. Contingency plans and emergency procedures have been incorporated in work plans.	☐	☐	☐	☐
TRAINING (10.0)				
34. Personnel handling hazardous waste have appropriate training.	☐	☐	☐	☐

SECTION 3	Yes	No	N/A	N/O
OFFSITE DISPOSAL (11.0)				
35. Disposal facilities identified using the procedures in HSE-79.	☐	☐	☐	☐
36. Disposal facilities evaluated under Waste Subcontractor Qualification Procedure in HSE-84.	☐	☐	☐	☐
37. Waste characterization, sampling, and analysis procedures in HSE-79 followed.	☐	☐	☐	☐
Evaluate Land Disposal Restrictions (11.3)				
Identification of Treatment Standards (11.3.1)				
38. Waste characterized and waste codes determined.	☐	☐	☐	☐
39. LDR exemptions identified.	☐	☐	☐	☐
40. Alternate treatment standards evaluated.	☐	☐	☐	☐
41. Waste determined to be wastewater or non-wastewater.	☐	☐	☐	☐
42. Treatment standards identified.	☐	☐	☐	☐
43. Universal Treatment Standards (UTS) identified.	☐	☐	☐	☐
Confirm Final Disposal Options (11.4)				
44. Disposal facilities waste profile forms have been completed.	☐	☐	☐	☐
45. Client signatures have been obtained on waste profile forms.	☐	☐	☐	☐
46. Signed waste profile forms and enclosures have been submitted to the disposal facility.	☐	☐	☐	☐
OFFSITE TRANSPORT (12.0)				
47. Transporter has documented H&S and monitoring program and written spill response plan.	☐	☐	☐	☐
48. Transporter is permitted in the state and has disposal facilities listed on their permit.	☐	☐	☐	☐
49. Transporter can service origin and destination state and disposal facility.	☐	☐	☐	☐
50. Transporter can meet proposed shipment schedule.	☐	☐	☐	☐
51. Disposal facility accepted waste and issued approval letter.	☐	☐	☐	☐
Manifesting (12.1)				
52. Manifest and LDR notification/certification form completed.	☐	☐	☐	☐
53. Manifest includes reference no., shipping name, hazard class, ID no., and packaging group.	☐	☐	☐	☐
54. DOT trained staff completed manifest.	☐	☐	☐	☐
55. Manifest is for the state where the waste will be disposed.	☐	☐	☐	☐
56. Pre-shipment manifest review completed.	☐	☐	☐	☐
57. Original signed manifest returned to client within 35 days of ship date.	☐	☐	☐	☐
58. Waste shipments tracked using Waste Tracking Form.	☐	☐	☐	☐
Waste Pickup (12.2)				
59. Signed shipping papers have been delivered to project site.	☐	☐	☐	☐
60. Individual assigned to supervise pickup and ensure transporter signs manifest.	☐	☐	☐	☐
61. Onsite representative must not sign any shipping documents unless authorized under contract.	☐	☐	☐	☐
RECORDKEEPING AND REPORTING (13.0)				
Copies of Waste Profiles (13.1)				
62. Two copies of completed, signed profile forms(s) and documentation for CH and client files.	☐	☐	☐	☐
Copies of Shipping Documents (13.2)				
63. Keep copy of all manifests in project file.	☐	☐	☐	☐
64. Manifest copies distributed to agencies, client and project file.	☐	☐	☐	☐
Recordkeeping (13.2.1)				
Copies of the following documents should be maintained by the client and CH2M HILL for at least 3 years from the date the hazardous waste was accepted by the initial transporter.				
65. Manifests signed by the disposal facility.	☐	☐	☐	☐
66. LDR notification and certification forms (must be retained for 5 years)	☐	☐	☐	☐
67. Biennial reports	☐	☐	☐	☐
68. Exception reports	☐	☐	☐	☐
69. Hazardous waste characterization information.	☐	☐	☐	☐

SECTION 3

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

Item #	Corrective Action Planned/Taken	Date Corrected

Attachment 8
Applicable Material Safety Data Sheets

ALCONOX®

1. Product Identification

Synonyms: Proprietary blend of sodium linear alkylaryl sulfonate, alcohol sulfate, phosphates, and carbonates.
CAS No.: Not applicable.
Molecular Weight: Not applicable to mixtures.
Chemical Formula: Not applicable to mixtures.
Product Codes: A461

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Alconox®	N/A	90 - 100%	Yes

proprietary detergent mixture

3. Hazards Identification

Emergency Overview

CAUTION! MAY BE HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO EYES AND RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 0 - None
Reactivity Rating: 1 - Slight
Contact Rating: 2 - Moderate
Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
May cause irritation to the respiratory tract. Symptoms may include coughing and shortness of breath.
Ingestion:
May cause irritation to the gastrointestinal tract. Symptoms may include nausea, vomiting and diarrhea.

Skin Contact:
No adverse effects expected.
Eye Contact:
May cause irritation, redness and pain.
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
No information found.

4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Wash exposed area with soap and water. Get medical advice if irritation develops.
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 expected to be a fire hazard.
Explosion:
No information found.
Fire Extinguishing Media:
Dry chemical, foam, water or carbon dioxide.
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.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust. When mixed with water, material foams profusely. Small amounts of residue may be flushed to sewer with plenty of water.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Moisture may cause material to cake. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
- OSHA Permissible Exposure Limit (PEL):
15 mg/m3 total dust, 5 mg/m3 respirable fraction for nuisance dusts.
- ACGIH Threshold Limit Value (TLV):
10 mg/m3 total dust containing no asbestos and < 1% crystalline silica for Particulates Not Otherwise Classified (PNOC).

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, a half-face dust/mist respirator may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece dust/mist respirator 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. 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.

Skin Protection:
Wear protective gloves and clean body-covering clothing.

Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
White powder interspersed with cream colored flakes.

Odor:
No information found.

Solubility:
Moderate (1-10%)

Specific Gravity:
No information found.
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
No information found.
Melting Point:
No information found.
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Carbon dioxide and carbon monoxide may form when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
No information found.
Conditions to Avoid:
No information found.

11. Toxicological Information

No LD50/LC50 information found relating to normal routes of occupational exposure.

```
--------\Cancer Lists\-----------------------------------------------------
                                        ---NTP Carcinogen---
Ingredient                              Known    Anticipated    IARC
Category
----------------------------------   -----    -----------    -------------
Alconox®                                 No          No            None
proprietary detergent mixture
```

12. Ecological Information

Environmental Fate:
This product is biodegradable.

Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal 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

Not regulated.

15. Regulatory Information

```
--------\Chemical Inventory Status - Part 1\------------------------------
Ingredient                                          TSCA  EC   Japan
Australia
---------------------------------------------  ----  ---  -----  ---------
Alconox®                                            Yes  No    No       No
proprietary detergent mixture

--------\Chemical Inventory Status - Part 2\------------------------------
                                                          --Canada--
Ingredient                                          Korea  DSL   NDSL  Phil.
---------------------------------------------  -----  ---   ----  -----
Alconox®                                             No    No    Yes    No
proprietary detergent mixture

-------\Federal, State & International Regulations - Part 1\--------------
                                        -SARA 302-    ------SARA 313------
Ingredient                              RQ    TPQ     List  Chemical Catg.
--------------------------------------  ---   -----   ----  --------------
Alconox®                                   No    No      No         No
proprietary detergent mixture

------\Federal, State & International Regulations - Part 2\---------------
                                                     -RCRA-    -TSCA-
Ingredient                                 CERCLA    261.33     8(d)
----------------------------------------  ------     ------    ------
Alconox®                                   No        No         No
proprietary detergent mixture

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

16. Other Information

NFPA Ratings: Health: **0** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
CAUTION! MAY BE HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO EYES AND RESPIRATORY TRACT.
Label Precautions:
Avoid contact with eyes.
Keep container closed.
Use with adequate ventilation.
Avoid breathing dust.
Wash thoroughly after handling.
Label First Aid:
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 case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. In all cases, get medical attention.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 15, 16.

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

NITRIC ACID

SPEX INDUSTRIES INC -- NITRIC ACID BLANK, PLBLK-HN03 -- 6850-00N020537

==========

MSDS Safety Information

==========

FSC: 6850
MSDS Date: 03/04/1988
MSDS Num: BLRMY
LIIN: 00N020537
Tech Review: 08/02/1995
Product ID: NITRIC ACID BLANK, PLBLK-HN03
Responsible Party
Cage: 07977
Name: SPEX INDUSTRIES INC
Address: 3880 PARK AVENUE
City: EDISON NJ 08820 US
Info Phone Number: 201-549-7144
Emergency Phone Number: 201-549-7144
Preparer's Name: LINDA OLCHVARY
Review Ind: N

==========

Contractor Summary

==========

Cage: 07977
Name: SPEX CERTIPREP INC
Address: 203 NORCROSS AVE
City: METUCHEN NJ 08840 US
Phone: 732-549-7144

==========

Ingredients

==========

Cas: 7697-37-2
RTECS #: QU5775000
Name: NITRIC ACID (SARA III)
% by Wt: 5
OSHA PEL: 2 PPM/4 STEL
ACGIH TLV: 2 PPM/4 STEL; 9192
EPA Rpt Qty: 1000 LBS
DOT Rpt Qty: 1000 LBS
Ozone Depleting Chemical: N

==========

Health Hazards Data

==========

LD50 LC50 Mixture: LC50: (INHALE/RAT) 224 PPM(NO2)/30M
Route Of Entry Inds - Inhalation: YES
Skin: YES
Ingestion: YES
Carcinogenicity Inds - NTP: NO
IARC: NO
OSHA: NO
Effects of Exposure: CONC NITRIC ACID MAY BE FATAL IF TOO MUCH IS INHALED/ABSORBED THRU SKIN.CONC NITRIC ACID VAP/MIST IS IRRITANT OF EYES, MUC MEMB & SKIN.IN CONT W/EYES, PRODUCES SEVERE BURNS WHICH MAY

RESULT IN PERMANE NT DMG & VISUAL IMPAIRMENT.ON SKIN, LIQ/CONC VAP PRODUCES IMMED, SEVERE & PENETRATING BURNS; CONC (SEE EFTS OF OVEREXP)
Explanation Of Carcinogenicity: NOT RELEVANT
Signs And Symptoms Of Overexposure: HLTH HAZ: SOLN CAUSES DEEP ULCERS & STAINS SKIN BRIGHT YELLOW/YELLOWISH BROWN COLOR.VAP & MIST MAY ERODE EXPSD TEETH W/PRLNGD EXPOS.INGEST OF LIQ WILL CAUSE IMMED PAIN & BURNS OF MOUTH, ESOPHAGUS & GI TRACT.INHAL MAY BE FATAL CAUSING SPASM,INFLAM & EDEMA OF LARYNX & BRONCHI, CHEM PNEUM & PULM EDEMA. SYMP (SUPP DATA)
Medical Cond Aggravated By Exposure: NONE SPECIFIED BY MANUFACTURER.
First Aid: EYES: FLUSH WITH WATER FOR AT LEAST 15 MINUTES OCCASIONALLY LIFTING UPPER AND LOWER EYELIDS. SKIN: REMOVE CONTAMINATED CLOTHING, THEN FLUSH WITH WATER FOR AT LEAST 15 MINUTES. WASH CLOTHING THOROµGHLY BEFORE REUSE. INHAL: MOVE TO FRESH AIR. IF IRRITATION CONTINUES, CALL MD IMMEDIATELY. INGEST: CALL MD IMMEDIATELY (FP N).
==========
Handling and Disposal
==========
Spill Release Procedures: VENT AREA. DILUTE SPILL W/WATER & NEUT W/ SODA ASH, LIMESTONE, ETC. WIPE UP & PUT IN A SEALED CNTNR FOR PROPER DISP. WASH SPILL SITE OFF W/WATER AFTER MATL PICK UP IS COMPLETE. WEAR CHEM RESISTANT GLA SSES, GLOVES & CLTHG. WEAR NIOSH/MSHA APPRVD RESP.
Neutralizing Agent: SEE SPILL/RELEASE PROCEDURES.
Waste Disposal Methods: CONTACT LOCAL HAZARDOUS OR CHEMICAL WASTE DISPOSAL AGENCY FOR REGULATIONS. DISPOSAL MUST BE IN ACCORDANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS (FP N).
Handling And Storage Precautions: CONCENTRATED NITRIC ACID WILL ATTACK SOME FORMS OF PLASTICS, RUBBER AND COATINGS. STORE AT ROOM TEMPERATURE. KEEP TIGHTLY SEALED WHEN NOT IN USE.
Other Precautions: HAVE IMMEDIATE AVAILABILITY OF AN EYE WASH IN CASE OF EMERGENCY. AVOID INHALATION, INGESTION AND CONTACT WITH EYES AND SKIN.
==========
Fire and Explosion Hazard Information
==========
Flash Point Text: NOT COMBUSTIBLE
Extinguishing Media: APPROPRIATE TO SURROUNDING FIRE CONDITIONS.
Fire Fighting Procedures: WEAR NIOSH/MSHA APPRVD SCBA & FULL PROT EQUIP (FP N). CONC HNO3 REACTS EXPLO W/COMBUST ORG/READILY OXIDIZABLE MATLS SUCH AS; ALCOHOL, WOOD, (SEE SUPP DATA)
Unusual Fire/Explosion Hazard: CONC HNO3 IS NOT COMBUST, BUT IS STRONG OXIDIZER & ITS HEAT OF RXN W/REDUCING AGENTS/COMBUST MAY CAUSE IGNIT. CAN REACT W/METALS TO RELEASE FLAM HYDROGEN GAS.
==========
Control Measures
==========
Respiratory Protection: NIOSH/MSHA APPROVED RESPIRATOR.
Ventilation: USE IN A CHEMICAL FUME HOOD.
Protective Gloves: CHEMICAL RESISTANT GLOVES.
Eye Protection: CHEM WORK GOGG/FULL LENGTH FACESHLD(FPN)
Other Protective Equipment: CHEMICAL RESISTANT CLOTHING. EYE WASH IN CASE OF EMERGENCY AND A LAB COAT. DELµGE SHOWER (FP N).
Work Hygienic Practices: WASH CAREFULLY AFTER USE.
Supplemental Safety and Health: FIRE FIGHT PROC: TURPENTINE/METAL POWDERS/ HYDROGEN SULFIDE/ETC. MATLS TO AVOID: ALCOHOL/WOOD/TURPENTINE, METAL POWDERS/HYDROGEN SULFIDE/ETC. CONT W/STRONG BASES WILL CAUSE VIOLENT SPLATTERING.EFTS OF OVEREXP: INCL BURNING SENSATION, COµGH, WHEEZING, LARYNGITIS, SHORTNESS OF BREATH, HDCH, NAUS & VOMIT.
==========

Physical/Chemical Properties
==========
HCC: C1
Spec Gravity: APPROXIMATELY 1
Solubility in Water: SOLUBLE
Appearance and Odor: TRANSPARENT WITH AN ACRID ODOR.
==========
Reactivity Data
==========
Stability Indicator: YES
Stability Condition To Avoid: ELEVATED TEMPERATURES MAY CAUSE CONTAINERS TO BURST AND LIBERATE TOXIC NOX.
Materials To Avoid: CONC HNO3 IS A POWERFUL OXIDIZING AGENT. IT REACTS EXPLO W/COMBUST ORG/READILY OXIDIZABLE MATLS SUCH AS; (SUPP DATA)
Hazardous Decomposition Products: WILL RELEASE TOXIC NITROGEN OXIDE FUMES AND VAPORS.
Hazardous Polymerization Indicator: NO
Conditions To Avoid Polymerization: NOT RELEVANT
==========
Toxicological Information
==========
==========
Ecological Information
==========
==========
MSDS Transport Information
==========
==========
Regulatory Information
==========
==========
Other Information
==========
==========
Transportation Information
==========
Responsible Party Cage: 07977
Trans ID NO: 25204
Product ID: NITRIC ACID BLANK, PLBLK-HN03
MSDS Prepared Date: 03/04/1988
Review Date: 01/17/1992
Article W/O MSDS: N
Multiple KIT Number: 0
Unit Of Issue: NK
Container QTY: NK
==========
Detail DOT Information
==========
DOT PSN Code: KFD
DOT Proper Shipping Name: NITRIC ACID
DOT PSN Modifier: OTHER THAN RED FUMING, WITH NOT MORE THAN 70 PERCENT NITRIC ACID
Hazard Class: 8
UN ID Num: UN2031
DOT Packaging Group: II
Label: CORROSIVE
Special Provision: B2,B47,B53,T9,T27

Non Bulk Pack: 158
Bulk Pack: 242
Max Qty Pass: FORBIDDEN
Max Qty Cargo: 30 L
Vessel Stow Req: D
Water/Ship/Other Req: 44,66,89,90,110,111
==========
Detail IMO Information
==========
IMO PSN Code: KPF
IMO Proper Shipping Name: NITRIC ACID
IMO PSN Modifier: ,OTHER THAN RED FUMING,ALL CONCENTRATIONS
IMDG Page Number: 8195
UN Number: 2031
UN Hazard Class: 8
IMO Packaging Group: I/II
Subsidiary Risk Label: -
EMS Number: 8-03
MED First Aid Guide NUM: 610
==========
Detail IATA Information
==========
IATA PSN Code: RWI
IATA UN ID Num: 2031
IATA Proper Shipping Name: NITRIC ACID
IATA PSN Modifier: ,OTHER THAN RED FUMING, WITH 20% OR LESS NITRIC ACID
IATA UN Class: 8
IATA Label: CORROSIVE
UN Packing Group: II
Packing Note Passenger: 807
Max Quant Pass: 1L
Max Quant Cargo: 30L
Packaging Note Cargo: 813
==========
Detail AFI Information
==========
AFI PSN Code: RWI
AFI Symbols: T
AFI Proper Shipping Name: NITRIC ACID
AFI PSN Modifier: ,OTHER THAN RED FUMING, WITH LESS THAN 20% NITRIC ACID
AFI Hazard Class: 8
AFI UN ID NUM: UN2031
AFI Packing Group: II
AFI Label: CORROSIVE
Back Pack Reference: A12.11
==========
HAZCOM Label
==========
Product ID: NITRIC ACID BLANK, PLBLK-HN03
Cage: 07977
Company Name: SPEX CERTIPREP INC
Street: 203 NORCROSS AVE
City: METUCHEN NJ
Zipcode: 08840 US
Health Emergency Phone: 201-549-7144
Date Of Label Review: 10/18/1991
Label Date: 10/18/1991

Chronic Hazard IND: N
Eye Protection IND: YES
Skin Protection IND: YES
Signal Word: DANGER
Respiratory Protection IND: YES
Health Hazard: Moderate
Contact Hazard: Severe
Fire Hazard: None
Reactivity Hazard: None
Hazard And Precautions: ACUTE: CORROSIVE & FATAL IF TOO MUCH IS INHALED/ABSORBED THRU SKIN. CAUSES SEVERE EYE BURNS WHICH MAY RESULT IN PERMANENT DMG & VISUAL IMPAIRMENT. CAUSES SKIN BURNS, DEEP ULCERS & YELLOW/YELLOWISH BRO WN STAINS ON SKIN. SWALLOWING LIQ WILL CAUSE IMMEDIATE PAIN & BURNS OF MOUTH, ESOPHAGUS & GI TRACT. INHAL MAY BE FATAL CAUSING SPASM, INFLAM & EDEMA OF LARYNX & BRONCHI, CHEM PNEUMONIA & PULM EDEMA. A VOID INHAL, INGEST & EYE/SKIN CONTACT. CHRONIC EFTS: VAPOR & MIST MAY ERODE EXPOSED TEETH WITH PROLONGED EXPOSURE.

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ISOBUTYLENE

AIRGAS INC -- ISOBUTYLENE-C4H8
==========
MSDS Safety Information
==========
FSC: 6665
NIIN: 01-214-8247
MSDS Date: 01/16/1998
MSDS Num: CLCRL
Product ID: ISOBUTYLENE-C4H8
MFN: 01
Responsible Party
Cage: UO451
Name: AIRGAS INC
Address: 259 RADNOR-CHESTER RD SUITE 100
City: RADNOR PA 19087-5240
Info Phone Number: 1-610-687-5253
Emergency Phone Number: (800)424-9300
Resp. Party Other MSDS No.: DOCUMENT NUMBER: 1031
Chemtrec IND/Phone: (800)424-9300
Published: Y
==========
Preparer Co. when other than Responsible Party Co.
==========
Cage: 0KBF5
Name: CHEMICAL SAFETY ASSOCIATES INC
Address: 9163 CHESAPEAKE DR
City: SAN DIEGO CA 92123-1002
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Contractor Summary
==========
Cage: UO451
Name: AIRGAS INC
Address: 259 RADNOR-CHESTER RD SUITE 100
City: RADNOR PA 19087-5240
Phone: 1-610-687-5253
Cage: 7Z016
Name: KAMPI COMPONENTS CO., INC.
Address: 210 RT 13
Box: 721
City: BRISTOL PA 19007-3517
Phone: 215-736-2000
Contract Number: SP0440-00-M-JA63
==========
Item Description Information
==========
Item Manager: S9G
Item Name: CALIBRATION GAS CYL
Specification Number: NONE
Type/Grade/Class: NONE
Unit of Issue: EA
UI Container Qty: 1
Type of Container: CYLINDER

==========
Ingredients
==========
Cas: 115-11-7
RTECS #: UD0890000
Name: ISOBUTYLENE
> Wt: 90.

Name: MAXIMUM IMPURITIES
< Wt: 1.
==========
Health Hazards Data
==========
Route Of Entry Inds - Inhalation: YES
Carcinogenicity Inds - NTP: NO
IARC: NO
OSHA: NO
Effects of Exposure: ACUTE: THE MOST SIGNIFICANT HAZARD IS OXYGEN-DEFICIENT
ATOMSPHERES. AT HIGH CONCENTRATIONS UNCONSCIOUSNESS OR DEATH MAY OCCUR.
CONTACT WITH LIQUIDFIED GAS OR RAPIDLY EXPANDING GASES MAY CAUSE FROSTBIT
E.
ISOBUTYLENE ALSO HAS SOME DEGREE OF ANESTHETIC ACTION AND CAN BE MILDLY
IRRITATING TO THE MUCOUS MEMBRANES. CHRONIC: NO KNOWN ADVERSE HEALTH
EFFECTS
ASSOCIATED WITH CHRONIC EXPOSURE TO ISOBUTYLENE. TARGET ORGANS:
RESPIRATORY
SYSTEM.
Explanation Of Carcinogenicity: ISOBUTYLENE IS NOT FOUND ON THE FOLLOWING
LISTS: FEDERAL OSHA Z LIST, NTP, IARC, CAL/OSHA, AND THEREFORE IS NEITHER
CONSIDERED TO BE NOR SUSPECTED TO BE A CANCER-CAUSING AGENT BY THESE
AGENCIES.
Signs And Symptoms Of Overexposure: INHALATION: SYMPTOMS OF OXYGEN
DEFICIENCY
INCLUDE RESPIRATORY DIFFICULTY, HEADACHES, RINGING IN EARS, DIZZINESS,
DROWSINESS, UNCONSCIOUSNESS, NAUSEA, VOMITING, AND DEPRESSION OF ALL THE
SENSES. UNDER SOME CIRCUSTANCES OF OVEREXPOSURE, DEATH MAY OCCUR.
First Aid: RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO
ISOBUTYLENE WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT. AT A MINIMUM,
SELF-CONTAINED BREATHING APPARATUS AND FIRE-RETARDANT PERSONAL PROTECTIVE
EQUIPMENT SHOULD BE WORN. FIRE PROTECTION MUST BE PROVIDED DURING RESCUE
SITUATIONS. REMOVE VICTIMS(S) TO FRESH AIR. TRAINED PERSONNEL SHOULD
ADMINISTER OXYGEN AND/OR CARDIO-PULMONARY RESUS CITATION, IF NECESSARY. IN
CASE OF FROSTBITE, PLACE FROSTBITEN PART IN WARM WATER. (CONTD. SEE OTHER
INFORMATION)
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Handling and Disposal
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Spill Release Procedures: UNCONTROLLED RELEASES SHOULD BE COVERED BY
TRAINED
PERSONNEL USING PRE-PLANNED PROCEDURES. PROPER PROTECTIVE EQUIPMENT SHOULD
BE
USED. ADEQUATE FIRE PROTECTION MUST BE PROVIDED. MINIMUM PERSONAL PROTE
CTIVE
EQUIPMENT SHOULD BE LEVEL B: FIRE RETARDANT PROTECTIVE CLOTHING, GLOVES
RESISTANT TO TEARS AND SELF CONTAINED BREATHING APPARATUS. USE NON-
SPARKING

TOOLS AND (CONTD. SEE "WASTE DISPOSAL))
Waste Disposal Methods: WASTE DISPOSAL MUST BE IN ACCORDANCE WITH APPROPRIATE
FEDERAL, STATE, AND LOCAL REGULTIONS. RETURN CYLINDERS WITH ANY RESIDUAL PRODUCT TO AIRGAS INC. DO NOT DISPOSE OF LOCALLY. (CONTD. FROM "SPILL REL EASE") EQUIPMENT. IF NOT ABLE TO STOP RELEASE, ALLOW GAS TO RELEASE IN PLACE
OR REMOVE TO A SAFE ARE A AND ALLOW GAS TO RELEASE.
Handling And Storage Precautions: STORE IN COOL(,< 125F), DRY, WELL-VENTILATED AREA AWAY FROM SOURCES OF HEAT, IGNITION, DIRECT SUNLIGHT. COMPRESSED GASES PRESENT SAFETY HAZARD. STORE AWAY FROM OXIDIZERS, OXIGEN, CHLORINE, FLUORINE, H EAVILY TRAFFICKED AREAS, EMERGENCY EXITS. POST "NO SMOKING OR NO OPEN FLAMES " SIGNS.
Other Precautions: ELECTRICAL EQUIPMENT SHOULD BE NON-SPARKING. MOVE CYLINDERS
WITH HAND TRUCK. DO NOT DRAG, ROLL, DROP, STRIKE EACH OTHER. SECURE FIRMLY.
DO NOT HEAT CYLINDER OR USE OILS OR GREASE ON GAS-HANDLING FITTI NGS OR EQUIPMENT. USE DESIGNATED CGA FITTINGS. DO NOT USE ADAPTERS. USE CHECK VALVE
OR TRAP IN DISCH ARGE LINE.
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Fire and Explosion Hazard Information
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Flash Point Method: CC
Flash Point: <-10.C, 14.F
Autoignition Temp: =465.C, 869.F
Lower Limits: 1.8
Upper Limits: 9.6
Extinguishing Media: EXTINGUISH ISOBUTYLENE FIRES BY SHUTTING OFF THE SOURCE OF
THE GAS. USE WATER SPRAY OR A FOAM AGENT TO COOL FIRE-EXPOSED CONTAINERS, STRUCTURES AND EQUIPMENT.
Fire Fighting Procedures: STRUCTURAL FIREFIGHTERS MUST WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE EQUIPMENT. THE BEST FIRE-FIGHTING TECHNIQUE MAY BE SIMPLY TO LET THE BURNING GAS ESCAPE FROM THE PRESSURIZED CY
LINDER, TANK CAR, OR PIPELINE. STOP THE LEAK BEFORE EXTINGUISHING FIRE. LEAKING GAS COULD EXPLOSIVELY RE-IGNITE.
Unusual Fire/Explosion Hazard: WHEN INVOLVED IN A FIRE, THIS MATERIAL MAY IGNITE AND PRODUCE TOXIC GASES, INCLUDING CARBON MONOXIDE AND CARBON DIOXIDE.
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Control Measures
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Respiratory Protection: MAINTAIN OXYGEN LEVELS ABOVE 19.5% IN THE WORKPLACE. USE SUPPLIED AIR RESPIRATORY PROTECTION IF OXYGEN LEVELS ARE BELOW 19.5% OR DURING EMERGENCY RESPONSE TO A RELEASE OF ISOUTYLENE. IF RESPIRATORY PROTECTION IS REQUIRED, FOLLOW THE REQUIREMENTS OF THE FEDERAL OSHA RESPIRATORY STANDARD (29 CFR 1910.134) OR EQUIVALENT STATE STANDARDS.
Ventilation: USE ADEQUATE VENTILATION. LOCAL EXHAUST VENTILATION IS PERFERRED, BECAUSE IT PREVENTS ISOBUTYLENE DISPERSION INTO THE WORKPLACE BY EMLIMINATING IT AT THE SOURCE
Protective Gloves: RESISTANT TO TEARS. USE LOW-TEMPERATURE PROTECTIVE GLOVED (E.G., KEVLAR)
Eye Protection: SPLASH GOGGLES OR SAFETY GLASSES.

Other Protective Equipment: USE BODY PROTECTION . TRANSFER OF LARGE QUANTITIES UNDER PRESSURE MAY REQUIRE PROTECTIVE EQUIPMET TO PROTECT FROM SPLASHES OF LIQUIDFIED PRODUCT AS WELL AS FIRE RETARANAT ITEMS.
Work Hygienic Practices: AS WITH ALL CHEMICALS, AVOID GETTING ISOBUTYLENE IN YOU. DO NOT EAT OR DIRNK WHILE HANDLING CHEMICALS. BEWARE OF ANY SIGNS OF DIZZINESS OR FATIGUE; EXPOSURES TO FATAL CONCENTRATIONS OF ISOBUTYLENE COULD OCCUR WITHOUT ANY SIGNIFICANT WARNING SYMPTOMS.
Supplemental Safety and Health: (CONTD. FROM FIRST AID) DO NOT USE HOT WATER. IF WARM WATER NOT AVAILABLE, OR IMPRACTICAL TO USE, WRAP AFFECTED PARTS GENTLY IN BLANKETS. (SEE OTHER INFORMATION)

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Physical/Chemical Properties

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HCC: G2
Boiling Point: =-6.9C, 19.6F
Melt/Freeze Pt: =-140.C, -220.F
Vapor Pres: 39 PSIA
Vapor Density: 0.15LB/FT3
Spec Gravity: 1.997
pH: NA
Solubility in Water: INSOLUBLE
Appearance and Odor: COLORLESS LIQUID/ GAS WITH THE UNPLEASANT ODOR OF BURNING COAL.

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Reactivity Data

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Stability Indicator: YES
Stability Condition To Avoid: CONTACT WITH INCOMPATIBLE MATERIALS AND EXPOSURE TO HEAT, SPARKS, AND ORTHER SOURCES OF IGNITION. CYLINDERS EXPOSED TO HIGH TEMPERATURES OR DIRECT FLAME CAN RUPTURE OR BURST.
Materials To Avoid: STRONG OXIDIZERS (E.G., CHLORINE, BROMINE PENTAFLUORIDE, OXYGEN, OXYGEN DIFLUORIDE, AND NITROGEN TRIFLUORIDE).
Hazardous Decomposition Products: WHEN IGNITED IN THE PRESENCE OF OXYGEN, THIS GAS WILL BURN TO PRODUCE CARBON MONOXIDE AND CARBON DIOXIDE.
Hazardous Polymerization Indicator: NO
Conditions To Avoid Polymerization: WILL NOT OCCUR.

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Toxicological Information

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Toxicological Information: LC50 (RAT, INHALATION): 620 G/M3/ 4 HOURS; LC50 (MOUSE, INHALATION): 415 G/M3/ 2 HOUR. ISOBUTYLENE IS NOT FOUND ON FEDERAL OSHA Z LIST, NTP, IARC, CAL/OSHA, AND THEREFORE IS NEITHER CONSIDERED TO BE NOR SUSPECTED TO BE A CANCER-CAUSING AGENT BY THESE AGENCIES. PRODUCT MAY BE MILDLY IRRITATING TO THE MUCOUS MEMBRANES. IN ADDITION, CONTACT WITH RAPIDLY EXPANDING GASES CAN CAUSE FROSTBITE TO EXPOSED TISSUE. ISOBUTYLENE IS NOT KNOWN TO CAUSE SENSITIZATION IN HUMANS. NO MUTAGENIC EFFECTS, NO EMBRYOTOXIC EFFECTS, NO TERATOGENIC EFFECTS, NO REPRODUCTIVE TOXICITY EFFECTS HAVE BEEN DESCRIBED FOR BUTYLE NE.

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Ecological Information

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Ecological: ENVIRONMENTAL STABILITY: THIS GAS WILL BE DISSIPATED RAPIDLY IN WELL-VENTILATED AREAS. EFFECTS OF MATERIAL ON PLANTS OR ANIMALS: ANY ADVERSE EFFECT ON ANIMALS WOULD BE RELATED TO OXYGEN-DEFICIENT ENVI RONMENTS. NO ADVERSE EFFECT IS ANTICIPATED TO OCCUR TO PLANT LIFE, EXCEPT FOR FROST PRODUCED IN THE PRESENCE OF RAPIDLY EXPANDING GASES. EFFECT OF

CHEMICAL ON AQUATIC LIFE: NO EVIDENCE IS CURRENTLY AV AILABLE ON THE EFFECTS OF ISOBUTYLENE ON AQUATIC LIFE.

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MSDS Transport Information

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Transport Information: THIS MATERIAL IS HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION. PROPER SHIPPING NAME: ISOBUTYLENE; CLASS: 2.1 (FLAMMABLE GAS); UN 1055; PKG: N/A; DOT LABELS REQUIRED: FLAMMABLE GAS; NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (1996): 115. ALTERNATE DESCRIPTION: PSN: PETROLEUM GASES, LIQUIDFIED; CLASS: 2.1 (FLAMMABLE GAS); UN 1075; PKG N/A; DOT LABEL REQUIRE D: FLAMMABLE GAS; NORTH AMERICAN EMERGENCY GUIDEBOOK NUMBER: 115; MARINE POLLUTANT: ISOBUTYLENE IS NOT CLASSIFIED BY THE DOT AS A MARINE POLLUTANT (AS DEFINED BY 49 CFR 172.101, APPENDIX B). CANADA: SAME AS ABOVE.

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Regulatory Information

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Sara Title III Information: ISOBUTYLENE IS NOT SUBJECT TO THE REPORTING REQUIREMENTS OF SECTION 302, 304, AND 313 OF TITLE I I I OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT. U.S. SARA THRESHOLD PLANNING QUANTITY: N/A. U. S. CERCLA REPORTABLE QUANTITY (RQ): NOT APPLICIABLE.ING RE Federal Regulatory Information: ISOBUTYLENE IS LISTED ON THE U.S. TSCA INVENTORY. ISOBUTYLENE IS SUBJECT TO REPORTING REQUIREMENTS OF SECTION 112(R) OF THE CLEAN AIR ACT. THRESHOLD QUANTITY FOR THIS GAS IS 10,000 LB. DEPENDING ON SP ECIFIC OPERATIONS INVOLVING USE OF ISOBUTYLENE, REGULATIONS OF THE PROCESS SAFETY MANAGEMENT OF HIGHLY HAZARDOUS CHEMICALS MAY BE APPLICABLE (29 CFR 1910.119) UNDER THIS REGULATION ISOBUTYLENE IS NOT LISTED IN APPENDIX A; HOWEVER, ANY PROCESS THAT INVOLVES A FLAMMABLE GAS ON-SITE, IN ONE LOCATION, IN QUANTITIES OF 10,000 LB (4,553 KG) OR GREATER IS COVERED UNDER THIS REGULATION UNLESS IT IS USED AS A FUEL. State Regulatory Information: CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): ISOBUTYLENE IS NOT ON THE CALIFORNIA PROPOSITION 65 LISTS. PRODUCT COVERED UNDER FOLLOWING STATE REGULATIONS: AK: DESIGNATED TOXIC AND HAZARDOUS SUBSTANCES. CA: PERMISSIBLE EXPOSURE LIMITS FOR CHEMICAL CONTAMINANTS; FL: SUBSTANCE LIST; MA: SUBSTANCE LIAT; MN: LIST OF HAZARDOUS SUBSTANCES; NJ: RIGHT TO KNOW HAZARDOUS SUBSTANCE LIST; PA: HAZARDOUS SUBSTANCE LIST; RI: HAZARDOUS SUBSTANCE LIST; TX: HAZARDOUS SUBSTANCE LIST: WV: HAZARDOUS SUBSTANCE LIST; WI: TOXIC AND HAZARDOUS SUBSTANCES.

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Other Information

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Other Information: (CONTD. FROM FIRST AID) DO NOT USE HOT WATER. IF WARM WATER NOT AVAILABLE, WRAP AFFECTED PARTS IN BLANKETS. ALTERNATIVELY, IF FINGERS OR HANDS ARE FORTBITTEN, PLACE IN ARMPIT. HAVE VICTIM GENTLY EXERC ISE AFFECTED PARTS WHILE BEING WARMED. SEEK MEDICAL ATTENTION. TAKE COPY OF LABEL AND MSDS TO PHYSICIAN WITH VICTIM. NFPA RATING: HEALTH: 1; FLAMMIBILITY: 4; REACTIVITY: 0. RATINGS: HEALTH: 1; FLAMMABILITY: 4; REACTIVITY: 0; PROTECTIVE EQUIPMENT: B. CANADIAN W SYMBOLS: CLASS A: COMPRESSED GAS; CLASS B1: FLAMMABLE GAS.

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Transportation Information

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Responsible Party Cage: UO451
Trans ID NO: 156921

Product ID: ISOBUTYLENE-C4H8
MSDS Prepared Date: 01/16/1998
Review Date: 05/14/2001
MFN: 1
Multiple KIT Number: 0
Unit Of Issue: EA
Container QTY: 1
Type Of Container: CYLINDER
Additional Data: TRANSPORTATION DATA PER MANUFACTURER'S MSDS.
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Detail DOT Information
==========
DOT PSN Code: HTR
DOT Proper Shipping Name: ISOBUTYLENE
DOT PSN Modifier: SEE ALSO PETROLEUM GASES, LIQUEFIED
Hazard Class: 2.1
UN ID Num: UN1055
Label: FLAMMABLE GAS
Special Provision: 19
Packaging Exception: 306
Non Bulk Pack: 304
Bulk Pack: 314,315
Max Qty Pass: FORBIDDEN
Max Qty Cargo: 150 KG
Vessel Stow Req: E
Water/Ship/Other Req: 40
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Detail IMO Information
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IMO PSN Code: IRQ
IMO Proper Shipping Name: ISOBUTYLENE
IMDG Page Number: 2147
UN Number: 1055
UN Hazard Class: 2(2.1)
IMO Packaging Group: -
Subsidiary Risk Label: -
EMS Number: 2-07
MED First Aid Guide NUM: 310
==========
Detail IATA Information
==========
IATA PSN Code: OHI
IATA UN ID Num: 1055
IATA Proper Shipping Name: ISOBUTYLENE
IATA UN Class: 2.1
IATA Label: FLAMMABLE GAS
Packing Note Passenger: FORB
Max Quant Pass: FORB
Max Quant Cargo: 150KG
Packaging Note Cargo: 200
Exceptions: A1
==========
Detail AFI Information
==========
AFI PSN Code: OHI
AFI Proper Shipping Name: ISOBUTYLENE
AFI Hazard Class: 2.1

AFI UN ID NUM: UN1055
Special Provisions: P4
Back Pack Reference: A6.3, A6.5

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HAZCOM Label
==========
Product ID: ISOBUTYLENE-C4H8
Cage: UO451
Assigned IND: Y
Company Name: AIRGAS INC
Street: 259 RADNOR-CHESTER RD SUITE 100
City: RADNOR PA
Zipcode: 19087-5240
Health Emergency Phone: (800)424-9300
Label Required IND: Y
Date Of Label Review: 05/14/2001
Status Code: A
Label Date: 05/14/2001
Origination Code: F
Eye Protection IND: YES
Skin Protection IND: YES
Signal Word: DANGER
Respiratory Protection IND: YES
Health Hazard: Moderate
Contact Hazard: Moderate
Fire Hazard: Severe
Reactivity Hazard: None
Hazard And Precautions: FLAMMABLE LIQUID AND GAS UNDER PRESSURE. CAN FORM EXPLOSIVE MIXTURES WITH AIR. MAY CAUSE FROSTBITE. KEEP AWAY FROM HEAT (<125F), FLAMES, AND SPARKS. STORE AND USE WITH ADEQUATE VENTILATION. MOST SIGNIFICANT HAZARD IS OXYGEN-DEFICIENT ATOMSPHERES.
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HCL/ MURIATIC ACID

OLIN CORPORATION -- HCL (MURIATIC ACID), CPE298002

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MSDS Safety Information

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FSC: 6810
NIIN: 00-045-8918
MSDS Date: 03/28/1997
MSDS Num: CHVMT
Product ID: HCL (MURIATIC ACID), CPE298002
MFN: 02
Responsible Party
Cage: 99530
Name: OLIN CORPORATION
Address: 501 MERRITT 7
Box: 4500
City: NORWALK CT 06856-4500
Info Phone Number: 203-356-3449
Emergency Phone Number: 800-OLIN-911(1-800-654-6911)
Published: Y

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Contractor Summary

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Cage: 99530
Name: OLIN CORPORATION
Address: 501 MERRITT 7
Box: 4500
City: NORWALK CT 06856-4500
Phone: 203-750-3000/800-511-MSDS

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Item Description Information

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Ingredients

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Cas: 7647-01-0
RTECS #: MW4025000
Name: HYDROCHLORIC ACID (SARA 302/313) (CERCLA)
% Wt: 8-38
OSHA PEL: C 5 PPM
ACGIH TLV: C 5 PPM
EPA Rpt Qty: 5000 LBS
DOT Rpt Qty: 5000 LBS

Cas: 7732-18-5
Name: WATER
% Wt: 62-93
OSHA PEL: N/K (FP N)
ACGIH TLV: N/K (FP N)

Name: SUP DAT: OCCUR TO ENTIRE GI TRACT, INCL STOM & INTESTINES, CHARACTERIZED BY NAUS, VOMIT, DIARR, ABDOM PAIN,

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Name: ING 3: BLEEDING, &/TISS ULCERATION. INGEST CAUSES SEVERE DAMAGE TO GI TRACT W/POTENTIAL TO CAUSE PERFORATION.

Name: ING 4: CHRONIC: INHAL: RPTD/PRLNG EXPOS TO CONCS >ACCEPTED OCCUP LIMS MAY CAUSE DENTAL DISCOLORATION & EROSION

Name: ING 5: OF TEETH. SKIN: RPTD CONT W/MIST HAS BEEN REPORTED TO CAUSE CONT DERM (SKIN RASH). PRLNG/RPT EXPOS W/LIQ

Name: ING 6: MAY CAUSE PERM DMG. INGEST: INGEST OF SIGNIFICANT AMTS IS UNLIKELY BECAUSE OF ITS ACUTE CORR ACTION.

Name: FIRST AID PROC: INHAL: IF PERS EXPERIENCES NAUS, HDCH/DIZZ, PERS SHOULD STOP WORK IMMED & MOVE TO FRESH AIR

Name: ING 8: UNTIL THESE SYMPS DISAPPEAR. IF BRTHG IS DFCLT, ADMIN OXYGEN, KEEP PERS WARM & AT REST. CALL MD. IN THE

Name: ING 9: EVENT THAT INDIVIDUAL INHALES ENOµGH VAP TO LOSE CONSCIOUSNESS,
PERS SHOULD BE MOVED TO FRESH AIR AT ONCE

Name: ING 10: & MD SHOULD BE CALLED IMMED. IF BRTHG HAS STOPPED, ARTF RESP SHOULD BE GIVEN IMMED. IN ALL CASES, ENSURE

Name: ING 11: ADEQUATE VENTILATION AND PROVIDE RESPIRATORY PROTECTION BEFORE THE PERSON RETURNS TO WORK.

Name: SPILL PROC: REQS. HAZ CONCS IN AIR MAY BE FOUND IN LOC SPILL AREA & IMMED DOWNWIND. AIR RELEASE. VAPS MAY BE

Name: ING 13: SUPPRESSED BY USE OF WATER FOG/VAP SUPPRESSANT FOAM. DIKE & CONTAIN ALL RUN-OFF WATER FOR TREATMENT AS

Name: ING 14: HAZ WASTE. WATER RELEASE: THIS MATL IS HVR/AIR & SOL IN WATER. CONTAIN CONTAM WATER BY BLDG A DIKE OF

Name: ING 15: COMPATIBLE ABSORBS. VACUUM/PUMP MATL TO NEUT CONTR & TREAT. LAND SPILL: COMPATIBLE ABSORBS: SAND, CLAY

Name: ING 16: SOIL & COMMERCIAL ABSORBS. SPILL RESIDUERS: DISP OF PER GUIDELINES UNDER WASTE DISP. THIS MATL MAY BE

Name: ING 17: NEUT FOR DISP; YOU ARE REQUESTED TO CONT OCEAN AT 800-OLIN-911
BEFORE BEGINNNING ANY SUCH OPERATION.
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Health Hazards Data
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LD50 LC50 Mixture: NONE SPECIFIED BY MANUFACTURER.
Route Of Entry Inds - Inhalation: YES
Skin: YES
Ingestion: YES
Carcinogenicity Inds - NTP: NO
IARC: NO
OSHA: NO

Effects of Exposure: ACUTE: INHAL: MIST/VAP/HYDROGEN CHLORINE GAS MAY CAUSE IRRIT OF MUC MEMB & RESP TRACT W/SYMPS OF BURNING, CHOKING * COµGHING. AT EXPOS CONCS >TLV, DMG MAY OCCUR TO MUC MEMB (ULCERATIONS OF NOSE & THRO AT) & RESP TRACT. AT THESE HIGH CONCS, SEV BRTHG DFCLTYS MAY OCCUR WHICH MAY BE DELAYED IN ONSET & MAY (EFTS OF OVEREXP)
Explanation Of Carcinogenicity: NOT RELEVANT.
Signs And Symptoms Of Overexposure: HLTH HAZ: BE DUE TO PULM EDEMA (FLUID IN LUNG) /LARYNGEAL EDEMA/SPASM. SKIN: HYDROFLUORIC ACID MIST MAY RAPIDLY CAUSE SKIN INFLAMM & BURNS. DIRECT CONT OF LIQ WILL BE CORR TO SKIN & CAN CAUSE SEV IRRI T &/BURNS CHARACTERIZED BY REDNESS, SWELL & SCAB FORM. POTENTIAL FOR SCARRING & ULCERATION OF CONTACTED TISS (SUP DAT)
Medical Cond Aggravated By Exposure: RESPIRATORY AND CARDIOVASCULAR DISEASE.
First Aid: EYES: IMMED FLUSH W/LGE AMTS OF WATER FOR AT LEAST 15 MIN, OCCAS LIFTING UPPER & LOWER EYELIDS. CALL MD AT ONCE. SKIN: IMMED FLUSH W/WATER FOR AT LEAST 15 MIN. CALL MD. IF CLTHG COMES IN CONT W/PROD, IT SHOULD BE REMOVED IMMED & LAUNDERED BEFORE REUSE. INGEST: IMMED DRINK LGE QTYS OF WATER. DO NOT INDUCE VOMIT. CALL MD AT ONCE. DO NOT GIVE ANYTHING BY MOUTH IF PERS IS UNCON/HAVING CONVLS.

==========
Handling and Disposal
==========
Spill Release Procedures: FOR ALL TRANSPORTATION ACCIDENTS, CALL CHEMTREC AT 800-424-9300. REPORTABLE QUANTITY: THIS PROD IS SUBJECT TO REPORTABLE QTY W/RESPECT TO HYDROFLUORIC ACID. RQ'S ARE SUBJECT TO CHANGE & REFERENCE SHOULD BE MADE TO 40 CFR 302.4 FOR CURRENT
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.
Waste Disposal Methods: CARE MUST BE TAKEN TO PVNT ENVIRON CONTAM FROM USE OF MATL. THE USER HAS THE RESPONSIBILITY TO DISP OF UNUSED MATL, RESIDUES & CONTRS IN COMPLIANCE W/ALL RELEVANT LOC, STATE & FED LAWS & REGS REGARDING TREATMENT, STOR & DISP FOR HAZ & NON HAZ WASTES
Handling And Storage Precautions: DO NOT TAKE INTERNALLY. AVOID CONT W/SKIN, EYES & CLTHG. AVOID BRTHG MIST/VAP. STORE IN COOL, CLEAN, WELL-VENTED AREA. DO NOT STORE >100F (>38C).
Other Precautions: DO NOT EXPOSE TO DIRECT LIGHT. SHELF LIFE LIMITATIONS: 1 YEAR. GLASS/POLYETHYLENE CONTRS REC. WHEN SHIPPED W/OXIDIZERS, MUST BE SEPARATED BY 18 INCHES, W/WOOD PALLETS & ABSORB MATL IN BETWEEN.
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Fire and Explosion Hazard Information
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Extinguishing Media: ON SMALL FIRES, USE DRY CHEMICAL OR CARBON DIOXIDE. ON LARGE FIRE, USE WATER.
Fire Fighting Procedures: WEAR NIOSH APPROVED SCBA & FULL PROTECTIVE EQUIPMENT (FP N). USE WATER TO COOL CONTAINERS EXPOSED TO FIRE.
Unusual Fire/Explosion Hazard: NOT COMBUSTIBLE BUT CONTACT WITH COMMON METALS PRODUCES FLAMMABLE HYDROGEN GAS. MAY ALSO RELEASE CHLORINE GAS BY REACTION WITH OXIDIZING AGENTS.
==========
Control Measures
==========
Respiratory Protection: NONE SPECIFIED BY MANUFACTURER.ALLY REQUIRED. IF VAPORS, MISTS, OR AEROSOLS ARE GENERATED, WEAR A NIOSH APPROVED FULL FACEPIECE, EQUIPPED WITH CHEMICAL CARTRIDGES APPROVED FOR HYDROGEN CHLORIDE.
Ventilation: N/R EXHST VENT IS REC IF VAPS, MIST/AEROSOLS ARE GENERATED.OTHERWISE, USE GOOD GENERAL ROOM VENTILATION.

Protective Gloves: NEOPRENE GLOVES.
Eye Protection: ANSI APRV CHEM SFTY GOGGS&FFACE SHLD(FPN
Other Protective Equipment: ANSI APPRVD EMER EYEWASH & DELµGE SHOWER (FP N).
BOOTS, APRON.FULL IMPERMEABLE SUIT REC IF EXPOS TO LGE PORTION OF BODY.
Work Hygienic Practices: UPON CONTACT WITH SKIN OR EYES, WASH OFF WITH
WATER.
Supplemental Safety and Health: MATLS TO AVOID: METALLIC OXIDES,
MAGNESIUM, OLEUM, PERCHLORIC ACID, ZINC. EFTS OF OVEREXP: ALSO EXISTS.
EYE: EXPOS TO MIST MAY RSLT IN IRRIT &/SEV BURNS W/PERM DMG & POSS LOSS OF
SIGHT. DIRECT CONT W/ LIQ WILL BE CORR TO EYE W/RSLTG SEV BURNS, POTENTIAL
VISUAL IMPAIRMENT/LOSS OF SIGHT. INGEST: IRRIT &/BURNS CAN
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Physical/Chemical Properties
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B.P. Text: >212F,100C
M.P/F.P Text: -101F,-74C
Vapor Pres: <210 @ 20C
Vapor Density: 1.3
Spec Gravity: 1.035-1.188
pH: <1
Evaporation Rate & Reference: APPROX 1 (WATER=1)
Solubility in Water: COMPLETE
Appearance and Odor: CLEAR, COLORLESS LIQUID; PUNGENT, SUFFOCATING ODOR
Percent Volatiles by Volume: 100
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Reactivity Data
==========
Stability Indicator: YES
Stability Condition To Avoid: HEAT, EXPOSURE TO SUNLIGHT.
Materials To Avoid: ALKALINE MATLS, ALUMINUM, AMINES, CARBONATES, IRON,
SULFURIC ACID, HYDROXIDES, LEATHER & OTHER FABRICS, (SUP DAT)
Hazardous Decomposition Products: FLAMM HYDROGEN GAS BY REACTION W/MANY
METALS
(E.G. ALUMINUM). CHLORINE GAS IS RELEASED BY REACTION W/OXIDIZING AGENTS.
Hazardous Polymerization Indicator: NO
Conditions To Avoid Polymerization: NOT RELEVANT.
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Toxicological Information
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Ecological Information
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MSDS Transport Information
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Regulatory Information
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Other Information
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HAZCOM Label
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Product ID: HCL (MURIATIC ACID), CPE298002
Cage: 99530
Company Name: OLIN CORPORATION

Street: 501 MERRITT 7
PO Box: 4500
City: NORWALK CT
Zipcode: 06856-4500
Health Emergency Phone: 800-OLIN-911; (1-800-654-6911)
Label Required IND: Y
Date Of Label Review: 06/23/1998
Status Code: C
Label Date: 06/23/1998
Origination
Chronic Hazard IND: Y
Eye Protection IND: YES
Skin Protection IND: YES
Signal Word: DANGER
Respiratory Protection IND: YES
Health Hazard: Slight
Contact Hazard: Severe
Fire Hazard: None
Reactivity Hazard: None
Hazard And Precautions: ACUTE: INHAL: MIST/VAP/HCL GAS MAY CAUSE IRRIT OF MUCOUS MEMB & RESP TRACT W/BURN SYMPS, CHOKE & COµGH. AT EXPOS >TLV, MAY DMG MUC MEMB & RESP TRACT. AT HIGH CONC, SEV BRTHG DFCLTYS WHICH MAY BE DELAY ED IN ONSET & BE DUE TO PULM EDEMA, LARYNGEAL EDEMA/SPASM. SKIN: HCL ACID MIST MAY CAUSE INFLAM & BURNS. DIRECT CONT OF LIQ IS CORR CAUSING SEV IRRIT &/BURNS & ULCER OF CONTACTED TISS. EYE: EXPOS TO M IST MAY CAUSE IRRIT &/SEV BURNS W/PERM DMG & POSS SIGHT LOSS. INGEST: IRRIT &/BURNS CAN OCCUR TO GI TRACT. CHRONIC: RPTD/PRLNG EXPOS TO HI CONC MAY CAUSE DENTAL DISCOLOR & EROSION. SKIN: DERM. PERM DM G. INGEST: INLIKELY BECAUSE OR ACUTE CORR ACTION.

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Disclaimer (provided with this information by the compiling agencies): This information is formulated for use by elements of the Department of Defense. The United States of America in no manner whatsoever expressly or implied warrants, states, or intends said information to have any application, use or viability by or to any person or persons outside the Department of Defense nor any person or persons contracting with any instrumentality of the United States of America and disclaims all liability for such use. Any person utilizing this instruction who is not a military or civilian employee of the United States of America should seek competent professional advice to verify and assume responsibility for the suitability of this information to their particular situation regardless of similarity to a corresponding Department of Defense or other government situation.

SULFURIC ACID, < 10%

MSDS Number: **S8236** * * * * * Effective Date: **05/08/03** * * * * *
Supercedes: **09/14/00**

1. Product Identification

Synonyms: Sulfuric acid solution; Sulfuric Acid Volumetric Solutions 2.0 Normal and below
CAS No.: 7664-93-9
Molecular Weight: 98.07
Chemical Formula: H2SO4 in H2O
Product Codes:
J.T. Baker: 4699, 4703, 4704, 5640, 5641, 5642, 5690, 5692, 5693, 5694
Mallinckrodt: 6843, 7610, H366, H372, H381, H389, H392, H641

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Sulfuric Acid	7664-93-9	0.1 - 10%	Yes
Water	7732-18-5	90 - 99%	No

3. Hazards Identification

Emergency Overview

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. CANCER HAZARD. STRONG INORGANIC ACID MISTS CONTAINING SULFURIC ACID CAN CAUSE CANCER. Risk of cancer depends on duration and level of exposure.
J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate
Flammability Rating: 0 - None
Reactivity Rating: 1 - Slight
Contact Rating: 3 - Severe (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White (Corrosive)

Potential Health Effects

Inhalation:
Corrosive. Effects should be less severe than from exposure to higher concentrations of sulfuric acid. Symptoms may include irritation of the nose and throat, labored breathing, as well as lung edema, damage to the mucous membranes and upper respiratory tract.

Ingestion:
Corrosive. Effects should be less severe than from exposure to higher concentrations of sulfuric acid. Symptoms may include severe burns of the mouth, throat, and stomach. 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. May cause sore throat, vomiting, diarrhea.

Skin Contact:
Corrosive. Effects should be less severe than from exposure to higher concentrations of sulfuric acid. Symptoms may include redness, pain, and burns to the skin. 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.

Eye Contact:
Corrosive. Effects should be less severe than from exposure to higher concentrations of sulfuric acid. Symptoms may include blurred vision, redness, pain, and burns to eye tissue. Concentrated solutions 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

First aid procedures given apply to concentrated solutions. Exposures to dilute solutions may not require these extensive first aid procedures.

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:
Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition.
Explosion:
Contact with most metals causes formation of flammable and explosive hydrogen gas.
Fire Extinguishing Media:
Dry chemical, foam, water or carbon dioxide. Concentrated solutions are water reactive.
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 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. Protect from freezing. 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) -
1 mg/m3(TWA), 3 mg/m3 (STEL), A2 - suspected human carcinogen for sulfuric acid contained in strong inorganic acid 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, colorless solution.

Odor:
Odorless.

Solubility:
Miscible in water.

Specific Gravity:
ca. 1.0 (0.1%), 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):
> 95
Boiling Point:
No information found.
Melting Point:
3C (100%), -32C (93%), -38C (78%), -64C (65%).
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
(The following information applies to concentrated solutions). 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:
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, incompatibles.

11. Toxicological Information

Toxicological Data:
Oral rat LD50: 2140 mg/kg; inhalation rat LC50: 510 mg/m^3/2H; standard Draize, eye rabbit, 250 µg (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.

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--------\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 NOT MORE THAN 51% ACID)
Hazard Class: 8
UN/NA: UN2796
Packing Group: II
Information reported for product/size: 20L

International (Water, I.M.O.)

Proper Shipping Name: SULPHURIC ACID (WITH NOT MORE THAN 51% ACID)
Hazard Class: 8

UN/NA: UN2796
Packing Group: II
Information reported for product/size: 20L

15. Regulatory Information

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--------\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: No          (Pure / Liquid)
```

Australian Hazchem Code: 2R
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.

16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
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. 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.
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:
No Changes.
Disclaimer:
****
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****
Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

YSI 3167 Conductivity Calibrator 1,000 microohm/cm

YSI INC -- YSI 3167 CONDUCTIVITY CALIBRATOR 1,000 MICROMHO/CM -- 6630-00N066903

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

Product ID: YSI 3167 CONDUCTIVITY CALIBRATOR 1,000 MICROMHO/CM
MSDS Date: 06/20/1994
FSC: 6630
NIIN: 00N066903
MSDS Number: CBDYY
=== Responsible Party ===
Company Name: YSI INC
Address: 1725 BRANNUM LANE
City: YELLOW SPRINGS
State: OH
ZIP: 45387
Country: US
Info Phone Num: 800-765-4974
Emergency Phone Num: 800-765-4974
CAGE: 97794
=== Contractor Identification ===
Company Name: YSI INC
Address: 1725 BRANNUM LA
Box: City: YELLOW SPRINGS
State: OH
ZIP: 45387
Country: US
Phone: 800-765-4974
CAGE: 97794

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

Ingred Name: POTASSIUM CHLORIDE
CAS: 7447-40-7
RTECS #: TS8050000
Fraction by Wt: <1%
OSHA PEL: N/K
ACGIH TLV: N/K

Ingred Name: IODINE; (IODINE, CRYSTALE RESUBLIMED)
CAS: 7553-56-2
RTECS #: NN1575000
Fraction by Wt: <1%
OSHA PEL: 0.1 PPM, C
ACGIH TLV: 0.1 PPM, C

Ingred Name: WATER
CAS: 7732-18-5
RTECS #: ZC0110000
Fraction by Wt: BALANCE
OSHA PEL: N/K
ACGIH TLV: N/K

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: INHAL IF MISTS/SPLASHES OF IODINE SOLN CAN CAUSE SEV IRRIT, W/POTNTL DESTRUCT OF RESP TISS, SPASMS & EDEMA (CHOKING) IN THROAT & LUNGS, DEPENDING ON FREQUENCY & DEGREE OF EXPOS. OTHER REPO RTED POTNTL EFTS ARE COμGH, BURNING SENSATION, LARYNGITIS, HDCH & NAUS. SKIN: MAY CAUSE IRRIT W/RPTD (EFTS OF OVEREXP)
Explanation of Carcinogenicity: NOT RELEVANT
Effects of Overexposure: HLTH HAZ: EXPOS. EYES: CAN CAUSE IRRIT & POTNTL DMG W/RPTD EXPOS. INGEST: CAN CAUSE IRRIT OF MOUTH, THROAT & UPSET STOMACH. CHRONIC: NO CHRONIC EFFECTS REPORTED.
Medical Cond Aggravated by Exposure: NONE SPECIFIED BY MANUFACTURER.

First Aid Measures

First Aid: INHAL: REMOVE TO FRESH AIR. GET ARTF RESP & GET MED ATTENTION AS NEEDED. SKIN: WASH EXPOSED AREAS W/SOAP & WATER FOR 15 MINS. REMOVE CONTAM CLTHG & WASH BEFORE RE-USING. EYES: FLUSH W/WATER FOR AT LST 15 MINS. INGEST: RINSE OUTH IF SWALLOWED, DO NOT INDUCE VOMIT. GET PROMPT MED ATTN. IN ALL CASES: GET MEDICAL ATTENTION IF EFFECTS PERSIST.

Fire Fighting Measures

Flash Point: NONE
Lower Limits: NONE
Upper Limits: NONE
Extinguishing Media: MEDIA SUITABLE FOR SURROUNDING FIRE .
Fire Fighting Procedures: USE NIOSH/MSHA APPROVED SCBA & FULL PROTECTIVE EQUIPMENT .
Unusual Fire/Explosion Hazard: MATERIAL IS BASICALLY WATER, & IS NOT COMBUSTIBLE NOR DOES IT EMIT FLAMMABLE VAPORS.

Accidental Release Measures

Spill Release Procedures: FLUSH TO SEWER OR GROUND W/LOTS OF WATER.
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.

Handling and Storage

Handling and Storage Precautions: KEEP CONTAINERS CLOSED & DO NOT HEAT OVER ABOUT 125F. DISCARD ANY MATERIAL THAT MAY BE CONTAMINATED, OR WHICH OTHERWISE MAY HAVE CHANGED COMPOSITION.
Other Precautions: USE PERSONAL PROTECTION AS DESCRIBED IN PROTECTIVE MEASURES SECTION. AVOID CONDITIONS THAT CAUSE MISTING OR SPLASHING. DO NOT SWALLOW.

Exposure Controls/Personal Protection

Respiratory Protection: USE A NIOSH/MSHA APPROVED RESPIRATOR FOR LIQUID MISTS &/OR SPLASHES. GET SUPPLIER RECOMMENDATIONS.
Ventilation: PROVIDE ADEQUATE VENTILATION.
Protective Gloves: WATER-RESISTANT GLOVES.
Eye Protection: ANSI APPROVED CHEM WORKERS GOGGS(SUPDAT)

Other Protective Equipment: EYE WASH FOUNTAIN & DELµGE SHOWER WHICH MEET ANSI DESIGN CRITERIA . WEAR A MOUTH COVER WHEN THERE IS SPLASHING.
Work Hygienic Practices: NONE SPECIFIED BY MANUFACTURER.
Supplemental Safety and Health
EYE PROT: & FULL LENGTH FACESHIELD .

Physical/Chemical Properties

Boiling Pt: B.P. Text: 212F,100C
Melt/Freeze Pt: M.P/F.P Text: 32.0F,0.0C
Vapor Pres: = WATER
Vapor Density: =WATER VAP
Spec Gravity: 1
pH: NEUT
Evaporation Rate & Reference: = WATER
Solubility in Water: INFINITE
Appearance and Odor: CLEAR BLUISH TINTED LIQUID; SLIGHT ACRID ODOR.

Stability and Reactivity Data

Stability Indicator/Materials to Avoid: YES
EXTENSIVE CONTACT MAY CAUSE REACTION W/ALUMINUM, STEEL, ZINC, MAGNESIUM.
Stability Condition to Avoid: NONE.
Hazardous Decomposition Products: NONE FROM WATER SOLUTION.

Disposal Considerations

Waste Disposal Methods: DISPOSAL MUST BE I/A/W FEDERAL, STATE & LOCAL REGULATIONS . DISPOSE OF I/A/W APPLICABLE REGULATIONS FOR LIQUID WASTES. IS NOT A RCRA HAZARDOUS WASTE AS OF THIS DATE. EMPTY CNTNRS: RINSE. DISPOSAL AS APPROPRIATE FOR GLASS & PLASTIC CONTAINERS.

Disclaimer (provided with this information by the compiling agencies): This information is formulated for use by elements of the Department of Defense. The United States of America in no manner whatsoever, expressly or implied, warrants this information to be accurate and disclaims all liability for its use. Any person utilizing this document should seek competent professional advice to verify and assume responsibility for the suitability of this information to their particular situation.

HELIUM

Product Identification

Product ID:HELIUM
MSDS Date:12/01/1992
FSC:6830
NIIN:01-008-3431
MSDS Number: BWXRX
=== Responsible Party ===
Company Name:PRAXAIR INC
Address:39 OLD RIDGEBURY RD
City:DANBURY
State:CT
ZIP:06810-5113
Country:US
Info Phone Num:800-772-9247
Emergency Phone Num:800-772-9247
CAGE:0LV01
=== Contractor Identification ===
Company Name:PRAXAIR, INC.
Address:39 OLD RIDGEBURY RD
Box:City:DANBURY
State:CT
ZIP:06810-5113
Country:US
Phone:800-772-9247; 800-PRAXAIR
CAGE:0LV01

Composition/Information on Ingredients

Ingred Name:HELIUM
CAS:7440-59-7
RTECS #:MH6520000
Fraction by Wt: 100%
ACGIH TLV:SIMPLE ASPHYXIANT

Hazards Identification

Routes of Entry: Inhalation:YES Skin:NO Ingestion:NO
Reports of Carcinogenicity:NTP:NO IARC:NO OSHA:NO
Health Hazards Acute and Chronic:INHALATION: ASPHYXIANT. CAN CAUSE RAPID SUFFOCATION/DEATH DUE TO OXYGEN DEFICIENCY.
Explanation of Carcinogenicity:NONE
Effects of Overexposure:HEADACHE, DROWSINESS, DIZZINESS, EXCITATION, EXCESS SALIVATION, VOMITING, UNCONSCIOUSNESS.

First Aid Measures

First Aid:SKIN: WASH W/SOAP & WATER. INHALATION: REMOVE TO FRESH AIR. GIVE CPR/OXYGEN IF NEEDED. EYES: FLUSH W/WATER. OBTAIN MEDICAL ATTENTION IN ALL CASES. NOTE TO PHYSICIAN: NO SPECIFIC ANTIDOTE. PRODUCT IS I NERT. TREATMENT OF OVEREXPOSSURE SHOULDBE DIRECTED AT CONTROL OF SYMPTOMS & CLINICAL CONDITION.

Fire Fighting Measures

Extinguishing Media:USE MEDIA APPROPRIATE FOR SURROUNDING FIRE.
Fire Fighting Procedures:EVACUATE ALL PERSONNEL FROM DANGER AREA. IMMEDIATELY DELUGE CONTAINERS W/WATER SPRAY FROM MAXIMUM DISTANCE UNTIL COOL, THEN SAFELY REMOVE CONTAINERS FROM AREA.
Unusual Fire/Explosion Hazard:CONTAINER MAY RUPTURE DUE TO HEAT OF FIRE.

Accidental Release Measures

Spill Release Procedures:EVACUATE ALL PERSONNEL FROM AREA. WEAR SCBA WHERE NEEDED. SAFELY SHUT OFF LEAK. VENTILATE AREA & MOVE LEAKING ASSEMBLY TO WELL VENTILATED AREA. TEST AREA/CONFINED AREAS FOR SUFFICIENT OXYGEN CONTENT P RIOR TO PERMITTING REENTRY TO AREA.

Handling and Storage

Handling and Storage Precautions:STORE & USE W/ADEQUATE VENTILATION. CLOSE VALVE WHEN NOT IN USE & WHEN EMPTY.
Other Precautions:DON'T GROUND CYLINDER/ALLOW TO BECOME PART OF AN ELECTRICAL CIRCUIT. DON'T STRIKE ARC ON CYLINDER. USE PIPING & EQUIPMENT ADEQUATELY DESIGNED TO WITHSTAND PRESSURES TO BE ENCOUNTERED. NEVER WORK ON A PRESSURIZED SYSTEM. (SEE SUPP)

Exposure Controls/Personal Protection

Respiratory Protection:WEAR AIR PURIFYING/AIR SUPPLIED RESPIRATOR WHERE LOCAL &/GENERAL EXHAUST VENTILATION ISN'T ADEQUATE TO KEEP WORKER EXPOSURE BELOW APPLICABLE TLV'S DURING WELDING W/THIS PRODUCT. AIR SUPPLIED RESPIRATO R REQUIRED IF WORKING IN CONFINED AREAS.
Ventilation:LOCAL/GENERAL EXHAUST TO MAINTAIN CONCENTRATION OF HAZARDOUS FUMES & GASES 125F, ARC
Hazardous Decomposition Products:NONE

Disposal Considerations

Waste Disposal Methods:SLOWLY RELEASE INTO ATMOSPHERE. DISPOSE OF ANY PRODUCT/RESIDUE/DISPOSABLE CONTAINER/LINER IN AN ENVIRONMENTALLY ACCEPTABLE MANNER IAW/FEDERAL, STATE & LOCAL REGULATIONS.

Disclaimer (provided with this information by the compiling agencies): This information is formulated for use by elements of the Department of Defense. The United States of America in no manner whatsoever, expressly or implied, warrants this information to be accurate and disclaims all liability for its use. Any person utilizing this document should seek competent professional advice to verify and assume responsibility for the suitability of this information to their particular situation.

TETRACHLOROETHYLENE

1. Product Identification

Synonyms: ethylene tetrachloride; tetrachloroethene; perchloroethylene; carbon bichloride; carbon dichloride
CAS No.: 127-18-4
Molecular Weight: 165.83
Chemical Formula: Cl2C:CCl2
Product Codes:
J.T. Baker: 9218, 9360, 9453, 9465, 9469
Mallinckrodt: 1933, 8058

---

2. Composition/Information on Ingredients

```
  Ingredient                                    CAS No         Percent
Hazardous
  ----------------------------------------   ------------   ------------
---------

  Tetrachloroethylene                           127-18-4         99 - 100%
Yes
```

---

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS CENTRAL NERVOUS SYSTEM, LIVER AND KIDNEYS. SUSPECT CANCER HAZARD. MAY CAUSE CANCER. Risk of cancer depends on level and duration of exposure.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 1 - Slight
Contact Rating: 2 - Moderate (Life)
Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES
Storage Color Code: Blue (Health)

Potential Health Effects

Inhalation:
Irritating to the upper respiratory tract. Giddiness, headache, intoxication, nausea and vomiting may follow the inhalation of large amounts while massive amounts can cause breathing arrest, liver and kidney damage, and death. Concentrations of 600 ppm and more can affect the central nervous system after a few minutes.
Ingestion:
Not highly toxic by this route because of low water solubility. Used as an oral dosage for hookworm (1 to 4 ml). Causes abdominal pain, nausea, diarrhea, headache, and dizziness.
Skin Contact:
Causes irritation to skin. Symptoms include redness, itching, and pain. May be absorbed through the skin with possible systemic effects.
Eye Contact:
Causes irritation, redness, and pain.
Chronic Exposure:
May cause liver, kidney or central nervous system damage after repeated or prolonged exposures. Suspected cancer risk from animal studies.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired liver or kidney function may be more susceptible to the effects of the substance. The use of alcoholic beverages enhances the toxic effects.

---

4. First Aid Measures

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

Note to Physician:
Do not administer adrenaline or epinephrine to a victim of chlorinated solvent poisoning.

---

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard but becomes hazardous in a fire situation because of vapor generation and possible degradation to phosgene (highly toxic) and hydrogen chloride (corrosive). Vapors are heavier than air and collect in low-lying areas.
Explosion:
Not considered to be an explosion hazard. Containers may explode when involved in a fire.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire. 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.

---

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.

---

7. Handling and Storage

Store in a cool, dry, ventilated area away from sources of heat or ignition. Isolate from flammable materials. Protect from direct sunlight. Wear special protective equipment (Sec. 8) for maintenance break-in or where exposures may exceed established exposure levels. Wash hands, face, forearms and neck when exiting restricted areas. Shower, dispose of outer clothing, change to clean garments at the end of the day. Avoid cross-contamination of street clothes. Wash hands before eating and do not eat, drink, or smoke in workplace. 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):
100 ppm (TWA), 200 ppm (ceiling),

300 ppm/5min/3-hour (max)

-ACGIH Threshold Limit Value (TLV):
25 ppm (TWA), 100 ppm (STEL); listed as A3, animal carcinogen
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.
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 full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

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9. Physical and Chemical Properties

Appearance:
Clear, colorless liquid.
Odor:
Ethereal odor.
Solubility:
0.015 g in 100 g of water.
Specific Gravity:
1.62 @ 20C/4C
pH:
No information found.
% Volatiles by volume @ 21C (70F):
100
Boiling Point:
121C (250F)
Melting Point:
-19C (-2F)
Vapor Density (Air=1):
5.7
Vapor Pressure (mm Hg):
18 @ 25C (77F)
Evaporation Rate (BuAc=1):
0.33 (trichloroethylene = 1)

---

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Slowly decomposed by light. Deteriorates rapidly in warm, moist climates.
Hazardous Decomposition Products:
Carbon dioxide and carbon monoxide may form when heated to decomposition. Hydrogen chloride gas and phosgene gas may be formed upon heating. Decomposes with moisture to yield trichloroacetic acid and hydrochloric acid.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Strong acids, strong oxidizers, strong alkalis, especially NaOH, KOH; finely divided metals, especially zinc, barium, lithium. Slowly corrodes aluminum, iron and zinc.
Conditions to Avoid:
Moisture, light, heat and incompatibles.

---

11. Toxicological Information

Oral rat LD50: 2629 mg/kg; inhalation rat LC50: 4100 ppm/6H; investigated as a tumorigen, mutagen, reproductive effector.

```
  --------\Cancer Lists\-----------------------------------------------------
----
                                          ---NTP Carcinogen---
  Ingredient                              Known    Anticipated    IARC
Category
  ------------------------------------   -----    -----------    ---------
----
  Tetrachloroethylene (127-18-4)          No          Yes            2A
```

---

12. Ecological Information

Environmental Fate:
When released into the soil, this material is expected to quickly evaporate. When released into the soil, this material may leach into groundwater. When released into the soil, this material may biodegrade to a moderate extent. When released to water, this material is expected to quickly evaporate. When released into water, this material is not expected to biodegrade. This material is not expected to significantly bioaccumulate. When released into the air, this material may be moderately degraded by reaction with photochemically produced hydroxyl radicals.
Environmental Toxicity:
The LC50/96-hour values for fish are between 1 and 10 mg/l. The LC50/96-hour values for fish are between 10 and 100 mg/l. This material is expected to 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: TETRACHLOROETHYLENE
Hazard Class: 6.1
UN/NA: UN1897
Packing Group: III
Information reported for product/size: 20L

International (Water, I.M.O.)

Proper Shipping Name: TETRACHLOROETHYLENE
Hazard Class: 6.1
UN/NA: UN1897
Packing Group: III
Information reported for product/size: 20L

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15. Regulatory Information

```
  --------\Chemical Inventory Status - Part 1\----------------------------
-----
  Ingredient                                        TSCA  EC   Japan
Australia
  ------------------------------------------------  ----  ---  -----  -----
----
  Tetrachloroethylene (127-18-4)                     Yes  Yes   Yes
Yes

  --------\Chemical Inventory Status - Part 2\----------------------------
-----
                                                            --Canada--
  Ingredient                                        Korea  DSL   NDSL
Phil.
  ------------------------------------------------  -----  ---   ----  ----
-
  Tetrachloroethylene (127-18-4)                     Yes   Yes   No     Yes
```

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  --------\Federal, State & International Regulations - Part 1\-----------
-----
                                                -SARA 302-    ------SARA 313-
-----
  Ingredient                                    RQ    TPQ     List  Chemical
Catg.
  ----------------------------------------  ---   -----   ----  ---------
-----
  Tetrachloroethylene (127-18-4)            No    No      Yes        No

  --------\Federal, State & International Regulations - Part 2\-----------
-----
                                                            -RCRA-    -TSCA-
  Ingredient                                    CERCLA     261.33     8(d)
  ----------------------------------------  ------     ------    ------
  Tetrachloroethylene (127-18-4)            100        U210       No


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

WARNING:
THIS PRODUCT CONTAINS A CHEMICAL(S) KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER.

Australian Hazchem Code: 2[Z]
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.

---

16. Other Information

NFPA Ratings: Health: **2** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
WARNING! HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS CENTRAL NERVOUS SYSTEM, LIVER AND KIDNEYS. SUSPECT CANCER HAZARD. MAY CAUSE CANCER. Risk of cancer depends on level and duration of exposure.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe vapor or mist.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Label First Aid:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. 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. In all cases call a physician.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 3, 11.

Disclaimer:

****

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****

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

TRICHLOROETHYLENE

1. Product Identification

Synonyms: Trichloroethene; TCE; acetylene trichloride; Ethinyl trichloride
CAS No.: 79-01-6
Molecular Weight: 131.39
Chemical Formula: C2HCl3
Product Codes:
J.T. Baker: 5376, 9454, 9458, 9464, 9473
Mallinckrodt: 8600, 8633

---

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Trichloroethylene	79-01-6	100%	Yes

---

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF SWALLOWED OR INHALED. AFFECTS HEART, CENTRAL NERVOUS SYSTEM, LIVER AND KIDNEYS. CAUSES SEVERE SKIN IRRITATION. CAUSES IRRITATION TO EYES AND RESPIRATORY TRACT. SUSPECT CANCER HAZARD. MAY CAUSE CANCER. Risk of cancer depends on level and duration of exposure.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate (Poison)
Flammability Rating: 1 - Slight
Reactivity Rating: 1 - Slight
Contact Rating: 3 - Severe
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: Blue (Health)

Potential Health Effects

Inhalation:
Vapors can irritate the respiratory tract. Causes depression of the central nervous system with symptoms of visual disturbances and mental confusion, incoordination, headache, nausea, euphoria, and dizziness. Inhalation of high concentrations could cause unconsciousness, heart effects, liver effects, kidney effects, and death.
Ingestion:
Cases irritation to gastrointestinal tract. May also cause effects similar to inhalation. May cause coughing, abdominal pain, diarrhea, dizziness, pulmonary edema, unconsciousness. Kidney failure can result in severe cases. Estimated fatal dose is 3-5 ml/kg.
Skin Contact:
Cause irritation, redness and pain. Can cause blistering. Continued skin contact has a defatting action and can produce rough, dry, red skin resulting in secondary infection.
Eye Contact:
Vapors may cause severe irritation with redness and pain. Splashes may cause eye damage.
Chronic Exposure:
Chronic exposures may cause liver, kidney, central nervous system, and peripheral nervous system effects. Workers chronically exposed may exhibit central nervous system depression, intolerance to alcohol, and increased cardiac output. This material is linked to mutagenic effects in humans. This material is also a suspect carcinogen.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders, cardiovascular disorders, impaired liver or kidney or respiratory function, or central or peripheral nervous system disorders 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.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Call a physician.
Skin Contact:
Immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Note to Physician:
Do not administer adrenaline or epinephrine to a victim of chlorinated solvent poisoning.

---

5. Fire Fighting Measures

Fire:
Autoignition temperature: 420C (788F)
Flammable limits in air % by volume:
lel: 8; uel: 12.5
Explosion:
A strong ignition source, e. g., a welding torch, can produce ignition. Sealed containers may rupture when heated.
Fire Extinguishing Media:
Use water spray to keep fire exposed containers cool. If substance does ignite, use CO_2, dry chemical or foam.
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. Combustion by-products include phosgene and hydrogen chloride gases. Structural firefighters' clothing provides only limited protection to the combustion products of this material.

---

6. Accidental Release Measures

Ventilate area of leak or spill. Remove all sources of ignition. 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. Use non-sparking tools and equipment. Collect liquid in an appropriate container or 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.

---

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from any source of heat or ignition. Isolate from incompatible substances. 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:
Trichloroethylene:

-OSHA Permissible Exposure Limit (PEL):
100 ppm (TWA), 200 ppm (Ceiling),
300 ppm/5min/2hr (Max)

-ACGIH Threshold Limit Value (TLV):
50 ppm (TWA) 100 ppm (STEL);
listed as A5, not suspected as a human carcinogen.

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, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus. Breathing air quality must meet the requirements of the OSHA respiratory protection standard (29CFR1910.134). This substance has poor warning properties. 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. Neoprene is a recommended material for personal protective equipment.

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, colorless liquid.

Odor:
Chloroform-like odor.

Solubility:
Practically insoluble in water. Readily miscible in organic solvents.

Specific Gravity:
1.47 @ 20C/4C

pH:
No information found.

% Volatiles by volume @ 21C (70F):
100

Boiling Point:
87C (189F)

Melting Point:
-73C (-99F)

Vapor Density (Air=1):
4.5
Vapor Pressure (mm Hg):
57.8 @ 20C (68F)
Evaporation Rate (BuAc=1):
No information found.

---

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Will slowly decompose to hydrochloric acid when exposed to light and moisture.
Hazardous Decomposition Products:
May produce carbon monoxide, carbon dioxide, hydrogen chloride and phosgene when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Strong caustics and alkalis, strong oxidizers, chemically active metals, such as barium, lithium, sodium, magnesium, titanium and beryllium, liquid oxygen.
Conditions to Avoid:
Heat, flame, ignition sources, light, moisture, incompatibles

---

11. Toxicological Information

Toxicological Data:
Trichloroethylene: Oral rat LD50: 5650 mg/kg; investigated as a tumorigen, mutagen, reproductive effector.
Reproductive Toxicity:
This material has been linked to mutagenic effects in humans.

```
  --------\Cancer Lists\-------------------------------------------------
----
                                          ---NTP Carcinogen---
  Ingredient                              Known    Anticipated    IARC
Category
  ------------------------------------   -----    -----------    ---------
----
  Trichloroethylene (79-01-6)             No          Yes            2A
```

---

12. Ecological Information

Environmental Fate:
When released into the soil, this material may leach into groundwater. When released into the soil, this material is expected to quickly evaporate. When released to water, this material is expected to quickly evaporate. This material has an experimentally-determined bioconcentration factor (BCF) of less than 100. This material is not expected to significantly bioaccumulate. When released into the air, this material may be moderately degraded by

reaction with photochemically produced hydroxyl radicals. When released into the air, this material is expected to have a half-life between 1 and 10 days.
Environmental Toxicity:
The LC50/96-hour values for fish are between 10 and 100 mg/l. This material is expected to be slightly 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: TRICHLOROETHYLENE
Hazard Class: 6.1
UN/NA: UN1710
Packing Group: III
Information reported for product/size: 4L

International (Water, I.M.O.)

Proper Shipping Name: TRICHLOROETHYLENE
Hazard Class: 6.1
UN/NA: UN1710
Packing Group: III
Information reported for product/size: 4L

---

15. Regulatory Information

```
  --------\Chemical Inventory Status - Part 1\----------------------------
-----
  Ingredient                                          TSCA  EC   Japan
Australia
  ----------------------------------------------  ----  ---  -----  -----
----
  Trichloroethylene (79-01-6)                      Yes  Yes   Yes
Yes

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

```
                                                          --Canada--
  Ingredient                                        Korea  DSL   NDSL
Phil.
  ----------------------------------------------  -----  ---   ----  ----
-
  Trichloroethylene (79-01-6)                        Yes   Yes   No     Yes

  --------\Federal, State & International Regulations - Part 1\-----------
-----
                                              -SARA 302-    ------SARA 313-
-----
  Ingredient                                  RQ    TPQ     List  Chemical
Catg.
  ----------------------------------------  ---   -----   ----  ---------
-----
  Trichloroethylene (79-01-6)                 No    No      Yes        No

  --------\Federal, State & International Regulations - Part 2\-----------
-----
                                                            -RCRA-    -TSCA-
  Ingredient                                  CERCLA     261.33     8(d)
  ----------------------------------------  ------     ------    ------
  Trichloroethylene (79-01-6)                 100        U228       No


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

WARNING:
THIS PRODUCT CONTAINS A CHEMICAL(S) KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER.

Australian Hazchem Code: None allocated.
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.

---

16. Other Information

NFPA Ratings: Health: **2** Flammability: **1** Reactivity: **0**
Label Hazard Warning:
WARNING! HARMFUL IF SWALLOWED OR INHALED. AFFECTS HEART, CENTRAL NERVOUS SYSTEM, LIVER AND KIDNEYS. CAUSES SEVERE SKIN IRRITATION. CAUSES IRRITATION TO EYES AND RESPIRATORY TRACT. SUSPECT CANCER HAZARD. MAY CAUSE CANCER. Risk of cancer depends on level and duration of exposure.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe vapor.
Keep container closed.

Use only with adequate ventilation.
Wash thoroughly after handling.
Keep away from heat and flame.

Label First Aid:

If swallowed, induce vomiting immediately as directed by medical personnel. 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 case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. In all cases call a physician. Note to physician: Do not administer adrenaline or epinephrine to a victim of chlorinated solvent poisoning.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 3.

Disclaimer:

****

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****

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

CIS 1,2-DICHLOROETHENE

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

Product ID:0-659 CIS 1,2-DICHLOROETHENE
MSDS Date:06/02/1992
FSC:6550
NIIN:00F037480
MSDS Number: BWJDT
=== Responsible Party ===
Company Name:CHEM SERVICE INC
Address:660 TOWER LN
Box:3108
City:WEST CHESTER
State:PA
ZIP:19381-3108
Country:US
Info Phone Num:215-692-3026/800-452-9994
Emergency Phone Num:215-692-3026/800-452-9994
CAGE:84898
=== Contractor Identification ===
Company Name:CHEM SERVICE INC
Box:3108
City:WEST CHESTER
State:PA
ZIP:19381
Country:US
Phone:215-692-3026
CAGE:84898
Company Name:CHEM SERVICE, INC
Address:660 TOWER LN
Box:599
City:WEST CHESTER
State:PA
ZIP:19301-9650
Country:US
Phone:610-692-3026
CAGE:8Y898

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

Ingred Name:DICHLOROETHENE
CAS:156-59-2
RTECS #:KV9420000

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

Routes of Entry: Inhalation:YES Skin:YES Ingestion:YES
Reports of Carcinogenicity:NTP:NO IARC:NO OSHA:NO
Health Hazards Acute and Chronic:SKIN: MAY BE HARMFUL IF ABSORBED. CAN CAUSE IRRITATION. INHALATION: MAY BE HARMFUL. DUST &/VAPORS CAN CAUSE RESPIRATORY TRACT IRRITATION. CAN BE IRRITATING TO MUCOUS MEMBRANCES. INGESTION: MAY BE HARM FUL. EYES: IRRITATION. EXPOSURE CAN CAUSE LIVER DAMAGE. NARCOTIC AT HIGH CONCENTRATIONS.
Explanation of Carcinogenicity:NONE
Effects of Overexposure:IRRITATION, NARCOTIC.

First Aid Measures

First Aid:EYES: FLUSH CONTINUOUSLY W/WATER FOR 15-20 MINS. SKIN: FLUSH W/WATER FOR 15-20 MINS. IF NOT BURNED, WASH W/SOAP & WATER TO CLEANSE. INHALATION: REMOVE TO FRESH AIR. GIVE CPR/OXYGEN IF NEEDED & CONTINU E LIFE SUPPORT UNTIL MEDICAL ASSISTANCEARRIVES. INGESTION: RINSE MOUTH OUT W/WATER, IF CONSCIOUS. OBTAIN MEDICAL ATTENTION IN ALL CASES.

Fire Fighting Measures

Flash Point:42.8F
Extinguishing Media:CO2, DRY CHEMICAL POWDER/SPRAY.
Unusual Fire/Explosion Hazard:FLAMMABLE CHEMICAL. VAPORS MAY TRAVEL CONSIDERABLE DISTANCE TO IGNITION SOURCE & FLASH BACK. DECOMPOSITION PRODUCTS ARE CORROSIVE.

Accidental Release Measures

Spill Release Procedures:EVACUATE AREA. WEAR APPRORPRIATE OSHA REGULATED EQUIPMENT. VENTILATE AREA. ABSORB ON VERMICULITE/SIMILAR MATERIAL. SWEEP UP & PLACE IN APPROPRIATE CONTAINER/HOLD FOR DISPOSAL. WASH CONTAMINATED SURFAC ES TO REMOVE ANY RESIDUES.

Handling and Storage

Handling and Storage Precautions:STORE IN A COOL DRY PLACE ONLY W/COMPATIBLE CHEMICALS. KEEP TIGHTLY CLOSED. STORE UNDER REFRIGERATION.
Other Precautions:AVOID CONTACT W/SKIN, EYES & CLOTHING. DON'T BREATH VAPORS. CONTACT LENSES SHOULDN'T BE WORN IN THE LABORATORY. ALL CHEMICALS SHOULD BE CONSIDERED HAZARDOUS. AVOID DIRECT PHYSICAL CONTACT.

Exposure Controls/Personal Protection

Respiratory Protection:WEAR APPROPRIATE OSHA/MSHA APPROVED SAFETY EQUIPMENT.
Ventilation:CHEMICAL SHOULD BE HANDLED ONLY IN A HOOD.
Eye Protection:EYE SHIELDS
Supplemental Safety and Health

Physical/Chemical Properties

Boiling Pt:B.P. Text:140F
Melt/Freeze Pt:M.P/F.P Text:-112F
Solubility in Water:INSOLUBLE
Appearance and Odor:COLORLESS LIQUID

Stability and Reactivity Data

Stability Indicator/Materials to Avoid:YES
STRONG OXIDIZING AGENTS, MAGNESIUM, ALUMINUM.
Stability Condition to Avoid:MOISTURE, AIR, LIGHT, HEAT & OTHER IGNITION SOURCES.
Hazardous Decomposition Products:TOXIC FUMES

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

Waste Disposal Methods:BURN IN A CHEMICAL INCINERATOR EQUIPPED W/AN AFTERBURNER & SCRUBBER IAW/FEDERAL, STATE & LOCAL REGULATIONS.

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TRANS-1,2-DICHLOROETHENE

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

Product ID:TRANS-1,2-DICHLOROETHENE, O-660
MSDS Date:09/01/1988
FSC:6810
NIIN:00N067797
MSDS Number: CBGMP
=== Responsible Party ===
Company Name:CHEM SERVICE INC
Box:3108
City:WEST CHESTER
State:PA
ZIP:19381
Country:US
Info Phone Num:215-692-3026
Emergency Phone Num:215-692-3026
CAGE:84898
=== Contractor Identification ===
Company Name:CHEM SERVICE INC
Box:3108
City:WEST CHESTER
State:PA
ZIP:19381
Country:US
Phone:215-692-3026
CAGE:84898
Company Name:CHEM SERVICE, INC
Address:660 TOWER LN
Box:599
City:WEST CHESTER
State:PA
ZIP:19301-9650
Country:US
Phone:610-692-3026
CAGE:8Y898

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

Ingred Name:ETHYLENE, 1,2-DICHLORO-, (E)-; (TRANS-1,2-DICHLOROETHYLENE) (SARA 313) (CERCLA)
CAS:156-60-5
RTECS #:KV9400000
OSHA PEL:200 PPM (MFR)
ACGIH TLV:200 PPM (MFR)
EPA Rpt Qty:1000 LBS
DOT Rpt Qty:1000 LBS

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

LD50 LC50 Mixture:LD50 (ORAL RAT): 7536 MG/KG.
Routes of Entry: Inhalation:YES Skin:YES Ingestion:YES
Reports of Carcinogenicity:NTP:NO IARC:NO OSHA:NO
Health Hazards Acute and Chronic:ACUTE: CAN BE HARMFUL IF ABSORBED THRU SKIN, INHALED/SWALLOWED. CAN CAUSE SKIN AND EYE IRRITATION. CAN BE IRRITATING TO MUCOUS MEMBRANES. VAPORS AND/OR DIRECT EYE CONTACT

CAN CAUSE SEVERE EYE BURNS. C HRONIC: PROLONGED EXPOSURE MAY CAUSE NAUSEA, HEADACHE, DIZZINESS AND/OR EYE DAMAGE. CAN CAUSE LIVER & KIDNEY INJURY.

Explanation of Carcinogenicity:NOT RELEVANT.

Effects of Overexposure:SEE HEALTH HAZARDS.

Medical Cond Aggravated by Exposure:NONE SPECIFIED BY MANUFACTURER.

First Aid Measures

First Aid:AN ANTIDOTE IS A SUBSTANCE INTENDED TO COUNTERACT EFT OF POIS. IT SHOULD BE ADMIN ONLY BY MD/TRAINED EMER PERS. MED ADVICE CAN BE OBTAINED FROM POIS CTL CTR. EYES: FLUSH CONTINUOUSLY W/WATER FOR AT LE AST 15 MIN. SKIN: FLUSH W/WATER FOR 15-20 MIN. IF NO BURNS HAVE OCCURRED, USE SOAP & WATER TO CLEANSE SKIN. INHAL: REMOVE TO FRESH AIR. ADMIN OXYGEN IF DFCLT BRTHG. IF BRTHG HAS STOPPED, (SUP DAT)

Fire Fighting Measures

Flash Point:42.8F,6.0C

Extinguishing Media:USE CARBON DIOXIDE, DRY CHEMICAL POWDER OR WATER SPRAY.

Fire Fighting Procedures:WEAR NIOSH/MSHA APPROVED SCBA & FULL PROTECTIVE EQUIPMENT .

Unusual Fire/Explosion Hazard:NONE SPECIFIED BY MANUFACTURER.

Accidental Release Measures

Spill Release Procedures:EVACUATE AREA. WEAR APPROPRIATE OSHA-REGULATED EQUIPMENT. VENTILATE AREA. ABSORB ON VERMICULITE OR SIMILAR MATERIAL. SWEEP UP AND PLACE IN AN APPROPRIATE CONTAINER. HOLD FOR DISPOSAL. WASH CONTAMINATE D SURFACES TO REMOVE ANY RESIDUES.

Neutralizing Agent:NONE SPECIFIED BY MANUFACTURER.

Handling and Storage

Handling and Storage Precautions:ALL CHEMICALS SHOULD BE CONSIDERED HAZARDOUS. AVOID DIRECT PHYSICAL CONTACT! USE APPROPRIATE OSHA/MSMA APPROVED SAFETY EQUIPMENT.

Other Precautions:AVOID CONT W/SKIN, EYES, & CLTHG. KEEP TIGHTLY CLSD & STORE IN COOL DRY PLACE. STORE ONLY W/COMPATIBLE CHEM. PERS NOT SPECIFICALLY & PROPERLY TRAINED SHOULD NOT HANDLE THIS CHEM/ITS CONTR. THIS PROD I S FURNISHED FOR LAB USE ONLY! (SUP DAT)

Exposure Controls/Personal Protection

Respiratory Protection:USE NIOSH/MSHA APPROVED RESPIRATOR APPROPRIATE FOR EXPOSURE OF CONCERN .

Ventilation:THIS CHEMICAL SHOULD BE HANDLED ONLY IN A HOOD.

Protective Gloves:IMPERVIOUS GLOVES .

Eye Protection:ANSI APPRVD CHEM WORKERS GOGGS .

Other Protective Equipment:EMERGENCY EYEWASH & DELUGE SHOWER MEETING ANSI DESIGN CRITERIA .

Work Hygienic Practices:CONTACT LENSES SHOULD NOT BE WORN IN THE LABORATORY.

Supplemental Safety and Health

FIRST AID PROC: ADMIN ARTF RESP. IF PATIENT IN CARD ARREST, ADMIN CPR.

CONTINUE LIFE SUPPORTING MEASURES UNTIL MED ASSIST HAS ARRIVED. INGEST: CALL MD IMMED . OTHER PREC: THIS PROD MAY NOT BE US ED AS DRUGS, COSMETICS, AGRICULTURAL/PESTICIDAL PRODS, FOOD ADDITIVES/AS HOUSEHOLD CHEMICALS.

Physical/Chemical Properties

Boiling Pt:B.P. Text:118F,48C
Melt/Freeze Pt:M.P/F.P Text:-58F,-50C
Spec Gravity:1.257
Solubility in Water:INSOLUBLE
Appearance and Odor:COLORLESS LIQUID

Stability and Reactivity Data

Stability Indicator/Materials to Avoid:YES
INCOMPATIBLE WITH STRONG OXIDIZING AGENTS, STRONG BASES. REACTS WITH WATER AND MOST REACTIVE HYDROGEN COMPOUNDS.
Stability Condition to Avoid:FLAMMABLE.
Hazardous Decomposition Products:DECOMPOSITION LIBERATES TOXIC FUMES. DECOMPOSITION PRODUCTS ARE CORROSIVE.

Disposal Considerations

Waste Disposal Methods:BURN IN A CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER. DISPOSE OF IN ACCORDANCE W/LOCAL, STATE & FEDERAL REGULATIONS .

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1,2-DICHLOROETHANE

1. Product Identification

Synonyms: Ethylene dichloride; dichloroethylene; 1,2-Bichloroethane
CAS No.: 107-06-2
Molecular Weight: 98.96
Chemical Formula: ClCH2CH2Cl
Product Codes:
J.T. Baker: 9302, H076
Mallinckrodt: 4966, 5338

---

2. Composition/Information on Ingredients

```
  Ingredient                                    CAS No         Percent
Hazardous
  ----------------------------------------   ------------   ------------
---------

  Ethylene Dichloride                           107-06-2         90 - 100%
Yes
```

---

3. Hazards Identification

Emergency Overview

WARNING! FLAMMABLE LIQUID AND VAPOR. HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. AFFECTS CENTRAL NERVOUS SYSTEM, LIVER, KIDNEYS, AND CARDIOVASCULAR SYSTEM. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. POSSIBLE CANCER HAZARD. MAY CAUSE CANCER BASED ON ANIMAL DATA. Risk of cancer depends on duration and level of exposure.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)
Flammability Rating: 3 - Severe (Flammable)
Reactivity Rating: 2 - Moderate
Contact Rating: 3 - Severe
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER
Storage Color Code: Red (Flammable)

Potential Health Effects

Inhalation:
Inhalation of vapors irritates the respiratory tract. May cause headache, weakness, cyanosis, nausea, vomiting, and diarrhea. These symptoms may be followed by central nervous system effects, liver damage, kidney damage, adrenal gland damage, cyanosis, weak and rapid pulse and unconsciousness. Death can occur from respiratory and circulatory failure.
Ingestion:
Causes irritation to the gastrointestinal tract. Symptoms may include nausea, vomiting and diarrhea. Toxic effects parallel those of inhalation. Doses of 0.5 - 1.0 g/kg can be fatal.
Skin Contact:
Causes irritation, rash and blister formation. Prolonged contact can cause skin burns. Can be absorbed through skin with toxic effects.
Eye Contact:
Vapors cause eye irritation. Splashes cause severe irritation, possible corneal burns and eye damage.
Chronic Exposure:
Repeated or prolonged exposure may cause weight loss, low blood pressure, jaundice, reduced urinary output, dermatitis, eye damage and anemia. Dichloroethane is a suspected human carcinogen based on animal data.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems, or impaired liver, kidney, cardiovascular, neurological or 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.
Ingestion:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
Wash skin with soap or mild detergent and water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Call a physician.
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:
Flash point: 13C (55F) CC
Autoignition temperature: 413C (775F)
Flammable limits in air % by volume:
lel: 6.2; uel: 15.9
Flammable.
Explosion:
Above flash point, vapor-air mixtures are explosive within flammable limits noted above. Sealed containers may rupture when heated. Contact with strong oxidizers may cause fire. Vapors can flow along surfaces to distant ignition source and flash back. Sensitive to static discharge.
Fire Extinguishing Media:
Dry chemical, foam or carbon dioxide. Water spray may be used to keep fire exposed containers cool, dilute spills to nonflammable mixtures, protect personnel attempting to stop leak and disperse vapors.
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. Combustion by-products include phosgene and hydrogen chloride gases.

---

6. Accidental Release Measures

Ventilate area of leak or spill. Remove all sources of ignition. 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. Use non-sparking tools and equipment. Collect liquid in an appropriate container or 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! If a leak or spill has not ignited, use water spray to disperse the vapors, to protect personnel attempting to stop leak, and to flush spills away from exposures. 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 SOLUSORB® solvent adsorbent is recommended for spills of this product.

---

7. Handling and Storage

Protect against physical damage. Store in a cool, dry well-ventilated location, away from any area where the fire hazard may be acute. Outside or detached storage is preferred. Separate from incompatibles. Containers should be bonded and grounded for transfers to avoid static sparks. Storage and use areas should be No Smoking areas. Use non-sparking type tools and equipment, including explosion proof ventilation. Wear special protective equipment (Sec. 8) for maintenance break-in or where exposures may exceed established

exposure levels. Wash hands, face, forearms and neck when exiting restricted areas. Shower, dispose of outer clothing, change to clean garments at the end of the day. Avoid cross-contamination of street clothes. Wash hands before eating and do not eat, drink, or smoke in workplace. 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):
50 ppm (TWA), 100 ppm (ceiling)
200 ppm (max)/5 min/3 hour

- ACGIH Threshold Limit Value (TLV):
10 ppm (TWA), A4 - not classifiable as a human carcinogen

- NIOSH IDLH:
50 ppm

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. This substance has poor warning properties.

Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact. Polyvinyl alcohol (PVA) and Viton are recommended materials for personal protective equipment.

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 heavy liquid.

Odor:
Chloroform-like odor.

Solubility:
0.81g/100g water @ 20C (68F).

Specific Gravity:

1.24 @ 20C
pH:
No information found.
% Volatiles by volume @ 21C (70F):
100
Boiling Point:
83.4C (181F)
Melting Point:
-35.4C (-31F)
Vapor Density (Air=1):
3.42
Vapor Pressure (mm Hg):
87 @ 25C (77F)
Evaporation Rate (BuAc=1):
No information found.

---

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Darkens on exposure to air or light.
Hazardous Decomposition Products:
Emits toxic fumes of phosgene, hydrogen chloride, acetylene, and vinyl chloride when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Aluminum or magnesium powder, oxidizing agents, reducing agents, organic peroxides, alkali and alkali earth metals, nitric acid, caustics, nitrogen tetraoxide, ammonia, and dimethylaminopropylamine.
Conditions to Avoid:
Heat, flame, sources of ignition, light and incompatibles.

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11. Toxicological Information

Oral rat LD50: 500 mg/kg; inhalation rat LC50: 1000 ppm.7H; skin rabbit LD50: 2800 mg/kg; irritation eye rabbit, Standard Draize, 63 mg severe; skin rabbit, Open Draize, 625 mg mild; investigated as a tumorigen, mutagen, reproductive effector.

```
  --------\Cancer Lists\-----------------------------------------------------
----
                                          ---NTP Carcinogen---
  Ingredient                              Known    Anticipated    IARC
Category
  ------------------------------------   -----    -----------    ---------
----
  Ethylene Dichloride (107-06-2)           No          Yes            2B
```

---

12. Ecological Information

Environmental Fate:
When released into the soil, this material is expected to quickly evaporate. When released into the soil, this material may leach into groundwater. When released to water, this material is expected to quickly evaporate. When released into the water, this material is expected to have a half-life between 1 and 10 days. This material has a log octanol-water partition coefficient of less than 3.0. This material is not expected to significantly bioaccumulate. When released into the air, this material may be moderately degraded by reaction with photochemically produced hydroxyl radicals. When released into the air, this material is expected to have a half-life of greater than 30 days. When released into the air, this material may be removed from the atmosphere to a moderate extent by wet deposition.
Environmental Toxicity:
This material is not expected to be toxic to aquatic life. The LC50/96-hour values for fish are over 100 mg/l. The EC50/48-hour values for daphnia are over 100 mg/l.

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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: RQ, ETHYLENE DICHLORIDE
Hazard Class: 3, 6.1
UN/NA: UN1184
Packing Group: II
Information reported for product/size: 52L

International (Water, I.M.O.)

Proper Shipping Name: ETHYLENE DICHLORIDE
Hazard Class: 3, 6.1
UN/NA: UN1184
Packing Group: II
Information reported for product/size: 52L

International (Air, I.C.A.O.)

Proper Shipping Name: ETHYLENE DICHLORIDE

Hazard Class: 3, 6.1
UN/NA: UN1184
Packing Group: II
Information reported for product/size: 52L

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15. Regulatory Information

```
  --------\Chemical Inventory Status - Part 1\----------------------------
-----
  Ingredient                                        TSCA  EC   Japan
Australia
  ----------------------------------------------  ----  ---  -----  -----
----
  Ethylene Dichloride (107-06-2)                     Yes  Yes   Yes
Yes

  --------\Chemical Inventory Status - Part 2\----------------------------
-----
                                                             --Canada--
  Ingredient                                        Korea  DSL   NDSL
Phil.
  ----------------------------------------------  -----  ---   ----  ----
-
  Ethylene Dichloride (107-06-2)                     Yes   Yes   No     Yes

  --------\Federal, State & International Regulations - Part 1\-----------
-----
                                              -SARA 302-    ------SARA 313-
-----
  Ingredient                                  RQ    TPQ     List  Chemical
Catg.
  ----------------------------------------  ---   -----   ----  ---------
-----
  Ethylene Dichloride (107-06-2)              No    No      Yes        No

  --------\Federal, State & International Regulations - Part 2\-----------
-----
                                                          -RCRA-    -TSCA-
  Ingredient                                  CERCLA     261.33     8(d)
  ----------------------------------------  ------     ------    ------
  Ethylene Dichloride (107-06-2)              100        U077       No


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

WARNING:
THIS PRODUCT CONTAINS A CHEMICAL(S) KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER.

Australian Hazchem Code: 2YE
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.

---

16. Other Information

NFPA Ratings: Health: **2** Flammability: **3** Reactivity: **0**
Label Hazard Warning:
WARNING! FLAMMABLE LIQUID AND VAPOR. HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. AFFECTS CENTRAL NERVOUS SYSTEM, LIVER, KIDNEYS, AND CARDIOVASCULAR SYSTEM. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. POSSIBLE CANCER HAZARD. MAY CAUSE CANCER BASED ON ANIMAL DATA. Risk of cancer depends on duration and level of exposure.
Label Precautions:
Wash thoroughly after handling.
Do not breathe vapor.
Keep container closed.
Use only with adequate ventilation.
Do not get in eyes, on skin, or on clothing.
Keep away from heat, sparks and flame.
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 call a physician.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 3, 11.
Disclaimer:
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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

VINYL CHLORIDE

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

Product ID:VINYL CHLORIDE
MSDS Date:10/01/1985
FSC:6810
NIIN:00N034925
MSDS Number: BQCBT
=== Responsible Party ===
Company Name:MATHESON GAS PRODUCTS
Address:932 PATTERSON PLANK RD
City:EAST RUTHERFORD
State:NJ
ZIP:07073
Country:US
Info Phone Num:201-933-2400
Emergency Phone Num:201-933-2400
CAGE:0FB11
=== Contractor Identification ===
Company Name:MATHESON GAS PRODUCTS
Address:30 SEAFIEW DRIVE
Box:City:SEACAUCUS
State:NJ
ZIP:07096
Country:US
Phone:201-867-4100, CHEMTREC 800-424-9300
CAGE:0FB11

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

Ingred Name:ETHYLENEM, CHLORO-; (VINYL CHLORIDE) (SARA III)
CAS:75-01-4
RTECS #:KU9625000
OSHA PEL:SEE 1910.1017
ACGIH TLV:5 PPM, A1; 9293
EPA Rpt Qty:1 LB
DOT Rpt Qty:1 LB

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

LD50 LC50 Mixture:NONE SPECIFIED BY MANUFACTURER.
Routes of Entry: Inhalation:YES Skin:NO Ingestion:YES
Reports of Carcinogenicity:NTP:YES IARC:YES OSHA:YES
Health Hazards Acute and Chronic:ACUTE:INHAL MAY CAUSE DROWS, BLURRED VISION, STAG GAIT, & TINGLING & NUMBNESS IN THE FEET & HANDS. IN HIGH CONC VINYL CHLORIDE ACTS AS AN ANESTHETIC. CONTACT WITH LIQ VINYL CHLORIDE MAY CAUSE SEVERE I RRITATION & BURNS. CHRONIC: VINYL CHLORIDE IS A RECOGNIZED CARCINOGEN & HAS CAUSED CANCER IN MAN.(EFTS OF OVEREXP)
Explanation of Carcinogenicity:VINYL CHLORIDE: KNOWN CARCINOGEN (NTP), GROUP 1 (IARC); OSHA REGULATED
Effects of Overexposure:SEE HEALTH HAZARDS.
Medical Cond Aggravated by Exposure:NONE SPECIFIED BY MANUFACTURER.

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

First Aid:INHAL: MOVE VICTIM TO FRESH AIR. IF NOT BRTHG, GIVE ARTF RESP. IF BRTHG IS DIFFICULT, GIVE OXYGEN. CALL A PHYSICIAN. EYE/SKIN: IMMED FLUSH EYE/SKIN WITH PLENTY OF WATER FOR AT LEAST 15 MIN. REMOVE CON TAMINATED CLOTHING AND SHOES. CALL A PHYSICIAN. INGEST: GET MD IMMEDIATELY . NOTE: SKIN BURNS CAN BE TREATED BY THE APPLICATION OF MAGNESIUM PASTE (MAGNESIUM OXIDE AND GLYCERINE).

Fire Fighting Measures

Lower Limits:4%
Upper Limits:22%
Extinguishing Media:TO EXTING A VINYL CHLORIDE FIRE STOP THE FLOW OF GAS. IF THE FLOW CANNOT BE STOPPED, LET THE FIRE BURN ITSELF(SUPP DATA)
Fire Fighting Procedures:FIRE FIGHTERS MUST WEAR NIOSH/MSHA APPROVED SCBA AND FULL PROTECTIVE EQUIPMENT . FIREIGHTERS TURNOUT GEAR IS INADEQUATE.
Unusual Fire/Explosion Hazard:CYLINDERS THAT ARE EXPOSED TO FIRE MAY RUPTURE WITH VIOLENT FORCE. EXTING SURROUNDING FIRE & KEEP CYLINDERS COOL USING A WATER SPRAY APPLIED FROM THE(SUPP DATA)

Accidental Release Measures

Spill Release Procedures:EVACUATE AREA. PERSONNEL EQUIPPED W/SPECIAL PERSONAL PROTECTIVE SUITS FOR FIRE/CHEMICALS AND POSITIVE PRESSURE NIOSH/MSHA APPROVED SCBA CAN RE-ENTER THE AREA AND ATTEMPT TO STOP LEAK.
Neutralizing Agent:NONE SPECIFIED BY MANUFACTURER.

Handling and Storage

Handling and Storage Precautions:CYLINDERS SHOULD BE STORED AND USED IN DRY, WELL VENT AREAS AWAY FROM SOURCES OF HEAT OR IGNITION. DO NOT STORE WITH OXIDIZERS.
Other Precautions:BEFORE USING: 1)SECURE CYLINDER TO PVNT IT FROM FALLING OR BEING KNOCKED OVER. 2) INSTALL CHECK VALVES/TRAPS TO PVNT SUCKBACK TO CYLNDER. 3)LEAK CHECK LINES & EQUIP. 4) HAVE APPRVD RESP PROT & OTHER P ROT EQUIP. 5) HAVE AN EMER (SUPP DAT

Exposure Controls/Personal Protection

Respiratory Protection:NIOSH/MSHA APPROVED POSITIVE PRESSURE SCBA SHOULD BE WORN IF IT IS SUSPECTED THAT VINYL CHLORIDE IS IN THE AIR.
Ventilation:NONE SPECIFIED BY MANUFACTURER.
Protective Gloves:IMPERVIOUS GLOVES.
Eye Protection:CHEM WORK GOGG/FULL LENGTH FSHLD .
Other Protective Equipment:EYE WASH STATIONS & SAFETY SHOWERS READILY AVAILABE.
Work Hygienic Practices:NONE SPECIFIED BY MANUFACTURER.
Supplemental Safety and Health
EXTING MEDIA:OUT WHILE COOLING CYLINDER & SURROUNDINGS USING A H*2O SPRAY. EXPLO HAZ:MAX POSS DISTANCE. FLAMM & TOX GASES MAY SPREAD FROM A SPILL AFTER FIRE IS EXTING & BE SUBJECT TO REIGNIT. THERMAL DECOMP PRODS MAY INCL HCL & PHOSGENE . OTHER PREC: PLAN COVERING STEPS TO BE TAKEN IN CASE OF ACCIDENTAL RELEASE.

Physical/Chemical Properties

HCC:G2
Boiling Pt:B.P. Text:7.2F,-13.8C
Melt/Freeze Pt:M.P/F.P Text:-245F,-154C
Vapor Pres:234KPA@21C
Spec Gravity:2.21
Solubility in Water:1.07 CM3/1 ML H*2O
Appearance and Odor:COLORLESS, HIGHLY FLAMM GAS WITH A PLEASANT, SWEET ODOR AT HIGH CONC.

Stability and Reactivity Data

Stability Indicator/Materials to Avoid:YES
OXIDIZING MATLS, ACTIVE METALS, ALUMINUM ALLOYS AND ORGANOMETALLICS.
Stability Condition to Avoid:AVOID EXPOSURE TO SUNLIGHT, HEAT, AIR, OXYGEN PEROXIDES AND OTHER STRONG OXIDIZING AGENTS.
Hazardous Decomposition Products:HYDROGEN CHLORIDE, PHOSGENE, CARBON MONOXIDE.
Conditions to Avoid Polymerization:OXYGEN (AIR), HEAT, SUNLIGHT, MOISTURE AND FREE RADICAL INITIATORS OR OTHER CATALYTIC MATERIALS.

Disposal Considerations

Waste Disposal Methods:DISPOSAL MUST BE IN ACCORDANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS .

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Buffer Solution (Borate), pH 10 (Color Coded Blue)

1. Product Identification

Synonyms: None.
CAS No.: Not applicable to mixtures.
Molecular Weight: Not applicable to mixtures.
Chemical Formula: Not applicable to mixtures.
Product Codes: 5655

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Water	7732-18-5	> 99%	No
Boric Acid	10043-35-3	< 1%	No
Potassium Hydroxide	1310-58-3	< 1%	Yes
C.I. Acid Blue 9 Disodium Salt	3844-45-9	< 1%	No
Citric Acid	77-92-9	< 1%	No
Sodium Benzoate	532-32-1	< 1%	No
Propylene Glycol	57-55-6	< 1%	No
FD & C Red No. 40	25956-17-6	< 1%	No
Propyl Paraben	94-13-3	< 1%	No

3. Hazards Identification

Emergency Overview

DANGER! CORROSIVE. HARMFUL IF SWALLOWED OR INHALED. CAUSES BURNS TO ANY AREA OF CONTACT.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate
Flammability Rating: 0 - None

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

Potential Health Effects

The health effects from exposure to diluted forms of this chemical are not well documented. They are expected to be less severe than those for concentrated forms which are referenced in the descriptions below.

Inhalation:
Respiratory tract irritant, may cause serious burns on acute contact. Severe injury is usually avoided by the self-limiting coughing and sneezing symptoms.
Ingestion:
Toxic! Corrosive to mucous membranes and may cause perforation of the esophagus and stomach. Abdominal pain, nausea, vomiting, general gastro-intestinal upset can be expected.
Skin Contact:
Irritant, possibly corrosive if contact is prolonged. Soreness, redness, destruction of skin may result.
Eye Contact:
Irritant, possibly corrosive to eye tissues. Tearing, redness, pain, impaired vision are symptoms.
Chronic Exposure:
Development of a defatting dermatitis on prolonged contact with potassium hydroxide has been reported. Continued irritation may lead to increased susceptibility to respiratory illness.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems, or impaired kidney or respiratory function may be more susceptible to the effects of the substance.

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4. First Aid Measures

First aid procedures given apply to concentrated solutions. Exposures to dilute solutions may not require these extensive first aid procedures.
Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
Ingestion:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention immediately. Wash clothing before reuse. Thoroughly clean shoes before reuse.
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 considered to be a fire hazard.
Explosion:
Sealed containers may rupture when heated.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
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.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Contain and recover liquid when possible. Collect liquid in an appropriate container or 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.

7. Handling and Storage

Keep in a tightly closed container. Store in a cool, dry, ventilated area. Protect against physical damage. Separate from acids and alkalis. Protect from freezing. 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 Potassium Hydroxide [1310-58-3]:
- ACGIH Threshold Limit value (TLV):
2 mg/m3 Ceiling
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 half facepiece particulate respirator (NIOSH type P95 or R95 filters) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest.. A full-face piece particulate respirator (NIOSH type P100 or R100 filters) 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. Please note that N filters are not recommended for this material. 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.

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.

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9. Physical and Chemical Properties

Appearance:

Blue liquid.

Odor:

Odorless.

Solubility:

Complete (100%)

Specific Gravity:

No information found.

pH:

10

% Volatiles by volume @ 21C (70F):

ca. 99 (as water)

Boiling Point:

No information found.

Melting Point:

No information found.

Vapor Density (Air=1):

No information found.

Vapor Pressure (mm Hg):

No information found.

Evaporation Rate (BuAc=1):

No information found.

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10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Potassium oxide at very high temperatures.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Acids.
Conditions to Avoid:
Incompatibles.

11. Toxicological Information

For potassium hydroxide: Oral rat LD50: 273 mg/kg; Investigated as a mutagen. Skin Irritation Data (std Draize, 50 mg/24 H): Human, Severe; Rabbit, Severe. Eye Irritation Data(Rabbit, non-std test,1 mg/24 H, rinse): Moderate.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Water (7732-18-5)	No	No	None
Boric Acid (10043-35-3)	No	No	None
Potassium Hydroxide (1310-58-3)	No	No	None
C.I. Acid Blue 9 Disodium Salt (3844-45-9)	No	No	3
Citric Acid (77-92-9)	No	No	None
Sodium Benzoate (532-32-1)	No	No	None
Propylene Glycol (57-55-6)	No	No	None
FD & C Red No. 40 (25956-17-6)	No	No	None
Propyl Paraben (94-13-3)	No	No	None

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
Potassium Hydroxide: TLm: 80 ppm/Mosquito fish/ 24 hr./ Fresh water

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: CORROSIVE LIQUID, BASIC, INORGANIC, N.O.S. (POTASSIUM HYDROXIDE)
Hazard Class: 8
UN/NA: UN3266
Packing Group: III
Information reported for product/size: 20L

International (Water, I.M.O.)

Proper Shipping Name: CORROSIVE LIQUID, BASIC, INORGANIC, N.O.S. (POTASSIUM HYDROXIDE)
Hazard Class: 8
UN/NA: UN3266
Packing Group: III
Information reported for product/size: 20L

International (Air, I.C.A.O.)

Proper Shipping Name: CORROSIVE LIQUID, BASIC, INORGANIC, N.O.S. (POTASSIUM HYDROXIDE)
Hazard Class: 8
UN/NA: UN3266
Packing Group: III
Information reported for product/size: 20L

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\--------

Ingredient	TSCA	EC	Japan	Australia
Water (7732-18-5)	Yes	Yes	Yes	Yes
Boric Acid (10043-35-3)	Yes	Yes	Yes	Yes
Potassium Hydroxide (1310-58-3)	Yes	Yes	Yes	Yes
C.I. Acid Blue 9 Disodium Salt (3844-45-9)	Yes	Yes	Yes	Yes
Citric Acid (77-92-9)	Yes	Yes	Yes	Yes
Sodium Benzoate (532-32-1)	Yes	Yes	Yes	Yes
Propylene Glycol (57-55-6)	Yes	Yes	Yes	Yes
FD & C Red No. 40 (25956-17-6)	Yes	Yes	No	Yes
Propyl Paraben (94-13-3)	Yes	Yes	Yes	Yes

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

		--Canada--		
Ingredient	Korea	DSL	NDSL	Phil.

Water (7732-18-5)	Yes	Yes	No	Yes
Boric Acid (10043-35-3)	Yes	Yes	No	Yes
Potassium Hydroxide (1310-58-3)	Yes	Yes	No	Yes
C.I. Acid Blue 9 Disodium Salt (3844-45-9)	Yes	Yes	No	Yes
Citric Acid (77-92-9)	Yes	Yes	No	Yes
Sodium Benzoate (532-32-1)	Yes	Yes	No	Yes
Propylene Glycol (57-55-6)	Yes	Yes	No	Yes
FD & C Red No. 40 (25956-17-6)	Yes	Yes	No	Yes
Propyl Paraben (94-13-3)	Yes	Yes	No	Yes

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

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Water (7732-18-5)	No	No	No	No
Boric Acid (10043-35-3)	No	No	No	No
Potassium Hydroxide (1310-58-3)	No	No	No	No
C.I. Acid Blue 9 Disodium Salt (3844-45-9)	No	No	No	No
Citric Acid (77-92-9)	No	No	No	No
Sodium Benzoate (532-32-1)	No	No	No	No
Propylene Glycol (57-55-6)	No	No	No	No
FD & C Red No. 40 (25956-17-6)	No	No	No	No
Propyl Paraben (94-13-3)	No	No	No	No

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

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Water (7732-18-5)	No	No	No
Boric Acid (10043-35-3)	No	No	No
Potassium Hydroxide (1310-58-3)	1000	No	No
C.I. Acid Blue 9 Disodium Salt (3844-45-9)	No	No	No
Citric Acid (77-92-9)	No	No	No
Sodium Benzoate (532-32-1)	No	No	No
Propylene Glycol (57-55-6)	No	No	No
FD & C Red No. 40 (25956-17-6)	No	No	No
Propyl Paraben (94-13-3)	No	No	No

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

Australian Hazchem Code: None allocated.
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.

16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
DANGER! CORROSIVE. HARMFUL IF SWALLOWED OR INHALED. CAUSES BURNS TO ANY AREA OF CONTACT.
Label Precautions:

Do not breathe mist.
Do not get in eyes, on skin, or on clothing.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.

Label First Aid:

If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. 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 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: 8.

Disclaimer:

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

Buffer Solution (Phosphate), pH 7 (Color Coded Yellow)

1. Product Identification

Synonyms: None.
CAS No.: Not applicable to mixtures.
Molecular Weight: Not applicable to mixtures.
Chemical Formula: Not applicable to mixtures.
Product Codes: 5656

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Potassium Phosphate Monobasic	7778-77-0	< 1%	No
Sodium Phosphate, Dibasic	7558-79-4	< 1%	No
Propylene Glycol	57-55-6	< 1%	No
FD & C Yellow No. 5	1934-21-0	< 1%	No
Water	7732-18-5	> 98%	No

3. Hazards Identification

Emergency Overview

As part of good industrial and personal hygiene and safety procedure, avoid all unnecessary exposure to the chemical substance and ensure prompt removal from skin, eyes and clothing.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 0 - None
Flammability Rating: 0 - None
Reactivity Rating: 0 - None
Contact Rating: 1 - Slight

Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
No adverse health effects via inhalation.
Ingestion:
Not expected to be a health hazard via ingestion. Large oral doses may cause irritation to the gastrointestinal tract.
Skin Contact:
Not expected to be a health hazard from skin exposure. May cause mild irritation and redness.
Eye Contact:
No adverse effects expected. May cause mild irritation, possible reddening.
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
No information found.

4. First Aid Measures

Inhalation:
Not expected to require first aid measures. Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:
Not expected to require first aid measures. If large amounts were swallowed, give water to drink and get medical advice.
Skin Contact:
Not expected to require first aid measures. Wash exposed area with soap and water. Get medical advice if irritation develops.
Eye Contact:
Not expected to require first aid measures. Wash thoroughly with running water. Get medical advice if irritation develops.

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
Use protective clothing and breathing equipment appropriate for the surrounding fire.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Contain and recover liquid when possible. Collect liquid in an appropriate container or 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. 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.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. 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:
None established.
Ventilation System:
In general, dilution ventilation is a satisfactory health hazard control for this substance. However, if conditions of use create discomfort to the worker, a local exhaust system should be considered.
Personal Respirators (NIOSH Approved):
Not expected to require personal respirator usage.
Skin Protection:
Wear protective gloves and clean body-covering clothing.
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:
Yellow liquid.
Odor:
Odorless.
Solubility:
Complete (100%)
Specific Gravity:
No information found.
pH:
7.0

% Volatiles by volume @ 21C (70F):
ca. 98
Boiling Point:
No information found.
Melting Point:
No information found.
Vapor Density (Air=1):
Not applicable.
Vapor Pressure (mm Hg):
Not applicable.
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Oxides of phosphorous, sodium and carbon may be formed when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
No information found.
Conditions to Avoid:
No information found.

11. Toxicological Information

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Potassium Phosphate Monobasic (7778-77-0)	No	No	None
Sodium Phosphate, Dibasic (7558-79-4)	No	No	None
Propylene Glycol (57-55-6)	No	No	None
FD & C Yellow No. 5 (1934-21-0)	No	No	None
Water (7732-18-5)	No	No	None

12. Ecological Information

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

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal 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

Not regulated.

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\--------

Ingredient	TSCA	EC	Japan	Australia
Potassium Phosphate Monobasic (7778-77-0)	Yes	Yes	Yes	Yes
Sodium Phosphate, Dibasic (7558-79-4)	Yes	Yes	Yes	Yes
Propylene Glycol (57-55-6)	Yes	Yes	Yes	Yes
FD & C Yellow No. 5 (1934-21-0)	Yes	Yes	Yes	Yes
Water (7732-18-5)	Yes	Yes	Yes	Yes

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

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Potassium Phosphate Monobasic (7778-77-0)	Yes	Yes	No	Yes
Sodium Phosphate, Dibasic (7558-79-4)	Yes	Yes	No	Yes
Propylene Glycol (57-55-6)	Yes	Yes	No	Yes
FD & C Yellow No. 5 (1934-21-0)	Yes	Yes	No	Yes
Water (7732-18-5)	Yes	Yes	No	Yes

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

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Potassium Phosphate Monobasic (7778-77-0)	No	No	No	No
Sodium Phosphate, Dibasic (7558-79-4)	No	No	No	No
Propylene Glycol (57-55-6)	No	No	No	No
FD & C Yellow No. 5 (1934-21-0)	No	No	No	No
Water (7732-18-5)	No	No	No	No

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

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Potassium Phosphate Monobasic (7778-77-0)	No	No	No
Sodium Phosphate, Dibasic (7558-79-4)	5000	No	No
Propylene Glycol (57-55-6)	No	No	No
FD & C Yellow No. 5 (1934-21-0)	No	No	No
Water (7732-18-5)	No	No	No

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

Australian Hazchem Code: None allocated.
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.

---

16. Other Information

NFPA Ratings: Health: **0** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
As part of good industrial and personal hygiene and safety procedure, avoid all unnecessary exposure to the chemical substance and ensure prompt removal from skin, eyes and clothing.
Label Precautions:
None.
Label First Aid:
Not applicable.
Product Use:
Laboratory Reagent.
Revision Information:
No Changes.
Disclaimer:
****
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****

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

Buffer Solution (Biphthalate), pH 4 (Color Coded Red)

1. Product Identification

Synonyms: None.
CAS No.: Not applicable to mixtures.
Molecular Weight: Not applicable to mixtures.
Chemical Formula: Not applicable to mixtures.
Product Codes: 5657

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Water	7732-18-5	97 - 98%	No
Potassium Acid Phthalate	877-24-7	1 - 2%	Yes
Propylene Glycol	57-55-6	< 1%	No
FD & C Red No. 40	25956-17-6	< 1%	No

3. Hazards Identification

Emergency Overview

CAUTION! MAY CAUSE IRRITATION TO SKIN AND EYES.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 0 - None
Flammability Rating: 0 - None
Reactivity Rating: 0 - None
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)

Potential Health Effects

Information on the human health effects from exposure to this substance is limited.

Inhalation:
Not expected to be an inhalation hazard. May cause irritation to respiratory tract because of slight acidity. Symptoms may include coughing and sore throat.
Ingestion:
Large doses may produce nausea, vomiting, and abnormal sensations in hands and feet. Because of slight acidity, causes irritation to the mucous membranes.
Skin Contact:
Contact may cause irritation, with redness and pain.
Eye Contact:
May cause eye irritation.
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
No information found.

---

4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:
If large amounts were swallowed, give water to drink and get medical advice.
Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention if irritation develops.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting upper and lower eyelids occasionally. Get medical attention if irritation persists.

---

5. Fire Fighting Measures

Fire:
Not expected to be a fire hazard.
Explosion:
No information found.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
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.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Contain and recover liquid when possible. Collect liquid in an appropriate container or 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.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. 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:
None established.
Ventilation System:
In general, dilution ventilation is a satisfactory health hazard control for this substance. However, if conditions of use create discomfort to the worker, a local exhaust system should be considered.
Personal Respirators (NIOSH Approved):
Not expected to require personal respirator usage.
Skin Protection:
Wear protective gloves and clean body-covering clothing.
Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Clear, reddish liquid.
Odor:
Odorless.
Solubility:
Completely soluble in water.
Specific Gravity:
No information found.
pH:
4.0
% Volatiles by volume @ 21C (70F):
ca. 98
Boiling Point:

No information found.
Melting Point:
No information found.
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Carbon dioxide and carbon monoxide may form when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
No information found.
Conditions to Avoid:
Heat, incompatibles.

11. Toxicological Information

No LD50/LC50 information found relating to normal routes of occupational exposure.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Water (7732-18-5)	No	No	None
Potassium Acid Phthalate (877-24-7)	No	No	None
Propylene Glycol (57-55-6)	No	No	None
FD & C Red No. 40 (25956-17-6)	No	No	None

12. Ecological Information

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

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal 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

Not regulated.

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\--------

Ingredient	TSCA	EC	Japan	Australia
Water (7732-18-5)	Yes	Yes	Yes	Yes
Potassium Acid Phthalate (877-24-7)	Yes	Yes	Yes	Yes
Propylene Glycol (57-55-6)	Yes	Yes	Yes	Yes
FD & C Red No. 40 (25956-17-6)	Yes	Yes	No	Yes

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

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Water (7732-18-5)	Yes	Yes	No	Yes
Potassium Acid Phthalate (877-24-7)	Yes	Yes	No	Yes
Propylene Glycol (57-55-6)	Yes	Yes	No	Yes
FD & C Red No. 40 (25956-17-6)	Yes	Yes	No	Yes

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

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Water (7732-18-5)	No	No	No	No
Potassium Acid Phthalate (877-24-7)	No	No	No	No
Propylene Glycol (57-55-6)	No	No	No	No
FD & C Red No. 40 (25956-17-6)	No	No	No	No

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

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Water (7732-18-5)	No	No	No
Potassium Acid Phthalate (877-24-7)	No	No	No
Propylene Glycol (57-55-6)	No	No	No
FD & C Red No. 40 (25956-17-6)	No	No	No

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

Australian Hazchem Code: None allocated.
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.

16. Other Information

NFPA Ratings: Health: **1** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
CAUTION! MAY CAUSE IRRITATION TO SKIN AND EYES.
Label Precautions:
Avoid contact with eyes, skin and clothing.
Keep container closed.
Wash thoroughly after handling.
Label First Aid:
In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Get medical attention if irritation develops or persists.
Product Use:
Laboratory Reagent.
Revision Information:
No Changes.
Disclaimer:
****
Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.
****

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

Material Safety Data Sheet

August 1, 2001

YSI Incorporated

1725 Brannum Lane
Yellow Springs, OH 45387
USA

Information and Emergency Phone: (937) 767-7241

SECTION 1 - MATERIAL IDENTIFICATION

PRODUCT NAME: **YSI 3682 Zobell Solution** FORMULA: n/ap
Chemical Type: Inorganic chloride / cyanide
CAS No. n/app

SECTION 2 - HAZARDOUS / IMPORTANT INGREDIENTS

Chemical	CAS No.	PERCENT	PEL/TLV	CARCINOGEN (OSHA, NTP, IARC)
Potassium chloride	7447-40-7	72 - 78%	none	no
Potassium ferrocyanide, trihydrate	14459-95-1	10 - 15%	none	no
Potassium ferricyanide	13746-66-2	10 - 15%	none	no

SECTION 3 - CHEMICAL AND PHYSICAL PROPERTIES

Appearance: white powder
Odor: none
pH: neutral
Water Solubility: infinite
Evaporation Rate: n/av
Boiling Point: n/av
Melting Point: n/av
Specific Gravity: n/av
Vapor Pressure: n/ap
Vapor Density: n/ap

SECTION 4 - FIRE AND EXPLOSION HAZARDS

Flash Point: none Explosive Limits: none
Extinguishing Media: n/ap
Special Firefighting Procedures and Hazards: Material is not combustible. May emit toxic fumes when heated, such as NOx, HCN. HCl. Wear protection as described in Section 6.

SECTION 5 - REACTIVITY INFORMATION

Stable: X Unstable: Precautions: none known
Hazardous Polymerization: Occurs: Does Not Occur: X
Incompatibility: strong acids and oxcidizing agents.
Hazardous Decomposition Products: When heated, possibly NOx, HCN, HCl.

SECTION 6 - HEALTH HAZARDS / PROTECTIVE MEASURES / FIRST AID

Inhalation:
Possible irritation from dusts. (see CHRONIC below)
Use a NIOSH approved respirator for dusts. Get supplier recommendations. Provide adequate ventilation.
Minimize dusty conditions.
Remove to fresh air and provide artificial respiration if needed.

Skin:
Possible irritation from dusts. (see CHRONIC below)
Wear dust-proof gloves and other body protection as needed. Minimize dusty conditions.
Wash exposed areas with soap and water for 15 minutes. Remove contaminated clothing, and wash before re-using.

Eyes:
Possible irritation from dust.
Wear dust barrier goggles. Eliminate dusty conditions.
Flush with water for 15 minutes.

Ingestion
No effects expected from normal use and minor amounts ingested. Large amounts, over 1 tablespoon, can cause digestive system upset s. (see CHRONIC below)
Reduce dusting. Avoid mouth breathing. Use facemask. Provide adequate ventilation.
Avoid swallowing. Spit out. Drink large amounts of water. Induce vomiting if person is conscious. Otherwise, and if effects persist, get medical attention.

CHRONIC EFFECTS: None reported for this material. "Cyanides" in general are often reported as toxic to humans. Therefore, it is recommended that exposure via skin, inhalation, and ingestion be limited.

IN ALL CASES: GET MEDICAL ATTENTION IF EFFECTS PERSIST.

Most likely routes of entry: skin, eyes, ingestion.

SECTION 7 - PRECAUTIONS FOR SAFE HANDLING AND USE

Spills and Leaks: Take up powder in any container and hold for disposal. Flush residual to sewer or ground. Provide personal protection as described in Section 6.

Storage and Handling: Keep containers closed. Discard any material that may be contaminated. Minimize dusting.

Waste Disposal: Is not listed as RCRA hazardous waste at this date. Cyanides are restricted in water disposed to streams and to sewers. Therefore, landfill disposal is indicated; check with local disposal companies.

Empty Containers: Rinse well. Dispose as appropriate for glass and plastic containers.

SECTION 8 - REGULATORY INFORMATION

DOT: Not regulated.
SARA Title III, S.313, Form R: Nothing reportable.

The information contained herein is based on data available at this time and is believed to be accurate. However, no warranty is expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof. Since information contained herein may be applied under conditions beyond our control, and with which we may be unfamiliar, no responsibility is assumed for the results of its use. The person receiving this information shall make his own determination of the suitability of the material for his particular use.

Attachment 9
Behavioral Based Loss Prevention Field Forms

Activity Hazard Analysis
Pre-Task Safety Plans
Incident Report Form
Safe Work Observation Form
Incident & Near-Loss Investigation Report Form
Root Cause Analysis Form

ACTIVITY HAZARDS ANALYSIS

Activity Hazard Analysis **Decontamination of Equipment**		**Analyzed By/Date** **Reviewed By/Date:**
Principal Tasks	**Potential Hazards**	**Recommended Controls (Level D PPE site wide for all operations)**
General Activity	Slips, trips, falls	• Use care during foot travel, and clear the area of slip and trip hazards • Use barricades • Use guardrails • Cover holes.
	Muscle Strain / Back Injury	• Use proper lifting technique. • Buddy system for heavy lifts • Use lifting/transport equipment
Decon/Cleaning of Equipment	Contact with contaminated water	• Wear required PPE • Utilize proper hand washing and hygiene controls • Avoid vapors
Equipment to be Used	**Inspection Requirements**	**Training Requirements**
Hand Tools,	Daily inspection of equipment prior to operation	• Site specific training – Toolbox safety meetings • 40 hr Hazwoper • HazCom Training

ACTIVITY HAZARDS ANALYSIS

Activity Hazard Analysis Handling & Storing IDW		**Analyzed By/Date Reviewed By/Date:**
Principal Tasks	**Potential Hazards**	**Recommended Controls (Level D PPE site wide for all operations)**
General Activity	Slips, trips, falls	• Use care during foot travel, and clear the area of slip and trip hazards • Use barricades • Use guardrails • Cover holes.
Moving drums or heavy equipment	Muscle Strain / Back Injury	• Use proper lifting technique. • Buddy system for heavy lifts • Use lifting/transport equipment
	Crushing Injuries	• Wear safety boots • Use care setting loads • Use blocks or support for loads
Equipment to be Used	**Inspection Requirements**	**Training Requirements**
Hand Tools,	Daily inspection of equipment prior to operation	• Site specific training – Toolbox safety meetings • 40 hr Hazwoper • HazCom Training

Activity Hazard Analysis (AHA)

Activity: Mobilization	**Date:**
	Project: Remedial Investigation **ST. LOUIS ORDNANCE PLANT, FORMER HANLEY AREA,, ST. LOUIS, MO**
Description of the work: Mobilization/Site preparation for sampling activities.	**Field Team Leader/Site Safety Health Officer:**
	Review for latest use: Each time before the job is performed.

Task Breakdown	Identify & Analyze the Hazards	Identify Hazard Controls
Mobilization/Site Setup Support Functions	General safety hazards at construction sites (i.e. Slips/Trips/Falls, noise, housekeeping, etc.)	• Site work will be performed during daylight hours whenever possible. Work conducted during hours of darkness will require enough illumination intensity to read a newspaper without difficulty. • Hearing protection worn in areas where you need to shout to hear someone within 3 feet. • Good housekeeping must be maintained at all times in project work areas. • Common paths of travel established and kept free from accumulation of materials. • Provide slip-resistant surfaces, ropes, and /or other devices to be used. • Specific areas should be designated for the proper storage of materials. • Tools, equipment, materials, and supplies will be stored in an orderly manner. • As work progresses, scrap and unessential materials must be neatly stored or removed from the work area. • Containers should be provided for collecting trash and other debris and will be removed at regular intervals. • Spills will be cleaned up. Oil and grease will be cleaned from walking and working surfaces.

Activity Hazard Analysis (AHA)

Task Breakdown	Identify & Analyze the Hazards	Identify Hazard Controls
	Chemical (chemicals brought to site)	▪ All chemicals brought on site must be approved by CH2M HILL and must have MSDS on file at the site. ▪ Chemicals must be stored in approved containers, no leaks, dents, rust etc.
	Traffic Hazards (Motor Vehicles)	▪ All vehicles are visually inspected before operating. ▪ All vehicles shall have properly functioning brake systems, brake lights, audible horn, powered wipers, defoggers/defrosters, and, if used in low visibility situations (dark, rain, etc.), headlights and taillights (two each). ▪ Seat Belts will be worn at all times that vehicle is being operated. ▪ Cracked or broken windshields or glass shall be reported to the vehicle coordinator. ▪ All users shall have a valid driver's license ▪ All vehicles and equipment shall be operated in accordance with the manufacturer's operating instructions.
	Manual Lifting	▪ Employees shall be instructed in safe lifting techniques. Back straight, bend at knees, load close to the body, lift smoothly, and do not twist. ▪ Utilize material handling devices such as hand trucks. ▪ Manual lifts of over 75 pounds require two people. Employees are encouraged to get help for any lift that appears excessive.
	Fire Hazards	▪ Storage areas and yards shall be kept free from accumulation of unnecessary combustible materials. ▪ A fire extinguisher will be located in each vehicle and/or equipment
	Temperature Extremes	▪ Employees shall be trained in the recognition of cold stress and appropriate actions to take ▪ Personnel will be briefed on Heat Stress or Cold Exposure of Project Site Specific Health and Safety Plan
	Excessive Noise	

Activity Hazard Analysis (AHA)

Task Breakdown	Identify & Analyze the Hazards	Identify Hazard Controls
	Portable Electric Tools Extension Cords Movement or transport of materials, supplies and equipment to the work site by manual and/or mechanical means Injury to eyes from airborne particulates, flying debris and chemical exposure Flammable Liquid Storage Stacking and storing of materials	▪ Wear hearing protection in noise environments exceeding 85dBA. ▪ Noise reduction requirements for hearing protection will be determined by Anderson & Associates. ▪ Portable electric tools that are unsafe due to faulty plugs, damaged cords, or other reason shall be removed from service. ▪ A Ground Fault Circuit Interrupter (GFCI) device shall protect portable electric tools and all cord and plug-connected equipment ▪ Extension cords that have faulty plugs, damaged insulation, or are unsafe in any way shall be removed from service. ▪ Cords shall be protected from damage from sharp edges, projections, pinch points (doorways), and vehicular traffic. ▪ Cords shall be suspended with a non-conductive support (rope, plastic ties, etc.) ▪ Cords shall be inspected prior to, during, and after each use. ▪ Wear at all times: hard hats, and sturdy, ankle high, safety-toed leather work boots and safety vests at all times. Leather gloves shall be worn when handling materials with rough, sharp, or slippery surfaces. ▪ Protective eyewear with side shields that meet the ANSI Z-87.1 standard shall be worn at all times. If work conditions warrant, full-face shields, goggles, or chemical goggles must be worn ▪ Storage of gasoline and diesel fuels shall only be stored in approved containers. ▪ No hot work, welding, or smoking shall be allowed

Activity Hazard Analysis (AHA)

Task Breakdown	Identify & Analyze the Hazards	Identify Hazard Controls
		within 50 ft of flammable and combustible liquid storage areas. ▪ All materials stored in tiers shall be stacked, racked, blocked, interlocked, or in some means secured to prevent sliding, falling, or collapsing. ▪ Cylindrical materials such as piping shall be blocked, bound, or racked to contain spreading or rolling. ▪ Used lumber shall have all nails removed. Lumber shall be stacked on level, supporting sills in such a way that it is stable and self-supporting
EQUIPMENT TO BE USED	**INSPECTION REQUIREMENTS**	

	PRINT	SIGNATURE	
Supervisor Name:	_____	_____	**Date/Time:**_____
Safety Officer Name:	_____	_____	**Date/Time:**_____
Employee Name(s):	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
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	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____

ACTIVITY HAZARD ANALYSIS (AHA)

ACTIVITY NAME: GROUNDWATER SAMPLING –REMEDIAL INVESTIGATION. HANLEY AREA, FORMER ST. LOUIS ORDNANCE PLANT, ST. LOUIS, MO	**DATE:**	**NEW___** **REVISED____**	**PAGE ____OF ____**
ASSOCIATE(S)/JOB TITLE PERFORMING THE JOB/TASK:	**SUPERVISOR(S):**		**ANALYSIS PERFORMED BY:**
PROJECT NAME AND JOB/TASK LOCATION:	**DEPARTMENT(S):**		**REVIEWED BY:**
PERSONAL PROTECTIVE EQUIPMENT:	**SHIFT (if applicable):**		**APPROVED BY:**

	JOB STEPS	**POSSIBLE HAZARDS**	**PROCEDURE/ACTION TO CONTROL OR ELIMINATE**
1.	**Mobilization and travel between wells**	**Vehicle Operation** 1) Opening/closing doors, windows and trunk 2) Loading objects 3) Driving 4) Parking 5) Distractions 6) Emergency preparedness	1) Keep fingers and hands free from pinch points 2) Use a golfer lift (raise one leg) while removing items from trunk. 3) Follow the Smith System's "5 keys of Safe Driving". a) Aim high in steering b) Get the Big picture c) Keep your eyes moving d) Leave yourself an out e) Make sure others see you 4) Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier 5) **Do not** do the following while driving: a) Talk on a mobile phone b) Eat or drink c) Take your eyes off of the road to adjust radio 6) Wear seat belt, maintain a first aid kit, and inform others of travel plans.
		Traffic 1) Struck by	1) The following precautions must be taken when working around traffic: • a) Exercise caution when exiting traveled way or parking along street – avoid sudden stops, use flashers, etc. b) Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier. c) Wear reflective/high-visibility safety vests. d) Eye protection should be worn to protect from flying debris. e) Remain aware of factors that influence traffic related hazards and required controls – sun glare, rain, wind, flash flooding, limited sight-distance, hills, curves, guardrails, width of shoulder, etc. f) Always remain aware of an escape route -- behind an established barrier, parked vehicle, guardrail, etc. g) Always pay attention to moving traffic – never assume drivers are looking out for you

2.	**Sampling and IDW Management**	**Slip/ Trip/ Fall** 1) Walking 2) Sampling (cords and tubing from well wizards, air compressors)	1) Precautions to take while sampling monitoring wells: a) Maintain housekeeping (i.e. hoses, debris, standing water, etc.) i. Store sampling equipment out of the way when it is not in use ii. Be aware of placement of cords and hoses from compressors and other equipment iii. Clean up any spills before continuing work
		Chemical Exposure 1) Field instrument calibration chemicals, sample preservative chemicals, decontamination solutions, untreated groundwater, compressor gasoline and oil	1) Review the "Site Specific Health and Safety Plan". a) Contaminants of Concern Table b) Refer to Personal Protective Equipment Schedule c) Refer to air monitoring d) Personal hygiene i. No eating, drink or smoking. ii. Wash hands and face after performing task 2) To prevent exposure from chemicals: a) Review Material Safety Data Sheet (MSDS). b) Utilize Personal Protective Equipment identified in this Health and Safety Plan c) Label all bottles and containers d) Store chemicals in properly labeled containers
3.	**Material Handling and ID Management**	**Lifting Objects (sample coolers, compressors)** 1) Back Strain 2) Crushed appendages, scrapes, abrasions and cuts	1) Utilize a material handling device to lift any object >25 pounds. For all other manual lifting, follow these recommendations: a) Stand with your feet at least shoulder distance apart. b) Position your feet to face the direction of travel. c) Slightly bend your knees. d) Start to squat, bending your hips and knees, not your waist. e) Keep load close to body and raise yourself using your leg and hip muscles. f) Tighten your stomach muscles as you lift. g) Avoid twisting movements. 2) Prevent crush hazards by: a) Not positioning fingers or toes under object b) Wearing steel toed or safety toed boots 3) Prevent abrasions, scrapes and cuts by: a) Being aware of sharp edges and other parts of stainless steel wells b) If sample containers break, clean up broken glass and dispose of in a puncture proof container. c) Decontamination procedures must also be followed if the broken container contained chemical preservative or untreated groundwater.

	PRINT NAME	SIGNATURE	
Supervisor Name:	_____	_____	**Date/Time:**_____
Safety Officer Name:	_____	_____	**Date/Time:**_____
Employee Name(s):	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	Date/Time:_____

ACTIVITY HAZARD ANALYSIS

Activity Hazard Analysis **Soil & Sediment Sampling**		**Analyzed By/Date** **Reviewed By/Date:**
Principal Tasks	**Potential Hazards**	**Recommended Controls (Level D PPE site wide for all operations)**
General Activity	Slips, trips, falls	• Use care during foot travel, and clear the area of slip and trip hazards • Use barricades • Use guardrails • Cover holes.
	Muscle Strain / Back Injury	• Use proper lifting technique. • Buddy system for heavy lifts • Use lifting/transport equipment
	Crushing Injuries	• Use caution when setting loads. • Wear required PPE.
Digging/Extracting Materials	Struck by equipment/objects	• Wear required PPE • Handling all sampling tools carefully – following SOPs for hand tools
	Contact with soils	• Wear required PPE • Utilize proper hand washing and hygiene controls • Avoid vapors
Equipment to be Used	**Inspection Requirements**	**Training Requirements**
Trucks, Hand Tools,	Daily inspection of equipment prior to operation	• Utilize only trained and experienced operators for operation of equipment. • Site specific training – Toolbox safety meetings • 40 hr Hazwoper • HazCom Training

Hazwoper = hazardous waste operations and emergency response - HazCom = OSHA Hazard Communications Standard (1910.1200)

ACTIVITY HAZARD ANALYSIS (AHA)

ACTIVITY NAME: SURFACE WATER SAMPLING –REMEDIAL INVESTIGATION. ST. LOUIS ORDNANCE PLANT, FORMER HANLEY AREA, ST. LOUIS, MO	**DATE:**	**NEW___** **REVISED____**	**PAGE ____OF ____**
ASSOCIATE(S)/JOB TITLE PERFORMING THE JOB/TASK:	**SUPERVISOR(S):**		**ANALYSIS PERFORMED BY:**
PROJECT NAME AND JOB/TASK LOCATION:	**DEPARTMENT(S):**		**REVIEWED BY:**
PERSONAL PROTECTIVE EQUIPMENT:	**SHIFT (if applicable):**		**APPROVED BY:**

JOB STEPS		**POSSIBLE HAZARDS**	**PROCEDURE/ACTION TO CONTROL OR ELIMINATE**
1.	**Mobilization and travel between sampling locations**	**Vehicle Operation** 1) Opening/closing doors, windows and trunk 2) Loading objects 3) Driving 4) Parking 5) Distractions 6) Emergency preparedness	1) Keep fingers and hands free from pinch points 2) Use a golfer lift (raise one leg) while removing items from trunk. 3) Follow the Smith System's "5 keys of Safe Driving". a) Aim high in steering b) Get the Big picture c) Keep your eyes moving d) Leave yourself an out e) Make sure others see you 4) Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier 5) **Do not** do the following while driving: a) Talk on a mobile phone b) Eat or drink c) Take your eyes off of the road to adjust radio 6) Wear seat belt, maintain a first aid kit, and inform others of travel plans.
		Traffic 1) Struck by	1) The following precautions must be taken when working around traffic: a) Exercise caution when exiting traveled way or parking along street – avoid sudden stops, use flashers, etc. b) Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier. c) Wear reflective/high-visibility safety vests. d) Eye protection should be worn to protect from flying debris. e) Remain aware of factors that influence traffic related hazards and required controls – sun glare, rain, wind, flash flooding, limited sight-distance, hills, curves, guardrails, width of shoulder, etc. f) Always remain aware of an escape route -- behind an established barrier, parked vehicle, guardrail, etc. g) Always pay attention to moving traffic – never assume drivers are looking out for you

2.	**Sampling and IDW Management**	**Slip/ Trip/ Fall** 1) Walking	1) Precautions to take while sampling surface water: a) Maintain housekeeping (i.e. standing water, etc.) i. Store sampling equipment out of the way when it is not in use
		Chemical Exposure 1) Field instrument calibration chemicals, sample preservative chemicals, decontamination solutions, untreated surface water	1) Review the "Site Specific Health and Safety Plan". a) Contaminants of Concern Table b) Refer to Personal Protective Equipment Schedule c) Refer to air monitoring d) Personal hygiene i. No eating, drink or smoking. ii. Wash hands and face after performing task 2) To prevent exposure from chemicals: a) Review Material Safety Data Sheet (MSDS). b) Utilize Personal Protective Equipment identified in this Health and Safety Plan c) Label all bottles and containers d) Store chemicals in properly labeled containers
3.	**Material Handling and IDW Management**	**Lifting Objects (sample coolers, compressors)** 1) Back Strain 2) Crushed appendages, scrapes, abrasions and cuts	1) Utilize a material handling device to lift any object >25 pounds. For all other manual lifting, follow these recommendations: a) Stand with your feet at least shoulder distance apart. b) Position your feet to face the direction of travel. c) Slightly bend your knees. d) Start to squat, bending your hips and knees, not your waist. e) Keep load close to body and raise yourself using your leg and hip muscles. f) Tighten your stomach muscles as you lift. g) Avoid twisting movements. 2) Prevent crush hazards by: a) Not positioning fingers or toes under object b) Wearing steel toed or safety toed boots 3) Prevent abrasions, scrapes and cuts by: a) Being aware of sharp edges and other parts of stainless steel wells b) If sample containers break, clean up broken glass and dispose of in a puncture proof container. c) Decontamination procedures must also be followed if the broken container contained chemical preservative or untreated surface water.

	PRINT NAME	SIGNATURE	
Supervisor Name:	_____	_____	**Date/Time:**_____
Safety Officer Name:	_____	_____	**Date/Time:**_____
Employee Name(s):	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	Date/Time:_____

ACTIVITY HAZARD ANALYSIS

Activity: Surveying	**Date:**
	Project: Remedial Investigation ST. LOUIS ORDNANCE PLANT, FORMER HANLEY AREA, ST. LOUIS, MO
Description of the work: Surveying of various sampling activities across the site.	**Site Safety Health Officer:**
	Review for latest use: **Before the job is performed.**

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)
Surveying **Equipment on this task:** Survey Transit	▪ Exposure to laser beam	▪ Personnel must not aim, nor look at any laser beam emitted by the transit. ▪ Care must be taken to prevent inadvertent aiming at non-survey personnel.
	▪ Hard hat constantly bumping instrument and hard hat falling off head.	▪ Instrument man may turn hard hat backwards while looking through the transit.

ACTIVITY HAZARD ANALYSIS

	PRINT	SIGNATURE	
Supervisor Name:	_____	_____	**Date/Time:**_____
Site Safety Health Officer Name:	_____	_____	**Date/Time:**_____
Employee Name(s):	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
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	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____

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Pre-Task Safety Plan (PTSP)

Project: _____ Location: _____Date:_____

Supervisor: _____ Job Activity:_____

_____

Task Personnel:

_____
_____
_____
_____

List Tasks:

_____
_____
_____
_____

Tools/Equipment Required for Tasks (ladders, scaffolds, fall protection, cranes/rigging, heavy equipment, power tools):

_____
_____
_____

Potential H&S Hazards, including chemical, physical, safety, biological and environmental (check that apply):

__ Chemical burns/contact	__ Trench, excavations, cave-ins	__ Ergonomics
__ Pressurized lines/equipment	__ Overexertion	__ Chemical splash
__ Thermal burns	__ Pinch points	__ Poisonous plants/insects
__ Electrical	__ Cuts/abrasions	__ Eye hazards/flying projectile
__ Weather conditions	__ Spills	__ Inhalation hazard
__ Heights/fall > 6 feet	__ Overhead Electrical hazards	__ Heat/cold stress
__ Noise	__ Elevated loads	__ Water/drowning hazard
__ Explosion/fire	__ Slips, trip and falls	__ Heavy equipment
__ Radiation	__ Manual lifting	__ Aerial lifts/platforms
__ Confined space entry	__ Welding/cutting	__ Demolition

Other Potential Hazards (Describe):

_____
_____
_____
_____
_____

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Hazard Control Measures (Check That Apply):			
PPE __ Thermal/lined __ Eye __ Dermal/hand __ Hearing __ Respiratory __ Reflective vests __ Flotation device	Protective Systems __ Sloping __ Shoring __ Trench box __ Barricades __ Competent person __ Locate buried utilities __ Daily inspections	Fire Protection __ Fire extinguishers __ Fire watch __ Non-spark tools __ Grounding/bonding __ Intrinsically safe equipment	Electrical __ Lockout/tagout __ Grounded __ Panels covered __ GFCI/extension cords __ Power tools/cord inspected
Fall Protection __ Harness/lanyards __ Adequate anchorage __ Guardrail system __ Covered opening __ Fixed barricades __ Warning system	Air Monitoring __ PID/FID __ Detector tubes __ Radiation __ Personnel sampling __ LEL/O2 __ Other	Proper Equipment __ Aerial lift/ladders/scaffolds __ Forklift/heavy equipment __ Backup alarms __ Hand/power tools __ Crane with current inspection __ Proper rigging __ Operator qualified	Welding & Cutting __ Cylinders secured/capped __ Cylinders separated/upright __ Flash-back arrestors __ No cylinders in CSE __ Flame retardant clothing __ Appropriate goggles
Confined Space Entry __ Isolation __ Air monitoring __ Trained personnel __ Permit completed __ Rescue	Medical/ER __ First-aid kit __ Eye wash __ FA-CPR trained personnel __ Route to hospital	Heat/Cold Stress __ Work/rest regime __ Rest area __ Liquids available __ Monitoring __ Training	Vehicle/Traffic __ Traffic control __ Barricades __ Flags __ Signs
Permits __ Hot work __ Confined space __ Lockout/tagout __ Excavation __ Demolition __ Energized work	Demolition __ Pre-demolition survey __ Structure condition __ Isolate area/utilities __ Competent person __ Hazmat present	Inspections: __ Ladders/aerial lifts __ Lanyards/harness __ Scaffolds __ Heavy equipment __ Cranes and rigging	Training: __ Hazwaste __ Construction __ Competent person __ Task-specific (THA) __ Hazcom
Field Notes:_____ _____ _____			

Name (Print): _____

Signature: _____ Date:_____

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Incident Report Form (Hardcopy)

Fax completed form to:
425.462.5957
CH2M HILL Seattle Office
Attention: Corporate HS&E Department

Type of Incident (Select at least one)

- ☐ Injury/Illness
- ☐ Environmental/Permit Issue
- ☐ Property Damage
- ☐ Near Miss
- ☐ Spill/Release
- ☐ Other

General Information (Complete for incident types)

Preparer's Name: _____ Preparer's Employee Number: _____
Date of Report: _____ Date of Incident: _____ Time of Incident: _____ am/pm

Type of Activity (Provide activity being performed that resulted in the incident)

- ☐ Asbestos Work
- ☐ Confined Space Entry
- ☐ Construction Mgmt- Hazwaste
- ☐ Construction Mgmt - Non-Hazwaste
- ☐ Demolition
- ☐ Drilling-Hazwaste
- ☐ Drilling-Non Hazwaste
- ☐ Drum Handling
- ☐ Electrical Work
- ☐ Excavation Trench-Hazwaste
- ☐ Excavation Trench-Non Haz
- ☐ Facility Walk Through
- ☐ General Office Work
- ☐ Keyboard Work
- ☐ Laboratory
- ☐ Lead Abatement
- ☐ Motor Vehicle Operation
- ☐ Moving Heavy Object
- ☐ Other (Specify) _____
- ☐ Process Safety Management
- ☐ Tunneling
- ☐ Welding
- ☐ Wetlands Survey
- ☐ Working from Heights
- ☐ Working in Roadways
- ☐ WWTP Operation

Location of Incident (Select one)

- ☐ Company Premises (CH2M HILL Office: _____)
- ☐ Field (Project #: _____ Project/Site Name: _____ Client: _____)
- ☐ In Transit (Traveling from: _____ Traveling to: _____)
- ☐ At Home

Geographic Location of Incident (Select region where the incident occurred)

- ☐ Northeast
- ☐ Southeast
- ☐ Northwest
- ☐ Southwest
- ☐ Corporate
- ☐ Canadian
- ☐ Asia Pacific
- ☐ Europe Middle East
- ☐ Latin America

If a CH2M HILL subcontractor was involved in the incident, provide their company name and phone number:
_____

Describe the Incident (Provide a brief description of the incident):
_____
_____
_____

Injured Employee Data (Complete for Injury/Illness incidents only)

If CH2M HILL employee injured

Employee Name: _____ Employee Number: _____

If CH2M HILL Subcontractor employee injured

Employee Name: _____ Company: _____

Injury Type

- ☐ Allergic Reaction
- ☐ Amputation
- ☐ Asphyxia
- ☐ Bruise/Contusion/Abrasion
- ☐ Burn (Chemical)
- ☐ Burn/Scald (Heat)
- ☐ Cancer
- ☐ Carpal Tunnel
- ☐ Concussion
- ☐ Cut/Laceration
- ☐ Dermatitis
- ☐ Dislocation
- ☐ Electric Shock
- ☐ Foreign Body in eye
- ☐ Fracture
- ☐ Freezing/Frost Bite
- ☐ Headache
- ☐ Hearing Loss
- ☐ Heat Exhaustion
- ☐ Hernia
- ☐ Infection
- ☐ Irritation to eye
- ☐ Ligament Damage
- ☐ Multiple (Specify) _____
- ☐ Muscle Spasms
- ☐ Other (Specify) _____
- ☐ Poisoning (Systemic)
- ☐ Puncture
- ☐ Radiation Effects
- ☐ Strain/Sprain
- ☐ Tendonitis
- ☐ Wrist Pain

Part of Body Injured

- ☐ Abdomen
- ☐ Ankle(s)
- ☐ Arms (Multiple)
- ☐ Back
- ☐ Blood
- ☐ Body System
- ☐ Buttocks
- ☐ Chest/Ribs
- ☐ Ear(s)
- ☐ Elbow(s)
- ☐ Eye(s)
- ☐ Face
- ☐ Finger(s)
- ☐ Foot/Feet
- ☐ Hand(s)
- ☐ Head
- ☐ Hip(s)
- ☐ Kidney
- ☐ Knee(s)
- ☐ Leg(s)
- ☐ Liver
- ☐ Lower (arms)
- ☐ Lower (legs)
- ☐ Lung
- ☐ Mind
- ☐ Multiple (Specify) _____
- ☐ Neck
- ☐ Nervous System
- ☐ Nose
- ☐ Other (Specify) _____
- ☐ Reproductive System
- ☐ Shoulder(s)
- ☐ Throat
- ☐ Toe(s)
- ☐ Upper Arm(s)
- ☐ Upper Leg(s)
- ☐ Wrist(s)

Nature of Injury

- ☐ Absorption
- ☐ Bite/Sting/Scratch
- ☐ Cardio-Vascular/Respiratory System Failure
- ☐ Caught In or Between
- ☐ Fall (From Elevation)
- ☐ Fall (Same Level)
- ☐ Ingestion
- ☐ Work Place Violence
- ☐ Inhalation
- ☐ Lifting
- ☐ Mental Stress
- ☐ Motor Vehicle Accident
- ☐ Multiple (Specify) _____
- ☐ Other (Specify) _____
- ☐ Overexertion
- ☐ Repeated Motion/Pressure
- ☐ Rubbed/Abraded
- ☐ Shock
- ☐ Struck Against
- ☐ Struck By

Initial Diagnosis/Treatment Date: _____

Type of Treatment

- ☐ Admission to hospital/medical facility
- ☐ Application of bandages
- ☐ Cold/Heat Compression/Multiple Treatment
- ☐ Cold/Heat Compression/One Treatment
- ☐ First Degree Burn Treatment
- ☐ Heat Therapy/Multiple treatment
- ☐ Multiple (Specify) _____
- ☐ Heat Therapy/One Treatment
- ☐ Non-Prescriptive medicine
- ☐ None
- ☐ Observation
- ☐ Other (Specify) _____
- ☐ Prescription- Multiple dose
- ☐ Prescription- Single dose
- ☐ Removal of foreign bodies
- ☐ Skin Removal
- ☐ Soaking therapy- Multiple Treatment
- ☐ Soaking Therapy- One Treatment
- ☐ Stitches/Sutures
- ☐ Tetanus
- ☐ Treatment for infection
- ☐ Treatment of 2nd /3rd degree burns
- ☐ Use of Antiseptics – multiple treatment
- ☐ Use of Antiseptics – single treatment
- ☐ Whirlpool bath therapy/multiple treatment

☐ Whirlpool therapy/single treatment ☐ X-rays positive/treatment of fracture
☐ X-rays negative
Number of days doctor required employee to be off work: _____

Number of days doctor restricted employee's work activity: _____
Equipment Malfunction : Yes ☐ No ☐ Activity was a Routine Task: Yes ☐ No ☐
Describe how you may have prevented this injury: _____
_____

Physician Information
Name: _____
Address: _____
City: _____
Zip Code: _____
Phone: _____

Hospital Information
Name: _____
Address: _____
City: _____
Zip Code: _____
Phone: _____

Property Damage (Complete for Property Damage incidents only)

Property Damaged: _____ Property Owner: _____
Damage Description: _____
Estimated Amount: $ _____

Spill or Release (Complete for Spill/Release incidents only)

Substance (attach MSDS): _____ Estimated Quantity: _____
Facility Name, Address, Phone No.: _____
Did the spill/release move off the property where work was performed?:
_____
Spill/Release From: _____ Spill/Release To: _____

Environmental/Permit Issue (Complete for Environmental/Permit Issue incidents only)

Describe Environmental or Permit Issue: _____
Permit Type: _____
Permitted Level or Criteria (e.g., discharge limit): _____
Permit Name and Number (e.g., NPDES No. ST1234):
_____
Substance and Estimated Quantity: _____
Duration of Permit Exceedance: _____

Verbal Notification (Complete for incident types)(Provide names, dates and times)

CH2M HILL Personnel Notified: _____
Client Notified: _____

Witnesses (Complete for incident types)

Witness Information (First Witness)
Name: _____
Employee Number (CH2M HILL):_____
Address: _____
City: _____
Zip Code _____
Phone:_____

Witness Information (Second Witness)
Name: _____
Employee Number (CH2M HILL): _____
Address: _____
City: _____
Zip Code:_____
Phone :_____

Additional Comments: _____
_____
_____

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Safe Work Observation Form		
Project:	Observer:	Date:
Position/Title of worker observed:	Background Information/ comments:	
Task/Observation Observed:		

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

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

Incident & Near-Loss Investigation Report Form

Employer Information

Company Name: _____

Project Name: _____ Task Order: _____

Project Location: _____

Task Location: _____

Job Assignment: _____

Preparer's Name: _____ Preparer's Employee Number: _____

Incident Specific Information

Date of Incident: _____ Time of Incident: _____ A.M./P.M.

Location of incident:

☐ Company premises
☐ Field
☐ In Transit
☐ Other:_____

Address where the incident occurred: _____

Equipment Malfunction : Yes ☐ No ☐
Activity was a Routine Task: Yes ☐ No ☐

Describe any property damage:
_____

Specific activity the employee was engaged in when the incident occurred:
_____
_____

All equipment, materials, or chemicals the employee was using when the incident occurred:
_____
_____

Describe the specific incident and how it occurred:
_____
_____
_____
_____
_____

Describe how this incident may have been prevented:
_____
_____
_____
_____
_____

Contributing Factors (Describe in detail why incident occurred):
_____
_____
_____
_____
_____

Date employer notified of incident: _____ To whom reported:
_____

Witness Information (First Witness)

Name: _____
Employee Number_____
Address:_____
City: _____
Zip Code : _____
Phone: _____

Witness Information (Second Witness)

Name: _____
Employee Number_____
Address:_____
City: _____
Zip Code : _____
Phone: _____

Additional information or
comments:_____
_____
_____

A ROOT CAUSE ANALYSIS FORM MUST BE COMPLETED FOR ALL INJURIES AND ILLNESSES OR ACTUAL LOSSES.

COMPLETION OF THE ROOT CAUSE ANALYSIS FORM FOR NEAR LOSSES IS OPTIONAL, AT THE DISCRETION OF THE HEALTH AND SAFETY MANAGER.

Root Cause Investigation

This attachment is provided to assist in accessing, completing, and reviewing an incident investigation. It is important to remember the following when conducting an investigation:

- Gather relevant facts, focusing on fact-finding, not fault-finding.
- Draw conclusions, pitting facts together into a probable scenario.
- Determine incident root causes, the basic causes why an unsafe act/condition existed.
- Develop and implement solutions, matching all identified root causes with solutions.

Documentation

The following should be included to document the incident.

Description

Provide a description of the event and the sequence of events and actions that took place prior to the incident. Start with the incident event and work backwards in time through all of the preceding events that directly contributed to the incident. The information should identify why the event took place as well as who was involved, when and where the event took place, and what actions were taken.

Cause Analysis

Using the form and flowchart in Attachment 1 the root cause of the incident will be determined. This form must be retained in the project and/or regional HS&E files.

Immediate Causes—List the substandard actions or conditions that directly affected the incident. The following are examples of immediate causes:

> ***Substandard Actions*:** Operating equipment without authority; failure to warn; failure to secure; operating at improper speed; making safety device inoperable; using defective equipment; failing to use PPE; improper loading; improper lifting; improper position for task; under influence of alcohol or drugs; horseplay.
>
> ***Substandard Conditions:*** Exposure to hazardous materials; exposure to extreme temperatures; improper lighting; improper ventilation; congestion; exposure to fire and explosive hazard; defective tools, equipment or materials; exposure to extreme noise; poor ventilation; poor visibility; poor housekeeping.

Basic Causes—List the personal and job factors that caused the incident. The following are examples of basic causes:

> ***Personal Factors:*** Capability; knowledge; skill; stress; motivation.
>
> ***Job Factors:*** Abuse or misuse; engineering; maintenance; purchasing; supervision; tools and equipment; wear and tear; work standards.

Corrective Action Plan

Include all corrective actions taken or those that should be taken to prevent recurrence of the incident. Include the specific actions to be taken, the employer and personnel responsible for implementing the actions, and a time frame for completion. Be sure the corrective actions address the causes. For example, training may prevent recurrence of an incident caused by a lack of knowledge, but it may not help an incident caused by improper motivation.

The following are examples of management programs that may be used to control future incidents. These programs should be considered when determining specific corrective actions.

> ***Management Programs***: Accident/incident analysis; emergency preparedness; engineering controls; general promotion; group meetings; health control; hiring and placement; leadership and administration; management training; organizational rules; personal protective equipment; planned inspections; program audits; program controls; purchasing controls; task analysis and procedures; task observation.

Root Cause Analysis Form

Root Cause Analysis (RCA)

Root Cause Categories (RCC): In the first column, enter the appropriate RCC from the choices below that applies to the root cause (RC) and/or contributing factor (CF) of the incident. Describe the specific root cause and corrective actions in their respective columns.

1. **Lack of skill or knowledge**
2. **Lack of or inadequate operational procedures or work standards**
3. **Inadequate communication of expectations regarding procedures or work standards**
4. **Inadequate tools or equipment**
5. **Correct way takes more time and/or requires more effort**
6. **Shortcutting standard procedures is positively reinforced or tolerated**
7. **Person thinks there is no personal benefit to always doing the job according to standards**

RCC #	Root Causes	Corrective Actions	RC[1]	CF[2]	Due Date	Completion Date	Date Verified

[1] RC = Root Cause **[2]CF = Contributing Factors (check which applies)**

Investigation Team Members

Name	Job Title	Date

Results of Solution Verification and Validation

Reviewed By

Name	Job Title	Date

Attachment 10
Biological Hazards and Controls

Tick-Borne Pathogens

There are 6 notifiable tick-borne pathogens that present a significant field hazard, and in some areas account for more than half of our serious field incidents. These procedures should be applied during any field activity—even in areas that are predominantly paved but with bordering vegetation.

Hazard Control

The methods for controlling exposure to ticks include, in order of most-preferred to least:

- Avoid tick habitats and ceasing operations in heavily infested areas.
- Reduce tick abundance through habitat disruption or application of acracide.
- Use personal protection, such as repellants and protective clothing.
- Perform frequent tick inspections and proper hygiene.

Vaccinations are not available and preventative antibiotic treatment after a bite is generally not recommended.

Avoidance and Reduction of Ticks

To the extent practical, tick habitats should be avoided. In areas with significant tick infestation, consider stopping work and withdrawing from area until adequate tick population control can be achieved. Stopping and withdrawing should be considered as seriously as entering an area without proper energy control or with elevated airborne contaminants. Tickborne pathogens present risk of serious illness! In areas where significant population density or infestation exists, tick reduction should be considered. Tick reduction can be achieved by disrupting tick habitats and direct population reduction through the use of tick-toxic pesticides (Damminix, Dursban, Sevin, etc.).

Habitat disruption may include only simple vegetative maintenance such as removing leaf litter and trimming grass and brush. Tick populations can be reduced between 72 and 100% when leaf litter alone is removed. In more heavily infested areas, habitat disruption may include grubbing, tree trimming or removal, and pesticide application (Damminix, Dursban, Sevin, etc.). This approach is practical in smaller, localized areas or perimeter areas that require occasional access. Habitat controls are to be implemented with appropriate health and safety controls, in compliance with applicable environmental requirements, and may be best left to the property owner or tenant, or licensed pesticide vendor. Caution should be exercised when using chemical repellents or pesticides in or around areas where environmental or industrial media samples will be collected for analysis.

Personal Protection

After other prevention and controls are implemented, personal protection is still necessary in controlling exposure to ticks. Personal protection must include of the following steps:

- So that ticks may be seen on your clothing wear light-colored clothing. Full-body New Tyvek (paper-like disposable coveralls) may also be used.
- To prevent ticks from getting underneath clothing tuck pants into socks or tape to boots.
- Wear long-sleeved shirts, a hat, and high boots.
- Apply DEET repellent to exposed skin or clothing per product label.

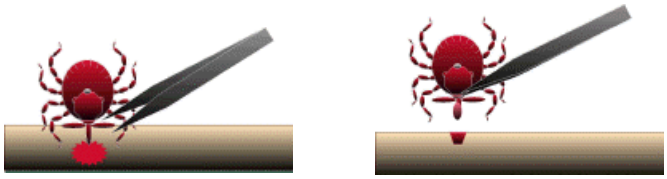
- Apply permethrin repellent per product label to the outside of boots and clothing before donning.
- Frequently check for ticks and remove from clothing.
- At the end of the day search your entire body for ticks (particularly groin, armpits, neck and head) and shower.
- To prevent pathogen transmission through mucous membranes or broken/cut skin, wash or disinfect hands and/or wear surgical-style nitrile gloves anytime ticks are handled.

Pregnant individuals and individuals using prescription medications should consult with their physician and/or pharmacists before using chemical repellents. Because human health effects may not be fully known, use of chemical repellents should be kept to a minimum frequency and quantity. Always follow manufacturers' use instructions and precautions. Wash hands after handling, applying, or removing protective gear and clothing. Avoid hand-to-face contact, eating, drinking, smoking, etc. when applying or using repellents. Remove and wash clothes per repellent product label. Chemical repellents should not be used on infants and children.

Vaccinations are generally not available for tick-borne pathogens. Although production of the LYMErix™ lyme disease vaccination has been ceased, vaccination may still be considered under specific circumstances and with concurrence from the consulting physician. Preventative antibiotic treatment in non-ill individuals who have had a recent tick bite is recommended in specific cases only.

Tick Removal

1. Use fine-tipped tweezers or shield your fingers with a tissue, paper towel, or nitrile gloves.
2. Grasp the tick as close to the skin surface as possible and pull upward with steady, even pressure. Do not twist or jerk the tick; this may cause the mouthparts to break off and remain in the skin. (If this happens, remove mouthparts with tweezers. Consult your healthcare provider if infection occurs.)



3. Do not squeeze, crush, or puncture the body of the tick because its fluids (saliva, hemolymph, gut contents) may contain infectious organisms. Releasing these organisms to the outside of the tick's body or into the bite area may increase the chance of infectious organism transmission.
4. Do not handle the tick with bare hands because infectious agents may enter through mucous membranes or breaks in the skin. This precaution is particularly directed to individuals who remove ticks from domestic animals with unprotected fingers. Children, elderly persons, and immunocompromised persons may be at greater risk of infection and should avoid this procedure.
5. After removing the tick, thoroughly disinfect the bite site and wash your hands with soap and water.
6. You may wish to save the tick for identification in case you become ill. Your doctor can use the information to assist in making an accurate diagnosis. Place the tick in a plastic

bag and put it in your freezer. Write the date of the bite on a piece of paper with a pencil and place it in the bag.

Note: Folklore remedies such as petroleum jelly or hot matches do little to encourage a tick to detach from skin. In fact, they may make matters worse by irritating the tick and stimulating it to release additional saliva, increasing the chances of transmitting the pathogen. These methods of tick removal should be avoided. In addition, a number of tick removal devices have been marketed, but none are better than a plain set of fine tipped tweezers.

First-Aid and Medical Treatment

Tick bites should always be treated with first-aid. Clean and wash hands and disinfect the bite site after removing embedded tick. Consult a healthcare professional if infection or symptoms and effects of tick-borne illnesses are develop.

Medical treatment for tick-borne infections include antibiotics and other medical interventions. Diagnosis of specific illness involves both clinical and laboratory confirmations. Preventative antibiotic treatment in non-ill individuals who have had a recent tick bite is recommended in specific cases only.

Previously infected individuals are not conferred immunity – re-infection from future tick bites can occur even after a person has contracted a tick-borne disease.

Hazard Recognition

An important step in controlling tick related hazards is understanding how to identify ticks, their habitats, their geographical locations, and signs & symptoms of tick-borne illnesses.

Tick Identification

There are five varieties of hard-bodied ticks that have been associated with tick-borne pathogens. These tick varieties include:

- Deer (Black Legged) Tick (eastern and pacific varieties)
- Lone Star Tick
- Dog Tick
- Rocky Mountain Wood Tick

These varieties and their geographical locations are illustrated on the following page.

Tick Habitat

In eastern states, ticks are associated with deciduous forest and habitat containing leaf litter. Leaf litter provides a moist cover from wind, snow, and other elements. In the north-central states, is generally found in heavily wooded areas often surrounded by broad tracts of land cleared for agriculture. On the Pacific Coast, the bacteria are transmitted to humans by the western black-legged (deer) tick and habitats are more diverse. Here, ticks have been found in habitats with forest, north coastal scrub, high brush, and open grasslands. Coastal tick populations thrive in areas of high rainfall, but ticks are also found at inland locations.

Illnesses and Signs & Symptoms

There are six notifiable tick-borne pathogens that cause human illness in the United States. These pathogens may be transmitted during a tick bite – normally hours after attachment. The illnesses, presented in approximate order of most common to least, include:

- Lyme (bacteria)
- RMSF (bacteria)
- Ehrlichiosis (bacteria)
- STARI (Southern Tick-Associated Rash Illness) (bacteria)
- Tularemia (Rabbit Fever) (bacteria)
- Babesia (protozoan parasite)

Symptoms will vary based on the illness, and may develop in infected individuals typically between 3 and 30 days after transmission. Some infected individuals will not become ill or may develop only mild symptoms. These illnesses present with some or all of the following signs & symptoms: fever, headache, muscle aches, stiff neck, joint aches, nausea, vomiting, abdominal pain, diarrhea, malaise, weakness, small solid, ring-like, or spotted rashes. The bite site may be red, swollen, or develop ulceration or lesions. A variety of long-term symptoms may result when untreated, including debilitating effects and death.

Poison Oak, Ivy and Sumac

Poison oak, ivy and sumac plants are the single most common cause of allergic skin reactions in the United States. They are caused by contact with urushiol, which is found in the sap of the plants. It is colorless or pale yellow oil that oozes from any cut or crushed part of the plant, including the roots, stems and leaves. The oil is active year round. Reaction to Poison Oak, Ivy, and Sumac ranges from no reaction to a severe "rhus" dermatitis. Rhus is the class of poisonous plants which includes poison oak, poison ivy, poison sumac, mango, and other urushiol containing plants. 3 of 4 people will develop dermatitis on contact with urushiol.

Contact with urushiol can occur in three ways: direct, indirect and airborne particles. Direct contact is touching the sap of the toxic plant, while indirect contact involves touching something which has urushiol on it, such as personal protective equipment (PPE), clothes, boots, field equipment, or any items that have come in contact with the plant (including your hands). Airborne urushiol particles, such as burning plants or spray from a weed whacker, may also contact the skin or be inhaled, causing internal inflammation.

The rash caused by urushiol can affect almost any part of the body, especially where the skin is thin, such as the face. The rash does not spread, although it may seem to when it breaks out in new areas. Actually, what happens is the urushiol absorbs more slowly into thicker skin, such as found on the forearms, legs and trunk.

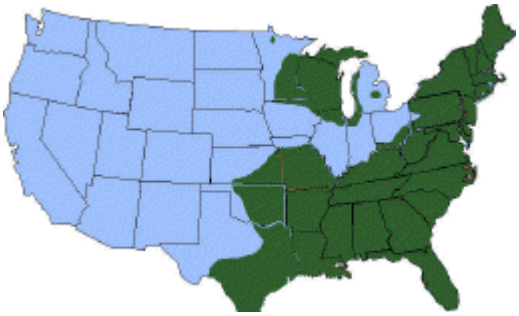
Identification

Poison Oak

Poison oak shrubs are usually 12 to 30 in chest high, or a tree-climbing vine, with triple leaflets and short, smooth hair underneath. A project site in Portland had 8-foot-tall poison oak bushes. Early berries are fuzzy and white; later, dun-colored. Plants are red and dark green in Spring and Summer, with yellowing leaves anytime especially in dry areas. Leaves

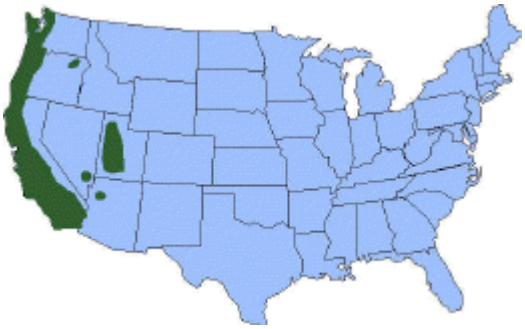
may achieve bright reds in Fall, but the plant loses its (yellowed, then brown) leaves in Winter, leaving toxic stems. All parts of the plant remain toxic throughout the seasons.

Deer Tick



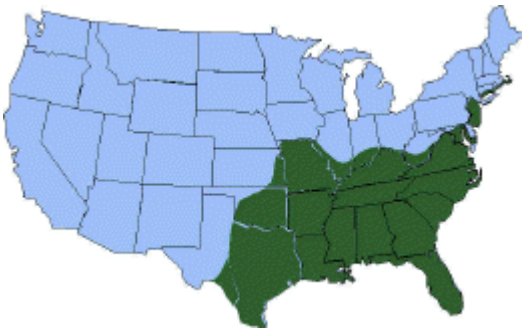
Distribution of Deer Tick (dark green)

From Left: adult female, adult male, nymph, and larvae Deer Tick (cm scale)



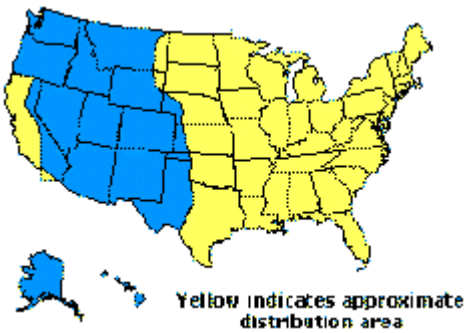
Distribution of Pacific Deer Tick (dark green)

Lone Star Tick

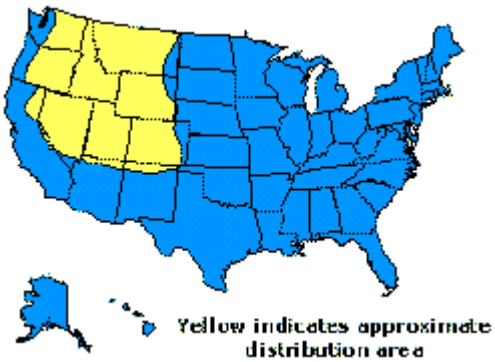


Distribution of Lone Star Tick (Green)

Dog Tick



Rocky Mountain Wood Tick



Poison Ivy

Poison ivy plants are frequently found around lakes and streams in the Midwestern and the Eastern parts of the United States and are commonly found growing along trails and roadsides. Poison ivy grows as a woody, ropelike vine that can grow along fences or up trees, a trailing shrub on the ground, or a free-standing shrub. It normally has three leaflets (groups of leaves on the same small stem coming off the larger main stem), but may vary from groups of three to nine. Poison ivy leaves are green in the summer and red in the fall with yellow or green flowers and white berries.

Poison Sumac

Poison sumac plants grow in boggy areas, especially in the Southeastern U.S.. Typically, poison sumac grows as a rangy shrub up to 15 feet tall. The plants are found to have seven to 13 smooth-edged leaflets and can have glossy pale yellow or cream-colored berries.

Primary contamination from poison oak, ivy or sumac, results from contact with bruised or broken plant parts that release "toxicodendrol," an oily resin containing the toxic chemical "urushiol."

Poison Ivy

Poison Sumac

Poison Oak

Exposure

Contamination with poison oak, ivy or sumac can happen through several pathways. These include

- Direct skin contact with any part of the plant
- Contact with clothing that has been contaminated
- Contact from removing shoes that have been contaminated (shoes have become coated with oil)
- Sitting in a vehicle that has become contaminated
- Contact with any objects or tools that have become contaminated

Exposure to poison oak, ivy or sumac often becomes an OSHA recordable illness. The dermatitis is so severe that many people seek medical care and get prescription cortisone creams or steroid shots to reduce the suffering caused by the itch. If exposed, refer to the CH2M HILL HSE&Q Injury and Illness Reporting brochure for proper action to take if contaminated.

Best Work Practices

If you must work on a site that has been identified to potentially contain poison oak, ivy or sumac, the following precautions are necessary:

- Identify plants containing urushiol – The best way to prevent exposure is to recognize the plant and avoid working in areas where poison oak, ivy or sumac is present.
- If you must work in areas with urushiol containing plants, contact you project manager and health and safety manager to determine the best procedures to prevent contamination.
- Do not drive vehicles onto the site where it will come into contact with poison oak, ivy or sumac. Vehicles which need to work in the area, such as drill rigs or heavy equipment must be washed and decontaminated as soon as possible after leaving the site.
- All tools used in the area, including those used to cut back the plants, surveying instruments used in the area, air monitoring equipment or other test apparatus must be decontaminated before they are placed back into the site vehicle. If on-site decontamination is not possible, use plastic to wrap any tools or equipment until they can be decontaminated. If working on or near the ground surface, place plastic on the ground to cover the grass and foliage.
- Personal protective equipment (PPE), including Tyvek® coveralls, gloves, and boot covers must be worn. PPE and plastic used to cover the ground must be placed into separate plastic bags and sealed if they are not disposed immediately into a trash receptacle.
- Shower as soon as possible to remove any potential contamination. Any body part with suspected or actual exposure should be washed with "Tecnu" or other product designed for removing urushiol. If you do not have Tecnu wash with cold water. Do not take a bath, as the oils can form and invisible film on top of the water and contaminate your entire body upon exiting the bath.
- Zanfel™ may also be used to treat exposed areas that are experiencing signs and symptoms of poison oak, ivy or sumac contamination. The CH2M HILL warehouses carry Zanfel™ products, which must be carried in First Aid Kits as deemed appropriate. Refer to the Zanfel™ information guide below for specific product and contact information.
- Use products such as IvyBlock™ to prevent poison oak, ivy and sumac contamination. IvyBlock™ is approved by the FDA to prevent the rash caused by poison oak, ivy and sumac.

If there is exposure use the following first aid procedures, or others you may find to alleviate the pain and itching.

Poison Oak, Ivy, and Sumac First Aid

Are there any of these problems?

- Swelling in the throat, tongue and/or lips
- A hard time breathing or swallowing
- Weakness, dizziness
- Bluish lips and mouth
- Unconsciousness

YES

Use emergency kit with adrenalin, if available, and Get Emergency Care.

NO

Do you have any of these problems?

- Skin that is very bright red.
- Pus.
- Rash that has spread to the mouth, eyes or genitals.
- Rash on large areas of the body or the face.

YES

Give first aid before seeing doctor:

- Take a hot shower (only after rash develops), put the rash area in hot water or pour hot water over it. Make sure the water is not too hot to burn the skin. The hot water causes itching at first, but brings relief later. Do not use soap.
- Take an over-the-counter antihistamine, such as Benadryl, as stated on the label.
- For weeping blisters:
- Mix 2 teaspoons of baking soda in 1 quarter (4 cups) of water.
- Dip squares of gauze in this mixture.
- Cover the blisters with the wet gauze for 10 minutes, four times a day. (Do not apply this to the eyes.)

NO

Urushiol Plant Facts

Myth	Fact
Poison oak, ivy, and sumac are contagious	Rubbing the rashes won't spread poison ivy to other parts of your body (or to another person). You spread the rash only if **urushiol oil** -- the sticky, resinlike substance that causes the rash -- has been left on your hands.
You can catch poison ivy simply by being near the plants	Direct contact is needed to release **urushiol oil**. Stay away from forest fires, direct burning, or anything else that can cause the oil to become airborne such as a lawnmower, trimmer, etc.
Leaves of three, let them be	Poison sumac has 7 to 13 leaves on a branch, although poison ivy and oak have 3 leaves per cluster.
Do not worry about dead plants	**Urushiol** oil stays active on any surface, including dead plants, for up to 5 years.
Breaking the blisters releases **urushiol** oil that can spread	Not true. But your wounds can become infected and you may make the scarring worse. In very extreme cases, excessive fluid may need to be withdrawn by a doctor.

Urushiol Oil is Potent

- Only 1 nanogram (billionth of a gram) needed to cause rash.
- Average is 100 nanograms for most people.
- 1/4 ounce of urushiol is typically all that is needed to cause a rash in every person on earth.
- 500 people could itch from the amount covering the head of a pin.
- Specimens of urushiol several centuries old have found to cause dermatitis in sensitive people.
- 1 to 5 years is normal for urushiol oil to stay active on any surface including dead plants.
- Derived from **urushi**, Japanese name for lacquer .

New Cream to Treat Exposure to Poison Plants

Exposure to poison oak, ivy and sumac can be uncomfortable, and in some cases the rash can become so severe that medical care is required. A new product is available Zanfel™ (www.zanfel.com) that helps prevent blistering and itching from becoming severe. If you are working in an area with poison oak, ivy or sumac, you can obtain this cream by contacting your regional Safety Program Assistants:

- SWR Julie Yeager/SAC
- NER Lynn Bong/MKE
- NWR Donita O'Brien/SEA
- SER Vanessa Wheelus/GNV
- CNR Donita O'Brien/SEA

Please remember, the cream does not replace preventative measures, including:

- Avoiding contact with poison oak, ivy and sumac.
- Wearing Tyvek coveralls and gloves to prevent contact.
- Washing with Tecnu® (or a similar product) after potential exposure.
- Washing clothing and decontaminating equipment with an oil-cutting detergent.

More information about Zanfel (from Zanfel):

Zanfel™ is an effective wash for urushiol-induced contact dermatitis. Urushiol is the toxin known to cause the itching and rash associated with poison oak, ivy, sumac, poisonwood, and related plants. Zanfel works by surrounding urushiol and bonding with it, thereby enabling it to be rinsed away. Unlike some products that require use within 10-20 minutes of contact or that required continued use until the rash is gone (which can take up to 5 weeks), Zanfel offers relief at any stages of the reaction and often with only one wash. Individuals with particularly severe reactions may require additional washes. Most individuals experience relief from the itching within 30 seconds of application. The rash will begin to subside within hours if the reaction is mild to moderate. Severe and systemic cases will still require medical attention. Severe cases are defined as breakouts that are present on more than 15 percent of the body, and new breakouts continue to develop after day 4.

Brown Recluse Spider

Adult brown recluse spiders have a leg span about the size of a quarter. Their body is about 3/8 inches long and about 3/16 inches wide. Males are slightly smaller in body length than females, but males have proportionally longer legs. Both sexes are venomous.

Recluse spiders have been known to habitat most of the lower 48 states; however the map shows its typical range.

- If bitten stay calm, immediately apply ice to the bite and to try and collect the spider (even a mangled part of the spider might help a professional with a diagnosis) and go to the ER.
- Shake out clothing and shoes before getting dressed.
- Inspect bedding and towels before use.
- Wear gloves when handling firewood, lumber, and rocks (be sure to inspect the gloves for spiders before putting them on).
- Remove bedskirts and storage boxes from underneath beds. Move the bed away from the wall.
- Exercise care when handling cardboard boxes (recluse spiders often are found in the space under folded cardboard flaps).

Attachment 11
Certified Industrial Hygienist Resume

William M. Berlett Jr.

Education

MPH, Environment and Occupational Health - Industrial Hygiene, University of Illinois
B.S., Meteorology, Western Illinois University

Professional Registrations

Illinois Dept. of Public Health, Illinois Licensed Asbestos Bldg. Inspector & Project Designer

Illinois Environmental Protection Agency, Illinois Licensed Industrial Hygienist

Distinguishing Qualifications

- Occupational Health and Safety Management
- Industrial Hygiene
- Indoor Air Quality
- Regulatory Compliance and Audits

Relevant Experience

William Berlett has 18 years of experience in providing occupational health, industrial hygiene and safety services in both technical and project management roles to a diverse group of employees/clients, including the EPA, DOE, DOD (Corps of Engineers, Army, Air Force), state agencies, municipalities, public works, utilities, oil and gas industries, petrochemical facilities, commercial offices, warehouses, recreational facilities, hospitals, educational facilities, and numerous manufacturing facilities (chemicals, electronics, automotive, food/beverages, pharmaceuticals, metals, scientific equipment, textiles, and household goods). Mr. Berlett has good interpersonal skills, and interacts well with management, professional and labor/trade employees and contractors – including project-teaming assignments.

Representative Projects

Health and Safety Program, Honeywell Alliance Partnership. Currently managing the Health and Safety Program for the Honeywell Alliance Partnership. CH2M HILL currently has over 90 remedial project sites within the United States within this program that are in various stages of remediation. Specific responsibilities include formulating the overall health and safety framework for all work performed at these Honeywell sites, developing policies and procedures, developing site-specific Health and Safety Plans, developing and conducting training and chartering sessions, performing site compliance audits, assisting the client in updating and maintaining their website, performing contractor safety evaluations, and managing incident reporting web-based platforms for the alliance worklevels of work.

Experience prior to CH2M HILL

Regulatory Compliance Audits, Various Clients. Conducted over 75 regulatory compliance audit projects for various manufacturing and industrial clients, including those in the petrochemical, pharmaceutical, chemical, and food/beverage industries. Audits include pre-audit information gathering, walk-through surveys (including photo-documentation), employee interviews, and policies and records review. This is followed by preparation of draft/final reports of findings and recommended corrective measures. Cost estimates of corrective actions are provided. Attorney-client privileged documentation is often required. Has extensive experience in the preparation and technical review of occupational safety and health written programs.

Industrial Hygiene/Indoor Air Quality Assessments, Industrial, Commercial and Residential Clients. Responsibilities include developing sampling strategy, collecting area and personal air samples, interpreting analytical data, determining regulatory compliance, writing reports, and project management. Conducted many building inspections for mold/biological concerns, developing appropriate sampling strategies and collecting the necessary air, bulk, and/or wipe samples, interpreting the data and developing practical, cost-effective remedial solutions that meet the clients needs. Co-authored SBC-Ameritech's Corporate-wide document entitled *Mold Investigation and Remediation Guidelines.*

Health and Safety Plans, Various Clients. Developed hundreds of site-specific Health and Safety Plans for both internal and external clients involving a wide array of contaminants and site activities. Site locations and activity types have included UST removals, subsurface investigations, hazardous materials removal, unexploded ordinances identification, Brownfield redevelopment, sludge removal within rivers and lakes, remediation at hazardous waste sites, radiation sites, active petrochemical facilities, former military bases, etc.

Asbestos Inspection Services, Commercial, Manufacturing, Utilities and Industrial Facilities. Field activities include reviewing plant or building blueprints, generating thorough sampling plans, and collecting samples. Office activities include project management, interpreting and compiling analytical data, and writing final reports.

Training Sessions. Conducted over 1,000 training sessions within a wide variety of IH and Safety topics providing compliance with EPA, OSHA and DOT regulations.

Health and Safety Management Systems. Managed and tracked the implementation of the firm-wide Health and Safety Management System for the GE&C Division of URS Corporation. Responsibilities included developing and providing OSHA/DOT/Internal Health & Safety training, performing office and field project audits, developing, reviewing, and approving site-specific health and safety plans, providing guidance to Regional Management on health and safety issues/risk management, reviewing health and safety legislation to determine impact on URS operations, participating in the Firmwide Health and Safety Advisory Committee, and conducting accident investigation and reporting. Currently, Mr. Berlett serves as an internal Regional H&S Manager for Central Division Region 4 that comprises of offices in Ohio, Michigan, Canada and Illinois.

Certifications

Certified Industrial Hygienist (CIH), American Board of Industrial Hygiene
Certified Mold Consultant, American Indoor Air Quality Council
USEPA – Asbestos Project Designer and Building Inspector

Appendix E

Corvallis ASL TO-15 Standard Operating Procedure

Corvallis ASL Standard Operating Procedure

ANALYTICAL METHOD FOR THE DETERMINATION OF VOLATILE ORGANICS IN AIR BY METHOD TO-15 USING CANISTERS AND GC/MS IN SCAN OR SIM MODE

APPROVED:

Ginger Collins

12/11/06

QA Officer — Date

12/11/06

Laboratory Director — Date

Documentation of reading this SOP will be kept in the ASL QAQC training database. Each analyst is responsible for entering their own training dates. By entering their name and date of reading the SOP each analyst is agreeing to the following statement:

> I have read and understood the following Standard Operating Procedure (SOP) and agree to follow the SOP as written. Any exceptions to the SOP will be recorded in the appropriate logbook or benchsheet and changes will be noted in the case narrative of the report to the client.

STANDARD OPERATING PROCEDURE

FOR VOLATILE ORGANICS IN AIR USING CANISTERS AND GC/MS IN SCAN OR SIM MODE BY COMPENDIUM METHOD TO-15

1.0 SCOPE AND APPLICATION

This document provides standard operating procedures for running Method TO-15 by gas chromatogram/mass spectrometer (GC/MS) in SCAN and SIM mode at CH2M HILL's Applied Sciences Laboratory in Corvallis, Oregon. These procedures are based upon Method TO-15 as published in "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air", Second Edition, January 1999 and the AFCEE QAPP, Version 3.1, August 2001.

This method is applicable to specific Volatile Organic Compounds (VOCs) that have been tested and determined to be stable when stored in pressurized and subambient pressure canisters.

2.0 OVERVIEW OF THE ANALYTICAL PROCESS

The sample holding time begins when the air sample is collected in the field. At sample collection, a chain of custody document should be initiated which describes the sample as well as any request for analytical work from the laboratory. After collection, samples should be delivered to the lab without delay.

Upon receipt at the laboratory, canisters are inspected for their condition and compared to the accompanying chain of custody document. Information is verified by Sample Custody personnel before the samples are assigned a unique laboratory identification number and logged into the LIMS system. See Sample Custody SOPs for more details.

If necessary, or requested, samples may be screened by EPA Method TO-12. (see Method TO-12, SOP AIR04).

During analysis, an air sample is passed through a cryogenic preconcentrator system where the VOCs are concentrated on a series of traps. The concentrator system is designed such that the bulk gases such as O_2, N_2, H_2O and CO_2 are removed from the sample and the remaining VOCs are collected on a capillary cryogenic trap. Subsequently, the cryogen is removed and the temperature of the trap is raised causing the condensed gases to thermally desorb from the trap. An inert gas carries the VOCs from the trap onto a gas chromatograph capillary column and finally onto a mass selective (MS) detector which identifies and quantitates the VOCs. All chromatographic data are acquired onto a centralized computer for convenient post-run processing, review, workup, and archival.

The MS is capable of operating in SCAN or SIM mode, depending on analytical or specific project requirements. SCAN mode is used for more conventional TO-15 analysis where ppbv levels of detection are required or tentatively identified compounds (TIC) are requested. In this mode the MS scans a range of ions (typically 35-250 amu). This range contains all ions necessary to identify and quantitate all compounds in the TO-15 list. But, this increased selectivity decreases sensitivity. SIM mode is utilized when reporting limits in the pptv range are requested. In SIM mode, the analyzer only looks at ions specific to the target compounds. Up to three ions are used per compound, 1 for quantitation, and 1 or 2 for qualification. This allows more time to be spent by the analyzer on each ion, which increases sensitivity, at the cost of selectivity. Because of this, it is not possible to produce TICs in SIM mode.

Before analysis of any sample, the instrument is tuned and quality control (QC) samples such as blanks, initial or continuing calibrations and laboratory control samples are analyzed as required by the client. If the analysis is being run in SIM mode a bromofluorobenzene (BFB) instrument tune check is not required. Other QC samples, such as duplicates, are analyzed once per batch of 20 samples.

Internal and surrogate standards are introduced with all calibration, blank, and sample (field and QC) analyses to monitor instrument performance through the analytical process.

3.0 TARGET ANALYTES, REPORTING LIMITS AND DETECTION LIMITS

Standard target analytes and reporting limits for analysis in SCAN and SIM modes are listed in Tables 2 and 3.

3.1 All reporting limits, QC frequency and QC acceptance criteria are subject to change on a client specific basis as requested by the client.

3.2 The method detection limit (MDL) is defined as the minimum concentration that can be measured and reported with a 99 percent confidence that the reported value is above zero. The MDLs were determined by analyzing seven or eight replicates of air spiked with the target compound list (TCL) analytes within ten times of the target MDL. The scatter of analytical results provides an estimate of the MDL. Three standard deviations are at the 99 percent confidence interval. A MDL study is performed once per 12 month period or whenever a major change occurs with the instrumentation or method. MDL studies are kept on file in the laboratory.

3.3 The reporting limits (RL) shall be verified by including a standard at or below the RL as the lowest point on the initial calibration curve. Any results that fall between the RL and 1/2 of the RL shall be qualified as estimated indicating the variability associated with the result. Reporting limits may increase due to dilution factors associated with pressurization of the canisters.

4.0 INTERFERENCES

4.1 Contamination may occur in the sampling system if canisters are not properly cleaned before use. Therefore, canisters are cleaned and certified (less than 20 ppbv total organic carbon) before each use. Canisters that are to be used for SIM analysis are certified by TO15 SIM to be 5 times less than the specific project reporting limits or less than the MDL, whichever is greater.

4.2 Contamination may occur from impurities in the dilution gas and carrier gas, pump and flow controllers, and solvent vapors in the laboratory. These sources of contamination are monitored through analysis of method blanks.

4.3 Cross-contamination can occur whenever samples containing high VOC concentrations are analyzed. Therefore, whenever an unusually concentrated sample is encountered, the analyst uses professional judgment when reviewing the following samples to determine whether reanalysis is necessary. Additionally, syringes are designated for either sample use or standard use.

5.0 SAFETY, WASTE MINIMIZATION AND POLLUTION PREVENTION

5.1 Laboratory wastes shall be separated and properly disposed complying with all federal, state, and local regulations. The wastes include collected solvent rinses; expired sample extracts and disposable labware (or other item as applicable) used in the preparation of the samples. These wastes shall be handled according to CVO SOP HAZ01, Waste Disposal.

5.2 Analysts are encouraged to reduce the amount of solvent or disposable labware waste whenever possible. More information on this topic can be found in "Less is Better: Laboratory Chemical Management Waste Reduction" located on the American Chemical Society website at http://membership.acs.org/c/ccs/pub_9.htm.

5.3 The safety of each reagent used in this SOP may not be precisely known. A reference file of material safety data sheets (MSDS) is available to all personnel.

5.4 Any unfamiliar field sample may contain contents beyond the list of chemicals listed in this SOP. All samples and extracts are treated as potential health hazards and handled with proper precautions.

5.5 When working in the laboratory, analysts must comply with all safety policies. (see the laboratory Health & Safety Officer or the GC Supervisor for details.)

6.0 SAMPLE COLLECTION, STORAGE, HOLDING TIMES AND PRESERVATION

6.1 Prior to field sampling, SUMMA® steel canisters are cleaned, certified, and tested for leaks. Canisters are cleaned by alternate pressurization and evacuation during heating (see Canister Cleaning SOP, AIR06). After cleaning, the canisters are certified by EPA method TO-12 (see Canister Certification by Method TO-12, SOP AIR07), by GC/MS method TO-15 or by GC/MS method TO-15 SIM.

6.2 Samples are collected and stored in SUMMA® canisters or Tedlar bags.

6.3 Each canister received by the laboratory is checked for its overall condition. After the canister has been logged into the laboratory notebook and the LIMS system, the pressure is checked with a pressure transducer. The canister valve is opened briefly and the pressure is recorded.

6.4 Canisters that contain samples requiring dilutions will be pressurized. Pressures and dilution factors are recorded after every pressurization (see Canister Pressurization SOP AIR11).

6.5 The samples are stored in a secure laboratory area. There are no method requirements for holding times for TO-15 analysis. Although the TO-15 method does state: "Most VOCs can be recovered from canisters near their original concentrations after storage times of up to 30 days."[2]

6.5.1 Analysis of air samples in canisters is completed within 21 days of the validated time of sample receipt to meet internal turn around times, unless otherwise specified by a project. AFCEE samples will be analyzed within 14 days of sample collection.

6.5.2 Analysis of air samples in Tedlar bags is completed within 21 days of the validated time of sample receipt to meet internal turn around times.

6.6 Samples are retained until analytical results have undergone a senior data review. After this process, the canisters are transferred to the cleaning area, held for 10 days, evacuated and cleaned (see Canister Cleaning SOP, AIR06).

7.0 APPARATUS AND MATERIALS

Note: ASL has two analytical systems, one designated for TO-15 analysis and one designated for TO-15 SIM analysis.

7.1 The concentrator/autosampler is a Tekmar Autocan or a Entech 7100A preconcentrator. See manufacturer's manuals for more details.

7.2 GC/MS system - Standard GC/MS operating parameters are listed in Table 5. The parameters may be optimized by the analyst to ensure proper separation and identification of target compounds.

7.2.1 The gas chromatographs (GC) are Agilent models 5890 and 6890 Series or equivalent. See manufacturer's manual for more details. Each is equipped with a DB-VRX 60m x 0.25mm capillary column or equivalent. Helium is the carrier gas.

7.2.2 The gas chromatograph is interfaced with a mass selective detector (MS: Agilent 5972 or 5973 Network or equivalent).

7.2.3 When the MS is placed in the SIM mode of operation, the MS monitors only preselected ions, rather than scanning all masses continuously between two mass limits. This allows increased sensitivity and ultimately lower reporting limits and method detection limits.

7.3 The GC/MS is interfaced to a high speed personal computer. The computer utilizes the Agilent ChemStation and Enviroquant software for acquisition, integration, quantitation, and storage of mass spectral data.

8.0 STANDARDS, GASES AND REAGENTS

All standard materials are documented in bound notebook logs. Upon receipt primary standards are logged into a centralized primary standards notebook. Intermediate and working standards are described in a separate notebook. Table 4 lists the target compound list (TCL), surrogate, and internal standard compounds and their respective concentrations.

8.1 SCAN mode calibration standards

8.1.1 Stock standards are purchased as custom made mixtures in gas cylinders. Each cylinder is prepared with specific compounds at specified concentrations. Cylinders purchased from vendors are traceable to a National Institute of Standards and Technology (NIST)

Standard Reference Material (SRM). Stock standard concentrations are approximately 100 ppbv for all TCL compounds. Primary standards are recertified yearly or replaced.

8.1.2 When stock standards are not commercially available, standards are prepared in house using pure neat compounds (See SOP AIR24, Preparation of Supplemental Standards).

8.1.3 Calibration standards can be used directly from the original cylinders or they can be prepared by adding 100 uL of organic free water to an evacuated 6L canister and pressurizing it to approximately 30 psi with the 100 ppbv primary standard. Then a calibration curve is created by injecting different volumes of standard. Injection volumes are normalized to 250 mLs. Therefore, injecting 50 mLs of stock standard into the preconcentrator is the same as making a 1:5 dilution to produce a 20 ppbv concentration standard.

8.1.4 Second source standards can be used directly from the original cylinders or they can be prepared by mixing proportional volumes of stock standard and nitrogen or ultra high purity air in a 6 liter SUMMA canister to achieve 100 ppbv for a final concentration. Injection volumes are normalized to 250 mLs. Therefore, injecting 50 mLs of stock standard into the preconcentrator is the same as making a 1:5 dilution to produce a 20 ppbv concentration standard.

8.2 SIM mode calibration standards

8.2.1 Stock standards are purchased as custom made mixtures in gas cylinders. Each cylinder is prepared with specific compounds at specified concentrations. Cylinders purchased from vendors are traceable to a National Institute of Standards and Technology (NIST) Standard Reference Material (SRM). Stock standard concentrations are approximately 100 ppbv for all TCL compounds. Primary standards are recertified yearly or replaced.

8.2.2 When stock standards are not commercially available, standards are prepared in house using pure neat compounds (See SOP AIR24, Preparation of Supplemental Standards).

8.2.3 Calibration standards are prepared by diluting the stock standard to 1000 pptv in a 6 L can. Then a calibration curve is created by injecting different volumes of standard. Injection volumes are normalized to 1000 mLs. Therefore, injecting 100 mLs of working standard into the preconcentrator is the same as making a 1:10 dilution to produce a 100 pptv concentration standard.

8.3 SCAN mode internal standards and surrogates

8.3.1 Stock standards are purchased as custom made mixtures in gas cylinders. Each cylinder is prepared with bromochloromethane, 1,4-difluorobenzene, toluene-d8, chlorobenzene-d5 and bromofluorobenzene at specified concentrations. Cylinders purchased from vendors are traceable to a National Institute of Standards and Technology (NIST) Standard Reference Material (SRM). Stock standard concentrations are approximately 1 ppmv for internal standards, 1 ppmv for toluene-d8, and 0.25 ppmv for bromofluorobenzene.

8.3.2 Surrogate and internal standards are prepared by making a 1:20 dilution of the stock standard in a 15 liter SUMMA canister.

8.4 SIM mode internal standards and surrogates

8.4.1 Stock standards are purchased as custom made mixtures in gas cylinders. Each cylinder is prepared with bromochloromethane, 1,4-difluorobenzene, toluene-d8, chlorobenzene-d5 and bromofluorobenzene at specified concentrations. Cylinders purchased from vendors are traceable to a National Institute of Standards and Technology (NIST) Standard Reference Material (SRM). Stock standard concentrations are approximately 1 ppmv for internal standards 1 ppmv for toluene-d8, and 0.25 ppmv for bromofluorobenzene.

8.4.2 Surrogate and internal standards are prepared by making a 1:2000 dilution of the stock standard in a 15 liter SUMMA canister. This is done by diluting the internal standard used for the SCAN mode.

8.5 The surrogate compound bromofluorobenzene is also used as the instrument performance check standard when running in SCAN mode.

8.6 Gases

The following gases are used as blanks, cryogen, and carrier gas:

8.6.1 Air -- Ultra high purity, zero grade

8.6.2 Nitrogen -- Grade 5

8.6.3 Helium -- Grade 5

8.6.4 Liquid Nitrogen

9.0 QA/QC

9.1 An initial demonstration of capability (IDC) study must be performed prior to use of the method by each analyst or after any significant changes to the method. An IDC study consists of four aliquots of standard processed through the entire analytical method. For NELAC certification purposes the IDC study may be used to satisfy the yearly training requirement for an analyst or work cell.

9.1.1 Prepare and analyze four spiked blank samples that is the same concentration as one of your calibration points, excluding the low and high levels.

9.1.2 Calculate the mean concentration found (X) in ppbv or pptv and the standard deviation of the concentration in ppbv or pptv for each analyte.

9.1.3 For each analyte X should be between 70% and 130% of the true value. The RSD should be 25% or less. If the results from all analytes meet these criteria then the system and analyst performance are acceptable. If any analyte fails to meet the criteria then investigate and correct the source of the problem and repeat the test.

9.2 The instrument is tuned using Perfluorotributylamine (PFTBA). When running in SCAN mode the tune is checked every 24 hours using bromofluorobenzene (BFB) and for AFCEE this tune is checked every 12 hours. If tune criteria can not be met, then a MS hardware tune must be performed. If criteria are still not met after re-tuning, then it may be necessary to clean the source. All maintenance shall be recorded in the instrument log book.

9.2.1 When tuning the 5972 MS use the maximum sensitivity tune and save it as BFB.u when the tune is completed

9.2.2 When tuning the 5973 Network MS us the low mass tune and save as lowmass.u when the tune is complete.

9.2.3 Tune evaluation

9.2.3.1 The peak widths should be less than 0.60, consistent with each other (±0.3) and have good peak shape.

9.2.3.2 The EM volts and repeller should have similar results to the last tune.

9.2.3.3 There should be minimal or no air leak.

9.2.3.4 The ISO Ratio should be close to 1 for mass 69, 4-5 for mass 219, and 9-11 for mass 502.

9.3 Method blanks are analyzed to monitor possible laboratory contamination. Laboratory method blanks are prepared with UHP air or grade 5 nitrogen in a certified canister every day samples are to be analyzed. The method blank is carried through the same analytical procedure as a field sample and contains the same amount of surrogate and internal standard that are added to each sample.

9.3.1 Method blanks are analyzed by injecting 250 mL (SCAN) or 1000 mL (SIM) into the preconcentrator and following procedures outlined in section 10.

9.3.2 The blank must not contain any target analyte at a concentration greater than the RL and must not contain additional compounds with elution characteristics and mass spectral features that would interfere with identification and measurement of a method analyte at its MDL. Generally, the blank concentration should be less than 5 times the project required reporting limit or less than the MDL, whichever is greater. AFCEE requires that the blank be less than the reporting limit. If target analytes are found in the method blank above the reporting limit, the source of the contamination must be considered. Usually, re-running the blank will clear up most problems (especially if the sample run prior to the blank was high in target analyte concentration.) If blank contamination is still present, the analyst should perform system maintenance. Some common problems are:

9.3.2.1 Cold spots, check heated zones for failure.

9.3.2.2 Low pressure in the blank sample canister, refill canister.

9.3.2.3 Leaky valves, check all concentrator valves for spindle scoring.

9.3.2.4 Buildup of methylene chloride in the room from extract vials. Ask other analyst to remove excess extract vials and waste.

9.3.3 Method blanks are analyzed at least once per 24-hour period or once per analytical batch.

9.4 An initial calibration curve is developed to demonstrate adequate instrument performance for sensitivity, linearity, resolution, and freedom from active sites.

9.4.1 A valid initial calibration curve must be established before any samples can be analyzed. The GC/MS is calibrated with at least 5 concentrations to determine instrument sensitivity and linearity of GC/MS response for the target compounds. Generally, concentrations of 1 ppbv (2.5 mLs), 5 ppbv (12.5 mLs), 10 ppbv (25 mLs), 20 ppbv (50 mL), 50 ppbv (125 mLs) and 100 ppbv (250 mLs) are used to calibrate in SCAN mode. Concentrations of 1 pptv (1 mLs), 5 pptv (5 mLs), 12.5 pptv (12.5 mLs), 25 pptv (25 mL), 50 pptv (50 mLs) and 250 pptv (250 mLs) are used to calibrate in SIM mode. One of the calibration levels should be at or below the reporting limit for the compounds of interest.

9.4.2 For the initial calibration, a relative response factor (RRF), a mean relative response factor and a percent relative standard deviation are calculated for each analyte. The equations for calculating these are shown in section 11.0 Data Reduction.

9.4.2.1 The %RSD for all compounds must be less than 30%. Up to two compounds may exceed 30 percent but may not exceed 40 %RSD.

9.4.2.2 For SIM analysis if the average response factor is greater than 15% but less than 30%, other calibrations, e.g. linear, may be used. If linear calibration is used, then R value must be > 0.995. Higher order calibrations, require a COD value > 0.99, and additional calibration points must be added, (6 points for second order regression, 7 points for third order regression, etc.).

9.4.2.3 AFCEE requires the %RSD for all compounds be less than 30 percent. No compounds may exceed this limit.

9.4.2.4 If these requirements are not met, then a new initial calibration must be performed. If this does not result in an acceptable initial calibration then system maintenance may be necessary.

9.4.3 No limit has been placed upon the amount of time that an initial calibration may be valid, nor is there a maximum limit on the number of samples associated with one initial calibration. As long as continuing calibration check standards pass continuing calibration criteria, then the initial calibration remains valid. In some instances, a new initial calibration is required. These conditions are listed below:

9.4.3.1 Major instrument maintenance.

9.4.3.2 Repeated failure to pass continuing calibration criteria.

9.4.3.3 Preparation of a new working internal standard.

9.5 An initial calibration verification using a second source standard shall be run at the end of each initial calibration to verify the calibration standard concentrations and accuracy of the calibration curve.

9.5.1 AFCEE requires that the second source standard be from a different vendor than the primary standard.

9.5.2 For AFCEE the %D for each compound must not exceed 25% of the expected value. For all other samples the %D for each compound must not exceed 30%. Samples may not be analyzed until this criterion is met.

9.6 Continuing calibration verifications are analyzed to ensure that the instrument continues to meet the instrument sensitivity and linearity requirements originally established by the initial calibration. Continuing calibrations are analyzed prior to analysis of QC, or field samples.

9.6.1 The initial calibration for each compound of interest should be verified prior to sample analysis, using the introduction technique and conditions used for samples. This is accomplished by analyzing one of the calibration standards used for initial calibration. Typical concentrations for calibration verification are 10 or 20 ppbv in SCAN mode and 25 or 50 pptv in SIM mode.

9.6.2 Continuing calibrations are analyzed at the beginning of every 24-hour time period or analytical batch. This frequency is increased to once every 12-hours if analyzing AFCEE samples.

9.6.3 The %D for each compound may not exceed 30 percent. For AFCEE the %D may not exceed 25% for any compound.

9.6.4 Failure to pass continuing calibration criteria requires reanalysis of the affected samples after evaluation of the system and corrective action are performed. Repeated failure to pass response factor criteria requires the performance of a new initial calibration.

9.7 When AFCEE samples are to be analyzed, a laboratory control samples (LCS) is analyzed once per analytical batch to determine if the entire method is in control.

9.7.1 The LCS shall be a volume of the calibration standard injected at or below the midpoint of the calibration curve for each midpoint. The LCS shall be carried through the complete analytical procedure.

9.7.2 The %D for each compound not listed in Table 6 (AFCEE Table for Accuracy, AFCEE QAPP, Version 3.1) may not exceed 25%.

9.8 Duplicate analysis is performed to determine precision. This is determined by comparing two replicates of a randomly selected sample and expressing the results as a percentage.

9.8.1 Duplicates will be analyzed on 5% or more of the samples analyzed. Duplicates do not need to be analyzed with every analytical batch.

9.8.2 Laboratory duplicate samples should be chosen randomly from a client batch of samples unless they are pre-selected by the client. Analysts should rotate the client selected for laboratory duplicates so that precision data is collected from a wide variety of sample matrices.

9.8.3 Replicate precision will be less than 25 %RPD and less than 20 %RPD for AFCEE samples.

9.8.4 If duplicate results fail to meet acceptance criteria then rerun the sample, if there is enough sample. Otherwise, report the exceptions in the case narrative. If the analyst feels that the errors are due to system failure and/or the repeated duplicate is still not reproducible then sample analysis should be stopped and corrective action taken.

9.9 Internal standards are added to all QC and field samples to correct for analytical variability. Three ISTD compounds, bromochloromethane, 1,4-difluorobenzene and chlorobenzene-d5, are added to each field and QC sample at a nominal concentration of 10 ppbv in SCAN mode and 25 pptv in SIM mode.

9.9.1 For AFCEE, internal standards areas shall not vary by more than ±40% from the average internal standard areas in the most recent calibration. In certain cases, the internal standards areas shall not vary by more than -50% or +200% from the internal standard areas in the mid calibration point of the most recent initial calibration. This should be verified in each projects QAP.

9.9.2 For CLP, internal standards areas shall not vary by more than ±40% from the internal standard in the continuing calibration for the day.

9.9.3 The retention time shift of the internal standards at each calibration level must be within 20 seconds of the mean retention time over the initial calibration range for each internal standard.

9.9.4 The retention time of any ISTD compound may not change more than 30 seconds from the latest continuing calibration.

9.9.5 When IS results are outside of criteria, corrective action shall be performed and samples reanalyzed.

9.10 Two surrogates, toluene-d8 and bromofluorobenzene, are added to all QC and field samples. The surrogate recoveries must be 70-130%. If surrogate recoveries are outside of acceptance criteria then the sample will be reanalyzed. If reanalysis does not fix the problem then it is up to the analyst to decide if the problem is a matrix interference or a system error. If the problem is a matrix interference then it should be noted on the case narrative. If the problem is a system error then corrective action should be taken and sample analysis stopped until the problem is fixed.

9.11 MDL studies are performed annually. MDLs must be less than or equal to one half of the reporting limit (the lowest calibration level). See MDL SOP, SOP14.

9.12 A limit of detection (LOD) and a limit of quantitation (LOQ) study must be performed in accordance with SOP32. This study is to be performed immediately after the MDL study. LOD recoveries must be 1-200% and LOQ must be 70-130%.

9.13 The major source of error for the analytical measurement is the pre-concentrator system.

10.0 PROCEDURE

10.1 Screening is an optional activity, but some form of screening is highly recommended. Screening can be performed by GC analysis, method TO-12, TO-14 or TO-15. An aliquot of the sample is injected into the GC and is carried through the analytical process (see Method TO-12, SOP AIR04). The results of the screen determine approximate dilutions if required.

10.2 Most canisters are pressurized upon receipt at the laboratory and will therefore have a dilution factor up to 4. Sample volumes are normalized to 250 mL when running in SCAN mode and 1000 mLs when running in SIM mode. Dilutions can be achieved by analysis of a smaller volume. If greater dilutions are required, the sample can be diluted into a tedlar bag.

10.3 Standards and/or sample canisters are attached to the manifold with a 1/4-inch swagelok fitting, keeping all valves closed.

10.4 A leak check is performed using the concentrator software, any leaks are repaired before analyses can proceed. After performing the leak check, the appropriate canister valves are opened.

10.5 Procedure for using Tekmar's Autocan

10.5.1 Tekmar's concentrator software is used to control the autosampler and concentration parameters. (See manufacturer's manual for more details.) A sequence is generated which contains such information as sample name, volume to inject, manifold position, concentrator method and analytical sequence. When the software opens it brings up a screen containing the sequence table. To create a new sequence and start the preconcentrator, complete the following:

10.5.2 The internal standard volume should be 50 mL.

10.5.3 Type in the sample name.

10.5.4 Type in the autosampler position.

10.5.5 Type in the volume of sample to be taken.

10.5.5.1 If the sample volume is measured by the mass flow controller in the autosampler the smallest volume that can accurately be taken is 50 mL. Sometimes a screening run is performed where only 25 mL is taken. These screened samples always need to be rerun even if the concentrations of target analytes are within the calibration range.

10.5.5.2 If the sample is a hand injection then type in 250 mL, even if you intend to inject a smaller volume. After the hand injection of sample, nitrogen is used to flush the port and to carry the sample onto the trap. This will make up what ever is left of the 250 mL.

10.5.6 Click on the "Method Filename" button and select the appropriate preconcentrator method. The most current methods are 8_TO14 and 9_TO14. These two versions are currently identical except for the time the autosampler will wait before starting the next sample. Version 8 is used when running volumes less than 500 mLs and version 9 is used when running volumes greater than 500 mLs.

10.5.7 Click on the "Add" button in the tool bar. Notice the sample has been added to the sequence table.

10.5.8 If you are doing hand inject samples proceed to 10.5.9. If you are doing multiple autosampler injections repeat steps 10.5.2 to 10.5.7 until all samples have been entered.

10.5.9 Click on the "Send" button. This sends the sequence information to the Autocan.

10.5.10 The Autocan's main screen will come back to the top and will say "Standby". Click on the step button. It should now read "Sample Desorb Ready, Press Step to Begin". Click on the step button. The concentrator will now go through a pressure measurement step and a special bake. The analyst can step through the special bake if they feel the instrument is clean. It is recommended to let this step proceed if the analysis is the first of the day.

10.6 Procedure for using Entech's 7100A preconcentrator for SCAN mode only

10.6.1 Entech's preconcentrator software is used to control the autosampler and concentration parameters. (See manufacturer's manual for more details.) A sequence is generated which contains such information as sample name, volume to inject (normalized to 250 mL), manifold position, concentrator method and analytical sequence. When the software opens it brings up a screen containing the sequence table. To create a new sequence and start the preconcentrator, complete the following:

10.6.2 The internal standard volume should be 50 mL.

10.6.3 Type in the sample name.

10.6.4 Type in the manifold position. You will need to click on the boxes in the tool bar that go from 1 to 4.

10.6.4.1 Position 1 is the autosampler.

10.6.4.2 Position 2 is not used.

10.6.4.3 Position 3 is a direct injection (by hand) through the port on the front of the concentrator).

10.6.4.4 Position 4 is directly connected to a calibration standard cylinder on the back of the instrument. This position should only be used if doing an initial calibration, continuing calibration verification or laboratory control sample.

10.6.5 Type in the autosampler position. You will need to click on the boxes in the tool bar that go from 1 to 16. If you have selected a manifold position of 2, 3 or 4 it will not matter what autosampler position is selected.

10.6.6 Type in the volume of sample to be taken.

10.6.6.1 If the sample is coming from the autosampler the smallest volume that can accurately be taken is 50 mL. Sometimes a screening run is performed where only 25 mL is taken. These samples always need to be rerun even if the concentrations of target analytes are within the calibration range.

10.6.6.2 If the sample is a hand injection then type in 250 mL, even if you intend to inject a smaller volume. After the hand injection of sample, nitrogen is used to flush the port and to carry the sample onto the trap. This will make up what ever is left of the 250 mL.

10.6.7 Click on the “Method” button in the tool bar and select the appropriate preconcentrator method. The most current method is TO14_7.

10.6.8 Click on the “Add” button in the tool bar. Notice the sample has been added to the sequence table.

10.6.9 If you are doing hand inject samples proceed to 10.6.10. If you are doing multiple autosampler injections repeat steps 10.6.3 to 10.6.8 until all samples have been entered.

10.6.10 Place the mouse arrow on the first sample that you would like to be analyzed and highlight that line, by clicking. Press the “Go” button in the tool bar. A message box will open and ask if you would like to save the sequence. The sequence should be saved as the current date plus the instrument id and the sequence number. For example 101903R1.

10.6.11 Click on the “View” button in the tool bar. This brings up a screen that shows what is going on with the instrument at any given time during the run.

10.7 The same analytical sequence must then be produced on the HP ChemStation. Additional, necessary information is the dilution factor and the analytical method (named for the most recent initial calibration, e.g. 0526TO14.M). All information is recorded in the bound and numbered instrument logbook.

10.7.1 In the ChemStation software go to sequence and then edit sample table. Type in the lab ID of the sample, analytical method, the lab ID again. Down below in the misc. info. type in the dilution factor. Remember that the dilution factor should include the dilution factor from can pressurization as well as the dilution factor from using a sample volume other than the normalized volume. Repeat for all samples. Click Ok.

10.7.2 Start the sequence by going to sequence and then run sequence. A screen will come up that will let you enter the analyst initials as well as where you would like the data saved. The data should be saved on the C:\ drive using the current date, instrument id and sequence number. For example C:\msdchem\1\data\101903G1. Click on “Run Sequence”.

10.8 The information in both sequence tables is recorded in the instrument log book. Figure 1 is an example page from this logbook.

10.9 Double check that the appropriate gases and liquid nitrogen are turned on. If you are doing an autosampler injection make sure that the canisters are open.

10.10 If you are doing a hand injection look at the view screen of the preconcentrator software. When it says “Trapping Sample” on the Autocan or “Equilibrating Pressure” on the Entech 7100A in the top of the screen it is time to inject the sample.

10.10.1 Select the appropriate syringe for the size of sample to be injected.

10.10.2 Rinse the syringe several times with the sample.

10.10.3 Fill the syringe beyond the volume to be injected and press out sample until you reach the desired volume.

10.10.4 Insert the syringe needle into the septum nut on the concentrator’s port 2 on the Autocan and port 1 on the Entech 7100A. Press the plunger slowly until the entire sample has been injected.

10.10.5 After the entire sample has been injected, pull it out of the septum and open the canister filled with nitrogen.

10.10.6 It has been found that methylene chloride contamination can be lowered by leaving the blank can open in between runs and minimizing extract vials in the room.

10.11 The concentrator may be started again for hand injections when GC-G is 8 minutes from completing its run and earlier if you are injecting more volume. For GC-R the concentrator can be started 15 minutes from the completed run.

10.12 All samples reported to the client are analyzed within an analytical sequence. An analytical sequence is a set of GC/MS acquisitions. A typical sequence includes the instrument tune, a method blank, an initial calibration and second source verification or continuing calibration, and ending with field or QC samples. For AFCEE the analytical sequence is expanded to include a laboratory control sample (LCS). A summary of the order of a typical analytical run is described below:

1. Calibration/Tune Check (Tune check for SCAN only)
    a. Initial calibration
        1. 1 ppbv or 1 pptv
        2. 5 ppbv or 5 pptv
        3. 10 ppbv or 12.5 pptv
        4. 20 ppbv or 25 pptv
        5. 50 ppbv or 50 pptv
        6. 100 ppbv or 250 pptv
        7. Second source calibration verification standard

        -and/or-

    b. Continuing calibration
    c. LCS (for AFCEE or as requested by client)
2. Blank
3. Samples
    a. Client samples
    b. Duplicate (5% of samples)

10.13 Samples must be diluted properly for analysis. Failure to make a needed dilution makes data interpretation difficult and very subjective. Over dilution provides unnecessarily high reporting limits to the client and should be avoided. Anything above the highest calibration point is reported as an estimate, this should be avoided.

10.14 Instrumental maintenance logs are maintained to monitor all adjustments to the system. Routine maintenance includes changing pump oil and foreline pellets, cleaning ion source, and replacing filaments and electron multiplier.

11.0 DATA REDUCTION

11.1 Calculations

11.1.1 Relative response factor: For the initial calibration, a relative response factor (RRF) is calculated for each analyte in each concentration level. The RRF is the ratio of amount of analyte in the compound to the amount of internal standard injected. The formula for calculating the RRF is shown in equation 1.

$$RRF = \frac{AxCis}{AisCx} \qquad \text{equation 1}$$

Where: RRF = relative response factor
Ax = area of the primary ion for the compound to measured.
Ais = area of the primary ion for the internal standard
Cis = concentration of internal standard spiking mixture (ppbv)
Cx = concentration of the compound in the calibration standard (ppbv)

11.1.2 Mean Relative response factor: Based on the RRFs calculated in equation 1, a mean relative response factor for each analyte is calculated. The mean RRF is the average of all RRFs for an analyte. The formula for calculating the mean RRF is shown in equation 2.

$$\overline{RRF} = \sum_{i=1}^{n} \frac{Xi}{n} \qquad \text{equation 2}$$

Where: $\overline{RRF}$ = mean relative response factor
Xi = RRF of the compound
n = number of points in the curve

11.1.3 Percent Relative Standard Deviation (%RSD): Based on results from equations 1 and 2 above, A percent relative standard deviation (%RSD) is calculated for each analyte. The %RSD is the ratio of the standard deviation (SD) of all RRFs for an analyte to the mean RRF for that analyte. The formulas for calculating %RSD and SD is shown in equations 3 and 4.

$$SD_{RRF} = \sqrt{\sum_{i=1}^{N} \frac{(RRFi - \overline{RRF})^2}{N-1}} \qquad \text{equation 3}$$

And

$$\%RSD = \frac{SD_{RRF}}{\overline{RRF}} \times 100 \qquad \text{equation 4}$$

Where: RRF = mean of initial relative response factors (per compound).
SDrrf= standard deviation of initial response factors (per compound)
RRFi= relative response factor at a concentration level
N = number of points in the curve (usually 6)

11.1.4 Relative Retention Times (RRT): Calculate the RRTs for each target compound over the initial calibration range using equation 5.

$$RRT = \frac{RTc}{RTis} \qquad \text{equation 5}$$

Where: RTc = retention time of target compound, seconds
RTis = retention time of internal standard, seconds

11.1.5 Mean of the Relative Retention Times ($\overline{RRT}$): Calculate the mean of the relative retention times for each analyte over the whole calibration using equation 6.

$$\overline{RRT} = \sum_{i=1}^{n} \frac{RRT}{n} \qquad \text{equation 6}$$

Where: $\overline{RRT}$ = Mean relative retention time for the target compound for each initial calibration standard
RRT = Relative retention time for the target compound at each calibration level

The RRT for each target compound at each calibration level must be within 0.06 RRT units of the mean RRT for the compound.

11.1.6 Mean Area Response ($\overline{\mathbf{Y}}$) for Internal Standard: Calculate the mean area response for each internal standard over the whole calibration range using equation 7.

$$\overline{Y} = \sum_{i=1}^{n} \frac{Yi}{n} \qquad \text{equation 7}$$

Where: $\overline{Y}$ = Mean area response

Y = Area response for the primary quantitation ion for the internal standard for each initial calibration standard

The area response Y of each calibration level must be within the 40% of the mean response $\overline{Y}$ of the whole calibration.

11.1.7 Mean Retention Times ($\overline{\mathbf{RT}}$): Calculate the mean retention times for each internal standard over the initial calibration range using equation 8.

$$\overline{RT} = \sum_{i=1}^{n} \frac{RTi}{n} \qquad \text{equation 8}$$

Where: $\overline{\mathbf{RT}}$ = Mean retention time, seconds
RT = Retention time for the internal standard for each initial calibration, seconds.

11.1.8 For the second source calibration verification, continuing calibration, LCS and ISTD a percent difference (%D) is calculated. For example, the %D is the ratio of the difference between the RRF in the continuing calibration and the mean RRF in the initial calibration. The formula for calculating %D is shown in equation 9.

$$\%D = \frac{RRFc - \overline{RRFi}}{\overline{RRFi}} x100 \qquad \text{equation 9}$$

Where: $\overline{RRFi}$ = mean RRF of the compound in the most recent initial calibration.
RRFc= RRF of the compound in the continuing calibration standard

11.1.9 Duplicate analysis is performed to determine precision. This is determined by comparing two replicates of the same sample and expressing the results as a percentage.

$$\%RPD = \frac{|X - Y|}{(X + Y)} x200 \qquad \text{equation 10}$$

Where: X = first measured value
Y = second measured value

11.1.10 Surrogate recovery (%REC):

$$\%REC = \frac{\text{observed value}}{\text{true value}} \times 100$$

11.2 Qualitative Analysis

11.2.1 Client requested compounds should be identified by an analyst competent in the interpretation of mass spectra by comparison of the sample mass spectrum and the spectrum of a standard of the suspected compound. Two criteria must be satisfied to verify the identifications. If either of these criteria are not met, analyst judgement must be used to determine the presence of a compound (See SOP 34, Quantitative Peak Identification using GC/MS). If it is not possible to confirm the compounds presence, that compound should be reported as a non-detect.

11.2.1.1 Elution of the sample component at the same GC retention time as the corresponding standard component. The RT of each internal standard must be ±0.33 min. from the RT in the most recent calibration check or curve. Target analytes must be ±0.06 RRT units of the RRT of the most recent calibration.

11.2.1.2 Correspondence of the sample component and standard component mass spectra. One or two ions are picked for each compound and used as qualifying ions. The relative abundance of these ions to the target ion for that compound are compared to the ratios determined from the initial calibration. All ratios that differ by more than 20% will be automatically flagged on the instrument print out and need to be examined more closely. The analyst should visually examine

the spectra and determine if the poor qualifying ratio was caused by interference.

11.2.2 When requested a library search is executed for all non-target sample components for the purpose of tentative identification (SCAN mode only). For this purpose, the most recent release of the NIST spectral library shall be used. Computer generated library search routines that would misrepresent the library or unknown spectra when compared to each other, must not be used. Compounds greater than a reporting limit of 1 times the dilution factor that can be tentatively identified via a library search can be reported, provided the match quality is 50% or greater. Non-target compounds that are identified are referred to as Tentatively Identified Compounds (TIC). TICs are quantified by the internal standard method. TIC concentration is calculated using the formula in equation 11.

$$\text{TIC Concentration} = \frac{AxCisDF}{\overline{Ais}RRF} \qquad \text{equation 11}$$

Where: RRF = 1
Ax = area of the TIC peak
Ais = internal standard area for the nearest ISTD
Cis = 10 ppbv (Internal standard concentration)
DF = dilution factor

11.3 Quantitative Analysis

Target Compounds identified are quantified by the internal standard method using the peak area of the characteristic ions of target analytes. The mean relative response factor (RRF) from the initial calibration analysis is used to calculate the concentration in the sample. The equation for determining concentration is shown in equation 12.

$$\text{TCL Analyte Concentration} = \frac{AxCisDF}{Ais\overline{RRF}} \qquad \text{equation 12}$$

Where: RRF = mean response factor from the initial calibration.
Ax = area of the characteristic ion for the compound to be measured
Ais = area of the characteristic ion for the specific internal standard
Cis = concentration of the internal standard spiking mixture (ppbv)
DF = dilution factor

12.0 DOCUMENTATION

12.1 Data review and laboratory checklist

Sample data must be reviewed with the associated quality control data. The following checklist should be consulted before releasing sample results.

12.1.1 Valid initial calibration
12.1.2 Valid continuing calibration
12.1.3 Valid tune
12.1.4 Valid method blank
12.1.5 Valid internal standard and surrogate recoveries
12.1.6 Positive samples double checked for interpretation
12.1.7 Results corrected for dilutions
12.1.8 Results adjusted for interferences/chemical noise
12.1.9 Valid qualifying ion ratios
12.1.10 Good chromatography

12.2 Data reporting

12.2.1 Analytical results are summarized from the raw data. The appropriate deliverables are produced using Microsoft Access, Microsoft Excel and Microsoft Word software. Sample results are reported without blank subtraction. TCL concentrations (including the reporting limits) should be reported with a maximum of three significant figures.

12.2.2 The case narrative will summarize any analytical or documentation exceptions along with the quality of the QC results.

12.2.3 All reports are reviewed and signed by a peer before delivery to the client.

12.3 GC/MS data deliverables

12.3.1 Access databases, Microsoft Word files and Microsoft Excel files are available at PC workstations to facilitate the production of summary data forms. A book of example deliverables is maintained by the group for convenient reference. The data package department keeps a copy of all previous work which may be consulted for information.

12.3.2 Three different levels of QC documentation are available to meet the needs of the client.

12.3.2.1 A level 2 data package includes a summary of analytical results (Form 1s) for all client samples and associated method blanks.

12.3.2.2 A level 3 data package includes summary forms for analytical results, QC, and calibration data summaries (CLP forms 1 to 8 or AFCEE forms 2-11) but instrument printouts are not included.

12.3.2.3 A level 4 data package includes all summary forms for a level 3 package plus hard copy documentation of all raw data for both samples and QC samples. All instrument output and related documentation are also provided in hard copy form.

12.3.3 A summary of documentation included in a CLP and AFCEE level 3 air toxics data package are outlined below. A level 2 data package will only include form 1s and a level 4 data package will include all forms as well as instrument printouts.

12.3.3.1 CLP Package Summary

* Cover Letter (level 2, 3, 4)
* Table of Contents (level 4 only)
* Client Sample Cross Reference (level 2, 3, 4)
* Section Divider (level 3, 4)
* Case Narrative (level 2, 3, 4)

Sample Data Summary

* Form 1As (level 2, 3, 4)
  Analytical results for each Target Compound List (TCL) analyte. One form is generated for each field sample submitted, laboratory blank, laboratory duplicate, and any dilutions. The TCL will consist of 38 compounds which are listed in method TO-15 unless a project specific list has been developed.
* Form 2 (level 3, 4)
  This form identifies the surrogate recovery for each field and laboratory sample.
* Form 3 (level 3, 4)
  Summarizes the results of any duplicates that are associated with the data included in the package.
* Form 4 (level 3, 4)
  This form identifies the specific field and laboratory samples associated with a specific laboratory blank.
* Form 5 (level 3, 4)
  Shows the results of the mass spectrometer tune verification and identifies both the field and laboratory samples associated with the tune.
* Form 6 (level 3, 4)
  Summarizes the results of the initial calibration including the relative response factors (RRF), average RRF, and percent relative standard deviation (%RSD) for each TCL analyte.
* Form 7 (level 3, 4)
  Summarizes the results of the continuing calibration including percent difference (%D) and acceptance criteria. Any outliers are flagged.
* Form 8 (level 3, 4)
  Summarizes for each field sample the internal standard (IS) areas and the associated retention times (RT) associated with a specific continu-

ing calibration. Acceptance criteria are defined and any outliers are flagged.

Optional Documentation

* Form 1Bs (level 3, 4)
  Analytical results for Tentatively Identified Compounds (TIC). One form is generated for each field sample submitted, laboratory blank, laboratory duplicate, and any dilutions. This form is included only if a TIC analysis has been requested in addition to a routine quantitation analysis.

12.3.3.2 AFCEE Package Summary

* Cover Letter (level 2, 3 ,4)
* Table of Contents (level 2, 3)
* Client Sample Cross Reference (level 2, 3, 4)
* Section Divider (level 3, 4)
* Case Narrative (level 2, 3, 4)

Sample Data Summary

* Form 2 (level 2, 3, 4)
  Analytical results for each Target Compound List (TCL) analyte. One form is generated for each field sample submitted, laboratory duplicate, and any dilutions. The TCL will consist of 38 compounds which are listed in method TO-15 unless a project specific list has been developed.
* Form 3 (level 3, 4)
  Summarizes the results of the initial calibration including the relative response factors (RRF), average RRF, and percent relative standard deviation (%RSD) for each TCL analyte.
* Form 4 (level 3, 4)
  Summarizes the results of the second source calibration verification including percent difference (%D) and acceptance criteria. Any outliers are flagged.
* Form 5 (level 3, 4)
  Summarizes the results of the continuing calibration including percent difference (%D) and acceptance criteria. Any outliers are flagged.
* Form 6 (level 2, 3, 4)
  Analytical results for each method blank for each Target Compound List (TCL) analyte. The TCL will consist of 38 compounds which are listed in method TO-15 unless a project specific list has been developed.
* Form 7 (level 3, 4)
  Summarizes the results of the laboratory control sample including percent recovery (%Rec) and acceptance criteria. Any outliers are flagged.
* Form 8 (level 3, 4)
  Summarizes the results of any duplicates that are associated with the data included in the package.
* Form 9 (level 3, 4)
  This form calculates the holding time from the date analyzed and date collected for each field sample submitted.
* Form 10 (level 3, 4)
  Shows the results of the mass spectrometer tune verification and identifies both the field and laboratory samples associated with the tune.
* Form 11 (level 3, 4)
  Summarizes for each field sample the internal standard (IS) areas and the associated retention times (RT) associated with a specific continuing calibration. Acceptance criteria are defined and any outliers are flagged.
* MDL Summary Page

This page lists all MDL replicates as well as the calculated MDL for each analyte.

12.3.4 Sample Results Raw Data (level 4 only)

Raw data submitted for an air toxics data package consists of instrument printouts which include:

12.3.4.1 Quantitation reports

Three quantitation reports are generated for each sample analyzed:

12.3.4.1.1 Air Analysis Data Report

The Air Analysis Data Report lists final concentrations and detection limits for each TCL analyte.

12.3.4.1.2 Target & Qualifier Ion Summary

The Target and Qualifier Ion Summary lists the target (primary) ion area counts and retention times; Qualifier (secondary) ion area counts; calculated and expected ratio between the secondary ion in the sample and the secondary ion in the GC/MS library; and sample concentrations for each analyte. Analyte concentrations reported in this summary list do not take into account dilution factors.

12.3.4.1.3 Area Percent Report

Finally, the Area Percent Report lists the total ion area count and retention time for each peak quantified.

12.3.4.2 A total ion chromatogram

One Total Ion Chromatogram is included for each sample analyzed. The Total Ion Chromatogram shows the peaks for all compounds that were detected by the instrument.

12.3.4.3 Mass spectra for each TCL analyte detected.

One mass spectra is generated for each analyte detected. The Mass spectra is a graph of mass to charge ratio versus ion abundance for each ion in an analyte. The mass spectra for each analyte detected in the sample are compared to the standard mass for that analyte. Mass spectra for compounds associated with initial and continuing calibrations, blanks, and duplicates are not included in the data package.

12.3.4.4 Raw data submitted for each initial calibration includes quantitation reports and total ion chromatograms.

12.3.4.5 Raw data submitted for the instrument performance check includes results from both the instrument tune using Perfluorotributylamine (PFTBA) and the instrument tune check using bromofluorobenzene (BFB). Raw data from the instrument tune includes ion chromatograms and mass spectra for PFTBA. Raw data from the instrument tune check includes ion abundance summary for BFB, ion abundance criteria for selected BFB ions, TIC, and mass spectra for BFB.

12.3.4.6 Optional Documentation (level 4 only)

Raw data for TICs consist of a library search summary of all TICs detected in a field sample. For each TIC peak, a list of possible compounds is generated by the GC/MS library. From the possible list of compounds, the GC/MS chemist will decide which compound best matches the TICs detected.

12.3.5 Sample Results Raw Data Outline

The outline below lists the raw data documentation included in a level 4 data package. Raw data for TICs are optional and are included only if a TIC analysis has been requested in addition to a routine quantitation analysis.

12.3.5.1 Sample Results

* Divider entitled "Sample Results"
* Raw data which includes the following three types of printouts:
  - Quantitation Reports
    - Air Analysis Data Report
    - Target and Qualifier Ion Summary
    - Area Percent Report
  - Total Ion Chromatogram
  - Mass Spectra

* Form 1B -optional- [analysis data summary - TICs]
* Raw Data -optional-
  - Library Search Summary

12.3.5.2 Initial Calibration
* Divider entitled "Initial Calibration"
* Raw data
  - Quantitation Reports
    - Response Factors Summary
    - Air Analysis Data Report
    - Target and Qualifier Ion Summary
    - Area Percent Report
  - Total Ion Chromatogram

12.3.5.3 Continuing Calibration
* Divider entitled "Continuing Calibration"
* Raw data
  - Quantitation Reports
    - Response Factors Summary
    - Air Analysis Data Report
    - Target and Qualifier Ion Summary
    - Area Percent Report
  - Total Ion Chromatogram

12.3.5.4 Instrument Performance Check Summary
* Divider entitled "Instrument Performance Check Summary"
* Raw data
  - Ion Chromatograms and Mass Spectra from PFTBA Tune.
  - Ion Abundance Criteria for Selected BFB Ions.
  - Summary of Ion Abundances for BFB
  - TIC and Mass Spectra for BFB

12.3.5.5 Method Blanks
* Divider entitled "Method Blanks"
* Form 1A for method blank
* Raw data
  - Quantitation Reports
    - Air Analysis Data Report
    - Target and Qualifier Ion Summary
    - Area Percent Report
  - Total Ion Chromatogram

12.3.5.6 Duplicate
* Divider entitled "Duplicate"
* Raw data
  - Quantitation Reports
    - Air Analysis Data Report
    - Target and Qualifier Ion Summary
    - Area Percent Report
  - Total Ion Chromatogram
  - Mass Spectra

12.3.5.7 Canister Certification
* Divider entitled "Canister Certification"
* Raw data
  - Quantitation Reports
    - Air Analysis Data Report
    - Target and Qualifier Ion Summary if by method TO-15
    - Area Percent Report if by method TO-15
  - Total Ion Chromatogram

12.3.5.8 Laboratory Bench Worksheets
* Divider entitled "Laboratory Bench Worksheets"
* Canister dilution worksheet

* Instrument log sheet

12.3.5.9 Chain of Custody

* Divider entitled "Chain of Custody"
* Copy of original chain of custody
* Analysis change order (if applicable)
* Sample receipt exception report (if applicable)
* Laboratory Bench worksheets (level 4 only)

13.0 REFERENCES

13.1 *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air: Method TO-14A, Second Edition*, U.S. Environmental Protection Agency, Research Triangle Park, NC, EPA 600/625/R-96/010b, January 1999.

13.2 *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air: Method TO-15, Second Edition*, U.S. Environmental Protection Agency, Research Triangle Park, NC, EPA 600/625/R-96/010b, January 1999.

14.0 DEFINITIONS

14.1 ASL – Applied Sciences Laboratory

14.2 CVO – Corvallis, OR

14.3 NELAC – National Environmental Laboratory Accreditation Conference

14.4 NELAP – National Environmental Laboratory Accreditation Program

14.5 QA/QC – Quality Assurance/Quality Control

14.6 QA – Quality Assurance

14.7 QC – Quality Control

14.8 SCAN – Mode of MS operation in which the instruments scans a range of specified ions.

14.9 SIM – Mode of operation in which only specific target compound's ions are scanned

14.10 SOP – Standard Operating Procedure

14.11 IDC – Initial Demonstration of Capability

14.12 RSD – Relative Standard Deviation

14.13 %D – Percent Difference

14.14 LCS – Laboratory Control Standard

14.15 QAP – Quality Assurance Plan

14.16 LCSD – Laboratory Control Standard Duplicate

14.17 Internal Standard (IS) – A pure analyte(s) added to a sample, extract, or standard solution in known amount(s) and used to measure the relative responses of other method analytes and surrogates that are components of the same sample or solution. The internal standard must be an analyte that is not a sample component.

14.18 Surrogate Standard (SS) – A pure analyte(s), which is extremely unlikely to be found in any sample, and which is added to a sample aliquot in known amount(S) before extraction or other processing and is measured with the same procedures used to measure other sample components. The purpose of the SS is to monitor method performance with each sample.

14.19 Laboratory Duplicates (Dup) – Two aliquots of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of duplicates indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

14.20 Field Duplicates (FD) – Two separate samples collected at the same time and place under identical circumstances and treated exactly the same throughout field and laboratory procedure. Analyses of Duplicates gives a measure of the precision associated with sample collection, preservation and storage, as well as with laboratory procedures.

14.21 Laboratory Replicates – An aliquot of sample is taken in the laboratory and prepared. The prepared sample is then analyzed twice. Laboratory replicates indicate precision associated with instrumentation and not sample preparation. For some test methods, a laboratory duplicate and a laboratory replicate may be the same thing.

14.22 Laboratory Reagent Blank (WB1, SB1, XB1) – An aliquot of reagent water or other blank matrix that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with other samples. The blank is used to

determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

14.23 Trip Blank (TB) – An aliquot of reagent water or other blank matrix that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the TB is to determine if method analytes or other interferences are present in the field environment.

14.24 Calibration Check Verification (CCV, CCC) – A solution of one or more compounds (analytes, surrogates, internal standard, or other test compounds) used to evaluate the performance of the instrument system with respect to a defined set of method criteria.

14.25 Blank Spike (BS1W, BS1S) – An aliquot of reagent water or other blank matrix to which known quantities of the method analytes are added in the laboratory. The BS is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements.

14.26 Stock Standard Solution (SSS) – A concentrated solution containing one ore more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source.

14.27 Primary Standard Solution (PSS) – A solution of several analytes prepared in the laboratory from stock standard solutions and diluted as needed to prepare calibration solutions and other needed analyte solutions.

14.28 Calibration Standard (CAL) – A solution prepared from the primary standard solution or stock standard solution and the internal standards and surrogate analytes. The Cal solutions are used to calibrate the instrument response with respect to analyte concentration.

14.29 Initial Calibration Verification (ICV) – A solution of method analytes of known concentrations which is used to fortify an aliquot of WB1 or sample matrix (MS). The ICV is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

Tables

TABLE 1

BFB INSTRUMENT PERFORMANCE CHECK
ION ABUNDANCE CRITERIA

m/e	**Ion Abundance Criteria**
50	15.0 - 40.0% of m/e 95
75	30.0 - 60.0% of m/e 95
95	Base peak, 100% relative abundance
96	5.0 - 9.0% of m/e 174
173	Less than 2% of m/e 174
174	>50.0 of m/e 95
175	5.0 - 9.0% of m/e 174
176	95.0 - 101.0% of m/e 174
177	5.0 - 9.0% of m/e 176

TABLE 2
SCAN METHOD ANALYTES

Formal name	**CAS Number**	**RL ppbv**
Dichlorodifluoromethane	75-71-8	1.0
Chloromethane	74-87-3	1.0
1,2-Dichloro-1,1,2,2-tetrafluoroethane	1320-37-2	1.0
Vinyl chloride	75-01-4	1.0
Bromomethane	74-83-9	1.0
Chloroethane	75-00-3	1.0
Trichlorofluoromethane	75-69-4	1.0
1,1-Dichloroethene	75-35-4	1.0
Methylene Chloride	75-09-2	1.0
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1.0
1,1-Dichloroethane	75-34-3	1.0
cis-1,2-Dichloroethene	156-59-2	1.0
Chloroform	67-66-3	1.0
1,2-Dichloroethane	107-06-2	1.0
1,1,1-Trichloroethane	71-55-6	1.0
Benzene	71-43-2	1.0
Carbon Tetrachloride	56-23-5	1.0
1,2-Dichloropropane	78-87-5	1.0
Trichloroethylene	79-01-6	1.0
cis-1,3-Dichloropropene	10061-01-5	1.0
trans-1,3-Dichloropropene	10061-02-6	1.0
1,1,2-Trichloroethane	79-06-5	1.0
Toluene	108-88-3	1.0
1,2-Dibromoethane	106-93-4	1.0
Tetrachloroethylene	127-18-4	1.0
Chlorobenzene	108-90-7	1.0
Ethylbenzene	100-41-4	1.0
m,p-Xylene	1330-20-7	2.0
Styrene	100-42-5	1.0
1,1,2,2-Tetrachloroethane	79-43-5	1.0
o-Xylene	95-47-6	1.0
1,3,5-Trimethylbenzene	108-67-8	1.0
1,2,4-Trimethylbenzene	95-63-6	1.0
1,3-Dichlorobenzene	541-73-1	1.0
1,4-Dichlorobenzene	106-46-7	1.0
1,2-Dichlorobenzene	95-50-1	1.0
1,2,4-Trichlorobenzene	120-82-1	1.0
Hexachlorobutadiene	87-68-3	1.0

TABLE 3
SIM METHOD ANALYTES

Formal name	**CAS Number**	**RL pptv**
Vinyl chloride	75-01-4	2.5
1,1-Dichloroethene	75-35-4	2.5
1,1-Dichloroethane	75-34-3	2.5
cis-1,2-Dichloroethene	156-59-2	2.5
Chloroform	67-66-3	2.5
1,2-Dichloroethane	107-06-2	2.5
Carbon Tetrachloride	56-23-5	2.5
Trichloroethylene	79-01-6	2.5
Tetrachloroethylene	127-18-4	2.5

TABLE 4
TYPICAL TCL STOCK STANDARDS

Formal name	CAS Number	Merck# ppbv	Conc.
TCL Analytes			
Dichlorodifluoromethane	75-71-8	3048	100
Chloromethane	74-87-3	5918	100
1,2-Dichloro-1,1,2,2-tetrafluoroethane	1320-37-2		100
Vinyl chloride	75-01-4	9796	100
Bromomethane	74-83-9	3720	100
Chloroethane	75-00-3	3729	100
Trichlorofluoromethane	75-69-4	9453	100
1,1-Dichloroethene	75-35-4	9798	100
Methylene Chloride	75-09-2		100
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1		100
1,1-Dichloroethane	75-34-3	3756	100
cis-1,2-Dichloroethene	156-59-2	87	100
Chloroform	67-66-3	2111	100
1,2-Dichloroethane	107-06-2	3743	100
1,1,1-Trichloroethane	71-55-6	449	100
Benzene	71-43-2	1063	100
Carbon Tetrachloride	56-23-5	1799	100
1,2-Dichloropropane	78-87-5	7755	100
Trichloroethylene	79-01-6		100
cis-1,3-Dichloropropene	10061-01-5	3059	100
trans-1,3-Dichloropropene	10061-02-6	3059	100
1,1,2-Trichloroethane	79-06-5	9450	100
Toluene	108-88-3	9357	100
1,2-Dibromoethane	106-93-4	5934	100
Tetrachloroethylene	127-18-4	9017	100
Chlorobenzene	108-90-7	2090	100
Ethylbenzene	100-41-4	3714	100
m,p-Xylene	1330-20-7	9890	200
Styrene	100-42-5	8732	100
1,1,2,2-Tetrachloroethane	79-43-5	9016	100
o-Xylene	95-47-6	9890	100
1,3,5-Trimethylbenzene	108-67-8	5752	100
1,2,4-Trimethylbenzene	95-63-6	7816	100
1,3-Dichlorobenzene	541-73-1	3039	100
1,4-Dichlorobenzene	106-46-7	3041	100
1,2-Dichlorobenzene	95-50-1	3040	100
1,2,4-Trichlorobenzene	120-82-1	9443	100
Hexachlorobutadiene	87-68-3		100
Surrogate			
Toluene-d8	2037-26-5		1000
Bromofluorobenzene	460-00-4		250
Internal Standard			
Bromochloromethane	74-97-5		1000
1,4-Difluorobenzene	540-36-3		1000
Chlorobenzene-d5	3114-55-4		1000

TABLE 5
GENERAL GC AND MS OPERATING CONDITIONS

Chromatography

Column	DB-VRX, 60m 0.25 mm I.D.
Carrier Gas	Helium 1 mL/min – constant flow

Temperature Program

Initial Temperature	40C
Initial Time	10 min

Level	Rate (C/min)	Final Temp (C)	Final Time (min)
1	12C/min	190C	0.0
2	6C/min	240C	1.7

TABLE 6
AFCEE QC Acceptance Criteria for Method TO14

Method	Analyte	Accuracy Air (% R)	Precision Air (% RPD)
TO-15	1,1,1-TCA	72-125	≤20
	1,2-DCA	75-125	≤20
	1,2-Dibromoethane	74-125	≤20
	Benzene	75-127	≤20
	Carbon tetrachloride	72-125	≤20
	Chloroform	75-125	≤20
	m-Xylene	75-125	≤20
	o-Xylene	75-137	≤20
	p-Xylene	75-125	≤20
	Styrene	75-135	≤20
	TCE	75-125	≤20

Figures

Figure 1

AIR TOXICS LABORATORY
INSTRUMENT LOG SHEET
GC/MS-R

LINE No.	DATE	CLIENT	BY	DIRECTORY	LAB ID	CONC. POS.	SAMPLE VOLUME	DF	FIELD ID.	GC/MS METHOD	ENTECH NAMELIST	COMMENTS
1												
2												
3												
4												
5												
6												
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9												
10												
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Appendix F

Corvallis ASL Sample Receiving Standard Operating Procedure

Standard Operating Procedure

STANDARD OPERATING PROCEDURE

FOR SAMPLE MANAGEMENT: INITIAL RECEIPT, INVENTORY, PRESERVATION VERIFICATION, LABELING AND STORAGE

APPROVED:

Ginger Collins

3/20/07

QA Officer — Date

3/20/07

Laboratory Director — Date

Documentation of reading this SOP will be kept in the ASL QAQC training database. Each analyst is responsible for entering their own training dates. By entering their name and date of reading the SOP each analyst is agreeing to the following statement:

> I have read and understood the following Standard Operating Procedure (SOP) and agree to follow the SOP as written. Any exceptions to the SOP will be recorded in the appropriate logbook or benchsheet and changes will be noted in the case narrative of the report to the client.

STANDARD OPERATING PROCEDURE

**FOR SAMPLE MANAGEMENT:
INITIAL RECEIPT, INVENTORY, PRESERVATION VERIFICATION, LABELING AND STORAGE**

1.0 SCOPE AND APPLICATION

A sample is physical evidence collected from a facility or from the environment. Controlling evidence is an essential part of any hazardous waste investigation effort. CH2M HILL Applied Sciences Laboratory Corvallis maintains a Custody section which is responsible for verifying that samples and associated documentation are in proper order when received by the laboratory. Any discrepancies are noted by the Custody section and acted on by the Client Services.

This standard operating procedure describes the steps followed by the Custody section when samples are received in the laboratory.

2.0 OVERVIEW OF THE ANALYTICAL PROCESS

Samples are received by the laboratory and the chain of custody is signed. The samples are checked against the chain of custody and an exception report is filled out if there are any discrepancies. Laboratory ID's are assigned to each sample and labels are attached to each sample container. Samples are then distributed to the appropriate storage areas.

3.0 TARGET ANALYTES, REPORTING LIMITS AND DETECTION LIMITS

Not applicable.

4.0 INTERFERENCES

Not applicable.

5.0 SAFETY, WASTE MINIMIZATION AND POLLUTION PREVENTION

5.1 All samples should be considered to be hazardous until proven otherwise. Therefore, all reasonable precautions to ensure the health and safety of persons receiving samples must be followed.

- 5.1.1 Coolers containing AFCEE samples are to be opened in the hood. Non-AFCEE samples can be opened in the hood or in the sample custody room at the custody personnel's discretion.
- 5.1.2 All sources of combustion should be kept away from samples.
- 5.1.3 Noxious odors should be handled by placing the samples in a hood.
- 5.1.4 Gloves, laboratory coats and safety glasses should be worn.

5.2 Spill prevention/leakage, odor and breakage response
Refer to the most recent version of CH2M HILL Chemical Hygiene Plan for response to breakage, odor and spill prevention.

6.0 SAMPLE COLLECTION, STORAGE, HOLDING TIMES AND PRESERVATION

Not applicable.

7.0 APPARATUS AND MATERIALS

7.1 Narrow range pH indicator strips
7.2 Plastic disposable pipettes
7.3 Infrared thermometer
7.4 Glass disposable pipettes
7.5 Disposable surgical gloves
7.6 Laboratory coat
7.7 Safety glasses

8.0 STANDARDS, GASES AND REAGENTS

Not applicable.

9.0 QA/QC

Not applicable.

10.0 PROCEDURE

10.1 Samples arrive in the laboratory via courier or hand delivered by the client. Documentation is signed in order for the samples to be relinquished.

10.2 The sample coordinator -- using the Chain of Custody (COC)-- performs the following tasks. All exceptions are recorded on a Sample Receipt Exceptions Report form (Figure 1) which is also used to notify the client of any problems observed during sample receipt. Every batch of samples will have a Sample Receipt Record Form (Figure 2) completed.

10.3 Initial check of samples and documentation

10.3.1 Remove and set aside the shipping documents.

10.3.2 Examine the shipping container and note the presence/absence and condition of custody seals. Custody seals must be present on the outside of the shipping container and they must be intact.

10.3.2.1 Record observations on the Sample Receipt Record Form.

10.3.2.2 Record exceptions on the Sample Receipt Exceptions Report.

10.3.3 <u>AFCEE only</u> – Check the outside of the cooler for radioactivity. Refer to SOP RAD01.

10.3.4 <u>AFCEE only</u> – Place the shipping container under a canopy or inside a fume hood and open.

10.3.5 All other samples can be opened in a well-ventilated area or under a fume hood. If any odors are detected, remove to the fume hood immediately.

10.3.6 <u>AFCEE only</u> – Check the inside of the cooler for radioactivity. Refer to SOP RAD01.

10.3.7 Temperature verification

10.3.7.1 Note the presence/absence of ice in the shipping container in the Sample Receipt Record Form. If ice is not present in the shipping container, document the exception in the Sample Receipt Exceptions Report.

10.3.7.2 Using the IR thermometer, measure the temperature of the samples. Record the temperature in the Sample Receipt Record Form.

10.3.7.3 If the temperature of the temperature blank or ice water exceeds 4°C (with a margin of +2°C) or if water samples are received frozen, an exception has occurred and must be recorded in the Sample Receipt Exceptions Report. Notify the client immediately.

10.3.8 Remove the COC, which should be in a waterproof bag inside the shipping container. Record the presence/absence of the COC on the Sample Receipt Record Form. Sign the COC indicating that the samples have been received. Samples received on Saturday will be signed on the COC as received Saturday and signed as logged in on Monday.

10.3.9 If there is no COC or if it is improperly filled out, it is documented in the Sample Receipt

Exceptions Report. The sample coordinator corrects it or creates a COC in consultation with the client services department and the client. Creating a COC in this manner is not documentary proof of legal chain of custody.

10.3.10 Carrier and air bill or other tracking number is kept with the COC.

10.3.11 Verify that the COC is properly filled out. This should include the following:

10.3.10.1 The project number (CH2M HILL)

10.3.10.2 Name of the project manager or client contact

10.3.10.3 Sample date

10.3.10.4 Sample matrix

10.3.10.5 Signatures, dates and times of both the sampling event and the relinquishing event.

10.3.10.6 All entries on the COC must be made in ink, or exceptions will be noted.

10.3.12 Remove the samples from the shipping container and organize them according to the client sample identifiers and by the tests required.

10.3.13 Verify the integrity and condition of all sample containers. Look for leakage, broken containers, contaminated coolers, odors, etc. Observations are written on the Sample Receipt Record, and any exceptions noted on the Sample Receipt Exceptions Report.

10.3.14 Note whether any of the samples are highly contaminated (especially if it is unexpected). If the suspected level of contamination appears unusually high or unexpected contact the laboratory project manager who will contact the client to obtain more information. Store these samples in the storage are according to the instructions Section 10.9.

10.4 Sample receipt logging

10.4.1 Verify that the suite of samples and containers received is consistent with the analyses requested on the Chain of Custody. Record all exceptions in the Sample Receipt Exceptions Report.

10.4.2 Assign to each sample and bottle a unique laboratory sample identification number (Lab Sample ID). The Lab Sample ID is composed of five parts: the year, the batch number, the sample number, the container type and the container replicate number.

10.4.2.1 The year the sample was received is indicated by the letter prefix. Each sequential year the laboratory assigns the next letter of the alphabet as a prefix to the batch number. Example E1249 was received in 2005, F1249 was received in 2006, and G1249 was received in 2007.

10.4.2.2 The assigned batch number is based on a Sample Custody Number Control Record which is maintained by the sample coordinator. A group of samples submitted for analysis at one time comprise a batch. The sample coordinator assigns to the batch the next available batch number.

10.4.2.3 The sample number within the batch is generally assigned to the samples in the same order as they appear on the Chain of Custody.

10.4.2.4 The container type is designated by a two to three letter code in LIMS and follows directly behind the sample number. The codes are assigned to specific bottle/preservation combinations and can be seen in Figure 4.

10.4.2.5 The container replicate number will go from 1 to X depending on the number of replicates of the same container. For example: 3 VOA vials arrive preserved with HCl all with the same field ID. The first vial will be labeled G124901VOC1, the second will be G124901VOC2 and the third will be G124901VOC3.

10.4.3 Transcribe the batch number and the sample number to the COC.

10.4.4 Label each sample container with the assigned Lab Sample ID using yellow labels, making sure the label does not cover any of the original field sample identification.

10.5 Verification of sample preservation. Documentation of sample preservation is done using the Sample Receipt Record Form. All exceptions are noted in the Sample Receipt Exceptions Report. Sample preservation is verified as follows.

10.5.1 Verification of samples designated for VOA analysis

Check water samples designated for volatile organic compound analysis (VOA) for adequate preservation as follows. These samples should be in designated 40-mL VOA vials.

10.5.1.1 Count the number of VOA vials received for each sample.

10.5.1.2 If there are fewer than three vials, document the exception in the Sample Receipt Exceptions Report. Skip the VOA sample preservation verification steps described below for every sample for which there are not at least three vials.

10.5.1.3 Select the vial designated as vial #3 or select one vial and mark the lid with an "X" or "•". Dip the tip of a glass disposable pipette into the vial. Apply pipette to pH strip. Allow the color to develop.

10.5.1.4 Compare the color on the developed pH strip to the color chart on the pH strip container to determine the sample pH.

10.5.1.4.1 If the pH is less than or equal to 2, record "pH≤2" on the Sample Receipt Record Form.

10.5.1.4.2 If the pH is greater than 2, record the actual pH measured on the Sample Receipt Record Form. Since this is an exception, document inappropriate sample preservation in the Sample Receipt Exceptions Report.

10.5.1.5 Verify the pH of every sample designated for VOA analysis unless there are fewer than three vials. Do not adjust VOA sample pH under any circumstances.

10.5.1.6 Inspect all VOA samples for headspace or bubbles. If the bubbles are greater than ¼ inch (6 mm), make a notation in the Sample Receipt Exceptions Report and notify the project manager.

10.5.2 Verification of samples designated for other analyses

10.5.2.1 Samples designated for certain analyses also require verification of preservation. Figure 3 identifies the preservation required for each analysis.

10.5.2.2 Immerse a disposable pipette into the sample, collect an aliquot, and remove. Use glass pipettes for samples in glass containers or plastic pipettes for samples in plastic containers.

10.5.2.3 Transfer a few drops of the aliquot onto a pH strip and allow color to develop.

10.5.2.4 Compare the color on the developed pH strip to the color chart on the pH strip container to determine the sample pH.

10.5.2.4.1 If the pH is within criteria, record the criterion on the Sample Receipt Record Form. For example, the pH requirement for TOC is pH<2 (see Figure 3); write "pH<2" on Sample Receipt Record Form. The pH requirement for Total and Amenable Cyanide is pH>12; write "pH>12" on the Sample Receipt Record Form.

10.5.2.4.2 If the pH is outside criteria, record the actual pH measured on the Sample Receipt Record Form. Since this is an exception, document inappropriate sample preservation in the Sample Receipt Exceptions Report.

10.5.2.4.3 If the pH is outside criteria, adjust the pH by adding the appropriate preservative until criteria are met. Figure 3 lists the appropriate preservative to use. Document in the Sample Receipt Record Form by writing the criterion followed by "ADJ" to signify that the pH was adjusted in the laboratory (*e.g.,* pH<2 ADJ). Volume of preservative added may not exceed 1% of the total volume of the sample. For example, when the sample volume is 1L (1000mL), the maximum preservative is 10mL.

10.5.2.5 Discard the disposable pipette and its contents. Do not dispense aliquots back into the sample container. Do not reuse disposable pipettes.

10.5.2.6 Close the sample and proceed to the next one.

10.6 Splitting Samples. If a sample is received in a single container requesting analysis from different analytical groups, this should be documented in the Sample Receipt Exceptions Report. If there is enough volume present, and it is approved by client services the sample may be split. Listed below is the procedure for splitting soil and water samples.

10.6.1 Soil samples received in glass jars requesting non-volatile analysis can be split using stainless steel spatulas. Samples requesting volatile analysis cannot be disturbed under

any circumstance until the VOA analysis has been completed.

10.6.2 Soil samples received in brass sleeves can be split using a pipe cutter. Teflon tape will be applied to the exposed ends and capped.

10.6.3 Unpreserved water samples can be split within 24-48 hours after receipt or if the client requests at a later time. The sample must be homogenized and poured into an unpreserved container. The pH of each container will be adjusted according to the analysis requested.

10.6.4 Exceptions or discrepancies are noted on the exception report.

10.7 CH2M HILL Applied Sciences Laboratory Corvallis reserves the right to reject samples if the following are not followed:

10.7.1 Proper, full, and complete documentation, which shall include sample identification, the location, date and time of collection, collector's name, preservation type, sample type and any special remarks concerning the sample.

10.7.2 Proper sample labeling to include unique identification and a labeling system for the samples with requirements concerning the durability of the labels (water-resistant) and the use of indelible ink.

10.7.3 Use of appropriate sample containers.

10.7.4 Adherence to specified holding times.

10.7.5 Adequate sample volume. Sufficient sample volume must be available to perform the necessary tests.

10.7.6 No custody seal as required by project.

10.7.7 Preservation inappropriate for analysis requested.

10.7.8 Sample container inappropriate for analysis requested.

10.7.9 Sample received out of holding time for analysis requested.

10.7.10 Samples have high levels of polychlorinated dibenzo-*p*-dioxins/dibenzofurans (PCDD/PCDF's)

10.7.11 Samples have a high level gross alpha or beta radiation

10.8 All exceptions must be documented in the Sample Receipt Exceptions Report.

10.8.1 If there is no COC or if it is improperly filled out,

10.8.1.1 Contact the Client Services Department for guidance about creating a COC.

10.8.1.2 Create a COC as required by the Client Services department in consultation with the client.
NOTE: Creating a COC in this manner is not documentary proof of legal chain of custody.

10.8.1.3 Send a copy of the Sample Receipt Exceptions Report to the client with a full description of the problem and action taken. Document this in the Client notification section of the Sample Receipt Exceptions Report.

10.8.2 If there are fewer than three VOA vials for any or all samples in a batch,

10.8.2.1 Do not verify the pH of the sample(s).

10.8.2.2 Indicate in the Sample Receipt Exceptions Report that there are not enough VOA vials to verify preservation before analysis and that sample pH will be verified at time of analysis. Sample holding times may be missed if sample preservation is inadequate because knowledge of the inadequacy will not be noted until analysis begins. Two actions need to be initiated to ensure that the samples are protected:

10.8.2.2.1 Set the sample holding time to 7 days during LIMS login. This is the standard recommended corrective action for Sample Receipt Exceptions Reports.

10.8.2.2.2 Circulate a copy of the Sample Receipt Exceptions Report and deliver it with the samples to the VOA storage area.

10.8.2.3 Send a copy of the Sample Receipt Exceptions Report to the client with a full description of the problem and the action taken. Document this in the Client notification section of the Sample Receipt Exceptions Report.

10.8.2.4 Send a copy of the Sample Receipt Exceptions Report to the analysis group that will analyze the inadequately preserved sample.

10.8.3 The client must be notified in a timely manner of all exceptions by telephone, facsimile

(fax), or other suitable means. Documentation of such notification must be maintained in the client notification section of the Sample Receipt Exceptions Report.

10.9 Sample storage. Distribute the samples to the laboratory for analysis as follows.

10.9.1 VOA samples

10.9.1.1 Place the samples in the refrigerator designated for VOA samples.

10.9.1.2 Submit a copy of the Sample Receipt Exceptions Record (if any) to the responsible party in organics.

10.9.2 Extractable organics samples

10.9.2.1 Place the samples in the walk-in cold room.

10.9.2.2 Submit a copy of the Sample Receipt Exceptions Record (if any) to the responsible party in the extractions laboratory.

10.9.3 Cations

10.9.3.1 Place soil samples in the walk-in cold room.

10.9.3.2 Place water samples in the walk-in cold room.

10.9.3.3 Submit a copy of the Sample Receipt Exceptions Record (if any) to the responsible party in the cations area.

10.9.4 Wet Chemistry

10.9.4.1 Place samples in the walk-in cooler.

10.9.4.2 Segregate samples into separate areas of the cooler as marked on the shelves.

10.9.5 Suspected or highly contaminated samples.

10.9.5.1 Samples are considered highly contaminated based on historical records, or if anyone in the field notifies the appropriate project manager.

10.9.5.2 These samples will be segregated and shipped in separate coolers on the last day of the sampling event (when possible).

10.10 All paperwork associated with a sample batch -- the COC, Sample Receipt Record Form, Sample Receipt Exceptions Report (if any), shipping receipts, and any other documents accompanying the samples -- are placed in a file folder. This information is used for logging in the samples into LIMS.

11.0 DATA REDUCTION

Not applicable.

12.0 DOCUMENTATION

See procedure.

13.0 REFERENCES

Not applicable.

14.0 DEFINITIONS

14.1 COC-Chain of Custody
14.2 AFCEE- Air Force Center of Environmental Excellence
14.3 LIMS-Laboratory Information Management Systems
14.4 ASL – Applied Sciences Laboratory
14.5 CVO – Corvallis, OR
14.3 QA/QC – Quality Assurance/Quality Control
14.4 QA – Quality Assurance
14.5 QC – Quality Control
14.6 SOP – Standard Operating Procedure
14.7 VOA- Volatile Organic Compound Analysis
14.8 TOC- Total Organic Carbon

14.9 FIGURE 1- Sample Receipt Exception Report

Sample Receipt Exception Report

Sample Batch Number: **Client/Project**

The following exceptions were noted:		
		Comments (write number of exception description and the impacted sample numbers)
	1. No custody seal as required by project	
	2. No chain-of-custody provided	
	3. Analysis, description, date of collection not provided	
	4. Samples broken or leaking on receipt.	
	5. Temperature of samples inappropriate for analysis requested	
	6. Container inappropriate for analysis requested	
	7. Inadequate sample volume.	
	8. Preservation inappropriate for analysis requested	
	9. Samples received out of holding time for analysis requested	
	10. Discrepancies between COC form and container labels.	
	11. Other.	

ACTION TAKEN:

Originator: Date:

Client was notified on: (Date/Time) Client Contact:

Client Services:

FIGURE 2- Sample Receipt Record Form

CH2MHILL
Analytical Services

Sample Receipt Record

Batch Number: _____ Date received: _____

Client/Project _____

VERIFICATION OF SAMPLE CONDITIONS (verify all items) * HD = Client Hand delivered Samples

Observation	YES	NO
Radiological Screening for AFCEE		
Were custody seals intact and on the outside of the cooler?		
If yes, Where? Front_____Rear_____Lt Side_____Rt Side_____		
Type of packing material: Ice Blue Ice Bubble wrap		
Was the Chain of Custody inside the cooler?		
Was the Chain of Custody properly filled out?		
Were the sample containers in good condition?		
Containers supplied by ASL?		
Any sample with < 1/2 holding time remaining? If so contact LPM		
Was there ice in the cooler? Enter temp. C		
All VOCs free of air bubbles ?		

VERIFICATION OF SAMPLE PRESERVATION

Sample No	Nutrients pH <2	Metals pH <2	Volatiles pH <2	Cyanides pH >12	TOC pH <2	TOX pH <2	Other (specify)	N/A (soils/unpres)
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								

LOGIN AND pH VERIFICATIONS PERFORMED BY

_____ Date/Time _____ Date/Time

FIGURE 3- Sample Container List

		Aqueous samples				Solid samples			
	Test	*Min. vol (mL)*	*Container size*	*Preservation*	*Holding time*	*Contain-er size*	*Preser-vation*	Verified per 40CFR136.3 (7/1/93)	*Holding time*
UNPRESERVED	Acidity	100	Unused plastic containers only · Pint (if total volume < 500 mL) · Quart (if total volume is > 500 mL and < 1,000 mL) · ½-gallon (if total volume is ≥ 1,000 mL)	4ºC	14 days	-	-	-	-
	Alkalinity	100		4ºC	14 days	-	-	-	-
	Biochemical Oxygen Demand (BOD)	200		4ºC	48 hrs	-	-	x	-
	Bromate	70		4ºC	28 days	-	-	-	-
	Bromide	70		4ºC	28 days	-	-	-	-
	BTU	-		-	-	8 oz.	4ºC	x	28 days
	Chloride	70		4ºC	28 days	8 oz.	4ºC	x	28 days
	Chlorine, total residual	20		4ºC	Immediate	-	-	-	-
	Chromium, hexavalent	300		4ºC	24 hrs	8 oz.	4ºC	x	24 hrs
	Color	100		4ºC	48 hrs	-	-	-	-
	Conductivity	100		4ºC	28 days	-	-	x	-
	Flashpoint	250		4ºC	28 days	8 oz.	4ºC		28 days
	Fluoride	100		4ºC	28 days	-	-	-	-
	Ignitability	500		4ºC	14 days	8 oz.	4ºC		14 days
	Nitrate	70		4ºC	48 hrs	-	-	-	-
	Nitrite	70		4ºC	48 hrs	-	-	-	-
	pH	20		4ºC	Immediate	8 oz.	4ºC	Immediate	Immediate
	Silica	100		HNO_3, pH<2	6 mos.	-	-	-	-
	Solids (total, dissolved, suspended, volatile)	150		4ºC	7 days	-	-	-	-
	Solids, Settleable	1000		4ºC	48 hrs	-	-	-	-
	Sulfate	70		4ºC	28 days	8 oz.	4ºC	x	28 days
	Sulfite	250		4ºC	Immediate	-	-		-
	Tannins & Lignins	150		4ºC	28 days	8 oz.	4ºC	8 oz.	-
	Turbidity	50		4ºC	48 hrs	-	-	-	-
H_2SO_4 preserved	Ammonia	200	Plastic, Pint	H_2SO_4, pH<2, 4ºC	28 days	8 oz.	4ºC	x	28 days
	Chemical Oxygen Demand (COD)	50	Plastic, pint	H_2SO_4, pH<2, 4ºC	28 days	8 oz.	4ºC	x	28 days
	Nitrate/Nitrite	70	Plastic, pint	H_2SO_4, pH<2, 4ºC	28 days	8 oz.	4ºC	x	28 days
	Phosphorus, total	100	Plastic, pint	H_2SO_4, pH<2, 4ºC	28 days	8 oz.	4ºC	x	28 days
	Kjeldahl and organic nitrogen (TKN)	300	Plastic, Pint	H_2SO_4, pH<2, 4ºC	28 days	8 oz.	4ºC	x	28 days
	TOC	80	2 x 40 ml	H_2SO_4, pH<2, 4ºC	28 days	-	-		-
	Total Organic Halogens	250	Glass, pint, amber	H_2SO_4, pH<2, 4ºC + $NaSO_3$	14 days	8 oz.	4ºC	x	14 days
Other Inorganics	Phosphorus, ortho	100	Plastic, pint	Filter immediately	48 hrs	8 oz.	4ºC	x	48 hrs
	Chlorate	50	Plastic, pint	.05% EDA	14 days	-	-	-	-
	Chlorite	50	Plastic, pint	.05% EDA	14 days	-	-	-	-
	Chlorine Demand	1000	Glass, quart, amber	4ºC	48 hours	-	-	-	-
	Sulfide	250	Plastic, pint	ZnAcet + NaOH, pH>9	7 days	8 oz.	4ºC	x	7 days
	Cyanide, total or amenable	250	Plastic, pint	NaOH, pH>12[a]	14 days[c]	8 oz.	4ºC	x	14 days[c]
	Hardness	150	Plastic, pint	H_2SO_4 or HNO_3, pH<2	6 mos	-	-	-	-
	Phenols (4-AAP)	500	Glass, 250-mL	H_2SO_4, pH<2	28 days	8 oz.	4ºC	x	28 days
	Odor	500	Glass, pint	4ºC	48 hours	-	-	-	-
	Oil and Grease	1000	Glass, 1-L	H_2SO_4 or HCl, pH<2	28 days	8 oz.	4ºC	x	28 days
	Total Petroleum Hydrocarbons (TPH)	1000	Glass, 1-L	HCl or H_2SO_4, pH<2	28 days	8 oz.	4ºC		28 days
	Surfactants (MBAS)	1000	Plastic, quart	4ºC	48 hrs	-	-	-	-
Metals	Mercury only	500	250-mL	HNO_3, pH<2	28 days	4 oz	4ºC	x	28 days
	Chromium, hexavalent	250	plastic, pint	4ºC	24 hours	8 oz.	4ºC		24 hours
	Other metals (excluding mercury)	500	100-mL	HNO_3, pH<2	6 mos	4 oz	4ºC	x	6 mos
	All metals (including mercury)	1000	250-mL	HNO_3, pH<2	28 d/6 mos	4 oz	4ºC	x	28 d/6 mos

FIGURE 3 Continued- Sample Container List

VOAs	**SW-846 methods**								
	- Aqueous	5 or 25	3 x 40-mL	HCl, pH<2	14 days	2 x 2 oz.	4ºC		14/40 days
	Miscellaneous Methods								
	- Aldehydes (SM 6252B)		3 x 40-mL	NH_4Cl	48 hours	-	-		-
	- Haloacetic Acids (SM 6251B)		3 x 40-mL	NH_4Cl	14 days	-	-		-
	- Methane/Ethane/Ethene		2 x 40-mL	4ºC	14 days	-	-		-
	- Methane/Carbon dioxide		2 x 40-mL	4ºC	14 days	-	-		-
	- Nonhalogenated hydrocarbons (8015B)		2 x 40-mL	4ºC	14 days	2 x 2 oz.	4ºC	-	14 days
	CLP methods	5 or 25	3 x 40-mL	HCl, pH<2	14 days	2 x 2 oz.	4ºC		14/40 days
	EDB/DBCP	35	3 x 40-mL	4ºC, $Na_2S_2O_3$	14 days	2 x 2 oz.	4ºC	-	14 days

a Should be used only in the presence of residual chlorine.

c Holding time is 24 hr when sulfide is present. Test using Pb acetate paper, remove sulfide using $CdNO_3$, filter, and adjust pH.

d If pH is not adjusted, the holding time changes to 7 days.

e If pH is not adjusted and sample is to be analyzed for Acrolein, holding time changes to 3 days.

g GC/MS may be used for screening the samples for the listed analyte(s); when known to be present, the preferred method is GC. These include: acrolein, acrylonitrile, benzidine, hexachlorocyclopentadiene, N-nitrosodimehtylamine, N-nitrosodiphenylamine, 2,3,7,8-TCDD, Endosulfan I and II, Endrin, a-BHC, d-BHC.

h Extract holding time is 7 days if stored under an inert atmosphere. If 1,2-Diphenylhydrazine is expected, adjust the pH to 4±0.2 to prevent rearrangement to benzidine.

i For the analysis of Diphenylnitrosamine, adjust pH to 7-10 with NaOH within 24 hours of sampling.

k If aldrin is a target compound, add 0.008% $Na_2S_2O_3$.

l Encore™ brand samplers are used for measured gram amount for non-aqueous volatiles requiring 5035 sample introduction.

FIGURE 4 - Sample Login Container Codes

Sample Login Container Codes	
Container Type	**Code**
Air Toxics	AIR
Aldehydes	ALD
COD	COD
Cyanide	CYN
Dissolved General Chemistry	DGN
Dissolved Metals	DMT
DOC	DOC
General Chemistry	GEN
HAA	HAA
MEE	MEE
Metals	MET
Miscellaneous	MSC
Nutrients	NUT
Oil and Grease	O&G
PAH	PAH
PCB	PCB
Pesticides	PES
SDS	SDS
Soil	SOI
Sulfide	SUL
Semi-Volatiles	SVC
Taste & Odor	T&O
THM	THM
Total Organic Carbon	TOC
Total Organic Halogens	TOX
TPH	TPH
UV-254	UV
VOC	VOC

Appendix G

USACE Kansas City District Data Quality Evaluation Guidelines

APPENDIX E

USACE Kansas City District Data Evaluation Guidelines

August 18, 2003; rev. February 22, 2006

Introduction

This guidance is meant to be used in accordance with the directions in the project QAPP for evaluating the quality of the data. The QAPP may use any part or none of this guidance as necessary to meet project demands. This is not a laboratory guidance and is not meant to interfere with the laboratory's compliance with the DOD QSM. It is to be used solely by data quality evaluators, reviewers, and usability assessors. This guidance is meant to serve as the base on which to build a data quality evaluation program using data generated from a project. It is understood that deviations from the written guidance will sometimes be necessary. It is expected that deviations will be listed and justified in writing.

When data fail to conform to the requirements stated in the QAPP, the data stand the risk of being rejected by the data evaluator.

Evaluation Procedure

Data quality will be determined by the evaluation of the minimum following items:

- Holding Times
- Method Detection Limits
- Blanks
- Laboratory Control Samples
- Matrix Spikes/Matrix Spike Duplicates
- Matrix Duplicates/Precision
- Surrogate Recoveries
- Second Column Confirmation
- Internal Standards (Optional)

Holding Times

1. In general, exceedance of holding times will be qualified as follows:

    a. If no evidence samples were properly preserved for volatiles, exceedance of a 7-day holding time results in "R."

    b. If samples were properly preserved for volatiles, exceedance of a 14-day holding time results in "R."

   c. For semivolatile compounds and anions, exceedance of holding time results in "R" qualified data.

2. Deviations to the above must be justified in writing. If comparison with historical data is considered, it must be considered along with other criteria; that is, historical data comparison will not be the primary reason for acceptance of data (no qualifier).

3. Corrective actions taken after holding time exceedance. Corrective actions that take place after 11/2 times the holding time will be rejected (R). If the laboratory routinely corrects after holding time, data will be rejected. Exceptions will be justified in writing.

Method Detection Limits

1. Result falling below either the MDL or the MRL will be flagged "U."

2. Results falling between the MDL/MRL and the PQL will be flagged "J."

3. Unless adequately addressed in the QAPP, data recorded as nondetect will be rejected if detection limits are above the action level (AL).

Blanks

1. If a blank is missing and no hierarchy[1] blank is available, the following is recommended:

   a. Low positive result of each specific analyte will be flagged "U." Low positive result is defined as any positive number less than 5 times the maximum blank contamination of that analyte found in any blank from any other batch in the dataset.

   b. Medium positive result will be estimated (J). Medium positive result will be any result between the low positive result defined above and 10 times that result.

   c. High positive result will be unqualified.

2. Samples associated with contaminated blanks will be reported with the analytical result followed by "U" when the analytical result is less than 5 times the blank contamination for uncommon lab contaminants or less than 10 times the blank contamination for common lab contaminants.

Laboratory Control Samples

1. The laboratory will be contacted for missing LCSs. Otherwise, data will be rejected.

2. For specific chemicals of concern, LCS recoveries must be within criteria. If not, corrective action must be taken. If this fails, the following qualifier assignment applies:

[1] A hierarchy blank is a blank that is used to evaluate contamination resulting from processes preceding and including the subject missing blank. That is, either an equipment blank or trip blank may be used as a hierarchy blank to the method blank.

a. For purge-and-trap, recoveries outside lab criteria but within 40–160% or 4sigma, whichever results in the wider range, the analytes are flagged "J" in all samples in the batch. If outside 40–160%, or 4sigma, data are flagged "R."

b. For inorganic analyses, recoveries outside lab criteria but within 60–140% or 4σ, whichever results in the wider range, the analytes are flagged "J" in all samples in the batch. If outside the 60–140% or 4σ, data are flagged "R."

c. For semivolatiles, recoveries outside lab criteria but within 60–140% or 4σ, whichever results in the wider range, the analytes are flagged "J" in all samples in the batch. If outside the 60–140% or 4σ, data are flagged "R."

3. Marginal exceedances will apply to all other chemicals.[2] Chemicals that fail in this category will be rejected. Acceptable recovery ranges for marginal exceedances are listed in item 2 above.

4. When ALs have been listed, sample results that are greater than 10-fold higher than the AL will be unqualified regardless of the magnitude of the LCS failure. Samples whose results are less than tenfold different (high or low) will be qualified according to the criteria listed under "Matrix Spikes/Matrix Spike Duplicates."

Matrix Spikes / Matrix Spike Duplicates

Paragraphs 3 through 5 evaluate whether it can be determined by the analytical result if the actual concentration of the analyte of concern is above or below the AL. If the analytical result is too close to the action level to make such a determination, the result is rejected as being unusable. Paragraphs 3 through 5 allows the data evaluator to make this determination. Note that these calculations are not needed if it is clear that the analytical result is far removed from the AL.

1. All matrix spikes outside acceptance criteria will be flagged "J" as a minimum.

2. Qualification will be based on the most significant failure in the MS and MSD pair.

3. For MS recoveries < 100%, the analytical result is rejected if the analytical result falls at or below the AL or at or above the number calculated from $\frac{(R)(AL)(200-RPD)}{100(200+RPD)}$, or

   AL ≥ sample result ≥ $\frac{(R)(AL)(200-RPD)}{100(200+RPD)}$.

   where

   AL = action level
   R = percent recovery
   RPD = relative percent difference

[2] A marginal exceedance is defined as being beyond the LCS control limit (3 standard deviations) but within the exceedance limit (4 standard deviations). The number of chemicals permitted to have MEs depend on the total number of chemicals in the LCS. This number may be found in the DOD QSM, DOD Appendix D, Section D2, page 180.

For example, if MS recovery (R) of chrysene is 75%, its RPD 20% and its AL 10 ppb, then data that are ≥ 6.13 ppb or ≤ 10 ppb are rejected.[3] If MS recoveries are not available for any specific COC, use LCS.

4. For MS recoveries > 100%, the analytical result is rejected if the analytical result falls at or above the action level (AL) or at or below the number calculated from $\frac{(R)(AL)(200+RPD)}{100(200-RPD)}$, or AL ≤ sample results ≤ $\frac{(R)(AL)(200+RPD)}{100(200-RPD)}$.

5. If the recovery of one member of the MS-MSD pair is < 100% and the recovery of the other member is > 100%, then sample result is rejected if $\frac{(R_1)(AL)(200-RPD)}{100(200+RPD)} \leq$ sample result ≤ $\frac{(R_2)(AL)(200+RPD)}{100(200-RPD)}$ with R_1 and R_2 the recoveries under 100% and over 100%, respectively.

6. Sample results not falling into the above ranges will be rejected if the MS or MSD fails and the LCS recovery falls outside the recoveries mentioned under "Laboratory Control Samples," item 2.

Matrix Duplicates and Precision

1. Refer to "Matrix Spikes/Matrix Spike Duplicates," which may be used to cover precision.
2. All other RPDs outside acceptance criteria will be flagged "J."

Surrogate Recoveries

1. If the surrogate is marginally out and the LCS/blanks surrogate also is out, qualify detects of the chemicals considered associated with the noncompliant surrogate (that is, chemicals with similar RTs and similar structure as surrogate) with "J" and nondetects with "UJ."
2. If the surrogate is marginally out in the sample and the surrogate in the LCS or blank is in, this should be considered a matrix effect. Qualify chemicals most closely associated with the surrogates with "J."
3. If the surrogate is grossly outside of 60–140% for purge-and-trap and 20–180% for extractable organics, whether the LCS/blanks surrogates are in or out, a corrective action should have been completed. In the absence of a corrective action, qualify nondetects with "R" and detects with "J."
4. No qualification if surrogates are out because of a chromatographic problem.
5. No qualification if surrogates are diluted out.

[3] The formula presented is calculating a concentration that is below the AL by the same amount as the percent MS recovery with an additional lowering considering the analytical variability (expressed as RPD).

6. Where multiple surrogates are present, if one or more grossly fail, the data are qualified on the most noncompliant surrogate.

Second Column Confirmation

1. What constitutes acceptable agreement between two columns will be issued by the laboratory.
2. In the case of a peak appearing on primary column, but confirmation not run, the following will apply:
   a. For long-term monitoring where the identity of the contamination is known for each well, lack of confirmation will result in a "J" qualifier. If information is critical, a footnote will be given that the location should be resampled.
   b. For areas that have been previously well characterized and for which past chromatograms have shown no interferences around the chemicals of concern, lack of confirmation may go unqualified. This basically covers remedial actions.
   c. For areas where contamination is questionable, lack of confirmation will result in a rejection (R) of the data with a footnote that the sampled area requires reinvestigation.
3. When confirmation was attempted, but interferences obscured the peak on the confirmation column, the result would be reported from the column that did not contain interferences and J-qualified. Surrogate recoveries will also be reported from that column.
4. When the RPD between the primary column peak and the secondary column peak is greater than 40%, the quantitation is taken from the smaller peak and J-qualified.

Internal Standards

1. The internal standard (IS) peak area of the CCV is the standard, acceptable peak area. The IS peak area of samples should be -50% to +100% of this area. IS areas falling outside this range will be qualified according to the following:
   a. For high IS areas in samples which will be greater than 2 times the standard area but less than 5 times the standard area should result in "UJ" for nondetects and "J" for detects.
   b. For IS areas greater than 5 times the standard area, a corrective action would be required. In the absence of a corrective action, any result less than the AL will be rejected. All other results will be flagged "J."
   c. For IS areas less than 1/2 the standard area but greater than 1/5 the standard area, positive results will be flagged "J."
   d. For IS areas less than 1/5 the standard area in either a matrix spiked sample or the LCS, the matrix spike or LCS recovery respectively will be used to determine any negative impact on the results. For low IS areas found in other samples, the surrogate recoveries will be used for the evaluation. If impacted and the sample

result is greater than the AL, the result will be rejected. Result also rejected if not-detected. All other results will be flagged either “R” or “J.”