Former N.L. Industries
3241 Walden Avenue
Depew, New York

BCA Index# B9-0554-98-12
Site# C-915200

Site Management Plan

Prepared For:

New York State
Brownfield Cleanup Program

October 16, 2009

Revisions to Final Approved Site Management Plan

Revision Number	Submittal Date	Summary of Revision	NYSDEC Approval Date

List of Acronyms

BCA - Brownfield Cleanup Agreement

BCP - Brownfield Cleanup Program

Benchmark - Benchmark Environmental Engineering & Science, PLLC

C - Celsius

CAMP - Community Air Monitoring Plan

COC - Certificate of Completion

COCs - constituents of concern

CRA - Conestoga-Rovers & Associates

DO - Dissolved Oxygen

ECs - Engineering Controls

EWP - Excavation Work Plan

FER - Final Engineering Report

GCL - geo-synthetic clay liner

HASP - Health and Safety Plan

ICs - Institutional Controls

IRM - Interim Remedial Measures

mg/kg - milligrams per kilogram

NTUs - Nephelometric Turbidity Units

NUS - NUS Corporation

NYCRR - New York Codes Rules and Regulations

NYS - New York State

NYSDEC - New York State Department of Environmental Conservation

NYSDEC-DD - NYSDEC Decision Document

ORP - Oxygen Reduction Potential

PAHs - polycyclic aromatic hydrocarbons

PPRs - Periodic Review Reports

QA/QC - Quality Assurance/Quality Control

RAP - Remedial Action Plan

RAWP - Remedial Action Work Plan

RI/FS - Investigation/Feasibility Study

SMP - Site Management Plan

SMRP - Site Management Reporting Plan

SRCM – Specifications of Remediation of Contaminated Materials

SVOCs - semi-volatile organics

TCLP - Toxicity Characteristics Leaching Procedure

USEPA - United States Environmental Protection Agency

XCG - XCG Consultants, Ltd.

Revisions to Final Approved Site Management Plan

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Section 1
Introduction and Description of Remedial Program

This Site Management Plan (SMP) is required as an element of the remedial program at the Former N.L. Industries Site (hereinafter referred to as the "Site") under the New York State (NYS) Brownfield Cleanup Program (BCP) administered by New York State Department of Environmental Conservation (NYSDEC). The site was remediated in accordance with: Brownfield Cleanup Agreement (BCA) Index# B9-0554-98-12, Site #C-915200, which was executed on May 30, 2006.

1.1 General

Norampac Industries Inc. entered into a BCA with the NYSDEC to remediate a 7.5 acre property located in in the Village of Depew, Town of Cheektowaga, County of Erie, NYS. This BCA required the Remedial Party, Former N.L. Industries Foundry, to investigate and remediate contaminated media at the site. A figure showing the site location and boundaries of this 7.5 acre Site is provided in Figure 1. The boundaries of the site are more fully described in the metes and bounds site description that is provided within Section 2.1.1.

After completion of the remedial work described in the Remedial Action Work Plan (RAWP), some impact was left in the subsurface at this site, which is hereafter referred to as "remaining impact." This SMP was prepared to manage remaining impact at the site until the Environmental Easement is extinguished in accordance with ECL Article 71, Title 36. All reports associated with the site can be viewed by contacting the NYSDEC or its successor agency managing environmental issues in NYS.

This SMP was prepared by Tighe & Bond, on behalf of Norampac, Inc. in accordance with the requirements in NYSDEC DER-10 Technical Guidance for Site Investigation and Remediation and the guidelines provided by NYSDEC. This SMP addresses the means for implementing the Engineering Controls (ECs) and Institutional Controls (ICs) that are required by the Environmental Easement for the site.

1.2 Purpose

A limited portion of the site contains impacted fill material which remains after completion of the remedial action. ECs and ICs have been incorporated into the site remedy to control exposure to remaining impacted fill material during the use of the site to ensure protection of public health and the environment. An Environmental Easement granted to the NYSDEC, and recorded with the Erie County Clerk, will require compliance with this SMP and all ECs placed on the site. This SMP specifies the methods necessary to promote compliance with all ECs required by the Environmental Easement for the impacted fill that remains at the site. This plan has been approved by the NYSDEC, and compliance with this plan is required by the grantor of the Environmental Easement and the grantor's successors and assigns. This SMP may only be revised with the approval of the NYSDEC.

This SMP provides a detailed description of all procedures required to manage remaining contamination at the site after completion of the Remedial Action, including:

- Implementation and management of all ECs and ICs
- Groundwater monitoring
- Performance of periodic inspections, certification of results, and submittal of Periodic Review Reports (PPRs)

To address these needs, this SMP includes an Engineering and Institutional Control Plan for implementation and management of the EC/ICs and a Monitoring Plan for implementation of Site Monitoring.

This SMP also includes a description of PRRs for the periodic submittal of data, information, recommendations, and certifications to NYSDEC.

It is important to note that:

i. This SMP details the site-specific implementation procedures that are required by the Environmental Easement. Failure to properly implement the SMP is a violation of the environmental easement, which is grounds for revocation of the Certificate of Completion (COC);

ii. Failure to comply with this SMP is also a violation of Environmental Conservation Law, 6NYCRR Part 375 and the Brownfield Cleanup Agreement for the Site, and

iii. thereby subject to applicable penalties.

1.3 Revisions

Revisions to this plan will be proposed in writing to the NYSDEC's project manager. In accordance with the Environmental Easement for the site, the NYSDEC will provide a notice of any approved changes to the SMP, and append these notices to the SMP that is retained in its files.

Section 2
Site Background

2.1 Site Location

The subject property is located at 3241 Walden Avenue in Depew, New York, which is a suburb to the east of Buffalo. The property is situated on the south side of Walden Avenue, approximately 580 feet west of the center line of Transit Road. The property is legally described as Part of Lot 68, Township 11, Range 7 of the Holland Land Company's Survey in the Village of Depew, Town of Cheektowaga, County of Erie. Metro Waste Paper Recovery Inc. (Metro Waste), currently operates a paper recycling facility at the site.

The subject property is approximately 7.5 acres in size. The site is located in a mixed commercial/industrial and residential area. Commercial/industrial properties adjoin the east and west sides of the subject site. The properties located across the street, on the north side of Walden Avenue, are a mixture of residential and some commercial sites (e.g. restaurant). The south side of the property is bordered by railway tracks elevated on a berm, while a concrete mixing plant is situated further to the south. The topography of the subject property and immediate surrounding area has a generally flat grade.

Metro Waste currently operates paper fiber recycling activities at the site. Operations are primarily limited to the eastern and central sections of the site while the western section of the site consists of vegetated open space and a stormwater detection pond. Paper fiber recycling has been conducted on the site by various companies since 1974.

2.1.1 Site Boundaries

As referenced in a Commitment for Title Insurance issued by Ticor Title Insurance Company with an effective date of December 30, 2008, the land referred to in the Commitment is described as follows:

> TICOR TITLE INSURANCE COMPANY, ORDER NO.: 5008-25273
>
> EFFECTIVE DATE: DECEMBER 30, 2008
>
> ALL THAT CERTAIN PLOT, PIECE OR PARCEL OF LAND, WITH THE BUILDINGS AND IMPROVEMENTS THEREON ERECTED, SITUATE, LYING AND BEING IN THE TOWN OF CHEEKTOWAGA, VILLAGE OF DEPEW, COUNTY OF ERIE AND STATE OF NEW YORK, BEING PART OF LOT 68, TOWNSHIP 11, RANGE 7 OF THE HOLLAND LAND COMPANY'S SURVEY, BOUNDED AND DESCRIBED AS FOLLOWS:
>
> BEGINNING AT A STONE MONUMENT IN THE SOUTHERLY LINE OF THE ELLICOTT ROAD, NOW KNOWN AS WALDEN AVENUE AT A DISTANCE OF 584.42 FEET WESTERLY FROM THE POINT OF THE "TRANSIT LINE" OR THE CENTERLINE OF TRANSIT ROAD; RUNNING THENCE WESTERLY ALONG THE SAID SOUTHERLY LINE OF WALDEN AVENUE 1513.6 FEET TO THE NORTHWESTERLY CORNER OF LANDS CONVEYED TO CHARLES A. FINNEGAN BY GEORGE W. WICKERSHAM AND EDWARD J. HANCY, AS EXECUTORS OF THE LAST WILL AND

> TESTAMENT OF MARY A.P. DRAPER, DECEASED, DATED MAY 5, 1922 AND RECORDED IN ERIE COUNTY CLERK'S OFFICE IN LIBER 1634 OF DEEDS AT PAGE 96; THENCE SOUTHERLY AT RIGHT ANGLES TO THE SOUTHERLY LINE OF WALDEN AVENUE A DISTANCE OF 173.16 FEET TO THE NORTHERLY LINE OF LANDS CONVEYED TO THE NEW YORK CENTRAL AND HUDSON RIVER RAILROAD COMPANY BY DEED RECORDED IN ERIE COUNTY CLERK'S OFFICE IN LIBER 301 OF DEEDS AT PAGE 202; THENCE EASTERLY AND ALONG THE NORTH LINE OF LANDS SO CONVEYED TO AFORESAID RAILROAD BY AFORESAID DEED 1511.13 FEET; THENCE NORTHERLY IN A STRAIGHT LINE AT RIGHT ANGLES WITH THE PRECEDING COURSE 259.18 FEET TO THE POINT OF BEGINNING.

A copy of the ALTA survey prepared by Nussbaumer & Clarke, Inc. of Buffalo, NY is included as Plan A to this report.

2.2 Site Description

For the purposes of this plan the property has been primarily subdivided into three sections as depicted on Figure 2. These property sections are identified as the eastern section which contains all the site building structures, the central section which contains the containment cell, and the remediated western section of the site.

As discussed in the June 2005 NYSDEC Decision Document (NYSDEC-DD), the NYSDEC, as part of their evaluation of the proposed alternatives, selected soil consolidation and capping as the remedial remedy for the site. The NYSDEC selected remedy consisted of the excavation of impacted fill material from the western section of the property for consolidation on the central section of the site within a 1.1 acre impacted fill containment cell. Upon completion of the consolidation of the impacted fill within the cell, a surface cover system (i.e. asphalt/vegetative cap) would be place over the cell to allow for truck parking (increasing the completed cell size to 1.5 acres). In addition, surface covers systems (i.e. asphalt, concrete, 12-inches of clean fill) would be placed on other areas where impacted fill material was exposed at the surface. Details of the remedial actions conducted within the central and western sections of the property are provided within the Final Engineering Report (FER).

The NYSDEC concluded that this remedy would virtually eliminate any human exposure though direct contact to the impacted fill and that inhalation of air-borne particles would be prevented as wind scouring of exposed surface soils would no longer occur. The implementation of this strategy also required the installation of several new cover systems and the continued maintenance of existing systems.

2.2.1 Eastern Section

The eastern section of the site contains a majority of the site's improved structures, including the main plant and office building, a scale house, and a small storage building. In addition, the eastern section of the site also contains the trucking yard, the former "rail siding" area, and a parking lot (located on the eastern side of the building).

The main plant and office building are estimated to occupy an area of approximately 63,400 ft^2. The east side of the property is paved with asphalt for employee parking. A truck loading/unloading and trailer parking area are located west of the building. In November 1999, the trucking yard was re-surfaced with new gravel. According to Norampac, approximately 400 tons of gravel was imported to the site in order to provide a minimum cover of approximately 3 inches across the trucking yard. In December 2004, Metro Waste paved the trucking yard to provide a better driving surface for the trucks that entered the property on a daily basis to load and unload shipments. The existing granular surface was considered a sufficient sub-base and was graded prior to installing the asphalt, which consisted of 4.5 inches of binder coat and 1.5 inches of asphalt topcoat. In addition to the asphalt, a new concrete apron, approximately 6 inches thick, was constructed adjacent to the west side of the building. In addition, the area identified as the former "rail siding" area was also paved with 6-inches of asphalt (4 inches binder coat and 2 inches top coat) on August 15, 2008 as part of the NYSDEC-DD.

2.2.2 Central Section

The central section of the property contains the containment cell that was constructed as part of the NYSDEC-DD. This area is now used as a parking area for Metro Waste. The former lagoon and marsh area were also formerly located along the southern side of this section of the site.

2.2.3 Western Section

The area between the central section of the property and the west property line is identified as the western section of the site. The western section of the site is currently comprised of undeveloped land and a stormwater detention pond.

Soil remediation activities consisted of the excavation of impacted soils from the western (undeveloped) section of the site and the consolidation and construction of a containment cell within the central portion of the site by utilizing a portion of the excavated soils. These activities were completed utilizing the residential use soil cleanup criteria for lead of 400 milligrams per kilogram (mg/kg), as the targeted remedial objective (New York Codes Rules and Regulations (NYCRR) Soil Cleanup Objectives (6 NYCRR Part 375)). Excavation and consolidation activities were initiated on October 22, 2007, temporarily suspended from February 22, 2008 to May 5, 2008 due to weather conditions, and were completed on September 12, 2008.

2.3 Site History

The subject property was first developed for industrial use in 1892. Past on-site activities have included brass foundry operations conducted between 1892 and 1972 (i.e. 80 years), smelting operations carried out in the early part of the century, and the processing of babbitts. These operations were performed by various companies which reportedly include:

- Buffalo Brass Company (1892 – 1899) had operations along eastern section of the site
- Empire Smelting Company (early 1900's) conducted operations within the area of the current trucking yard
- Magnus Metal Corporation (1899 - 1936) which acquired a portion of the subject property from Buffalo Brass in 1899 and continued the brass foundry operations until 1936
- National Lead Company (1936 – 1972) acquired the entire property and operations from Magnus Metal Corporation. The name Magnus remained with the company, and was called Magnus Metal, a Division of National Lead Company

National Lead Company eventually changed its name to NL Industries Inc. N.L. Industries vacated the site in 1972

Waste produced by operations at the site, including the dredged material from a former settling lagoon, was apparently spread throughout the property. Waste foundry sands were also potentially disposed of on-site. These historical activities have caused the presence of elevated levels of lead, zinc, and copper to be present within the fill material.

2.3.1 Previous Investigations and Reports

The site has been environmentally characterized during several previous investigations, the information of which has been submitted to the NYSDEC. These investigation and remedial activities include the following:

- Potential Hazardous Waste Site Preliminary Assessment, N.L. Industries, Inc., 3241 Walden Avenue, Depew, NY, EPA Site ID Number NYD980531636, NUS Corporation (NUS), 1986
- Site Inspection Report, N.L. Industries/Buffalo Plant, Depew, New York, NUS, July 29, 1988
- Draft, Limited Phase 2 Environmental Site Assessment, 3241 Walden Avenue, Depew, New York, XCG Consultants, Ltd. (XCG), February 10, 1999
- Draft, Limited Phase 2 Environmental Site Assessment, Former Oil Tanks Area, 3241 Walden Avenue, Depew, New York, XCG, February 10, 1999
- Draft, Additional Phase 2 Environmental Site Assessment, 3241 Walden Avenue, Depew, New York, XCG, May 18, 1999
- Limited Phase 1 Environmental Site Assessment, Former N.L. Industries Site, 3241 Walden Avenue, Depew, New York, XCG, June 11, 1999
- Draft, Off-Site Surficial Soil Investigation, 3241 Walden Avenue, Depew, New York, XCG, July 26, 1999
- Report on the Implementation of the Interim Remedial Measures (IRM) at 3241 Walden Avenue, Depew, NY, July 12, 1999 to July 26, 1999, Norampac, September 14, 1999
- Final Remedial Investigation/Feasibility Study (RI/FS) for the Former NL Industries Site in Depew, NY, XCG, December 21, 2004
- Remedial Action Plan (RAP), Tighe & Bond, December 2006
- Specifications for the Remediation of Contaminated Materials (SRCM), Tighe & Bond, August 2007
- Groundwater Investigation Report, CRA, June 2009
- Test Pit Investigations Findings Letter, Benchmark Environmental Engineering & Science, PLLC, June 22, 2009

2.4 Geologic Conditions

2.4.1 Regional

The subject property is located in Erie County, which is comprised of two physiographic provinces. The northern half and western edge of Erie County is situated in the Erie-Ontario lake plain province while the southern portion is comprised of the Allegheny Plateau province. The study area is located in the Erie-Ontario lake plain province.

With the exception of areas near the major drainage ways, the Erie-Ontario Plain has little significant relief and its topography is typical of an abandoned lakebed. The elevation slopes upwards to the south to southeast, starting from approximately 569 feet above mean sea level at the Lake Erie shoreline. The study area is situated at approximately 676 feet above mean sea level.

Erie County is underlain by bedrock of the Upper Silurian and the Middle and Upper Devonian periods. The bedrock formations are in bands with an east-west alignment. The oldest formations are located in the northern section of Erie County and become younger towards the south. Bedrock underlying the county is relatively flat, but dips approximately 50 feet per mile to the southwest.

The City of Buffalo is underlain by the Onondaga Limestone, which is the lowest formation of the Devonian period in this area. The Hamilton Group is situated above and to the south of the Onondaga Limestone. This formation consists of shales and limestones in a band approximately 4 miles wide. Depew, which is a suburb to the east of Buffalo, is located near the border of the Onondaga Limestone and Hamilton Group.

The overburden soil is comprised of the Odessa silt loam, which is nearly level (0 to 3 percent slope) and is somewhat poorly drained. This soil contains a high clay content. The surficial layer is typically very dark greyish-brown silt loam less than 1 foot thick. The subsoil is a mottled silty clay in the upper portion and mottled reddish-brown silty clay in the lower part. The substratum consists of a varved reddish-brown, grey, or reddish-grey silty clay. This silty clay acts as a vertical migration barrier to contaminants present at surface.

2.4.2 Site Specific

The site-specific hydrogeology was determined from the various Phase 2 ESAs conducted at the subject property, including the subsurface investigation carried out as part of the RI/FS. The subsurface conditions at the various portions of the site are briefly summarized in this section. In general, the shallow fills across the site consist of varying types of fill material overlying a native silty clay stratum. Bedrock was not encountered in any of the deep boreholes drilled across the entire site (26 feet was the deepest borehole advanced).

In this report, fill material is defined as surficial soils of varying grades, such as sand, gravel, silty sand, and sandy silt. Further, fill material that has been mixed with metal waste (e.g. foundry sands, smelting residues, babbitt residues, process water residues, etc.) produced from decades of historical on-site industrial operations is referred to as impacted fill. The metal waste produced by the foundry operations, smelting operations, and processing of Babbitts, including the dredged material from the former settling lagoon and foundry sands, was apparently mixed and spread throughout the property.

As a result, the fill material across the site, which was originally clean, became impacted.

The impacted fill encountered at the western section of the site consisted of sand and gravel fill mixed with silty clay, and the metal waste produced by the historic site operations. Brick and concrete fragments were also encountered within the impacted fill. The depth of the impacted fill at the western section of the site was generally between approximately 2 to 6 feet below grade. The impacted fill is underlain by a native silty clay stratum. Occasional pebbles and gravel are present within the silty clay. The consistency of the native shallow soil unit increased from very stiff to hard with depth, and became less hard as the depth approached the shallow water-bearing zone which was encountered at a depth of ~15 feet below grade. The native silty clay was generally the same throughout the property.

Groundwater flow conditions at the site have been previously determined by the installation and gauging of seven groundwater monitoring wells that were located throughout the property prior to remedial efforts. Based on information obtained from the previously existing wells, there appears to be at last two different groundwater layers present beneath the site, and are separated by the top of the stiff native silty clay layer. Perched water has been encountered within the fill material at various drilling locations; however, the natural shallow groundwater-bearing zone is situated in the native silty clay. The low hydraulic conductivity of the silty clay causes infiltrated surface water to remain “perched” within the fill layer. This perched water appears to be sporadic and is not present in a continuous layer throughout the property. The upper portion of the silty clay was damp to moist and the consistency is stiff to hard (i.e. not saturated). This soil unit becomes soft and saturated at a greater depth (approximately 15 feet).

Based on historic water level measurements taken on two separate gauging occasions, groundwater at the site is estimated to flow in a northwesterly direction towards Scajaquada Creek which is located approximately 0.25 miles to the north of the site.

Groundwater in the area is not used for drinking purposes. The Village of Depew is serviced by municipal water, which is drawn from Lake Erie.

2.5 Stormwater

As part of the construction of the containment cell impermeable surface features on the property were subsequently increased.

Due to the increase in paved areas created by the containment cell, the containment cell was graded to direct a portion of the flow toward the western portion of the site. The grading was also designed to reduce the paved area flowing easterly to the existing piped network and CB-1 to pre-construction conditions. This reduced the peak flow in the piped network back to pre-construction levels, but increased the sheet flow toward Walden Ave within the area of the containment cell. The final grading of the containment cell is presented within the FER and the attached ALTA Survey prepared by Nussbaumer & Clarke, Inc.

In order to attenuate the peak runoff rate and to improve water quality, a retention pond was installed within the western portion of the site. The retention pond was constructed at the toe of the west slope of the containment cell. A portion of the asphalt cap flows directly into this pond. A stone trench was constructed along a portion of the toe of the north slope of the capped area to redirect runoff from the northern section of the cell to the pond.

An 8” HDPE outlet pipe was installed at the northeast corner of the pond. This outlet pipe helps attenuate peak runoff from the pond. The invert of this outlet pipe is set such that the Channel Protection Volume will be provided in the pond below the outlet invert. The outlet pipe was also equipped with a grate to prevent entry of trash or large debris that could clog the outlet pipe.

The outlet is piped to a pre-existing catch basin at the northeast corner of the capped area. This catch basin is connected to an existing pipe network that discharges to the 24” culvert in Walden Ave. The 24” culvert drains to the Scajaquada Creek.

Section 3
Summary of Remedial Investigation Findings

Environmental investigation activities were initiated on the site in the mid-1980s. NUS conducted the first environmental investigation of the subject property for the United States Environmental Protection Agency (USEPA). NUS completed an off-site reconnaissance of the property in early-1986 and prepared a report entitled "Potential Hazardous Waste Site Preliminary Assessment, N.L. Industries, Inc., 3241 Walden Avenue, Depew, NY, EPA Site ID Number NYD980531636." On March 31, 1987, NUS conducted a site inspection, on behalf of the USEPA, and collected three sediment and four soil samples for laboratory analyses. Elevated concentrations of several polycyclic aromatic hydrocarbons (PAHs) and metals (e.g. lead, copper, and zinc) were detected in the surficial soils. The results of this investigation are summarized in the NUS report entitled "Site Inspection Report, N.L. Industries/Buffalo Plant, Depew, New York," dated July 29, 1988.

In early 1998, NYSDEC approached Norampac regarding the elevated PAHs and metals detected at the subject property in 1987, and requested that Norampac carry out a subsurface investigation. Since that time, a number of subsurface investigations have been conducted at the site. These investigations are summarized within Section 2.3.1.

Based on the analytical data from these previous investigations and from information provided within the December 2004 RI/FS and NYSDEC-DD, constituents of concern (COCs) in the soil/fill material within the eastern and central sections of the site consists primarily of semi-volatile organics (SVOCs) and inorganic metals. A more in-depth discussion on COCs, and the nature and extent of site impact to is presented within the RI/FS.

3.1 Nature of Impact Fill

A majority of the fill material located within the eastern and central sections of the site contains concentrations of metals, primarily lead, exceeding the 6 NYCRR Part 375 Soil Cleanup Objectives for unrestricted use. The depth of the fill material within the eastern and central sections of the property is generally encountered at a depth of 2 to 6 feet below grade.

In addition to metals, residual SVOCs were also detected within the fill material from the eastern and central portions of the site but to a much lesser extent than metals. Generally, the residual SVOC impacts were typically found within the same areas as the metal impacts.

3.1.1 Gas Cylinders

Copper cylinders, reportedly containing methyl mercaptan gas, have previously been encountered during excavation activities at the site. During June 4 and 5, 2009, the Property Owner contracted Benchmark Environmental Engineering & Science, PLLC (Benchmark) of Lackawanna, NY to conduct a test pit investigation within the eastern section of the site in order to attempt to identify if additional cylinders existed on the site. During the investigation buried cylinders were encountered at several locations within the eastern section of the property. A copy of the June 22, 2009 report is included as Appendix A.

3.2 Extent of Impact Fill

For the purposes of this SMP, all fill material encountered within the eastern and central proportions of the site shall be considered as impacted with site COCs. Although actual concentrations of COCs may vary across the site due to the fill materials heterogeneity, it will be assumed that site related COCs are present at elevated concentrations until/unless specific characterization of the designated area has been conducted.

The underlying very stiff to hard native silty clay has been previously identified to be minimally impacted. This native material was found to act as an effective barrier against the vertical migration of site COCs from within the upper fill material into lower native formations and underlying groundwater.

The following subsections provides a brief summary of the degree and extent of lead impacted fill within the eastern portions of the property that were identified as part of the RI/FS investigation activities. A more detailed description of degree and extent of the impacted fill is provided within the RI/FS.

3.2.1 Trucking Yard

Metal-impacted fill encountered within the trucking yard consisted of sand and gravel at the surface becoming a mixture of sand, gravel, and silty clay with depth. The depth of the metal-impacted fill in this area generally ranges between approximately 4 and 5 feet below grade, and was encountered as deep as 6 feet.

The analytical results of soil samples historically collected from the fill material within this area contained concentrations of lead ranging from 4,900 mg/kg to 31,000 mg/kg.

3.2.2 Parking Lot

The underlying metal-impacted fill material located within the parking lot along the east side of the property, is comprised of coarse sand with gravel, ranged between approximately 1.5 and 2.5 feet below grade. The metal-impacted fill within the former basement area is approximately 10.5 to 11.5 feet below ground surface, where refusal was encountered.

Historical sampling in the parking lot was conducted in two different areas. The initial testing focused on the south side of the parking lot. Three oil tanks were formerly stored in this area, two of which were located below grade in a concrete-lined vault. The second investigation was carried out from the centre to the north end of the parking lot to determine the general quality of the fill material underlying the asphalt.

Soil samples from two boreholes drilled at the south end of the parking lot were collected from the material used to backfill the former oil tanks basement. The concentration of lead was much lower in this fill than the fill located elsewhere on the property. Lead was detected in these two samples at 18 ppm and 8 ppm, respectively.

Soil samples from two boreholes drilled within the south-central and southwest of the former tank area were collected and analyzed for lead. Lead was detected in these two samples at 1,500 ppm and 1,200 ppm.

Two boreholes were drilled in the north to central portions of the parking lot. Lead was detected in the fill material in these two boreholes at 22,000 mg/kg and 6,000 mg/kg, respectively.

3.2.3 Former Rail Siding Area

The overburden material along the former rail siding area consisted of rail ballast underlain by metal-impacted fill, which was comprised of sand and gravel, and silty clay mixed with metal waste from past on-site industrial operations. The metal-impacted fill was, encountered at a depth ranging between approximately 3 to 4 feet below grade was dark brown to black in color and was saturated with perched water.

Historical soil samples collected during previous investigations from within this area identified the presence of lead within the fill material at concentrations raging from 1,900 mg/kg to 13,000 mg/kg.

3.2.4 Under Building

Soil samples collected through the building floor slab were collected as part of the RI in order to fill-in the data gap in this area of the property. The boreholes were placed at different sections of the building in an effort to develop an understanding of the subsurface conditions beneath the structure.

Metals analyses were conducted in the fill material at seven locations. In the borehole located in the southeast area of the building, the fill material contained a lead concentration of 250 mg/kg; however, the lead concentrations in the fill material at the other locations ranged from 860 mg/kg to 27,000 mg/kg. Based on these results, a majority of the fill material beneath the floor slab is expected to contain elevated concentrations of lead above the TAGM 4046 Background Value.

Section 4
Summary of Remedial Actions

The December 2004 RI/FS report proposed seven remedial alternatives for managing the impacted fill material at the site. As discussed in the June 2005 NYSDEC-DD, the NYSDEC, as part of their evaluation of the proposed alternatives, selected soil consolidation and capping as the remedial remedy for the site. The NYSDEC selected remedy consisted of the excavation of impacted fill material from the western section of the property for the consolidation on the central section of the site followed by the construction of a 1.1 acre containment cell. In addition, surface covers systems (i.e. asphalt, concrete, 12-inches of clean fill) would be placed on other areas where impacted fill material was exposed at the surface.

The NYSDEC concluded that this remedy would virtually eliminate any human exposure through direct contact to the impacted fill and that inhalation of air-borne particles would be prevented as wind scouring of exposed surface soils would no longer occur. The implementation of this strategy also required the installation of several new cover systems and the continued maintenance of existing systems.

In December 2004 Metro Waste paved the trucking yard (located to the west of the building) to provide a better driving surface for the trucks that enter the site to load and unload shipments. The completion of the paving of the trucking yard was utilized as a cover system to limit public exposure to the identified COCs as detailed within the December 2004 RI/FS.

In accordance with the June 2005 NYDEC Decision Document, site remedial activities, specifically the excavation and reuse of 7,100 cubic yards of impacted soil/fill material from within the undeveloped western section of the site to construct an impacted soil/fill material containment cell within the central portion of the site. Excavation and consolidation activities were initiated on October 22, 2007, temporarily suspended from February 22, 2008 to May 5, 2008 due to weather conditions, and were completed on September 12, 2008. Remedial activities also included the removal of rail ties and impacted ballast covering of the area known as the “rail siding” area with an asphalt cover system.

The following is a summary of the remedial actions performed at the site:

- The excavation of impacted soils from the western (undeveloped) section of the site and consolidation and construction of a containment cell within the central portion of the site by utilizing a portion of the excavated soils in accordance with the NYSDEC Decision Document.

- The covering of the containment cell with a surface cap consisting of imported clean fill, a geo-synthetic clay liner (GCL) and soil/vegetative or asphalt cover. A ramp was constructed from the trucking yard to the top of the containment area to allow access for future parking on the top of the containment cell. The height of the placed impacted fill materials, prior to cap construction was 6 feet above ground. Jersey barriers are to be installed around the asphalt parking area for protection of the side slopes from the trucks.

- The construction of a GCL and Soil cover system on all non-paved areas (side slopes of the containment cell) of the containment cell. This cover system consists of approximately 12- inches of clean soil underlain by a GCL covering with a 6-inch sand layer between the GCL and impacted fill. All exposed soil has been hydro seeded as an erosion control methodology.

- The construction of a GCL and Asphalt cover system on all paved areas of the central section containment cell. This cover system consists of 6 inches of asphalt (4 inches binder coat and 2 inches top coat) underlain by 12-inches of clean fill, followed by a GCL covering with a 6-inch sand layer between the GCL and the impacted fill.

Further details regarding the remediation of the central and western sections of the site are included within the FER.

In addition to the remedial actions that were undertaken on the property, the following actions were also implemented in order to prevent exposure to any impacted fill material remaining on-site:

- The execution and recording of an Environmental Easement on the eastern and central portions of the site in order to restrict land use and prevent future exposure to any impacted fill remaining on the site.

- The development and implementation of a SMP for long term management of remaining contamination as required by the Environmental Easement, which includes plans for: (1) Institutional and Engineering Controls, (2) monitoring and (3) reporting.

4.1 Removal of Impacted Fill from the Site

Impacted material that was excavated from the western section of the site was either moved to the area designated for the containment cell or removed from the site for disposal at an approved disposal facility. The central section containment cell (approximately 1.1 acres in size) functions as a truck parking area. Approximately 7,100 cubic yards of impacted fill was placed in the containment cell and approximately 16,466 tons of impacted fill was transported offsite for disposal. The excavated areas within the western section of the site were backfilled with clean fill and restored to their approximate original grade. A figure depicting the topographic survey of the remediation areas in included as Figure 3.

A demarcation layer consisting of orange construction fencing was buried at the lateral extents of the excavation within the western section of the site. Table 1 and Figure 4 summarize the results of all soil samples remaining at the site after completion of remediation activities.

Additionally, as part of remedial activities, the railroad ties located within the area known as the “rail siding area” were removed and the area has been paved.

4.2 Goals of Remedial Action

The goals of the remedial activities conducted on the western portion of the property were to either remove or limit public accessibility to the previously identified COCs for the site, specifically lead and SVOCs as prescribed in the NYSDEC-DD.

Tighe & Bond utilized the residential use soil cleanup objectives as specified in Title 6 Part 375 of the NYCRR Soil Cleanup Objectives (6 NYCRR Part 375) for lead and SVOCs. A table summarizing the analytical results from the remedial actions is provided within the FER.

Section 5
Engineering and Institutional Control Plans

Since remaining impacted fill exists beneath certain areas of the site, ECs are required to protect human health and the environment. This section of the SMP describes the procedures for the implementation and management of all ECs at the site. The sections of the property subject to the Environmental Easement and the locations of the ECs (totaling 4.65 acres in size) are described in detail and depicted in the Nussbaumer & Clarke, Inc. ALTA Survey attached to this SMP.

5.1 Purpose

This plan provides the following:

- A description of all EC/ICs on the site
- The basic implementation and intended role of each EC
- A description of the features to be evaluated during each required inspection and periodic review
- A description of plans and procedures to be followed for implementation of ECs, such as the implementation of the Excavation Work Plan (EWP) for the proper handling of remaining impacted fill material that may be disturbed during maintenance or redevelopment work on the site
- Any other provisions necessary to identify or establish methods for implementing the ECs required by the site remedy, as determined by the NYSDEC.

5.2 Engineering Control Systems

The purpose of the EC systems is to eliminate the potential for human contact with fill material, percolation of precipitation through the impacted fill, and eliminate the potential for contaminated runoff from the site. As identified within the NYSDEC-DD, the existing and newly installed EC systems in place at the site consist of the following:

- Asphalt only: According to the RI/FS, the trucking yard within the eastern section of the site was recently paved in 2004 and is covered by 4.5 inches of sub-base material and 6-inches of asphalt (4.5 binder coat and 1.5 inches top coat). The eastern parking lot was historically paved with asphalt for employee parking. In addition, the area identified as the “rail siding area” was paved with 6-inches of asphalt (4 inches binder coat and 2 inches top coat) on 8/15/2008.
- Building and Apron Concrete: The floor of the existing building and exterior concrete pads/aprons are believed to be a minimum of 6 inches in thickness of concrete.
- GCL and Soil: All non-paved areas (side slopes of the containment cell) of the containment cell are covered by approximately 12- inches of clean soil underlain by a GCL covering with a 6-inch sand layer between the GCL and impacted fill. All

exposed environmentally clean soil/fill has been hydro seeded as an erosion control methodology.

- GCL and Asphalt: All paved areas of the central section containment cell are covered by 6 inches of asphalt (4 inches binder coat and 2 inches top coat) underlain by 12-inches of clean fill, followed by a GCL covering with a 6-inch sand layer between the GCL and the impacted fill.

A figure depicting the locations of each cover system type is included as Figure 5.

The EWP that appears in Appendix B outlines the procedures required to be implemented in the event a cover system is breached, penetrated or temporarily removed and any underlying remaining contamination is disturbed. Procedures for the inspection and maintenance of these cover systems are provided within Section 6 of this SMP.

5.3 Institutional Controls

A series of ICs are required by the NYSDEC-DD to: (1) implement, maintain and monitor the ECs; (2) prevent future exposure to remaining contamination by controlling disturbances of the subsurface contamination; and, (3) limit the use and development of certain portions of the site to industrial uses only. Adherence to these ICs on the site is required by the Environmental Easement and will be implemented under this SMP. These ICs are:

- Compliance with the Environmental Easement and this SMP by the Grantor and the Grantor's successors and assigns

- ECs must be operated and maintained as specified in this SMP

- All ECs on the Site must be inspected at a frequency and in a manner defined in the SMP

- Data and information pertinent to management of the Site must be reported at the frequency and in a manner defined in this SMP

ICs identified within the Environmental Easement may not be discontinued without an amendment to or extinguishment of the Environmental Easement.

The site has a series of ICs in the form of site restrictions. Adherence to these ICs is required by the Environmental Easement. Site restrictions that apply to the site are:

- The central and eastern portions of the property may only be used for industrial/commercial purposes provided that the long-term ECs/ICs included in this SMP are employed

- The central and eastern portions of the property may not be used for a higher level of use, such as unrestricted or restricted residential use without additional remediation and amendment of the Environmental Easement, as approved by the NYSDEC

- All future activities on the property that will disturb remaining impacted material must be conducted in accordance with this SMP

- The site owner or remedial party will submit to NYSDEC a written statement that certifies, under penalty of perjury, that: (1) controls employed at the site are unchanged from the previous certification or that any changes to the controls were approved by the NYSDEC; and, (2) nothing has occurred that impairs the ability of the controls to protect public health and environment or that constitute a violation or failure to comply with the SMP

- The groundwater beneath the central and eastern sections of the property may not be used for potable or non-potable purposes

5.4 Excavation Work Plan

The western section of the site has been remediated for unrestricted use. The eastern and central portions of the site contain remaining impacted fill material enclosed by several types of cover systems. Any future intrusive work that will penetrate the cover systems, or encounter or disturb the remaining impacted fill, including any modifications or repairs to the cover systems will be performed in compliance with the EWP that is attached as Appendix B to this SMP. Any work conducted pursuant to the EWP must also be conducted in accordance with the procedures defined in the Community Air Monitoring Plan (CAMP) for the site and in accordance with the contractor’s Health a Safety Plan (HASP) for the specific work activity to be conducted. A copy of the CAMP and an example of a HASP are attached on compact disk as Appendix C.

Any intrusive construction work will be performed in compliance with the EWP, the CAMP and the contractor’s HASP requirements, and will be included in the periodic inspection and certification reports submitted under the Site Management Reporting Plan (SMRP).

Any work conducted pursuant to the EWP must also be conducted in accordance with the procedures defined in a HASP and CAMP prepared for the site.

The site owner and contractors performing disruptive activities are responsible for the safe performance of all intrusive work, the structural integrity of excavations, proper disposal of excavation de-water, control of runoff from open excavations into remaining contamination, and for structures that may be affected by excavations (such as building foundations and bridge footings). The site owner will ensure that site development activities will not interfere with, or otherwise impair or compromise, the ECs described in this SMP.

5.4.1 Gas Cylinders

As discussed in Section 3.1.1 buried gas cylinders have been encountered during previous excavation activities at the site. If additional cylinders are encountered during any subsurface activities, excavation will cease and the Owner’s P.E. and NYSDEC will immediately be notified. All cylinders encountered will be evaluated by the Owner’s P.E. and the Owner will submit a removal plan to NYSDEC for review and approval. Appropriately trained personnel will excavate and remove all cylinders within the designated work area while following all applicable federal, state, and local regulations. Removed cylinders will be properly characterized and removed from the site.

Section 6
Inspections and Notifications

6.1 Inspections

Inspections of all remedial components installed at the site will be conducted at the frequency specified in the SMP. A comprehensive site-wide inspection will be conducted annually in the spring. The inspections will determine and document the following:

- Whether ECs continue to perform as designed
- If these controls continue to be protective of human health and the environment
- Compliance with requirements of this SMP and the Environmental Easement
- Achievement of remedial performance criteria
- Sampling and analysis of appropriate media during monitoring events
- If site records are complete and up to date
- Changes, or needed changes, to the remedial or monitoring system

The reporting requirements are outlined in the Periodic Review Reporting (PRR) section of this plan (Section 9).

6.1.1 Asphalt Only Cover System

Inspection of the asphalt only cover system will be conducted annually in the spring after all snow has melted or been plowed/cleared from the site. If during the inspection the cover system is determined to be damaged appropriate actions will be taken to repair, replace or reseal the damaged area.

Areas of significant damage or damaged areas which have the potential to allow public access/exposure to sub-base materials (as determined by the owner's Professional Engineer (P.E.)) will be immediately repaired. Degree of repair (i.e. resealing and/or placement of new asphalt) will be dependent on type and size of the damaged area. If the damage is determined to be of great significance that may cause for the disturbance of impacted materials, the provisions within the EWP shall be followed and worker protection measures implemented.

6.1.2 Building and Apron Concrete Cover System

The floor of the existing building and exterior concrete pads/aprons are believed to be a minimum of 6 inches in thickness of concrete.

The concrete cover system will be inspected annually in the spring for evidence of deterioration. If during the inspection the cover system is determined to be damaged, appropriate actions will be taken to repair, replace, or reseal the damaged area.

Cracks within the concrete that are determined (by the owners P.E.) to be of significant size and/or width will be repaired by grinding out a suitably-sized groove along the crack and filling the groove with an elastomeric caulk.

Areas of significant damage or damaged areas which have the potential to allow public access/exposure to sub-base materials (as determined by the owner's P.E.) will be immediately repaired. Degree of repair (i.e. resealing and/or placement) will be dependent on type and size of the damaged area. If the damage is determined to be of great significance that may cause for the disturbance of impacted materials, provisions within the EWP shall be followed and worker protection measures implemented.

6.1.3 GCL and Soil Cover System

All non-paved areas (side slopes of the containment cell) of the central section containment cell are covered by approximately 12 inches of clean soil underlain by a GCL covering with a 6-inch sand layer between the GCL and impacted fill. All exposed soil has been hydro seeded as an erosion control methodology.

The placement of clean fill material and vegetation over the liner was designed to prevent stormwater run-off from eroding or damaging the liner. Vegetative growth on the containment cell cover will be cut on a monthly basis, at a minimum, during the growing season. Areas that are non-accessible to mechanical equipment will be cut manually by appropriate means. Sink holes, erosion and/or bare spots noted during mowing will be repaired immediately. Clean topsoil will be emplaced and the areas re-seeded as necessary. In the unlikely scenario of substantial settling or subsidence of the soil occurs, the affected areas shall be immediately repaired.

Repairs to the GCL are not anticipated as the GCL will be contained below grade. If however damage to the containment cell occurs and repairs to the GCL become necessary (as determined by the Owner's P.E.), the area in question will be marked and then be temporarily covered with clean fill in order to limit public access to the impacted materials and a contractor will be contacted to schedule immediate repairs. In all cases provisions within the EWP shall be followed and worker protection measures implemented.

If the GCL liner becomes damaged or is in need of repair, it will be repaired by completely exposing the affected area by removing all foreign objects or soil, and a new section of GCL will be placed/patched over the damaged area with a minimum overlap of 12 inches on all edges. Accessory bentonite will be placed between the patch and the repaired material at a rate of a two pounds per lineal foot of edge spread in a six-inch width. If damage occurs on a slope, the same basic procedure will be used; however, the edges of the patch will be fastened to the repaired liner with contact cement, epoxy, or some other construction adhesive, in addition to the bentonite-enhanced seam.

6.1.4 GCL and Asphalt Cover System

All paved areas of the central section containment cell are covered by 6 inches of asphalt (4 inches binder and 2 inches top) underlain by 12-inches of clean fill, followed by a GCL covering with a 6-inch sand layer between the GCL and the impacted fill.

Inspection of the GCL and asphalt cover system will be conducted annually in the spring after all snow has melted or been plowed/cleared from the site. If during the inspection the asphalt portion of the cover system is determined to be damaged or significant subsidence within the asphalt portion of the cover system is noted, appropriate actions will be taken to repair, replace and/or reseal the damaged area.

Areas of significant damage or damaged areas which have the potentially to allow public access/exposure to sub-base materials (as determined by the owner's P.E.) will be immediately repaired. Degree of repair (i.e. resealing and/or placement of new asphalt) will be dependent on type and size of the damaged area. If the damage is determined to be of significance that causes disturbance to the GCL, repair procedures to the GCL will be implemented. In all cases provisions within the EWP shall be followed and worker protection measures implemented.

6.1.5 Retention Pond

The retention pond was constructed at the toe of the west slope of the containment cell. A portion of the asphalt cap flows directly into this pond. A stone trench was constructed along a portion of the toe of the north slope of the capped area to redirect runoff from the northern section of the cell to the pond.

An 8" HDPE outlet pipe was installed at the northeast corner of the pond. This outlet pipe help attenuate peak runoff rate from the pond. The invert of this outlet pipe is set such that the Channel Protection Volume will be provided in the pond below the outlet invert. The outlet pipe was also equipped with a grate to prevent entry of trash or large debris that could clog the outlet pipe.

The outlet is piped to a pre-existing catch basin at the northeast corner of the capped area. This catch basin is connected to an existing pipe network that discharges to the 24" culvert in Walden Ave.

Routine maintenance of the pond will be performed in order to accomplish the goal of the pond system which is to effectively remove sediment and pollutants from the stormwater flow as designed. At the completion of construction, all structures were operational and clean of sediment and debris. The systems efficiency in removing sediment and pollutants from the storm flows depends upon routine maintenance.

Inspections of the pond and associated piping will be conducted on a monthly basis for general condition. It is recommended that the inspections be conducted consistently by the same representative so that any changes to the system will be more apparent and noticed. If any unusual conditions or damage to the system is noted by the inspector, (as determined in consultation with the owner's P.E.) corrective actions will be implemented.

The following conditions would be considered critical and would for immediate attention:

- A berm about to be overtopped or being overtopped
- A berm about to be breached (by progressive erosion, slope failure, or other circumstances)
- A berm showing signs of piping or internal erosion indicated by increasingly cloudy seepage or other systems
- An opening being blocked or otherwise rendered inoperable, or having normal discharge restricted

The following maintenance will be completed as soon as possible after the defective condition is noted:

- All underbrush and trees will be removed from the embankment, and a good grass cover should be established
- Eroded areas and gullies on the embankment will be restored and reseeded
- Defective openings and other appurtenant features of the pond will be repaired

Although the remedy for some critical problems may be obvious (such as clearing a blocked spillway), all remedies will be discussed and evaluated with the owner's P.E. prior to implementation of the selected remedy.

6.1.6 Fencing

A chain-linked security fencing was placed around the sections of the property in order to prevent trespassing on to the property.

Inspection of the fencing will be conducted semi-annually in the spring after all snow has melted or been plowed/cleared from the site and in the fall prior to snowfall events.

Repairs to the fencing will include patching holes in the chain-link, reattaching the chain-link to the posts, replacing chain-link, removal of woody shrubs/growths from chain-link and/or replacing posts.

6.1.7 Vegetative Cover

Since vegetation has been established on portions of the cover system, a certain amount of maintenance is necessary. In the event that invading plants species become established on the cover system, the selective use of herbicides shall be used to control these plants. Under certain circumstances, if an infestation of large insects threatens a stand of vegetation, the use of insecticides may become necessary.

Inspections of vegetative cover will be conducted semi-annually in the spring after all snow has melted or been plowed/cleared from the site and in the fall prior to snowfall events. During each of the inspections, observations shall include the extent of bare areas susceptible to erosion and the presence of stressed vegetation. In addition the inspector shall note the presence of animal burrows. If repairs are made to the vegetative cover, monthly inspections shall be instituted until the vegetation has been re-established.

In addition to the cover systems, vegetatives were also planted along Walden Avenue, the pond and the railroad track (from the pond to the west end). Although not part of the cover systems, these vegetatives will be inspected periodically for damage/death and will be maintained and/or replaced with same or similar plantings to ensure ongoing survival.

6.2 Notifications

Notifications will be submitted by the property owner to the NYSDEC as needed for the following reasons:

- 60-day advance notice of any proposed changes in site use that are required under the terms of the BCA, 6NYCRR Part 375, and/or Environmental Conservation Law

- 15-day advance notice of any proposed ground-intrusive activities pursuant to the EWP

- Notice within 48-hours of any damage or defect to the foundations structures that reduces or has the potential to reduce the effectiveness of other Engineering Controls and likewise any action to be taken to mitigate the damage or defect

- Notice within 48-hours of any emergency, such as a fire, flood, or earthquake that reduces or has the potential to reduce the effectiveness of ECs in place at the site, including a summary of actions taken, or to be taken, and the potential impact to the environment and the public

- Follow-up status reports on actions taken to respond to any emergency event requiring ongoing responsive action shall be submitted to the NYSDEC within 45 days and shall describe and document actions taken to restore the effectiveness of the ECs

Any change in the ownership of the site or the responsibility for implementing this SMP will include the following notifications:

- At least 60 days prior to the change, the NYSDEC will be notified in writing of the proposed change. This will include a certification that the prospective purchaser has been provided with a copy of the BCA and all approved work plans and reports, including this SMP

- Within 15 days after the transfer of all or part of the site, the new owner's name, contact representative, and contact information will be confirmed in writing

6.3 Contingency Plan

In the event of any environmentally related situation or unplanned occurrence requiring assistance the Owner or Owner's representative(s) should contact the appropriate party from the contact list below. For emergencies, appropriate emergency response personnel should be contacted. Prompt contact should also be made to the Owner or Owner's representative(s). These emergency contact lists must be maintained in an easily accessible location at the site.

Organization / Name	**Title / Location**	**Telephone**
Owner - Norampac Leon Marineau	Vice President Kingsey Falls, Quebec, Canada	819-363-5702
Metro Waste Representative Tom Derkovitz	Site Manger Depew, NY	716-570-3952
Owner's P.E.	To be defined on a yearly basis	

Emergency Services		
Local Ambulance	-	911
Hospital	Mercy Hospital 565 Abbott Rd Buffalo, NY 14220-2039	716-826-7000
Local Police	Emergency Non Emergency	911 716-851-4415
Local Fire Department	-	911
EPA Region II	-	212-637-3000
Poison Control Center	-	800-222-1222
National Response Center	-	800-424-8802
Center for Disease Control	-	404-488-4100
CHEMTREX	-	800-424-9555
NYSDEC Spills Hotline		800-457-7362

Section 7
Site Monitoring Plan

7.1 General

The Monitoring Plan describes the measures for evaluating the performance and effectiveness of the remedy to reduce or mitigate contamination at the site, the soil cover system, and all affected site media identified below. This Monitoring Plan may only be revised with the approval of NYSDEC.

7.2 Purpose and Schedule

This Monitoring Plan describes the methods to be used for:

- Sampling and analysis of all appropriate media (e.g., groundwater, indoor air, soil vapor, soils)
- Assessing compliance with applicable NYSDEC standards, criteria and guidance, particularly ambient groundwater standards and Part 375 SCOs for soil
- Assessing achievement of the remedial performance criteria
- Evaluating site information periodically to confirm that the remedy continues to be effective in protecting public health and the environment
- Preparing the necessary reports for the various monitoring activities

To adequately address these issues, this Monitoring Plan provides information on:

- Information on all designed monitoring systems (e.g., well logs)
- Analytical sampling program requirements
- Reporting requirements
- Quality Assurance/Quality Control (QA/QC) requirements
- Inspection and maintenance requirements for monitoring wells
- Annual inspection and periodic certification

7.3 Groundwater Monitoring

A network of monitoring wells has been installed to monitor both up-gradient and down-gradient groundwater conditions at the site. The network of on-site [and off-site] wells has been designed based on the following criteria:

Six monitoring wells (MW-101 though MW-106F) were installed on the site in March 2009. Conestoga-Rovers & Associates (CRA) of Buffalo, NY provided oversight and direction of the installation of the monitoring wells. Figure 6 depicts the locations of the monitoring wells at the site.

The monitoring program will consist of the collection of depth to groundwater measurements to determine hydraulic gradients and groundwater flow direction, collection and analysis of groundwater samples to monitor for COCs in accordance with EPA Low Flow (Minimal Drawdown) Groundwater Sampling Procedures and inspection and maintenance of the monitoring wells. Information regarding the installation and initial groundwater sampling results are included in CRA's June 2009 report entitled *Groundwater Investigation Report* and is included as Appendix D of this SMP.

7.4 Groundwater Sampling Protocol

All monitoring well sampling activities will be recorded in a field book and an example of a groundwater field sampling log presented in Appendix E. Other observations (e.g., well integrity, etc.) will be noted on the well sampling log. The well sampling log will serve as the inspection form for the groundwater monitoring well network.

Work tasks to be completed before groundwater samples are collected include: sampling equipment procurement, inspection and calibration of all field equipment; the procurement and preparation of sample bottles, the collection of field water quality measurements; and, the collection of groundwater samples.

7.4.1 Equipment Procurement, Inspection and Calibration

Before mobilizing to the site, sampling personnel will procure the necessary equipment to conduct the sampling event, including a water quality meter, a water-level indicator, and low-flow related sampling equipment. The groundwater quality meter shall be capable of measuring groundwater temperature in degrees Celsius (C), pH in standard units, specific conductivity in micro-ohms per centimeter, turbidity in Nephelometric Turbidity Units (NTUs), oxygen reduction potential (ORP) in millivolts, and dissolved oxygen (DO) in milligrams per liter. The depth to groundwater (or soil water as in the case of MW-106F) shall be measured to the nearest 0.01-foot.

All equipment shall be inspected to verify that it is in good working order before sampling activities begin. Instrument calibration will be conducted on-site using factory prepared solutions and in accordance with manufacturer specifications.

7.4.2 Procurement and Preparation of Sample Bottles

The Owner's consultant will coordinate delivery of the appropriate sampling containers to a New York State certified laboratory for analysis. All sampling containers shall be laboratory pre-cleaned and shall contain the appropriate preservative. Upon receipt of the sampling containers from the lab the sampling personnel shall inspect the sample containers for integrity and completeness. A trip blank will be supplied by the laboratory and will accompany the groundwater samples at all times.

7.4.3 Field Records

All sampling activities shall be recorded with indelible ink in a bound, waterproof, survey-type field logbook. The field logbook shall include enough information to reconstruct the sampling events. This information will include, at minimum, the following:

- Field equipment used
- Condition of the wells
- Field measurements, including water levels and geochemical parameters
- Measurement, purging, and sample collection times

- Purge volumes
- Visual observations (e.g., water color/odor)
- Physical condition of wells
- Purge/decontamination water handling
- Sample identification numbers (including QA/QC samples)
- Sample parameters
- Sample collection time
- Names of sampling personnel
- Weather conditions

7.4.4 Groundwater Elevation Measuring Techniques

Before beginning the monitoring well purging process, a synoptic round of groundwater elevations will be measured using an electronic water-level meter. The depth to groundwater (or soil water as in the case of monitoring well MW-106F) and total monitoring well depth will be measured from the surveyed reference mark at the top of the well casing to the nearest 0.01-foot. The monitoring wells will be gauged in the order of increasing constituent concentrations to limit the possibility of cross contamination. The measurements and time of measurement will be recorded in the field logbook.

7.4.5 Monitoring Well Sampling Activities

To obtain representative samples, each monitoring well will be purged and sampled in accordance with the EPA's *Low Stress (low flow) Purging And Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells* standard operating procedure. A copy of the procedure is included as Appendix F. As part of the procedure depths to groundwater and water quality parameters (DO, ORP, pH, conductivity, turbidity, and temperature) will be measured during purging and record on the field data sheet provided in Appendix E.

All purged groundwater and decontamination water will be temporarily stored in drums on the day of sampling at a location selected by the owner's PE and site facility manager. An approved subcontractor will be utilized to remove all drums and arrange for appropriate disposal or, with approval, discharged to any appropriate POTW upon completion of sampling activities. There will be no long term (>90 days) storage of purged water drums on site.

7.4.6 Groundwater Sampling Parameters

Groundwater samples will be collected annually from each well within the monitoring well network. All collected groundwater samples will be analyzed for Target Compound List VOCs via EPA method SW486-8260B, Target Compound List metals via EPA Method SW486-6020 and EPA Method SW486-7470A, and SVOCs via EPA Method 8270C.

7.4.7 Quality Assurance/Quality Control

QA/QC will include the collection and analysis of duplicate groundwater samples, field equipment blanks, and trip blanks.

One blind duplicate sample will be collected per sampling event to evaluate the reproducibility of the sample collection and analytical procedures. The duplicate groundwater sample will be collected by alternately filling the environmental sample and the duplicate sample containers. The sample container will be labeled with a false name and time so that the laboratory cannot distinguish which sample is the duplicate. The correct sampling date, location, and time will be recorded in the field log book.

One field blank will be collected by running laboratory provided analyte free water through the sampling equipment. The field blank will be handled, transported and analyzed in the same manner as all other samples. One field blank will be collected for each round of sampling.

A trip blank is a sample of analyte-free media taken from the laboratory to the sampling site and returned to the laboratory unopened. A trip blank is used to document VOC contamination attributable to shipping and field handling procedures (i.e., diffusion of volatile organics through the septum during shipment and storage). A trip blank may also serve to detect contamination from containers (i.e., bottle blank). The aqueous trip blanks will be analyzed for VOCs via EPA Method 8260. A trip blank will be utilized for each day that groundwater samples are collected.

Sample integrity will be preserved with the addition of chemical preservatives (where appropriate) and by cooling the samples to 4°C before and during their transportation to the laboratory. Chemical additives necessary for sample preservation will be added to the sample containers by the analytical laboratory prior to releasing them to the sampling personnel.

Chain-of-custody will be maintained throughout the sampling program. Chain-of-custody documentation will accompany all samples from the field to the laboratory. Each sample will be assigned a number that will be recorded in a field logbook.

7.5 Inspection and Maintenance of Monitoring Wells

The monitoring well network and site cover systems will be inspected annually as part of monitoring and maintenance program as described in the following sections. As previously mentioned a copy of the inspection form is included as Appendix E. A plan depicting the locations of the monitoring well network is provided as Figure 6.

If biofouling or silt accumulation occurs within the sampling program monitoring wells, the wells will be physically agitated/surged and redeveloped. Additionally, monitoring wells will be properly decommissioned and replaced, if an event renders the wells unusable.

Repairs and/or replacement of wells in the monitoring well network will be performed based on assessments of structural integrity and overall performance.

The NYSDEC will be notified prior to any repair or decommissioning of monitoring wells for the purpose of replacement, and the repair or decommissioning and replacement process will be documented in the subsequent periodic report. Well decommissioning without replacement will be done only with the prior approval of NYSDEC. Well abandonment will be performed in accordance with NYSDEC's "Groundwater Monitoring Well Decommissioning Procedures." Monitoring wells that are decommissioned because they have been rendered unusable will be reinstalled in the nearest available location, unless otherwise approved by the NYSDEC.

7.6 Site-Wide Inspection

Site-wide inspections will be performed on a regular schedule at a minimum of once a year. Site-wide inspections will also be performed after all severe weather conditions that may affect Engineering Controls or monitoring devices. During these inspections, an inspection form will be completed (Appendix G). The form will compile sufficient information to assess the following:

- Compliance with all ICs, including site usage
- An evaluation of the condition and continued effectiveness of ECs
- General site conditions at the time of the inspection
- The site management activities being conducted including, where appropriate, confirmation sampling and a health and safety inspection
- Confirm that site records are up to date

7.7 Monitoring Reporting Requirements

Forms and any other information generated during regular monitoring events and inspections will be kept on file on-site. All forms, and other relevant reporting formats used during the monitoring/inspection events, will be (1) subject to approval by NYSDEC and (2) submitted at the time of the PRR, as specified in the Reporting Section of this SMP.

All monitoring results will be reported to NYSDEC on a periodic basis in the Periodic Review Report. The report will include, at a minimum:

- Date of event
- Personnel conducting field inspection/sampling activities
- Description of the activities performed
- Type of samples collected (e.g., soil, groundwater, etc)
- Copies of all field forms completed (e.g., well sampling logs, chain-of-custody documentation, etc.)
- Sampling results in comparison to appropriate standards/criteria
- A figure illustrating sample type and sampling locations
- Copies of all laboratory data sheets and the required laboratory data deliverables required for all points sampled (to be submitted electronically in the NYSDEC-identified format)
- Any observations, conclusions, or recommendations
- A determination as to whether groundwater conditions have significantly changed since the last reporting event

- A groundwater contour map
- Provide an assessment of compliance with groundwater standards and include a Data Usability Summary Report.

A copy of the monitoring reports will be kept into the Metro Waste Coordinator's office at 3241 Walden Avenue. The documentation will be available for onsite consultation only after a request to review the documents is approved by Norampac Industries Inc.

Section 8
Operation and Maintenance Plan

The site remedy does not rely on any mechanical systems, such as sub-slab depressurization systems or air sparge/ soil vapor extraction systems to protect public health and the environment. Therefore, the operation and maintenance of such components is not included in this SMP.

Section 9
Inspections, Reporting and Certifications

9.1 Site Inspections

9.1.1 Inspection Frequency

A site-wide inspection will be conducted annually. Inspections of ECs will also be conducted whenever a severe condition has taken place, such as an erosion or flooding event that may affect the ECs.

9.1.2 Inspection Forms, Sampling Data, and Maintenance Reports

All inspections and monitoring events will be recorded on the appropriate forms for their respective system. Additionally, a general site-wide inspection form will be completed during the site-wide inspection events. These forms are subject to NYSDEC revision.

All applicable inspection forms and other records, including all media sampling data and EC maintenance reports, generated for the site during the reporting period will be provided in electronic format in the PRR.

9.1.3 Evaluation of Records and Reporting

The results of the inspection and site monitoring data will be evaluated as part of the EC/IC certification to confirm that the:

- EC/ICs are in place, are performing properly, and remain effective
- The Monitoring Plan is being implemented
- The site remedy continues to be protective of public health and the environment and is performing as designed in the RAWP and FER.

9.1.4 Certification of Controls

After the last inspection of the reporting period, the Owner's Professional Engineer licensed to practice in New York State will prepare the following certification:

For each institutional or engineering control identified for the site, I certify that all of the following statements are true:

- The inspection of the site to confirm the effectiveness of the institutional and engineering controls required by the remedial program was performed under my direction
- The institutional control and/or engineering control employed at this site is unchanged from the date the control was put in place, or last approved by the Department
- Nothing has occurred that would impair the ability of the control to protect the public health and environment
- Nothing has occurred that would constitute a violation or failure to comply with the SMP for this control

- Access to the site will continue to be provided to the Department to evaluate the remedy, including access to evaluate the continued maintenance of this control
- Use of the site is compliant with the environmental easement
- The engineering control systems are performing as designed and are effective
- To the best of my knowledge and belief, the work and conclusions described in this certification are in accordance with the requirements of the site remedial program
- The information presented in this report is accurate and complete

The signed certification will be included in the PRR.

9.2 Periodic Review Report

A PRR will be submitted to the NYSDEC annually, beginning eighteen months after the Certificate of Completion is issued. In the event that the site is subdivided into separate parcels with different ownership, a single PRR will be prepared that addresses the site. The report will be prepared in accordance with NYSDEC DER-10 and submitted within 45 days of the end of each certification period. Media sampling results will also incorporated into the PRR.

The report will include:

- Identification, assessment and certification of all ECs/ICs required by the remedy for the site
- A completed EC/IC certification form
- Results of the required annual site inspections and severe condition inspections, if applicable
- All applicable inspection forms and other records generated for the site during the reporting period in electronic format
- A summary of any discharge monitoring data and/or information generated during the reporting period with comments and conclusions
- Data summary tables and graphical representations of contaminants of concern by media (groundwater, soil vapor), which include a listing of all compounds analyzed, along with the applicable standards, with all exceedances highlighted. These will include a presentation of past data as part of an evaluation of contaminant concentration trends
- Results of all analyses, copies of all laboratory data sheets, and the required laboratory data deliverables for all samples collected during the reporting period will be submitted electronically in a NYSDEC-approved format
- A site evaluation, which includes the following:
    - The compliance of the remedy with the requirements of the NYSDEC-DD
    - The operation and the effectiveness of all ECs including identification of any needed repairs or modifications

- Any new conclusions or observations regarding site contamination based on inspections or data generated by the Monitoring Plan for the media being monitored
- Recommendations regarding any necessary changes to the remedy and/or Monitoring Plan
- The overall performance and effectiveness of the remedy

The following certification language shall also be included within the report:

I certify that all information and statements in this certification form are true. I understand that a false statement made herein is punishable as a Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law. I, [name], of [business address], am certifying as [Owner or Owner's Designated Site Representative] (and if the site consists of multiple properties): [I have been authorized and designated by all site owners to sign this certification] for the site.

9.3 Corrective Measures Plan

If any component of the remedy is found to have failed, or if the periodic certification cannot be provided due to the failure of an institutional or engineering control, a corrective measures plan will be submitted to the NYSDEC for approval. This plan will explain the failure and provide the details and schedule for performing work necessary to correct the failure. Unless an emergency condition exists, no work will be performed pursuant to the corrective measures plan until it is approved by the NYSDEC.

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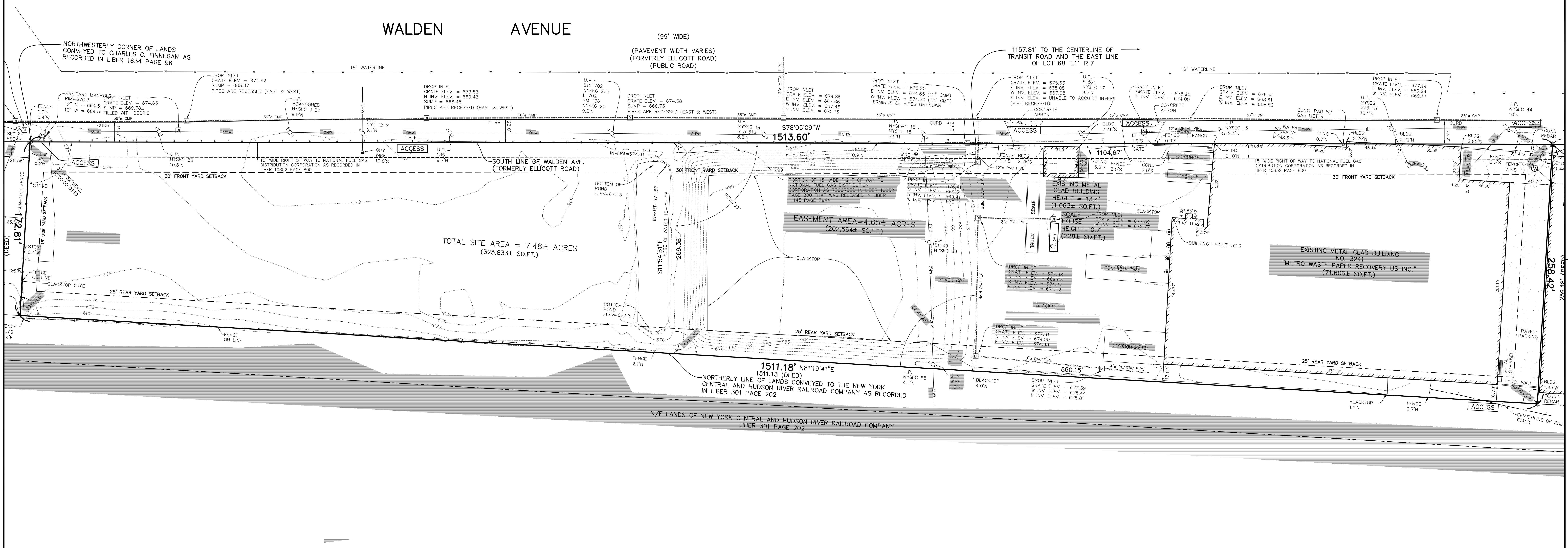


Graphic Scale:
0 50' 75' 100'

LEGEND

⊡	DROP INLET
◉	BOLLARD
⊘	UTILITY POLE
—OHW—	OVERHEAD WIRE
⋈	WATER VALVE
Ⓜ	MANHOLE (UNKNOWN TYPE)
Ⓢ	SANITARY MANHOLE

VERTICAL DATUM :
ELEVATIONS SHOWN ON THIS DRAWING ARE BASED UPON THE NORTH AMERICAN VERTICAL DATUM OF 1988

HORIZONTAL DATUM :
THIS DRAWING IS BASED ON AN ASSUMED COORDINATE SYSTEM AND ASSUMED NORTH ROTATION

EXISTING CONDITION SURVEY REFERENCE:

"ALTA/ACSM LAND TITLE SURVEY OF 3241WALDEN AVENUE, PART OF LOT(S) 68 TOWNSHIP 11 RANGE 7 VILLAGE OF DEPEW TOWN OF CHEEKTOWAGA COUNTY OF ERIE STATE OF NEW YORK" PREPARED BY NUSSBAUMER & CLARKE, INC., SHEET 1 OF 1, DATED 10/22/08, SCALE 1"=50'.

Former N.L. Industries Site Management Plan

3241 Walden Ave.
Depew, New York

October 2009

Mark	Date	Description

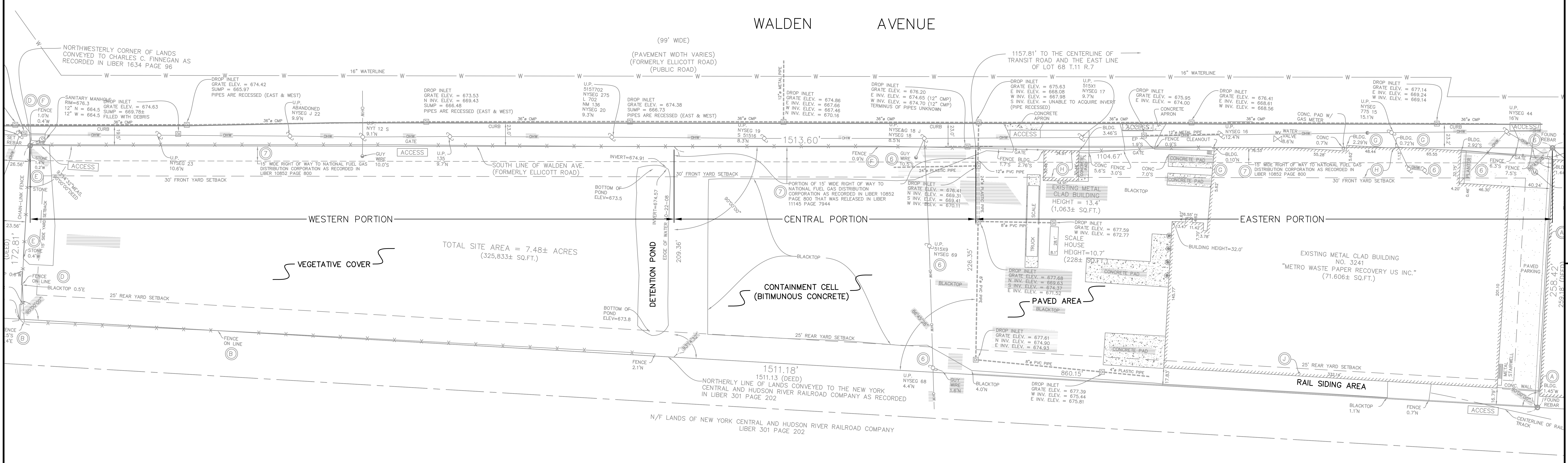
PROJECT NO:	12-6254
FILE:	SMP-126254-01.dwg
DRAWN BY:	DSH
CHECKED:	JTO
APPROVED BY:	TCC

Site Location Map

SCALE: As Noted

Figure 1

Tighe & Bond Inc: J:\C\C6254 - former nl\Drawings\0_Current\sheets\SMP-126254-01.dwg Layout Name: SMP_FIG-1 Plotted by: DFV Plotted on: Nov 03, 2009 - 3:09pm



Tighe & Bond Inc: J:\C\C6254 - former nl\Drawings\0_Current\sheets\SMP-126254-02A.dwg Layout Name: SMP_FIG-2 Plotted by: DFV Plotted on: Nov 03, 2009-2:51pm

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Former N.L. Industries Site Management Plan

3241 Walden Ave.
Depew, New York

October 2009

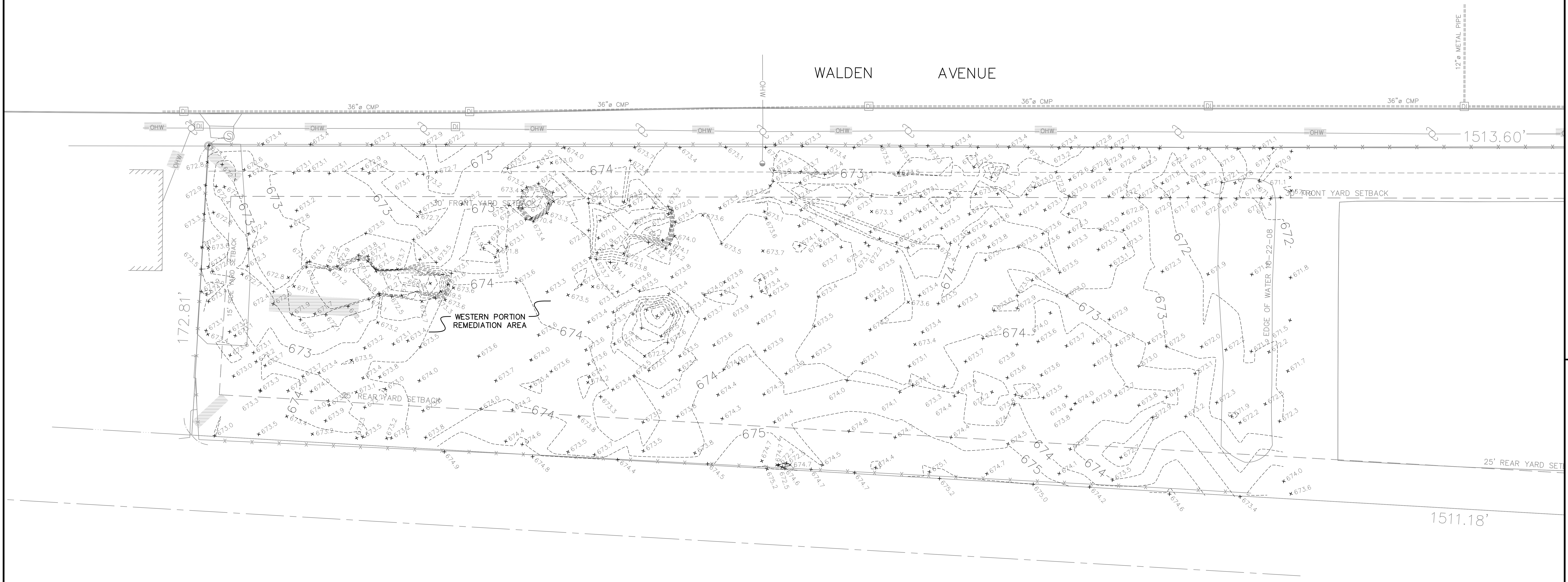
Mark	Date	Description

PROJECT NO:	12-6254
FILE:	SMP-126254-02A.dwg
DRAWN BY:	DSH
CHECKED:	JTO
APPROVED BY:	TCC

Property Section Map

SCALE: As Noted

Figure 2



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NORTH

Graphic Scale:
0 30' 45' 60'

Former N.L. Industries Site Management Plan

3241 Walden Ave.
Depew, New York

October 2009

Mark	Date	Description

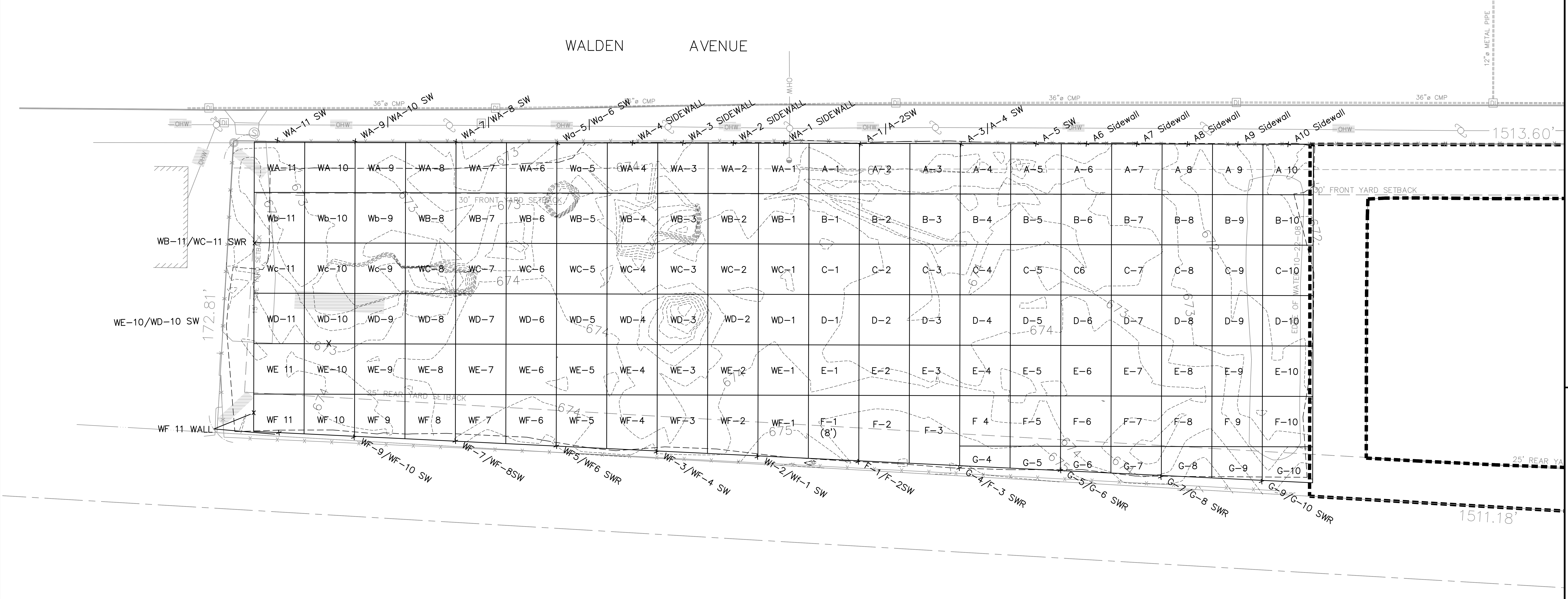
PROJECT NO:	12-6254
FILE:	SMP-126254-02A.dwg
DRAWN BY:	DSH
CHECKED:	JTO
APPROVED BY:	TCC

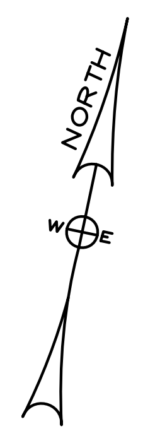
Topographical Survey of Excavation Area

SCALE: As Noted

Figure 3

Tighe & Bond Inc: J:\C\C6254 - former nl\Drawings\0_Current\sheets\SMP-126254-02A.dwg Layout Name: SMP_FIG-3 Plotted by: DFV Plotted on: Nov 03, 2009-2:56pm





Graphic Scale:
0 30' 45' 60'

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Former N.L. Industries Site Management Plan

3241 Walden Ave.
Depew, New York

October 2009

Mark	Date	Description

PROJECT NO: 12-6254
FILE: SMP-126254-02A.dwg
DRAWN BY: DSH
CHECKED: JTO
APPROVED BY: TCC

Remediation Soil Sampling Locations

SCALE: As Noted

Figure 4

Tighe & Bond Inc: J:\C\C6254 - former nl\Drawings\0_Current\sheets\SMP-126254-02A.dwg Layout Name: SMP_FIG-4 Plotted by: DFV Plotted on: Nov 03, 2009-3:01pm

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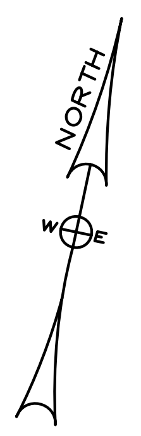
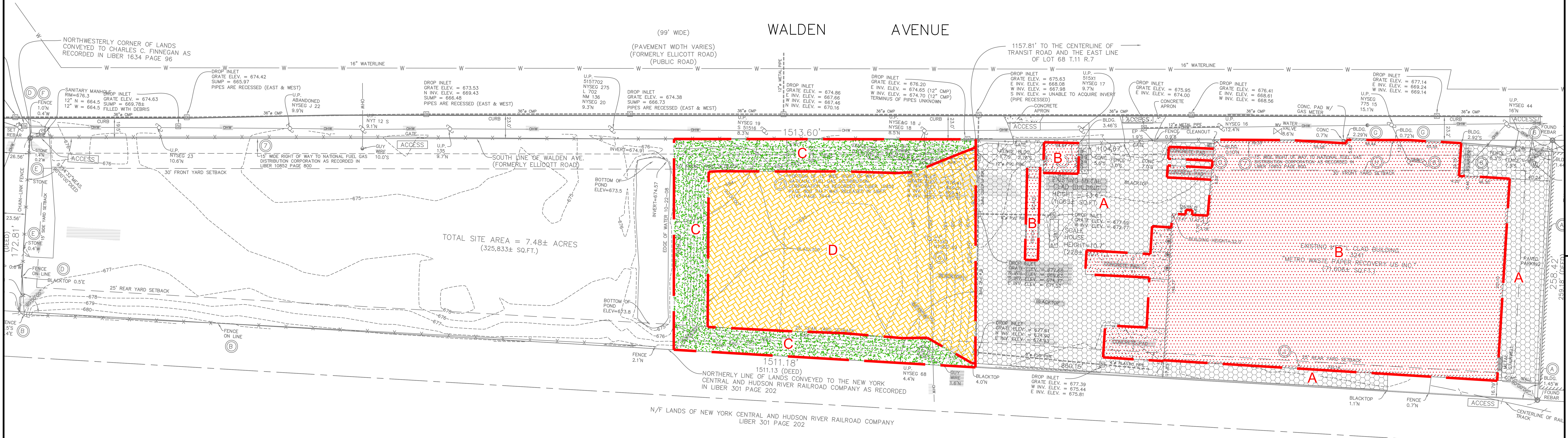
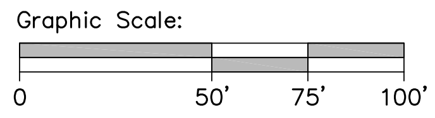






Former N.L. Industries Site Management Plan

3241 Walden Ave.
Depew, New York

October 2009

LEGEND

⬡	COVER SYSTEM A – ASPHALT ONLY
🟥	COVER SYSTEM B – BUILDING & APRON CONCRETE
🟩	COVER SYSTEM C – GEOSYNTHETIC CLAY LINER & SOIL
🟨	COVER SYSTEM D – GEOSYNTHETIC CLAY LINER, SOIL, & ASPHALT

Mark	Date	Description

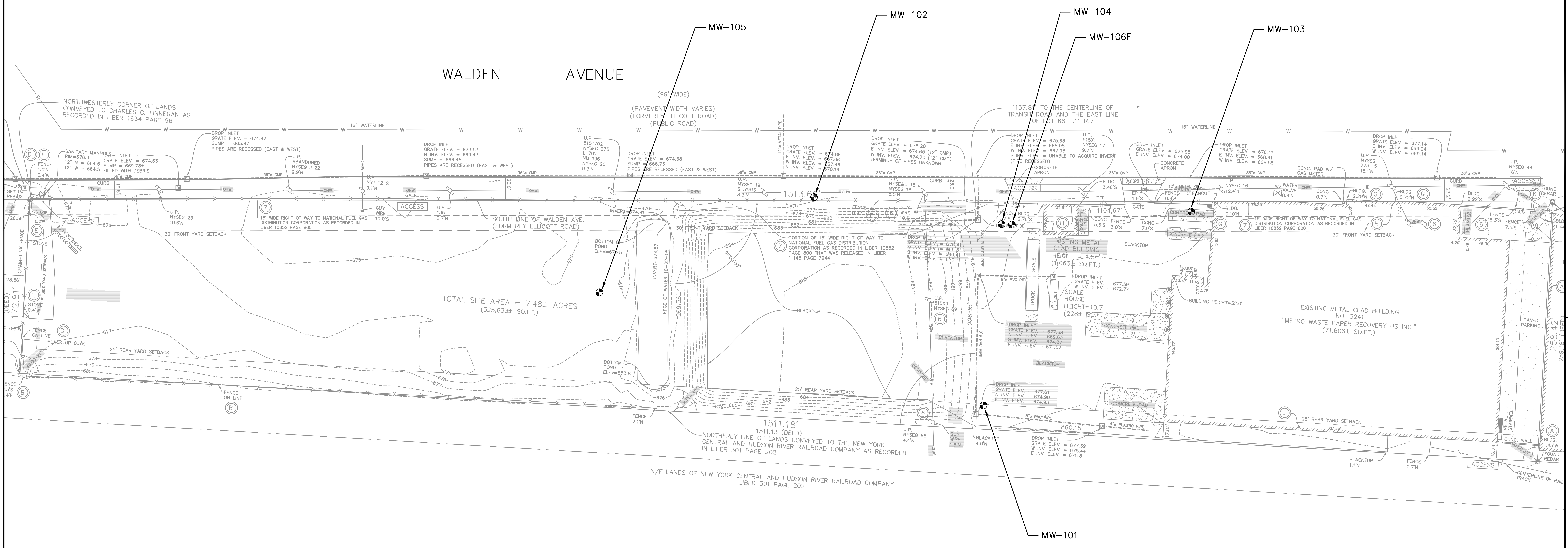
PROJECT NO:	12–6254
FILE:	SMP–126254–02A.dwg
DRAWN BY:	DSH
CHECKED:	JTO
APPROVED BY:	TCC

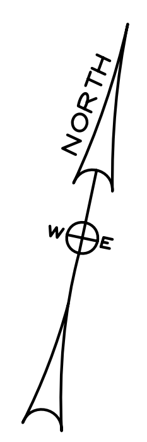
Locations of Cover Systems

SCALE: As Noted

Figure 5

Tighe & Bond Inc: J:\C\C6254 – former nl\Drawings\0_Current\sheets\SMP–126254–02A.dwg Layout Name: SMP_FIG–5 Plotted by: DFV Plotted on: Nov 03, 2009–3:03pm





LEGEND

● MW	MONITORING WELL

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Former N.L. Industries Site Management Plan

3241 Walden Ave.
Depew, New York

October 2009

Mark	Date	Description

PROJECT NO:	12-6254
FILE:	SMP-126254-02A.dwg
DRAWN BY:	DSH
CHECKED:	JTO
APPROVED BY:	TCC

Monitoring Well Location Map

SCALE: As Noted

Figure 6

Tighe & Bond Inc: J:\C\C6254 - former nl\Drawings\0_Current\sheets\SMP-126254-02A.dwg Layout Name: SMP_FIG-6 Plotted by: DFV Plotted on: Nov 03, 2009-3:06pm

Table 1
Norampac Industries
3241 Walden Ave., Depew, N.Y. 14303
Soil Analytical Results for Lead

Sample ID	Date Collected	Result (mg/Kg)
A-1	11/20/2007	26
A-1/A-2SW	1/29/2008	2,890
A-2	11/20/2007	34
A-3	11/20/2007	36
A-3/A-4 SW	1/29/2008	2,800
A-4	11/20/2007	50
A-5	11/20/2007	20
A-5 SW	1/29/2008	1,200
A-6	11/20/2007	10
A6 Sidewall	11/1/2007	11,000
A-7	11/20/2007	10
A7 Sidewall	11/1/2007	5,800
A 8	1/3/2008	158
A8 Sidewall	11/1/2007	8,600
A 9	1/3/2008	165
A9 Sidewall	11/1/2007	38,000
A 10	1/3/2008	362
A10 Sidewall	11/1/2007	4,900
B-1	11/20/2007	10
B-2	11/20/2007	15
B-3	11/20/2007	170
B-4	11/20/2007	14
B-5	11/20/2007	22
B-6	12/20/2007	21
B-7	12/20/2007	21
B-8	1/10/2008	9
B-9	1/10/2008	27
B-10	1/10/2008	6
C-1	11/20/2007	13
C-2	11/20/2007	16
C-3	12/11/2007	11
C-4	12/11/2007	27
C-5	12/11/2007	29
C 6	1/3/2008	76
C-7	12/6/2007	17
C-8	12/6/2007	14
C-9	12/6/2007	14
C-10	12/6/2007	84
D-1	12/11/2007	23
D-2	12/11/2007	12
D-3	12/11/2007	13
D-4	12/6/2007	112
D-5	12/6/2007	26
D-6	12/6/2007	15
D-7	12/6/2007	301
D-8	12/6/2007	20
D-9	12/6/2007	281
D-10	12/6/2007	60
E-1	12/20/2007	19
E-2	12/17/2007	25
E-3	12/17/2007	240
E-4	12/20/2007	17
E-5	12/17/2007	11
E-6	12/17/2007	27
E-7	12/17/2007	17
E-8	12/17/2007	10
E-9	12/17/2007	8
E-10	12/17/2007	13

Table 1
Norampac Industries
3241 Walden Ave., Depew, N.Y. 14303
Soil Analytical Results for Lead

Sample ID	Date Collected	Result (mg/Kg)
F-1 (8')	6/3/2008	16
F-1/F-2 SWR	6/4/2008	950
F-2	12/27/2007	43
F-3	12/27/2007	290
F 4	1/4/2008	13
F-5	12/27/2007	53
F-6	12/27/2007	27
F-7	12/27/2007	130
F-8	12/27/2007	59
F 9	1/4/2008	20
F-10	12/27/2007	170
G-4	12/27/2007	12
G-4/F-3 SWR	6/4/2008	3,000
G-5	12/27/2007	360
G-5/G-6 SWR	6/4/2008	98
G-6	12/27/2007	29
G-7	12/27/2007	87
G-7/G-8 SWR	6/4/2008	18,000
G-8	12/27/2007	11
G-9	12/27/2007	69
G-9/G-10 SWR	6/4/2008	40,000
G-10	12/27/2007	310
WA-1	1/9/2008	18
WA-1 SIDEWALL	1/9/2008	1,960
WA-2	1/9/2008	30
WA-2 SIDEWALL	1/9/2008	1,070
WA-3	1/9/2008	33
WA-3 SIDEWALL	1/9/2008	1,070
WA-4	1/9/2008	22
WA-4 SIDEWALL	1/9/2008	895
Wa-5	7/10/2008	99
WA-6	7/10/2008	18
Wa-5/Wa-6 SW	7/10/2008	806
WA-7	7/10/2008	11
WA-8	7/10/2008	13
WA-7/WA-8 SW	7/10/2008	408
Wa-9	7/11/2008	14
Wa-10	7/11/2008	6
WA-9/WA-10 SW	7/11/2008	221
Wa-11	7/14/2008	15
WA-11 SW	7/14/2008	212
WB-1	12/11/2007	19
WB-2	12/11/2007	25
WB-3	12/11/2007	11
WB-4	12/17/2007	10
WB-5	1/16/2008	10
WB-6	1/16/2008	9
WB-7	1/16/2008	14
WB-8	1/29/2008	24
WB-9	2/8/2008	11
WB-10	2/8/2008	10
WB-11	2/8/2008	36
WB-11/WC-11 SWR	7/14/2008	93

Table 1
Norampac Industries
3241 Walden Ave., Depew, N.Y. 14303
Soil Analytical Results for Lead

Sample ID	Date Collected	Result (mg/Kg)
WC-1	12/11/2007	13
WC-2	12/11/2007	33
WC-3	12/11/2007	12
WC-4	12/17/2007	27
WC-5	1/16/2008	18
WC-6	1/16/2008	8
WC-7	1/16/2008	14
WC-8	1/29/2008	14
WC-9	2/8/2008	13
WC-10	2/8/2008	11
WC-11	2/8/2008	9
WD-1	12/11/2007	47
WD-2	12/11/2007	13
WD-3	12/11/2007	9
WD-4	12/17/2007	12
WD-5	1/16/2008	10
WD-6	1/16/2008	22
WD-7	1/16/2008	9
WD-8	1/29/2008	12
WD-9	1/29/2008	15
WD-10	1/29/2008	15
WD-11	1/29/2008	12
WE-1	12/20/2007	15
WE-2	12/20/2007	14
WE-3	12/20/2007	17
WE-4	12/20/2007	15
WE-5	1/16/2008	9
WE-6	1/16/2008	14
WE-7	1/16/2008	10
WE-8	1/29/2008	39
WE-9	1/29/2008	13
WE-10	1/29/2008	7
WE-10/WD-10 SW	1/29/2008	120
WE 11	1/4/2008	49
WF-1	12/27/2007	59
WF-1/WF-2SW	1/29/2008	217
WF-2	12/27/2007	16
WF-3	12/27/2007	12
WF-3/WF-4 SW	1/29/2008	360
WF-4	12/27/2007	17
WF-5	12/27/2007	24
WF-5/WF-6 SWR	6/3/2008	120
WF-6	12/27/2007	15
WF 7	1/4/2008	112
WF-7/WF-8SW	1/29/2008	163
WF 8	1/4/2008	14
WF 9	1/4/2008	17
WF-9/WF-10 SW	1/29/2008	87
WF 10	1/4/2008	13
WF 11	1/4/2008	146
WF-11 WALL	1/4/2008	17

Recommended Soil Cleanup Concentration for Lead is 400 mg/Kg
mg/Kg = Milligram per Kilogram

TABLE 2
Backfill and Cover Soil Quality Standards (6NYCRR 375-6.7(d))

Constituent	CAS Number	Criteria
Metals (mg/kg)		
Arsenic	7440-38-2	13
Barium	7440-39-3	350
Beryllium	7440-41-7	7.2
Cadmium	7440-43-9	2.5
Chromium, hexavalent	18540-29-9	1
Chromium, trivalent	16065-83-1	30
Copper	7440-50-8	50
Total Cyanide		27
Lead	7439-92-1	63
Manganese	7439-96-5	1600
Total Mercury		0.18
Nickel	7440-02-0	30
Selenium	7782-49-2	3.9
Silver	7440-22-4	2
Zinc	7440-66-6	109
PCBs/Pesticides		
2,4,5-TP Acid (Silvex)	93-72-1	3.8
4,4’-DDE	72-55-9	0.0033
4,4’-DDT	50-29-3	0.0033
4,4’-DDD	72-54-8	0.0033
Aldrin	309-00-2	0.005
alpha-BHC	319-84-6	0.02
beta-BHC	319-85-7	0.036
Chlordane (alpha)	5103-71-9	0.094
delta-BHC	319-86-8	0.04
Dibenzofuran	132-64-9	7.0
Dieldrin	60-57-1	0.005
Endosulfan I	959-98-8	2.4
Endosulfan II	33213-65-9	2.4
Endosulfan sulfate	1031-07-8	2.4
Endrin	72-20-8	0.014
Heptachlor	*76-44-8*	0.042
Lindane	58-89-9	0.1
Polychlorinated biphenyls	1336-36-3	0.1
Semivolaitle Organic Compounds		
Acenaphthene	83-32-9	20
Acenapthylene	208-96-8	100
Anthracene	120-12-7	100
Benz(a)anthracene	56-55-3	1
Benzo(a)pyrene	50-32-8	1
Benzo(b)fluoranthene	205-99-2	1
Benzo(g,h,i)perylene	191-24-2	100
Benzo(k)fluoranthene	207-08-9	0.8
Chrysene	218-01-9	1.0
Dibenz(a,h)anthracene	53-70-3	0.3
Fluoranthene	206-44-0	100
Fluorene	86-73-7	30
Indeno(1,2,3-cd)pyrene	193-39-5	0.5
m-Cresol	108-39-4	0.3
Naphthalene	91-20-3	12
o-Cresol	95-48-7	0.3
p-Cresol	106-44-5	0.3
Pentachlorophenol	87-86-5	0.8
Phenanthrene	85-01-8	100
Phenol	108-95-2	0.33
Pyrene	129-00-0	100

TABLE 2
Backfill and Cover Soil Quality Standards (6NYCRR 375-6.7(d))

Constituent	CAS Number	Criteria
Volatile Orgainc Compounds		
1,1,1-Trichloroethane	71-55-6	0.7
1,1-Dichloroethane	75-34-3	0.3
1,1-Dichloroethene	75-35-4	0.3
1,2-Dichlorobenzene	95-50-1	1.1
1,2-Dichloroethane	107-06-2	0.02
cis -1,2-Dichloroethene	156-59-2	0.25
trans-1,2-Dichloroethene	156-60-5	0.19
1,3-Dichlorobenzene	541-73-1	2.4
1,4-Dichlorobenzene	106-46-7	1.8
1,4-Dioxane	123-91-1	0.1
Acetone	67-64-1	0.05
Benzene	71-43-2	0.06
n-Butylbenzene	104-51-8	12
Carbon tetrachloride	56-23-5	0.76
Chlorobenzene	108-90-7	1.1
Chloroform	67-66-3	0.37
Ethylbenzene	100-41-4	1
Hexachlorobenzene	118-74-1	0.33
Methyl ethyl ketone	78-93-3	0.12
Methyl tert-butyl ether	1634-04-4	0.93
Methylene chloride	75-09-2	0.05
n - Propylbenzene	103-65-1	3.9
sec-Butylbenzene	135-98-8	11
tert-Butylbenzene	98-06-6	5.9
Tetrachloroethene	127-18-4	1.3
Toluene	108-88-3	0.7
Trichloroethene	79-01-6	0.47
1,2,4-Trimethylbenzene	95-63-6	3.6
1,3,5-Trimethylbenzenef	108-67-8	8.4
Vinyl chloridef	75-01-4	0.02
Xylene (mixed)	1330-20-7	0.26

mfl = million fibers per liter
mg/L = milligrams per liter or ppm
μg/m^3 = micrograms per cubic meter
ppb = parts per billion
ppm = parts per million
mg/L = milligrams per liter or ppm
J - Result is less than the reporting limit, but greater than the method detection limit and the concentration is an approximate value.
* - Compound was found in the laboratory blank and sample.

Values listed are summarized from the compilation of the data listed in the RSRs (1996), the Comprehensive List of Approved Additional Polluting Substances Criteria and Alternative Criteria (2005), and the Proposed Revisions to the CT RSR's Volatilization Criteria (2003).

This table was compiled for use only as a quick reference tool, and the source document should be ultimately consulted for comparing site results with criteria and making cleanup and compliance decisions.

APPENDIX A

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

June 22, 2009

Mr. Jaspal S. Walia, P.E.
Environmental Engineer II
NY State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Ave.
Buffalo, NY 14203

Re: Former NL Industries Site, Walden Avenue, Depew
Test Pit Investigation Findings

Dear Mr. Walia:

Benchmark Environmental Engineering & Science, PLLC has prepared this report to summarize the findings of the recent test pit investigation performed at the subject Site.

Test pit work was performed on June 4th and 5th, 2009 per with our approved (May 14, 2009) Work Plan. Accordingly, test pits were completed at ten locations (i.e., test pits TP-1 through TP-10) as shown on Figure 1, attached. (Note that test pits TP-6 and TP-7 are extensions of prior test pits TP-09-01 and TP-09-02, respectively). In addition, at the request of the Department two additional test pits, deemed TP-11 and TP-12, were completed east of the storm water catch basin located near the northeast corner of the truck yard.

Test pits were advanced to the sooner of native soil, first encountered groundwater, or concentrated pockets of cylinders (where encountered). Prior to excavation, asphalt cover was saw-cut and staged onsite for future disposal. Excavated soil/fill was placed on poly sheeting and subsequently replaced/compacted in the test pits to the extent feasible. Excess soil/fill, comprising approximately 4 cubic feet of material, was placed in a new, DOT-approved 55-gallon steel drum and sealed for disposal by Metro Waste/Norampac personnel. Cylinders, where detected, were placed in the TP-11 subgrade or left in place at NYSDEC's direction. Following backfill, all test pit locations were restored with asphalt cold patch.

SUMMARY OF FINDINGS

A summary of test pit observations is presented as Table 1. Select photos are presented as Attachment 1. As indicted on Table 1, no cylinders were found at any of the test pit locations with the following exceptions:

- At TP-4, cylinders were encountered sparsely in fill soils. A total of 9 cylinders were identified in the initial test pit (30"L x 16"W x 44"D), representing a frequency of less than 1 per cubic foot. These cylinders were placed in the TP-11 subgrade. At DEC's request, the test pit was extended north and south approximately 1-foot, and similar conditions were encountered (i.e., 2 to 3 cylinders in each direction). These cylinders were left in place.

- At TP-7, two broken cylinders were found at the interface of the test pit and catch basin. These cylinders were placed in the TP-11 subgrade.

- At test pits TP-11 and TP-12, buried cylinders were encountered at depths of 1 to 1.5 feet below grade.

CONCLUSIONS AND RECOMMENDATIONS

The investigation did not reveal concentrated areas of cylinders at any locations with the exception of TP-11 and TP-12. At these locations, cylinders were detected 1-2 feet below grade beneath the asphalt parking area cover. No cylinders were detected at TP-09-01, located approximately 6 feet south of TP-11/12, or TP-09-02, located approximately 9-feet north of TP-11/12.

Concerning the potential eastern limit of the cylinders, Benchmark contacted PanAmerican Environmental, Inc. of Buffalo, NY, who provided oversight during construction of the truck scale located approximately 45 feet east of the catch basin. PanAmerican reports that no cylinders were encountered during this work. Therefore it appears that the concentrated area of cylinders are present in a maximum 15' wide x 45' long area as shown on Figure 1. Based on the depth to native soils in the area and field observations and photos taken by PanAmerican during catch basin construction, it is assumed that the cylinders are present in a layer approximately 1-2 feet thick beginning at a depth of 12-24" below grade.

Based on the isolated nature of the cylinders and their location proximate to adjacent utilities/structures and the site entrance off Walden Avenue (i.e., an unlikely area for new construction), their presence is not anticipated to pose a deterrent to potential future Site redevelopment. In addition, the presence of the cylinders beneath the truck yard paving poses no significant threat to human health or the environment. As such, it is recommended that the Site Management Plan be modified to include a description of the findings of this investigation and appropriate procedures for handling of cylinders if encountered near TP-11/12 or any other location across the Site during future redevelopment work.

Please do not hesitate to contact us if you have any questions.

Sincerely,
Benchmark Environmental Engineering & Science, PLLC

Thomas H. Forbes, P.E.
Project Manager

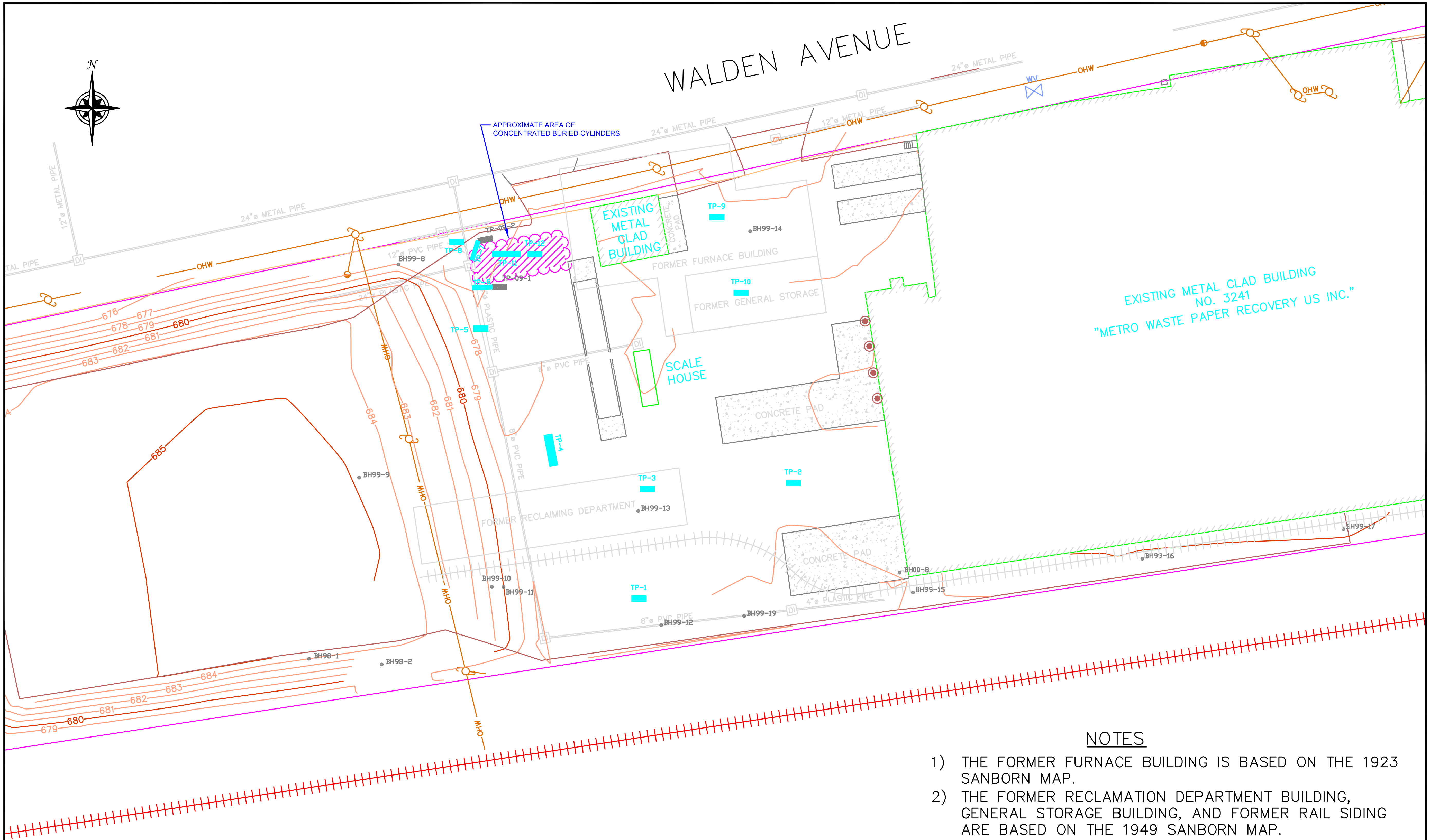
C: L. Marineau (Norampac)
C. Slater (Harter Secrest)
M. Forcucci (NYSDOH)
M. Doster (NYSDEC)
J. Charles (NYSDEC)

TABLE 1
FORMER NL INDUSTRIES SITE
TEST PIT INVESTIGATION SUMMARY

Test Pit Location	Description/Observations[1]
TP-1	Test pit dimensions 36" L x 16" W x 28"D, asphalt overlying fill soils. Top of groundwater encountered at 28" BGS. No cylinders or odors identified
TP-2	Test pit dimensions 36" L x 14" W x 25"D, asphalt overlying fill soils. Top of groundwater encountered at 25" BGS. No cylinders or odors identified
TP-3	Test pit dimensions 51" L x 16" W x 39"D, asphalt overlying fill soils. Top of groundwater encountered at 39" BGS. No cylinders or odors identified
TP-4	Final Test pit dimensions 60" L x 16" W x 44"D, asphalt overlying fill soils. Top of groundwater encountered at 42" BGS. Occasional cylinders identified, length expanded at DEC request - total of 14 cylinders found.
TP-5	Test pit dimensions 48" L x 18" W x 54"D, asphalt overlying fill soils. Top of native soil encountered at 54" BGS. No cylinders or odors identified
TP-6	Test pit dimensions 84" L x 16" W x 48"D, asphalt overlying fill soils. Top of native soil encountered at 36" BGS. No cylinders or odors identified
TP-7	Test pit dimensions 120" L x 16" W x 48"D, asphalt overlying fill soils. Top of native soil encountered at 36" BGS. Two broken cylinders encountered in fill soil at catch basin interface.
TP-8	Test pit dimensions 108" L x 18" W x 30"D, asphalt overlying fill soils. Top of native soil encountered at 30" BGS. No cylinders or odors identified
TP-9	Test pit dimensions 54" L x 20" W x 36"D, asphalt overlying fill soils. Top of native soil encountered at 24" BGS. No cylinders or odors identified
TP-10	Test pit dimensions 42" L x 17" W x 36"D, asphalt overlying fill soils. Top of native soil encountered at 24" BGS. No cylinders or odors identified
TP-11	Test pit dimensions 120" L x 18" W x 12"D Significant cylinders encountered at 12" BGS
TP-12	Test pit dimensions 48" L x 18" W x 24"D Significant cylinders encountered at 20" BGS.

Notes: Fill soils generally described as clay soil intermingled with varying quantities of brick, ash, and glass.

F:\CAD\Benchmark\Harter, Secrest, & Emery\Norampac\Brass Cylinder Investigation\Figure 1 - June 22, 2009.dwg, 6/22/2009 3:48:25 PM, Adobe PDF



NOTES

1) THE FORMER FURNACE BUILDING IS BASED ON THE 1923 SANBORN MAP.
2) THE FORMER RECLAMATION DEPARTMENT BUILDING, GENERAL STORAGE BUILDING, AND FORMER RAIL SIDING ARE BASED ON THE 1949 SANBORN MAP.
3) THIS FIGURE HAS BEEN ADOPTED FROM NUSSBAUMER & CLARKE, INC. NOVEMBER 2008 DRAWING.

LEGEND

● BH98-2 BORING LOCATION FROM PREVIOUS STUDY.

TP-09-1 ▬ TEST PIT LOCATION FROM PREVIOUS STUDY.

▬ TP-1 JUNE 2009 TEST PIT LOCATION.

DATE: APRIL 2009 (REV: MAY 14, 2009)
DRAFTED BY: JCT

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

726 EXCHANGE STREET
SUITE 624
BUFFALO, NEW YORK 14210
(716) 856-0599

JOB NO.: 0120-005-100

TEST PIT LOCATIONS

CYLINDER INVESTIGATION

FORMER NL INDUSTRIES SITE
DEPEW, NEW YORK
PREPARED FOR
HARTER SECREST & EMERY, LLP

FIGURE 1

ATTACHMENT 1

PHOTO LOG

PHOTOGRAPHIC LOG

Client Name: Harter, Secrest & Emery, LLP	**Site Location:** Norampac Site, 3241 Walden Ave	**Project No.:** 0120-005-100

Photo No. 1	**Date** 06/04/09

Direction Photo Taken:
Looking to the west

Description:
Test Pit 1 excavated to 28" below grade.

Photo No. 2	**Date** 06/04/09

Direction Photo Taken:
Looking to the north

Description:
Test Pit 2 excavated to 25" below grade.

Photo No.	**Date**
3	06/04/09

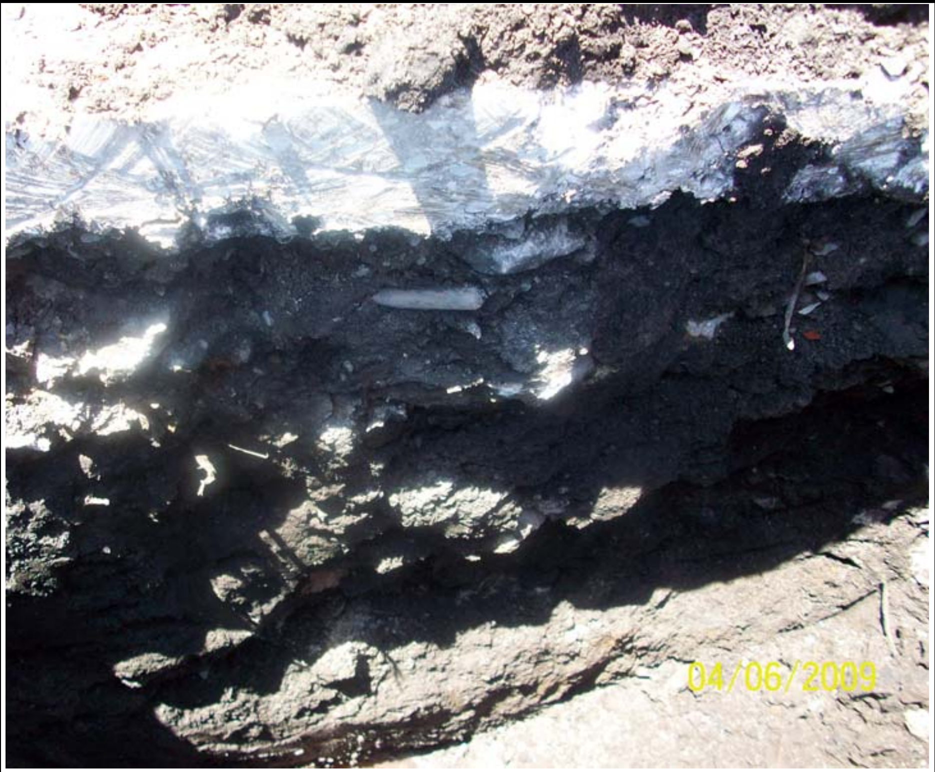
Direction Photo Taken:
Looking to the northeast

Description:
Test Pit 3 excavated to 39" below grade.

Photo No.	**Date**
4	06/04/09

Direction Photo Taken:
Looking to the west

Description:
Test Pit 4 excavated to 42" below grade. Cylinder in center of photo 3" below aphalt.



Prepared By: BG

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.:
Harter, Secrest & Emery, LLP	Norampac Site, 3241 Walden Ave	0120-005-100

Photo No.	Date
5	06/04/09

Direction Photo Taken:
Looking to the north

Description:
Test Pit 5 excavated to 54" below grade.

Photo No.	Date
6	06/04/09

Direction Photo Taken:
Looking to the south

Description:
Test Pit 6 excavated to 36" below grade.

PHOTOGRAPHIC LOG

Client Name:
Harter, Secrest & Emery, LLP

Site Location:
Norampac Site, 3241 Walden Ave

Project No.:
0120-005-100

Photo No.	**Date**
7	06/04/09

Direction Photo Taken:
Looking to the northeast

Description:
Test Pit 7 excavated to 36" below grade.

Photo No.	**Date**
8	06/05/09

Direction Photo Taken:
Looking to the east

Description:
Test Pit 8 excavated to 30" below grade.

Prepared By: BG

BENCHMARK
ENVIRONMENTAL
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SCIENCE, PLLC

PHOTOGRAPHIC LOG

Client Name:
Harter, Secrest & Emery, LLP

Site Location:
Norampac Site, 3241 Walden Ave

Project No.:
0120-005-100

Photo No.	**Date**
9	06/05/09

Direction Photo Taken:
Looking to the northwest

Description:
Test Pit 9 excavated to 24" below grade.

Photo No.	**Date**
10	06/05/09

Direction Photo Taken:
Looking to the Northwest

Description:
Test Pit 10 excavated to 24" below grade. Remains of a brick floor.

Prepared By: BG

Client Name:	Site Location:	Project No.:
Harter, Secrest & Emery, LLP	Norampac Site, 3241 Walden Ave	0120-005-100

Photo No.	Date
11	06/05/09

Direction Photo Taken:
Looking to the south

Description:
Test Pit 11 excavated to 12" below grade.

Photo No.	Date
12	06/05/09

Direction Photo Taken:
Looking to the north

Description:
Test Pit 12 excavated to 24" below grade. Cylinders found at approx 24" below grade.

PHOTOGRAPHIC LOG

Client Name: Harter, Secrest & Emery, LLP	**Site Location:** Norampac Site, 3241 Walden Ave	**Project No.:** 0120-005-100

Photo No.	**Date**
13	06/05/09

Direction Photo Taken:
Looking to the Northeast

Description:
Veiw of restored test pits 5, 6, 7, 8, 11 and 12.

APPENDIX B

Appendix B - Excavation Work Plan

B-1 Notification

At least 15 days prior to the start of any activity that is anticipated to encounter or disturb impacted fill material within the eastern and/or western sections of the site (as identified on Figure 2 of the SMP), the site owner or their representative will notify the NYSDEC. Currently, this notification will be made to:

Mr. Jaspal Walia
NYSDEC Region 9 Office
270 Michigan Avenue
Buffalo, NY 14203
(716) 851-7220

It is noted that since the western section of the property already meets unrestricted requirements, there is no requirement to notify the NYSDEC and any work being conducted within this section of the property

This notification will include:

- A detailed description of the work to be performed, including the location and areal extent, plans for site re-grading, intrusive elements or utilities to be installed below the soil cover, estimated volumes of impacted material to be excavated and any work that may impact an EC.
- A summary of environmental conditions anticipated in the work areas, including the nature and concentrations of COCs, potential presence of grossly contaminated media, and plans for any pre-construction sampling.
- A schedule for the work, detailing the start and completion of all intrusive work
- A summary of the applicable components of this EWP
- A statement that the work will be performed in compliance with this EWP and 29 CFR 1910.120.
- A copy of the contractor’s health and safety plan in electronic format.
- Identification of disposal facilities for potential waste streams.
- Identification of sources of any anticipated backfill, along with all required chemical testing results.

B-2 Soil Sampling Methods

Any impacted soil and/or fill that is excavated during on-site intrusive activities which cannot be used as fill below the cover system will be assumed to be impacted and be further characterized prior to transportation off-site for disposal at a permitted facility.

Visual, olfactory and instrument-based soil screening will be performed by a qualified environmental professional during all remedial and development excavations into impacted areas. Soil screening will be performed regardless of when the invasive work is done and will include all excavation and invasive work performed during development, such as excavations for foundations and utility work, after issuance of the COC.

For excavated soil/fill, one composite sample and a duplicate sample will be collected for each 100 cubic yards of soil/fill that will be generated from site activities. The composite sample will be collected from five grab locations. A duplicate composite sample will also be collected. PID measurements will be recorded for each of the five individual grab locations. One grab sample will be collected from the individual location with the highest PID measurement for volatile organic compound (VOC) analysis. If none of the five individual sample locations exhibit PID readings, one location will be selected at random. The composite and grab samples will be analyzed for constituents as required by the disposal facility.

Soil samples will be composited by placing equal portions of soil/fill from each of the five grab sample locations into a pre-cleaned, stainless steel (or Pyrex glass) mixing bowl. The soil/fill will be thoroughly homogenized using a stainless steel scoop or trowel and transferred to pre-cleaned jars provided by the laboratory. Sample jars will then be labeled and a chain-of-custody form will be prepared.

B-3 Stockpile Methods

Any disturbed impacted fill/soil requiring temporary stockpiling will be continuously encircled with a berm and/or silt fence. Hay bales will be used as needed near catch basins, surface waters and other discharge points.

Stockpiles will be kept covered at all times with appropriately anchored tarps. Stockpiles will be routinely inspected and damaged tarp covers will be promptly replaced.

Stockpiles will be inspected at a minimum once each week and after every storm event. Results of inspections will be recorded in a logbook and maintained at the site and available for inspection by NYSDEC.

B-4 Materials Excavation and Load Out

A qualified environmental professional or person under their supervision will oversee all invasive work and the excavation and load-out of all excavated material.

The owner of the property and its contractors are solely responsible for safe execution of all invasive and other work performed under this Plan.

The presence of utilities and easements on the site will be investigated by the qualified environmental professional. It will be determined whether a risk or impediment to the planned work under this SMP is posed by utilities or easements on the site.

Loaded vehicles leaving the site will be appropriately lined, tarped, securely covered, manifested, and placarded in accordance with appropriate Federal, State, local, and NYSDOT requirements (and all other applicable transportation requirements).

A truck wash will be operated on-site. The qualified environmental professional will be responsible for ensuring that all outbound trucks will be washed at the truck wash before leaving the site until the activities performed under this section are complete.

Locations where vehicles enter or exit the site shall be inspected daily for evidence of off-site soil tracking.

The qualified environmental professional will be responsible for ensuring that all egress points for truck and equipment transport from the site are clean of dirt and other materials derived from the site during intrusive excavation activities. Cleaning of the adjacent streets will be performed as needed to maintain a clean condition with respect to site-derived materials.

B-5 Materials Transport Off-Site

All impacted fill/soil material designated for disposal will be transported by licensed haulers in accordance with appropriate local, State, and Federal regulations, including 6 NYCRR Part 364. Haulers will be appropriately licensed and trucks properly placarded.

Material transported by trucks exiting the site will be secured with tight-fitting covers. Loose-fitting canvas-type truck covers will be prohibited. If loads contain wet material capable of producing free liquid, truck liners will be used.

All trucks will be washed prior to leaving the site. Truck wash waters will be collected and disposed of off-site in an appropriate manner.

All trucks loaded with site materials will exit the vicinity of the site using a task specific approved truck route. The task specific route will be determined based on the following criteria: (a) location of work to be performed on-site (b) limiting transport through residential areas and past sensitive sites; (c) use of city mapped truck routes; (d) prohibiting off-site queuing of trucks entering the facility; (e) limiting total distance to major highways; (f) promoting safety in access to highways; and (g) overall safety in transport.

Trucks will be prohibited from stopping and idling in the neighborhood outside the project site.

Egress points for truck and equipment transport from the site will be kept clean of dirt and other materials during site remediation and development.

Queuing of trucks will be performed on-site in order to minimize off-site disturbance. Off-site queuing will be prohibited.

B-6 Materials Disposal Off-Site

All soil/fill/solid waste excavated and removed from the site will be treated as contaminated and regulated material and will be transported and disposed in accordance with all local, State (including 6NYCRR Part 360) and Federal regulations. If disposal of soil/fill from this site is proposed for unregulated off-site disposal (i.e. clean soil removed for development purposes), a formal request with an associated plan will be made to the NYSDEC. Unregulated off-site management of materials from this site will not occur without formal NYSDEC approval.

Off-site disposal locations for excavated soils will be identified in the pre-excavation notification. This will include estimated quantities and a breakdown by class of disposal facility if appropriate, i.e. hazardous waste disposal facility, solid waste landfill, petroleum treatment facility, C/D recycling facility, etc. Actual disposal quantities and associated documentation will be reported to the NYSDEC in the Periodic Review Report. This documentation will include: waste profiles, test results, facility acceptance letters, manifests, bills of lading and facility receipts.

Non-hazardous historic fill and contaminated soils taken off-site will be handled, at minimum, as a Municipal Solid Waste per 6NYCRR Part 360-1.2. Material that does not meet Track 1 unrestricted SCOs is prohibited from being taken to a New York State recycling facility (6NYCRR Part 360-16 Registration Facility).

B-7 Gas Cylinders

As discussed in the SMP, buried gas cylinders have been encountered during previous excavation activities at the site. If additional cylinders are encountered during any subsurface activities, excavation will cease and the Owner's P.E. and NYSDEC will immediately be notified. All cylinders encountered will be evaluated by the Owner's P.E. and the Owner will submit a removal plan to NYSDEC for review and approval. Appropriately trained personnel will excavate and remove all cylinders within the designated work area while following all applicable federal, state, and local regulations. Removed cylinders will be properly characterized and removed from the site.

B-8 Materials Reuse On-Site

The qualified environmental professional will ensure that procedures defined for materials reuse in this SMP are followed and that unacceptable material does not remain on-site. Contaminated on-site material, including historic fill and contaminated soil, that is acceptable for re-use on-site will be placed below the demarcation layer or cover system, and will not be reused within a cover soil layer, within landscaping berms, or as backfill for subsurface utility lines.

Any demolition material proposed for reuse on-site will be sampled for asbestos and the results will be reported to the NYSDEC for acceptance. Concrete crushing or processing on-site will not be performed without prior NYSDEC approval. Organic matter (wood, roots, stumps, etc.) or other solid waste derived from clearing and grubbing of the eastern or central portions of the site will not be reused on-site.

Sub-grade material used to backfill excavations or placed to increase site grades or elevation in areas not under a cover system shall meet the following criteria:

- Off-site borrow soils will be documented as having originated from locations having no evidence of disposal or release of hazardous, toxic or radioactive substances, wastes or petroleum products.

- Off-site soils intended for use as site backfill cannot otherwise be defined as a solid waste in accordance with 6 NYCRR Part 360-1.2(a).

- If the Contractor designates a source as "virgin" soil, it shall be further documented in writing to be native soil material from areas not having supported any known prior industrial or commercial development or agricultural use.

- Virgin soils should be subject to collection of one representative composite sample per source. The sample should be analyzed for toxicity characteristic leaching procedure (TCLP) VOCs, SVOCs, pesticides, PCBs, arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and cyanide. The soil may not exceed any constituent limits as set forth in NYSDEC's Imported Backfill Limits – Track 2 Restricted Residential.

- Non-virgin soils will be tested via collection of one composite sample per 500 cubic yards of material from each source area. If more than 1,000 cubic yards of soil are borrowed from a given off-site non-virgin soil source area and both samples of the first 1,000 cubic yards are acceptable, the sample collection frequency will be reduced to one composite for every 2,500 cubic yards of additional soils from the same source, up to 5,000 cubic yards. For borrow sources greater than 5,000 cubic yards, sampling frequency may be reduced to one sample per 5,000 cubic yards. The sample should be analyzed for TCL VOCs, SVOCs, pesticides, PCBs, arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and cyanide. The soil may not exceed any constituent limits as set forth in NYSDECs Imported Backfill Limits – Track 2 Restricted Residential.

- All imported soils will meet the backfill and cover soil quality standards established in 6NYCRR 375-6.7(d). Based on an evaluation of the land use, protection of groundwater and protection of ecological resources criteria, the resulting soil quality standards are listed as Table 2 in the SMP. Soils that meet 'exempt' fill requirements under 6 NYCRR Part 360, but do not meet backfill or cover soil objectives for this site, will not be imported onto the site without prior approval by NYSDEC. Solid waste will not be imported onto the site. Trucks entering the site with imported soils will be securely covered with tight fitting covers. Imported soils will be stockpiled separately from excavated materials and covered to prevent dust releases.

B-9 Fluids Management

Pumping of water (i.e., groundwater and/or stormwater) that has accumulated within an open excavation will be done in such a manner as to prevent the migration of particulates, soil/fill, or unsolidified concrete materials and to prevent damage to the existing sub-grade. Water pumped from excavations will be managed properly in accordance with all applicable regulations so as to prevent endangerment of public health, site, or any portion of the construction.

In areas where groundwater may be contaminated or stormwater has accumulated in an known area of impacted fill, the water will be pumped from the excavation, containerized and then analyzed in accordance with the Surface Water and Groundwater Quality Standards set forth in 6 NYCRR Part 703.5 and in accordance with any local sewer authority requirements. If the water meets the surface water and groundwater quality standards, it may be discharged to the ground surface. If the water does not meet the surface water and groundwater quality standards, it may be discharged to the local sewer authority under a discharge permit. If the water quality is such that the local sewer authority discharge permit requirements will be exceeded, or the local sewer authority will not approve the discharge to a sewer, the water must be transported off-site for proper disposal or treated on-site via a treatment system that has been approved by NYSDEC.

B-10 Cover System Restoration

After the completion of soil removal and any other invasive activities the cover system will be restored in a manner that complies with the SMP.

Asphalt Only Cover System:

- Areas of significant damage or damaged areas which have the potentially to allow public access/exposure to sub-base materials (as determined by the owner's P.E.) will be immediately repaired. Degree of repair (i.e. resealing and/or placement of new asphalt) will be dependent on type and size of the damaged area. If the damage is determined to be of great significance that may cause for the disturbance of impacted materials, the SMP shall be followed and worker protection measures implemented.

Building and Apron Concrete Cover System:

- Cracks within the concrete that are determined (by the owners P.E.) to be of significant size and/or width will be repaired by grinding out a suitably-sized groove along the crack and filling the groove with an elastomeric caulk.
- Areas of significant damage or damaged areas which have the potentially to allow public access/exposure to sub-base materials (as determined by the owner's P.E.) will be immediately repaired. Degree of repair (i.e. resealing and/or placement) will be dependent on type and size of the damaged area. If the damage is determined to be of great significance that may cause for the disturbance of impacted materials, the SMP shall be followed and worker protection measures implemented.

GCL and Soil Cover System:

- All non-paved areas (side slopes of the containment cell) of the central section containment cell are covered by approximately 12 inches of clean soil underlain by a GCL covering with a 6-inch sand layer between the GCL and impacted fill. All exposed soil has been hydro seeded as an erosion control methodology.
- Repairs to the GCL are not anticipated as the GCL will be contained below grade. If however damage to the containment cell occurs and repairs to the GCL become necessary (as determined by the Owner's P.E.), the area in question will marked and then be temporarily covered with clean fill in order to limit public access to the impacted materials and a contractor will be contacted to schedule immediate repairs. In all cased the SMP shall be followed and worker protection measures implemented.
- If the GCL liner becomes damaged or is in need of repair, it will be repaired by completely exposing the affected area by removing all foreign objects or soil, and a new section of GCL will be placed/patched over the damaged area with a minimum overlap of 12 inches on all edges. Accessory bentonite will be placed between the patch and the repaired material at a rate of a quarter pound per lineal foot of edge spread in a six-inch width. If damage occurs on a slope, the same basic procedure will be used; however, the edges of the patch will be fastened to the repaired liner with contact cement, epoxy, or some other construction adhesive, in addition to the bentonite-enhanced seam.

GCL and Asphalt Cover System:

- Areas of significant damage or damaged areas which have the potentially to allow public access/exposure to sub-base materials (as determined by the owner's P.E.) will be immediately repaired. Degree of repair (i.e. resealing and/or placement of new asphalt) will be dependent on type and size of the damaged area. If the damage is determined to be of significance that causes disturbance to the GCL, repair procedures to the GCL as described in Section 4.3.4.1 will be implemented. In all cased the SMP shall be followed and worker protection measures implemented.

B-71 Stormwater Pollution Prevention

Although not anticipated, any disturbance of more than one acre of the site will require the Owner to follow the requirements for coverage under the Construction Storm Water General Permit including the submittal of a Notice of Intent (NOI) form and the development of a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP must fulfill all permit requirements and must be prepared in accordance with "Chapter Four: the Storm Water Management and Erosion Control Plan" in Reducing Impacts of Storm Water Runoff from New Development, NYSDEC, 1992. The Storm Water Management and Erosion Control Plan, in accordance with permit requirements, must provide the following information:

- A background discussion of the scope of the construction project.
- A statement of the storm water management objectives.
- An evaluation of post-development runoff conditions.
- A description of proposed storm water control measures.
- A description of the type and frequency of maintenance activities required to support the control measure.

The SWPPP will address issues such as erosion prevention, sedimentation control, hydraulic loading, pollutant loading, ecological protection, physical site characteristics that impact design, and site management planning. All descriptions of proposed features and structures at the site will include a description of structure placement, supporting engineering data and calculations, construction scheduling, and references to established detailed design criteria. The SWPPP will conform to all requirements as established by applicable regulatory agencies.

B-82 Contingency Plan

If buried drums or underground storage tanks (USTs) are encountered during any construction activities, excavation will cease and the Owner's P.E. and NYSDEC will immediately be notified. All drums and/or USTs encountered will be evaluated by the Owner's P.E. and unless immediate removal activities are required to prevent or mitigate a spill or release (as determined by the Owner's P.E.) the Owner will submit a removal plan, prepared in accordance with Section 5.5 of NYSDEC's DER-10 technical guidance, to the NYSDEC for review and approval. Appropriately trained personnel will excavate and remove all of the drums and/or USTs within the designated work area while following all applicable federal, state, and local regulations. Removed drums and/or USTs will be properly characterized and disposed off site. The soil/fill surrounding the buried drums and/or USTs will be considered as potentially contaminated and will be stockpiled and characterized pursuant this plan.

B-93 Community Air Monitoring Plan

Environmental air monitoring and visual observation will be conducted during any excavation activities. The air monitoring program will consist of two primary forms of environmental monitoring: Work Area Monitoring required by law for environmental remediation projects and intended to monitor the efficacy of project engineering controls; and voluntary Community Monitoring intended to gauge and document the impact (or lack thereof) of the project to the surrounding area.

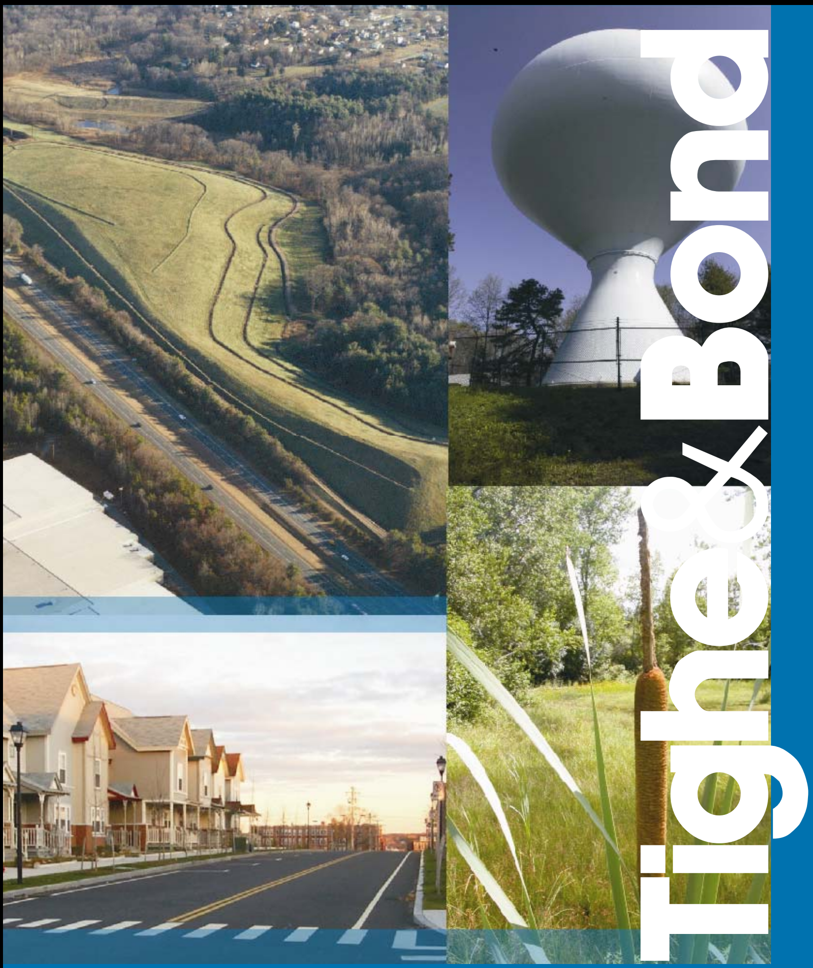
All air monitoring will be conducted in accordance with the NYSDEC approved October 2007 Community Air Monitoring Plan (CAMP). A copy of this plan will be kept on-site at all times.

B-104 Dust Control Plan

During construction activities and/or during the disturbance of a cover system, the surface of any disturbed soil/fill areas will be wetted with water or other dust suppressive agents to control dust during construction/disturbance. Any sub-grade material left exposed and/or any stockpile of excavated material prior to placement of final cover or removal from the site shall be covered with a temporary cover system (i.e., tarps, spray type cover system, etc.) to control fugitive dust to the extent practicable. Particulate monitoring shall be performed along the downwind occupied perimeter of the work area during sub-grade excavation, grading, and handling activities in accordance with Tighe & Bond's October 2007 Community Air Monitoring Plan (CAMP), and in accordance with NYSDEC's Technical and Administrative Guidance Memorandum (TAGM) 4031 (Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites).

As per TAGM 4031, dust suppression techniques that may be used at the site include applying water on roadways, wetting equipment, spraying water on buckets during excavation and dumping, hauling materials in properly covered or watertight containers, covering excavated areas and material after excavation activity ceases, establishing vegetative cover immediately after placement of cover soil, and reducing the excavation size and/or number of excavations.

APPENDIX C



NL Industries
3241 Walden Avenue
Depew, NY

Example
Health & Safety Plan

August 2009

Government • Real Estate • Education • Health Care • Industry

1 Introduction

2 Purpose

3 Health and Safety Plan

4 Hazard Management Plan

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Appendices

Section 1
Introduction

This document has been prepared by Tighe & Bond as an example to support the excavation and management of impacted soils from the former NL Industries Facility, City of Depew, County of Erie, State of New York. Each contractor performing work on the site shall be responsible for preparing their own site specific Health and Safety Plan that should be at least as protective as this example plan.

1.1 Background Information

The subject property is located at 3241 Walden Avenue in Depew, New York, which is a suburb to the east of Buffalo. The subject property was first developed for industrial use in 1892. Past on-site activities have included brass foundry operations conducted between 1892 and 1972 (i.e. 80 years), smelting operations carried out in the early part of the 20th century, and the processing of babbitt. These operations were performed by various companies, beginning with Buffalo Brass Company (Buffalo Brass) at the east side of the property. Magnus Metal Corporation (Magnus) acquired this portion of the subject property from Buffalo Brass in 1899 and continued the brass foundry operations until 1936. During the early-1900s, Empire Smelting Company conducted operations in the area of the current trucking yard. National Lead Company acquired the entire property from Magnus in 1936 and continued the brass foundry operations until 1972, when it vacated the site. The name Magnus remained with the company, and was called Magnus Metal, a Division of National Lead Company. National Lead Company eventually changed its name to NL Industries Inc.

Brass is an alloy of copper and zinc, and babbitt is formed from an alloy of various metals including lead and copper. In addition, antimony is a metallurgical component of babbitt. Wastes produced by these operations, including the dredged material from the former settling lagoon, were apparently spread throughout the property. Waste foundry sands were also potentially disposed of on-site. These historical activities explain the elevated levels of lead, zinc, and copper detected in the fill material.

Small copper canisters of gas were encountered at the site which was identified to contain gaseous compounds including ethyl mercaptan.

1.2 Purpose

This Health & Safety Plan provides as an example of an overall program for protecting human health, public safety, and the environmental while conducting construction/remediation activities at the site. Procedures outlined in this document are proved as examples of procedure that should be followed by all on-site personnel, staff, supervisors, and visitors. The major items of work to be performed by the contractor involved in the construction activities at the site include the following:

- Mobilization and site set-up
- Clearing and Grubbing
- Soil Excavation and Consolidation
- Backfilling and Final Restoration

- Drilling Activities
- Groundwater Monitoring

This document was prepared as an example to address the potential safety and health hazards of conducting the intrusive activities. This plan also provides information on requirements and procedures for on-site worker protection, environmental monitoring, emergency response, New York State Department of Environmental Conservation (NYSDEC) notification and hazardous materials handling. This example document shall be made available to all on-site workers and emergency response personnel as reference only, if no site specific plan is available. All site supervising personnel are required to become familiar with this plan and be responsible for enforcement.

The level of personal protective equipment used by the site workers is to be upgraded or downgraded based on site conditions at the time of the work and the judgment of the Site Health & Safety Officer (SHSO) and appropriate supervisory personnel in accordance with Appendix D. Any personnel entering the site shall receive site specific training in accordance with their HASP and sign off on a documentation form as shown in Appendix C.

The site specific information, as demonstrated in Appendix D, should be posted at all phones and bulletin boards at the site. Specific chemical information should be shown in the health and safety information contained in Appendix E. Appendix F of this plan includes a copy of the NIOSH/OSHA/USCG/EPA – Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. This example manual also provides general information on a variety of site hazards and chemicals that may be present on the site.

Section 2
Purpose

2.1 General

The purpose of this Health & Safety Plan is to provide standards for worker safety and protection during construction, excavation, remediation, processing, filling, and drilling activities conducted during the construction activities at the former NL Industries Facility (the “Site”). The plan also outlines standards and procedures relative to physical and chemical hazards potentially encountered at the site, communication, training, worker health monitoring, decontamination procedures, levels of personnel protection necessary for specific tasks, and emergency response procedures. Additionally, the construction and operation of the facility are to be in accordance with Occupational Health & Safety (OSHA) Regulations 29 CFR 1926 regarding construction practices.

Federal Regulations 29 CFR 1910.120 Hazardous Waste Operations and Emergency Response require the development of a specific Health & Safety Plan to protect worker health and safety at uncontrolled hazardous material release sites. There is the potential that hazardous materials will be encountered during the work at the “Site”. The Health & Safety Plan provided in Section 3.0 provides the information necessary to provide for worker safety. The Hazard Management Plan included as Section 4.0 contains information and procedures for hazard identification and emergency response actions, as well as reporting requirements and information relative to the storage and disposal of hazardous materials. The Excavation Safety Plan provided as Section 5.0 of this document provides information relative to the identification of excavation hazards and regulatory requirements for the protection of employees and equipment.

A copy of this example plan should be made available to each Contractor, Subcontractor, site worker or regulatory official and kept available at the construction site during all activities related to the project; however, each Contractor/Subcontractor is responsible for developing their own site procedures and worker protections.

2.2 Organizational Structure

Federal Regulations 29 CFR 1910.120 (b) (2) requires that a specific organizational structure be determined prior to the start of site activities to establish the chain of command and specify the responsibilities of supervisors and employees. At a minimum, all supervisory personnel must have completed the 40-hour personnel protection and safety course as required by OSHA Regulation 29 CFR 1910.120(e), associated yearly eight hour refresher courses, and the eight hour Supervisory Training Course in accordance with OSHA Regulation 29 CFR 1910.120 (e) (4). Designated Site Health & Safety Officers (SHSOs) shall also have completed training in first aid and CPR and have maintained certification.

2.2.1 Project Organizational Structure

The following supervisory structure has been identified for the implementation and management of the Health & Safety Plan. Responsible individuals are identified in Appendix D of this Plan. This does not represent the entire management structure for all site operations, only those positions directly related to implementation of the Health & Safety Plan.

2.2.2 Responsibility of Supervising Personnel

General responsibilities of designated personnel are outlined as follows:

Project Superintendent

The Project Superintendent is the lead manager of the site with the authority, knowledge and responsibility to direct all operations relevant to the project. The Project Superintendent is the primary responsible official for the project and has the authority to supervise and coordinate all activities at the site. The Project Superintendent may also be responsible in matters effecting the health and safety of site personnel and visitors.

Alternate Superintendent

The Alternate Superintendent assists the Project Superintendent in the implementation of all site operations and any necessary emergency response actions. In the event that the Project Superintendent is absent from the site or unable to carry out necessary duties, the alternate will assume responsibility to supervise and coordinate site operations and emergency response actions.

Site Health & Safety Officer (SHSO)

The SHSO shall be responsible for the implementation of this Health & Safety Plan. It is the responsibility of the SHSO to ensure that all site operations maintain compliance with this plan and to direct any mitigating measures necessary to ensure worker health and safety, protect the public health, and protect the environment. The SHSO will have the authority to stop any and all site operations if site safety is compromised. The SHSO will have the responsibility to modify the Health & Safety Plan as necessary to maintain site worker safety, in coordination with the Project Superintendent. The SHSO will have the lead responsibility in the event of an emergency.

Alternate SHSOs

Alternate SHSOs will be provided in the event the primary SHSO is not onsite. Alternate SHSOs will provide the same services and assume similar responsibilities as the primary SHSO. The primary SHSO or an alternate SHSO must be onsite at all times during the conducting of work activities associated with the reclamation, recycling, or processing of waste materials from the project areas. The onsite presence of an SHSO is not necessary for activities associated with the construction project.

Certified Industrial Hygienist/Certified Safety Professional (CIH, CSP)

The CIH/CSP develops the HASP and provides advice to the SHSO on safety matters. The CIH/CSP must review and approve all changes to the HASP.

Owner’s Professional Engineer (P.E.)

The owner’s Professional Engineer shall provide assistance as necessary to help maintain compliance and implement any requirements of the New York State Department of Environmental Conservation (NYSDEC).

Environmental Coordinators

It is not anticipated that an environmental coordinator will be required as a permanent presence during construction activities.

Other Supporting Personnel

In addition, the project management team may be assisted by other environmental, health and safety, or remedial experts, as necessary depending on site conditions and activities.

2.3 Site Information

Background information on site hazards is provided in the specification appendices and is summarized as follows:

- Impacted Soils (Lead, SVOCs)
- Contained or uncontained hazardous materials (Mercaptan Cylinders)
- Underground and aboveground utilities
- Overhead electrical lines
- Excessive Noise
- Heavy Equipment Hazards
- Dusts & Mists
- Chemical Hazards (petroleum, fuel, solvents, batteries, etc.)
- Physical Hazards, including, but not limited to, equipment, heat stress, solar radiation, etc.

Additional information on these hazards is shown in Appendix E and F.

Section 3
Health and Safety Plan

3.1 Site Control and Decontamination

This section of the Health & Safety Plan provides a description of the general site control and decontamination procedures that will be implemented at the former NL Industries Facility (the "Site") during this project. All site control and decontamination procedures will be conducted in accordance with Federal Regulations 29 CFR 1910.120 Hazardous Waste Operations and Emergency Response and all other applicable Federal, State and local regulations.

The Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, October 1995 prepared by the National Institute for Occupational Safety and Health (NIOSH), Occupational Safety & Health Administration (OSHA), U.S. Coast Guard (USCG) and U.S. Environmental Protection Agency (EPA), or more recent revision thereof should be used as a reference and guide for the implementation of the Safety & Hazard Management Plan. Much of the material contained in Section 3.0 and 4.0 has been summarized from this document.

3.1.1 Communications

Site Workers are to be provided with adequate information to recognize and evaluate anticipated potential hazards that may be encountered at the site during the construction activities. All training shall comply with applicable regulations including 29 CFR 1910.1200 Hazard Communication. The Site Health & Safety Officer (SHSO) shall provide all onsite personnel with an overview of the site-specific hazards at the site. The summary shall cover, at a minimum, the following topics:

- A brief description of the history of the site with regards to health and environmental hazards
- A description of the activities to which the hazard evaluation summary is applicable
- A description of any hazards which may be encountered, including the following:
    - Physical Hazards - terrain, traffic, equipment, severe weather (heat stress and frostbite), electrical hazards, noise
    - Chemical Hazards – materials used and stored at the site, materials released at the site
    - Biological Hazards – insects, plants, animals, pathogens, infectious materials
- A description of the levels of protection selected for specific tasks
- Equipment decontamination procedures if different from those specified herein
- Summary of emergency contacts for use in the event of fire, explosion, medical emergency or other emergency, including the location of the nearest telephone and an address and phone number to provide to emergency personnel
- Directions to the nearest hospital
- A summary of available recent monitoring data and relevant chemical information

- A summary of emergency procedures

3.1.2 Work Zones

Due to the nature of the construction activities, it is likely that site workers will encounter potentially hazardous conditions during the excavation and processing of waste materials from the site. To ensure worker health and safety, and the safety of the general public in the immediate vicinity of the site, Work Zones have been established for the construction activities in accordance with Appendix B to ensure that only properly trained and equipped personnel have access to areas where potentially hazardous conditions are expected. Work Zones to be used at the site for the construction activities are described as follows:

Exclusion Zone

The Exclusion Zone is the area where site operations could reasonably contact contaminated media, result in a release of hazardous material or result in a hazardous condition. For the purposes of the construction activities, all invasive site activities including drilling, trenching, and excavating will take place in an Exclusion Zone. All hazardous material recovery and cleanup operations shall also take place within a designated Exclusion Zone. The limits of the Exclusion Zone are to be determined by the Site Health & Safety Officer (SHSO) or designated alternate SHSO based on existing site data, air monitoring data, weather conditions and visual observations. The boundary of the Exclusion Zone is to be marked in the field using movable visual barriers, such as caution tape, fencing and pylons, as necessary.

Access control points are to be established to the Exclusion Zone to regulated access to this area. The Exclusion Zone may be further subdivided into different areas of contamination or potential hazard, as necessary. The level of Personal Protective Equipment (PPE) required in the Exclusion Zone is dependent on the project task and will be determined by the SHSO or alternated SHSO prior to the initiation of any work activities in the Exclusion Zone. At no time shall untrained workers, unauthorized personnel or site visitors enter the Exclusion Zone.

Contamination Reduction Zone (CRZ)

The CRZ is the transition area between the Exclusion Zone and the surrounding “clean” area, or Support Zone. The CRZ is established to reduce the likelihood that the Support Zone will become contaminated or otherwise affected by hazardous materials or environments within the Exclusion Zone. The CRZ provides physical distance between the Exclusion Zone and the Support Zone. All decontamination procedures are to be conducted within the CRZ. Access is limited to the CRZ, similar to the Exclusion Zone.

Support Zone

The Support Zone is the “clean” area from which command control operations are directed. All emergency response activities are directed from a command post established in the Support Zone. The location of the command post will be chosen by the SHSO or alternate SHSO based on prevailing weather conditions, wind direction and supporting facilities such as electric, water and phone service.

3.1.3 Emergency Response Procedures

All personnel shall be instructed to report to the SHSO in the event of an emergency situation. The SHSO will immediately take control of emergency response actions necessary to protect site worker health, public safety or the environment. These procedures are summarized in Appendix D and should be posted at all phones and bulletin boards at the site. The following sequence of actions shall be undertaken when responding to an emergency:

Initial Actions

Alert all site personnel to the emergency. Sound a site alarm to:

- Notify personnel of an emergency situation
- Stop work activities
- Proceed to the Contaminant Reduction Zone (CRZ) if working in the Exclusion Zone
- Lower background noise in order to speed communications
- Initiate emergency procedures and secure area where the incident has occurred.

Evaluation

Evaluate the emergency situation to determine the following:

- Location of the incident or release
- Affected site personnel
- Identity and quantity of substance released
- Identify and assess potential hazards associated with the emergency situation.

Develop a Response Strategy

Available information regarding the emergency and site emergency response capabilities should be evaluated to determine an appropriate response strategy. Consider the following:

- Onsite availability of trained personnel and equipment
- Offsite assistance necessary to conduct emergency response actions

Notification of Local & State Agencies

Notify appropriate State and Local agencies with direct roles in the emergency response. Request aid as necessary. Notify appropriate regulatory agencies. Provide hazard communication information to responders, as necessary.

Initiate Emergency Response Actions

The SHSO and regulator personnel (Fire Chief, etc.) will determine appropriate response procedures for the incident. A response action should not be attempted until backup personnel and evacuation routes have been identified. Rescue and response actions may include the following:

- Maintain personal contact with another responder (buddy system) when investigating the emergency situation. Personnel in the hazardous area are to maintain line-of-sight contact or direct communication with the command post supervisor

- Locate and survey casualties. Locate all victims and assess their condition. Determine resources needed for stabilization and transport
- Assess existing and potential hazards to site personnel and the public safety. Determine the need for onsite/offsite evacuation and response measures
- Allocate available resources (personnel and equipment) as necessary for rescue and incident response operations
- Initiate control measures to bring the emergency situation under temporary or complete control and prevent the spread of the emergency
- Extricate all victims from the site of the emergency situation
- Decontaminate victims before or after medical stabilization, as necessary. Decontaminate uninjured personnel in the CRZ decontamination area, or establish a new decontamination area if the CRZ is unsafe.
- Stabilize the emergency situation. Administer any medical procedures necessary prior to transport of the victims. Contain, stabilize or repair any hazardous situations that may have developed.
- Transport victims to the nearest hospital for medical treatment
- Evacuate the site and monitor site conditions, as necessary. Inform public officials if public safety is threatened
- Communicate hazard potential to Superintendent and to environmental coordinator. The environmental coordinator is to assess site conditions and develop a response plan for removal of hazardous materials and reporting as required under New York State Department of Environmental Conservation (NYSDEC) regulations and other applicable regulations.

Terminate Response Actions

The following actions should be undertaken by Site Health & Safety Officer (SHSO) or alternate SHSO once emergency response actions are terminated:

- Report the incident to appropriate agencies and authorities
- Document all emergency response actions
- Restock all equipment and supplies
- Replace or repair damaged equipment
- Review and revise site emergency response procedures, as necessary.

3.1.4 Emergency Medical Procedures

The following emergency medical procedures should be undertaken based on the described symptoms:

Inhalation

All site personnel should be familiar with the warning signals for inhalation hazards.

- If warning signals such as: dizziness, nausea, headache, shortness of breath, burning sensation in mouth, throat or lung or symptoms specific to hazard found at the site are apparent, the victim should leave the contaminated air space immediately. Have the SHSO contact emergency services and obtain health and safety information about potential contaminants.

- In unconscious, the victim should be pulled out of the contaminated area immediately if they do no have any injuries which would prohibit moving them (i.e. spinal injury). The rescuers should make sure that the area is safe to enter. If the area cannot be safety entered, attempt to ventilate this area. Do not attempt a rescue. Rescuers should make sure they are properly trained in First Aid and CPR and that they are wearing proper respiratory and protective equipment before attempting the rescue.
- If the victim is no longer breathing, mouth-to-mouth resuscitation or some other form of artificial respirator should be administered by a person who is properly trained and certified in a location away from the contaminated area.
- Obtain medical attention immediately

Skin Exposure

The skin should be washed with copious amounts of soap and water. If clothing is contaminated, it should be removed immediately and the skin washed thoroughly with running water. A shower for emergency use is to be available onsite if corrosive chemicals are encountered. It should be used immediately following exposure and clothes should be removed while showering. This procedure may be life-saving as certain highly toxic chemicals are rapidly absorbed through the skin.

All contaminated parts of the body, including the hair, should be thoroughly decontaminated. It may be necessary to wash repeatedly.

Ingestion

A poison control center or emergency service should be contacted immediately to determine an appropriate course of action. If possible, have health and safety information on the poison or hazardous material available when you call for help. Vomiting should be induced except when the substance presents an aspiration hazard, such as from a petroleum product; or when the substance is a strong acid or alkali. To induce vomiting, a tablespoon of salt or powdered mustard in a glass of warm water or syrup of ipecac from the First Aid Kit can be taken as an emetic.

Drinking plenty of water and placing a finger down the throat may also be effective in inducing vomiting. The treatment should be repeated until vomit is clear.

Medical attention should be obtained immediately

Eyes

If a toxicant should get in the eyes, they should be washed with plenty of water. The eye itself should be held open, rotated, and flooded with water so that all surfaces are washed thoroughly. Washing should be continued for at least fifteen minutes.

Medical attention should be obtained immediately.

Exposure to Heat or Cold

When working under severe weather conditions, personnel should be aware of the signs of heat stress, hypothermia and frostbite as well as the appropriate response actions.

- Heat Stress – If a worker shows signs of heat stroke (dry, hot, red skin, high body temperature) or heat exhaustion (cool, moist, pale or red skin, dilated pupils, nausea, and dizziness), the worker must be removed from the work area and cooled. Loosen clothing, elevate feet, and provide cool liquids. Heat stroke can be life threatening and requires rapid action.
- Hypothermia – If a worker shows signs of hypothermia (shivering, impaired judgment, drowsiness, clumsiness) the worker must be removed from the work area and warmed gradually.
- Frostbite – If a worker shows signs of frostbite (skin color changes to white or grayish-yellow then grayish-blue), the worker must be moved to a warm place. The affected area should be placed in warm (100-105°F) water. Do not rub or massage.
- Medical attention should be obtained immediately.

Stings and Bites

If still present, remove stinger with fingernail. Work the site with soap and water. Cover with bandage and apply ice. If severe allergic reactions appear (hives, itching, rash, nausea, vomiting, dizziness, swelling) seek medical attention immediately.

3.1.5 External Assistance

Appendix D contains a list of emergency and regulatory agencies that may be of assistance in the event of an emergency response action, spill or release of hazardous material.

3.1.6 Decontamination

Decontamination is the process of removing or neutralizing any site contaminants which may have accumulated on personnel or equipment to prevent the off-site transport of contaminants and protect site worker safety and public health. A decontamination area should be designated in the Contamination Reduction Zone (CRZ) to prevent the spread of any potential contamination to the “clean” Support Zone and offsite areas.

Personnel Decontamination

If Level D protection is used, any disposable inner gloves or protective clothing should be sealed in a plastic bag and properly disposed of in a trash receptacle. Moisture resistant outer gloves and outer boots to be re-used should be rinsed to remove gross contaminants, and then sealed in a plastic bag for re-use. Disposable equipment should be used whenever possible.

If Level C or greater protection is used, personnel are required to follow the decontamination procedures listed below, as they apply to the gear being worn:

- Wash boots thoroughly with clean water or an appropriate cleaning solution to remove gross contamination
- Scrub down outer boots in decontamination solution and rinse with water
- Remove boots
- If wearing re-usable rain gear, it should be cleaned in a similar manner as the boots

- Disposable Tyvek suites should be removed, sealed in plastic and placed in trash receptacle
- Spent respirator cartridges can also be discarded in the trash receptacle
- Remove outer gloves and wash in same manner as boots while wearing disposable inner gloves
- Use a new set of disposable glove to clean additional equipment including hard hat, safety glasses, etc.
- Thoroughly wash hands and face with soap and water prior to leaving the site
- Decontamination wash and rinse water will be collected and discharged to the leachate collection system holding tanks or sanitary sewer, as appropriate.

Equipment Decontamination

Proper decontamination of all equipment is necessary to avoid transferring contaminants from the site, thereby increasing the potential for exposure of onsite and offsite personnel. The measures described below should be followed prior to leaving the CRZ, as applicable to the equipment being used. Any variations from the procedures described below for reasons of worker health or safety must be described by the SHSO in a site hazard summary and appended to this Health & Safety Plan.

These measures are separate from, and may not be substituted for, other decontamination procedures associated with proper sampling protocol:

- General field equipment such as measuring tapes and shovels are to be decontaminated in the CRZ. The equipment is to be cleaned to remove gross contaminants, thoroughly rinsed with clean water or an appropriate cleaning solution and wiped dry with paper towels before leaving the work site.
- The rinse water from this operation will be collected and discharged to the leachate collection holding tanks or sanitary sewer, as appropriate.

Decontamination of drilling or excavating equipment will take place in the designated area of the CRZ should the equipment require removal from the CRZ. Decontamination of heavy equipment will entail a thorough steam cleaning, or washing and rinsing of the equipment with high pressure water followed by air drying. Additionally, the tires and undercarriages of vehicles exiting areas identified as having superficial hazardous materials will be sprayed with high pressure water and allowed to dry before leaving the CRZ.

3.1.7 Required Emergency Equipment

At a minimum, the construction site work area will equipped with the following items. All of the listed items will be tested and maintained as necessary to assure proper operation in an emergency situation. All required equipment will be readily accessible to employees in the work area. Required equipment will include:

- Hand-held portable radios to communicate with all site workers and equipment operators. In the event of an emergency, instructions will be relayed via radio and direct verbal communication.
- Telephones for emergency notification will be available at the command center.

- Portable fire extinguishers shall be stored in vehicular equipment, the command center, and the weigh scale. Fire extinguishers will be maintained at all open excavations and any tasks presenting a hazard for ignition. At a minimum, staging of fire extinguishers shall conform to OSHA Regulation 29 CFR 1926 Subpart F.
- Spill control and containment equipment available at the command center storage area should a hazardous material release occur. The spill control equipment will include chemical absorbents such as speedi-dry granular chips, oil absorbent pads, and absorbent booms, overpack drums, shovels, brooms, and mops. Neutralizing agents for caustic spills will also be kept at the command center storage area.
- An emergency eye wash station and emergency shower to be located at the decontamination area whenever corrosive chemicals are encountered.

3.1.8 Site Visitors

Visitors will be prohibited from the Exclusion Zone while intrusive activities are taking place. Any site visitors with access to the Exclusion Zone or CRZ will be trained in the use and selection of PPE so that the use of the PPE will protect them from potential site hazards. Site visitors will also receive training in general site safety and standard operating procedures from the SHSO prior to accessing the Exclusion Zone or CRZ. Visitors will wear PPE as dictated by the hazards and conditions present at the site. Any site visitors will be attended by at least one trained site worker at all times during a visit to the construction site, including the Support Zone.

3.2 Worker Training

All site workers involved in the excavation of the construction site are required to have health and safety training as outlined in 29 CFR 1910.120(e). These site workers are required to have completed a 40-hour personnel protection and safety course as required by OSHA Regulation 29 CFR Part 1910.120(e) for work at hazardous material release sites, and associated yearly eight hour refresher courses. Copies of current training documentation for all site workers will be documented by the SHSO and made available at the site for regulatory inspection. Prior to accessing the site, the SHSO shall provide an orientation session to site workers to explain potential and existing site hazards, required PPE, methods of reducing identified contaminant exposures, and provide a hazard evaluation summary in accordance with OSHA Regulations 29 CFR 1910.1200.

3.2.1 Site Specific Training

Prior to assignment to a job task where respirator use may be required, site workers will be required to document or be provided with respirator training as outlined in 29 CFR 1910.134(e
5). Respirator fit tests are to be conducted at twelve month intervals, or at any time when a condition that may change the fit of a respirator has occurred, such as change in weight, change in facial structure, extensive dental work, etc. The use of all respirators shall comply with a written respiratory program implemented by the SHSO.

3.2.2 Other Training

The additional training that is required of supervisory personnel is listed below:

Site Supervisors

All site supervisory personnel will be required to complete the eight hour Supervisory Training Course in accordance with OSHA Regulation 29 CFR 1910.120(e 4). Site supervisors include the Project Superintendent, Project Foremen, SHSO and alternate SHSOs. Site supervisors are also required to be certified in first aid and CPR.

OSHA Excavation Standard

For site excavations greater than four feet in depth, at least one worker will have "competent person" training as required by OSHA Regulation 29 CFR 1926.650 Subpart P Excavations. The "competent person" shall be responsible for the identification and assessment of excavation hazards and to implement safeguards, safety precautions, and engineering controls to maintain a safe excavation.

3.2.3 Medical Monitoring

All site workers involved in the excavation of the construction site are required to be participants in a medical monitoring program. The primary goal of medical monitoring is to provide evaluation and ongoing surveillance of the health status of workers potentially exposed to toxic substances as a result of work-related activities. The health monitoring program is an important tool in evaluating the effects of chronic low-level exposures or acute exposures related to reclamation operations at the site. The program shall meet or exceed the minimum requirements established in OSHA Regulation 29 CFR 1910.120.

The medical monitoring program includes laboratory testing, personnel medical history evaluation, physical examination, and specific systematic testing. The extent of medical monitoring shall be determined by an Occupational Physician prior to employment. Each participant in this medical monitoring program shall undergo a complete occupational history evaluation, and baseline physical examination typically including the following parameters:

- Pulmonary Function Studies
- Complete Blood Count
- Chemical Blood Profile
- Urinalysis
- Chest X-Ray
- Electrocardiogram
- Specific parameters as necessary dependent upon exposure

Specific tests and monitoring frequency shall be determined by an Occupational Physician. Prior to conducting any site work activities, an initial evaluation is conducted to establish baseline values for the above parameters for each participant. Re-evaluations are conducted on an annual basis to monitor potential changes in baseline conditions that may result from work with hazardous materials. In addition to an annual re-examination, provisions are made for specific post-exposure examinations in the event of a suspected exposure during a particular field event.

3.3 Personal Protective Equipment

The purpose of personnel protective equipment (PPE) is to shield or isolate a worker from the chemical, physical and biological hazards that may be encountered at the construction site. The level or protection afforded by the PPE must be appropriate to protect against the known or worst potential hazards expected to be encountered at the site. Protective equipment should be selected based on the concentrations and possible routes of exposure to known or potential worst case substances. The levels of personnel protective equipment are described in Section 3.3.1.

It is anticipated that Level D or C protection and basic site safety measures will be sufficient for construction activities. Any conditions warranting upgrading the required level of protection to Level B or A will be cause for all personnel to immediately leave the Exclusion Zone. The site will be re-evaluated and the Safety & Hazard Management Plan updated with the additional site information and modified accordingly.

Whenever Level C is in use, the breathing zone of the workers in the Exclusion Zone will also be monitored constantly utilizing a photo-ionization detector (PID). If the total volatile organic compounds concentration (as indicated by the PID) in the breathing zone of the workers approaches 50 ppm, work shall cease and crew will exit the work area and evaluate the need to upgrade to Level B.

The specific respiratory protective device selected for Level C protection shall be the device identified on each individual’s respirator fit test. In general, respirators will be supplied with combination cartridges for organic vapors, dusts, mists, and acid gases and shall be approved by the National Institute for Occupational Safety and Health (NIOSH). In the event that a site hazard evaluation summary identifies the potential for exposure to other chemical substances (i.e. formaldehyde, ammonia) additional cartridges will be supplied as necessary to be made available at the site to upgrade the level of respiratory protection.

3.3.1 Levels of Protection

Appendix B of this Plan provides a summary of the information shown below. Although it is unlikely that a level of protection, greater than Level C, during routine site construction activities, all four levels (A through D) are described below. Site workers are to be instructed to immediately leave the Exclusion Zone if conditions requiring Level A or Level B protection are observed or detected, pending further evaluation by the Site Health & Safety Officer (SHSO).

Level A

Level A protection should be worn when the highest available level of respiratory, skin, and eye contact protection is needed. While Level A provides the maximum available protection, it does not protect against all possible airborne or splash hazards. For example, suit material may be rapidly permeable to certain chemicals in high air concentrations or heavy splashes.

A. Personal Protective Equipment (PPE)

- Positive pressure self contained breathing apparatus (SCBA), OSHA/NIOSH approved, operated in the positive pressure mode.
- Totally encapsulated suit (boots and gloves attached).

- Gloves – inner (tight-fitting and chemical-resistant).
- Boots – chemical-protective, steel toe and shank. Depending on suit boot construction, worn over suit boot.
- Gloves – outer, chemical-resistant. Depending on suit construction, worn over suit gloves. May be replaced with tight-fitting, chemical-resistant gloves worn inside suit gloves.
- Underwear – cotton, “long-john” type (optional).
- Hard hat (under suit).
- Disposable protective suit, gloves and boots. Worn under or over encapsulating suit.
- Coveralls (under suit)
- Two (2) way radio communications.

B. Criteria for Use

Use Level A:

- When the type(s) and concentration(s) of toxic substances are known to require the highest level of combined protection to the respiratory tract, skin, and eyes. These conditions would be as follows:
    - Atmospheres which are “immediately dangerous to life and health” (IDLH). IDLH’s are detailed in the NIOSH/OSHA’s “Pocket Guide to Chemical Hazards” and/or other references
    - Known atmospheres or potential situations that would affect the skin or eyes, or could be absorbed into the body through these surfaces in toxic quantities
    - Potential situations are those where vapors may be generated or splashing may occur through site activities
    - Standard reference books should be consulted to obtain concentrations hazardous to skin, eyes, or mucous membranes
    - Explosive atmospheres greater than 10% of the lower explosive limit
    - Atmospheres containing less than 19.5% oxygen

C. At sites where the type(s) and/or potential concentration(s) of toxic substances are unknown.

- Unless there is information available to strongly indicate otherwise, the site should be presumed to present hazards to the respiratory system, skin, and eyes. Level A protection would provide the highest level of protection for the initial entry team.
- Enclosed areas such as buildings, manholes, etc.

D. When total vapor readings of 500 – 1,000 ppm are obtained on instruments such as the photo-ionization detector (PID) or organic vapor analyzer (OVA) in the atmosphere.

It is not anticipated that work will be done under conditions requiring Level A protection. If such conditions are encountered, operations will cease immediately and all personnel will immediately leave the area. Workers shall not re-enter the area until a more comprehensive HASP specifically appropriate for such conditions has been prepared, or until there is clear evidence that the conditions requiring Level A protection have abated.

Level B

Level B protection should be selected when the highest level of respiratory protection is needed, but exposure to the small unprotected areas of the body (i.e. neck and back of the head) is unlikely, or where concentrations are known to be within acceptable exposure standards.

A. Personal Protective Equipment (PPE)

- Positive pressure SCBA, NIOSH approved, operated in the positive pressure mode
- Hooded, two-piece chemical-resistant suit
- Gloves – outer, chemical-protective
- Boots – outer (chemical-protective, steel toe and shank)
- 2-way radio communications
- Hard hat
- Face shield (optional)

B. Criteria for Use

Use Level B

- When the type(s) and concentration(s) of hazardous substances are known to require the highest degree of respiratory protection; but a lower level of skin protection, i.e. in:
    - Atmospheres which are “immediately dangerous to life and health” (IDLH). Type(s) and concentration(s) of vapors in air do not present at hazard to the small, unprotected areas of the body
    - Atmospheres with concentrations of known substances greater than protection factors associated with full-face, “air purifying” respirators with appropriate cartridges
    - Explosive atmospheres greater than 10% of the lower explosive limit
    - Atmospheres less than 19.5% oxygen
- When a determination is made that potential exposure to the body parts not protected by a fully encapsulated suit (primarily neck, ears, etc.) is highly unlikely.
- Total vapor levels range from 50 – 500 ppm on instruments such as a photo-ionization detector or organic vapor analyzer and the atmosphere

does not contain suspected high levels of toxic substances affecting the skin or eyes.

- Normal drilling and sampling operations will cease if conditions are such that Level B protection would be required.

Level C

Level C protection should be selected when the types and concentrations of respirable materials are known, have adequate warning properties, or are reasonably assumed to be not greater than the protection factors associated with air-purifying respirators; and exposure to the few unprotected areas of the body (i.e. neck and back of the head) is unlikely to cause harm. Continuous monitoring of the site and/or individuals will be conducted during any “Level C” work activities.

A. Personnel Protective Equipment (PPE)

- Half-face, or full-face, air-purifying respirator (OSHA/NIOSH approved)
- Chemical-resistant outer clothing
- Gloves-inner (tight-fitting, chemical-resistant type or woven liners)
- Gloves-outer (chemical resistant)
- Hard hat (face shield optional)
- Boots-outer (chemical-protective, steel toe & shank)
- Safety glasses

B. Criteria for Use

- Site known to contain potentially hazardous materials resulting in air concentrations requiring a protection factor afforded by a full-face or half-face, air-purifying respirator (OSHA/NIOSH approved)
- Well-documented, reliable history of site and patterns of prior entry
- No evidence to suspect acute or chronic toxicity to exposed skin
- Total vapor reading between 0 – 50 ppm on instruments such as the photo-ionization detector or organic vapor analyzer. The following respirators shall be provided for the referenced total vapor levels:
    - Half-face Respirator – Total organic vapor readings using a PID of between 5 – 10 ppm
    - Full-face Respirator – Total organic vapor readings using a PID of between 10 – 50 ppm
    - Continuous air or personal monitoring should occur while wearing Level C protection.

Level D

Level D is the basic work uniform and should be worn for all site operations not requiring a higher level of protection. Level D is appropriate when no respiratory hazards exist and minimal chemical hazards exist.

A. Personnel Protective Equipment

- Standard work clothing
- Optional disposable chemical-resistant clothing appropriate for known or expected levels of contamination
- Boots/Shoes-safety or chemical-resistant boots (steel toe and shank)
- Safety glasses or safety goggles available for drilling, excavation and processing operations
- Gloves –disposable latex or cotton
- Optional moisture resistant outer gloves
- Hard hat available for drilling, excavation and processing operations

B. Criteria for Use

- No indication of airborne health hazards present

No gross indications above background on the photo-ionization detector and/or organic vapor analyzer.

3.3.2 PPE Selection & Chemical Compatibility

The selection of personal protective equipment (PPE) will depend on the type and concentration of hazardous material the wearer is expected to encounter. The selection of PPE will be continually update and evaluated by the SHSO as the construction project proceeds and additional field screening and analytical data is received. For the selection of chemical resistant clothing, the selection is conducted by evaluating the performance characteristics of the clothing against the requirements and limitations of site and task specific conditions. The SHSO will be responsible to ensure that the PPE is adequate and of safe design to allow workers to perform their specified tasks and to protect the site workers from injury or illness that may result from exposure to hazardous materials.

3.3.3 Respiratory Protection

The level and type of respiratory protection necessary to conduct site activities will be determined by the SHSO based on anticipated inhalation hazards that may be encountered at the site and during work activities. The SHSO shall implement a respirator protection program in accordance with OSHA Regulation 29 CFR 1910.134 prior to the start of any invasive activities associated with the construction project.

The specific respiratory protective devices selected for Level C or modified Level D protection shall be the device identified on each individual’s respirator fit test. For the construction project, respirators will be supplied with combination cartridges for organic vapors, dusts, mists, and acid gases and shall be approved by the National Institute of Occupational Safety & Health (NIOSH). In the event that the SHSO identifies the potential for exposure to other chemical substances (i.e. formaldehyde, ammonia) additional cartridges will be supplied as necessary to site workers potentially exposed to those conditions.

3.3.4 Eye Protection

Site workers will be required to wear safety glasses or chemical splash goggles when conducting all invasive or processing activities associated with this project. At the discretion of the SHSO, this requirement may be waived for specific activities where the SHSO determines that there is minimal risk of injury to the eyes. Chemical splash goggles shall be worn by site workers when chemical splashes or facial exposure to hazardous materials are likely. The use of contact lenses shall not be permitted by any site worker using a respirator, in potential chemical exposure areas, dusty environments, or heat generating areas.

3.3.5 Hearing Protection

All operations conducted involving sound intensities above 90 dB (approximate intensity of running heavy equipment) will be conducted using hearing protection for those operating the equipment or other site workers in the immediate area. Ear plugs or ear muffs shall be used for hearing protection.

3.4 Air Monitoring Plan

Continuous real-time air monitoring will be performed continuously using direct reading instruments during invasive site activities, and whenever there is the potential for employee chemical or particulate exposures to occur. Air monitoring data will be reviewed by the SHSO and to assure the proper selection and continued use of the appropriate PPE and/or engineering controls so that workers are not exposed to chemical concentrations that exceed PELs. Air monitoring will be conducted in accordance with OSHA Regulation 29 CFR 1910.120 and the New York State Department of Health (NYSDOH) and the Site-Specific Community Air Monitoring Plan.

The SHSO shall follow a Respiratory Protection Program that generally conforms with OSHA Regulation 29 CFR 1910.134.

3.4.1 Potential Contaminants

Section 2.3 provides a list of potential air contaminants of air emissions a site worker may encounter at the site. The major contaminants of concern include lead and buried cylinders containing mercaptans. The potential for significant exposure is greatest during invasive construction activities, processing operations, and downwind of either of these activities.

3.4.2 Frequency of Monitoring

Air monitoring will be performed continuously during all invasive site operations, and whenever there is a potential for employee chemical or particulate exposure. Air monitoring requirements during the processing of waste and waste residuals will be further determined by the SHSO prior to the start of processing activities. The SHSO will have direct responsibility for the implementation of the project air monitoring program.

3.4.3 Types of Monitoring Equipment

Although it is premature to specify the exact type of air monitoring equipment to be used onsite for air quality monitoring, the following types of monitoring equipment may be used during site operations:

Photo-ionization Detector (PID)

A PID will be used to measure total concentrations of organic vapors during all invasive site activities. A PID provides real-time response when measuring sudden gas emissions. The PID will be equipped with a 10.2-11.7 eV lamp and calibrated to isobutylene, a benzene substitute. During air monitoring usage, the PID will be set on the lowest scale, typically 0-20 parts per million (ppm) as benzene.

Because PID readings cannot be directly compared to permissible exposure levels (PELs), the SHSO will review the PELs for anticipated contaminants to be encountered and (1) back-calculate an equivalent PID reading or provide response curves for suspected contaminants, or (2) confirm direct reading instrument data with laboratory data.

Oxygen Meter

An oxygen meter will be used to measure oxygen concentrations in air during all invasive site operations.

Combustible Gas Indicator

A CGI will be used to monitor for potentially combustible concentrations of gases during all invasive site activities. The CGI shall measure the Lower Explosion Limit (LEL) and be calibrated to a methane standard.

Aerosol Monitor

An aerosol monitor capable of real-time readings and measurement of airborne particulate matter or a 0.1 – 10 micron size will be used to monitor excavation, processing and handling operations. This device shall be used to monitor dust and mist emissions, and potential concentrations of general airborne fibers (e.g. asbestos).

Radiation Detector

If necessary, a real-time radiation detector will be used at the construction site to monitor for varying levels of radiation during excavation, processing and handling operations.

Colorimetric Indicator Tubes

Colorimetric tubes will be available for use by the SHSO when a specific chemical is suspected.

Meteorological Station

A weather station may be set up onsite to monitor daily temperatures, rainfall, wind direction and wind velocity as part of odor control measures.

Other Instruments

Other air monitoring instruments such as carbon monoxide or carbon dioxide monitor may be used for air monitoring onsite.

All monitoring equipment to be used at the site will be calibrated on a daily basis.

3.4.4 Worker Monitoring Action Levels

The following site action levels have been selected to either upgrade site worker PPE or cease operations until the hazard event is evaluated and engineering controls are implemented, or the hazardous condition no longer exists. The SHSO is directly responsible for the implementation of the air monitoring program. Any changes in the action levels must be approved by the SHSO and documented in the site copy of the Safety & Hazard Management Plan-Section 4.0.

The SHSO will designate specific action levels for air contaminants such as carbon monoxide, carbon dioxide or others as necessary based on the site monitoring data.

3.4.5 Perimeter Monitoring Action Levels

Perimeter air monitoring will occur during intrusive work activities. The SHSO shall monitor the ambient air for soil particles using a hand-held, real time particulate monitor. Monitoring shall always be performed at downwind locations and at upwind controls to determine background levels.

The action level for soil particles at the site perimeter shall be the National Ambient Air Quality Standard (NAAQS) of 150 micrograms per cubic meter ($\mu g/m^3$) or 0.15 milligrams per cubic meter (mg/m^3) above background averaged over a fifteen minute time period.

Immediately upon exceeding the action level established above, the SHSO shall implement dust suppression measures as necessary.

Site workers shall temporarily cease intrusive activities if, following implementation of dust suppression measures the next hourly reading indicates continued exceedance above the action level.

Background levels upwind of the site may be taken into consideration if they are above the action level established for the site. The SHSO shall implement the following dust control measures during site activities:

- **Water Truck:** A water truck will be located on the site at all times. Water will be sprayed onto work area excavations as necessary to maintain dust levels below the worker and perimeter action levels.

  NOTE: Please note that liquid ethyl mercaptan is reactive with water. Care should be exercised when using water near this material.

- **Salt:** Salt will be applied to roadways as necessary to reduce dust levels throughout the site.
- **Coverings:** Piles of exposed impacted fill will be covered with plastic whenever they are left exposed for extended periods of time.
- **Foam:** Foams may be used for dust control if the preceding measures do not effectively reduce dust levels.

Section 4
Hazard Management Plan

4.1 Introduction

This example Hazard Management Plan has been developed in conjunction with the example *Soils Management Plan* (Attachment G), and provides the information necessary to respond to the discovery of hazardous materials, or hazardous material releases during all phases of the project. The plan covers procedures for identifying, containing, handling and storage of hazardous materials. For the purposes of this plan, soils and groundwater underlying the "site" that have been in contact with waste materials or waste contaminants will not be considered hazardous materials which require removal or special treatment. This plan also covers general reporting requirements necessary when hazardous materials are discovered or encountered. The discovery of hazardous materials or material suspected of being hazardous shall require that the SHSO be immediately notified and that the owner's Professional Engineer (P.E.) respond and direct containment and recovery operations. The P.E. shall take the lead in reporting all releases or discoveries of hazardous materials during the completion of the construction project for the purposes of the New York State Department of Environmental Conservation (NYSDEC).

4.2 Comprehensive Work Plan

The Comprehensive Work Plan identifies specific site tasks and hazards that may be reasonably associated with the tasks to provide site workers and the SHSO with the ability to identify hazards and take precautions necessary to eliminate the hazard or reduce the risk associated with the hazard. The plan also identifies resources necessary to reduce or eliminate existing and potential site hazards. Development of a Comprehensive Work Plan is a requirement of OSHA Regulation 29 CFR 1910.120.

4.2.1 Site Tasks

The following site tasks have been identified as innate to the project:

- Submittal of required plans and schedules
- Establish sedimentation and erosion controls at the site in accordance with the plan
- Clear and grub the site. Stage construction and maintain the site in a manner that prevents sedimentation of the surrounding sensitive areas
- Perform limited drilling & excavating (less than 4ft) activities
- Perform background and construction air monitoring
- Restore excavated areas
- Perform groundwater monitoring

4.2.2 Hazards Associated with Site Tasks

Potential health and safety hazards identified as associated with the project tasks include the following:

- Heavy Equipment Hazards
- Excavation Hazards
- Impacted Soils (Lead, SVOCs)
- Contained or uncontained hazardous materials (Mercaptan Cylinders)
- Underground and aboveground utilities
- Overhead electrical lines
- Fire & Explosion
- Hazardous Atmospheres
- Excessive Noise
- Dusts & Mists
- Chemical Hazards (petroleum, fuel, solvents, batteries, etc.)
- Physical Hazards, including, but not limited to, equipment, heat stress, solar radiation, etc

4.2.3 Resources Necessary to Reduce Potential Hazards

During the course of the project, site workers have the potential to come into contact with hazardous materials or be subject to hazardous conditions, such as the disturbance of a buried mercaptan cylinder. The following resources have been identified as necessary to reduce or eliminate potential site hazards:

Safety & Hazard Management Plan

Provides identification of existing and potential site hazards and methods to reduce the site hazards.

Air Monitoring Plan/Equipment

Provides onsite monitoring of potential airborne contaminants and atmospheric hazards.

Personal Protective Equipment (PPE)

Provides site workers protection from potential contaminant exposures.

Engineering Controls

Various controls such as barricades, mechanical ventilators and dust suppression methods (e.g. foams, wetting) will be employed onsite on an as needed basis to reduce or mitigate identified hazards or hazardous conditions.

Heavy Operating Equipment

Minimize site worker contact with excavated waste materials and potentially impacted soils.

4.2.4 Site Evaluations & Frequency

Prior to the start of the project, the SHSO shall perform an initial site characterization to identify any existing unsafe or hazardous conditions, and characterize atmospheric conditions at the site. This Safety & Hazard Management Plan is to be updated by the SHSO based on the characterization of initial site conditions.

Following the initial site characterization, site evaluations shall be conducted by the SHSO on a minimum daily frequency, prior to the start of site activities. Should conditions change during the course of the day, the SHSO shall re-evaluate the pre-work data and take additional readings with field instruments, or collect samples as necessary to insure a safe worker environment. All data recorded by the SHSO, revisions to the level of PPE required for specific tasks, and any engineering controls implemented to reduce site risks or control site hazards shall be documented by the SHSO.

4.2.5 Hazard identification

Suspected and potential site conditions that may pose inhalation, skin absorption, or other hazards which are considered to be Immediately Dangerous to Life or Health (IDLH) shall be identified during the initial site characterization and further evaluated as the project progresses. Examples of such hazards include potentially explosive or flammable conditions, discovery of hazardous materials, visible vapor clouds, biological indications of IDLH conditions, or IDLH conditions measured on field monitoring equipment.

4.2.6 Required Information

Prior to the start of any site construction activity, the following information will be obtained to the extent available and be communicated to all the site workers by the SHSO:

- Location, approximate size and history of the site
- Description of the tasks to be performed
- Duration of the planned activities
- Existing site topography and accessibility
- Safety and health hazards expected at the site
- Exposure pathways for hazardous materials and dispersion routes
- Status and capabilities of emergency response teams that would provide emergency assistance
- Hazardous substances and health hazards expected at the site and their chemical and physical properties

The SHSO shall provide a copy of this Health & Safety Plan to all site managers and foremen. Copies of this plan shall be available to all site employees in the site command center.

4.2.7 Personal Protective Equipment (PPE) for Characterization

Personal Protective Equipment (PPE) to be worn for any non-invasive site activities such as the initial site walkthrough for characterization will be limited to Level D PPE, unless other information indicates an upgrade in PPE is necessary (See Appendix B).

At this time, only invasive activities which expose potentially contaminated wastes, soils, and groundwater are anticipated to require an upgrade in the level of PPE to be used onsite. Construction activities which may require an upgrade in the level of PPE include waste handling and processing operations, as well as the operation and maintenance of any remedial systems. It is anticipated that inhalation hazards associated with non-invasive construction activities can be mitigated using engineering controls, such as forced ventilation and dust suppression.

4.2.8 Monitoring During Characterization

Air monitoring will be conducted during the initial site characterization by the SHSO using the equipment outlined in Section 3.4.3. Based on this evaluation, the SHSO shall indentify the necessary air monitoring equipment for daily site characterization.

4.2.9 Risk Identification & Employee Notification

Following the initial site characterization, the SHSO shall identify and evaluate the presence and concentrations of any hazardous conditions that are identified. The risks associated with the hazardous conditions will be assessed and communicated to workers performing the task where the risk has been identified.

The SHSO shall be responsible for the communication of all site hazards to site workers in accordance with OSHA Regulation 29 CFR 1910.1200 Hazard Communication. This information shall include a summary of physical, chemical, and toxicological properties of hazardous substances identified or potentially encountered at the site, physical safety hazards identified at the site, and any other hazards which may pose a risk to site worker health and safety. Hazardous conditions and site risks to consider include the following:

- Conditions identified as Immediately Dangerous to Life and Health (IDLH)
- Exposure to hazardous substances identified at the site. All exposure routes should be considered including inhalation, dermal exposures, ingestion and injection (puncture)
- Existing physical hazards and hazards associated with excavations less than 4 feet.

Section 5
Excavation Safety Plan

5.1 Excavation Hazards and Requirements

All site excavations shall be conducted in accordance with OSHA Regulations 29 CFR 1926.650 through 1926.652. Daily site excavation inspections are required and must be performed by a "competent person". This person is defined as an individual trained in "identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them". The excavating contractor typically provides these services.

5.1.1 Underground Utilities

Prior to excavation, an organization authorized to assess the location of underground utilities must be contacted 72 hours before digging. The underground utilities must be marked appropriately inside the work zone. If at any time during excavation underground utilities are approached, they must be exactly located by safe and acceptable means. To insure employee safety, the underground installments must be protected, supported, or removed.

5.1.2 Access and Egress

Ramps used for access and egress by workers must be designed by a competent person. Trench excavations that are greater than four feet in depth must contain a stairway, ladder, ramp or other safe and acceptable means of egress so as to allow no more than 25 feet of lateral movement.

5.1.3 Exposure to Falling Loads

No employee at any time shall be permitted beneath loads handled by lifting or digging equipment, and are required to stay away from equipment being loaded or unloaded to prevent exposures if spills or leaks occur.

5.1.4 Warning System for Mobile Equipment

Appropriate warning systems must be implemented to warn mobile equipment when they come too close to the edge of an excavation site.

5.1.5 Hazardous Atmospheres: Testing and Control

Any trench depth greater than five feet must be monitored for the presence of an oxygen deficient, oxygen enriched, flammable atmosphere or hazardous atmosphere prior to site worker entry in accordance with Appendix B.

Equipment used for monitoring include a photo ionization detector (PID), combustible gas detector (CGI), oxygen meter, hydrogen sulfide detector and if necessary a radiation meter.

Emergency rescue equipment must be on site if hazardous atmospheres cannot be controlled. They must include two sets of self-contained breathing apparatuses (SCBA), a safety harness, and a line or basket stretcher. They must be stationed in the

Contaminant Reduction Zone (CRZ) during all site excavation activities in the event that an emergency situation arises.

5.1.6 Water Accumulation

Site workers shall not work in excavations that have accumulated water, or where water is accumulating without proper protection. These may include support shields to prevent cave-ins, water retention systems to regulate water in-flow, or the use of a safety harnesses and lifelines.

Suitable methods for removing or preventing surface waters from entering the excavation site must be implemented. Excavations subject to heavy rainfall shall be inspected and monitored by a competent person.

5.1.7 Stability of Adjacent Structures

If an excavation site endangers the stability of adjacent structures, support systems shall be implemented to protect site workers and ensure the stability of the structure.

5.1.8 Protection from Lose Rock or Soil

Site workers shall be provided adequate protection from loose rock or soil that could fall or roll into the excavation and pose a danger to workers. Excavated or stock piled materials must be kept a minimum of two feet from the edge of the excavation to prevent them from rolling and falling into the site. Adequate retaining devices may also be used.

5.1.9 Inspections

A competent person must inspect the excavation daily, once at the beginning of the day before any work has been started and as necessary as work proceeds. Inspections are also required after rainstorms or other occurrences that may increase the likelihood of hazards associated with excavations. If the competent person determines a hazard exists, site workers shall be removed from the area until the situation is corrected.

5.1.10 Fall Protection

Walkways and bridges over excavations shall be provided with standard guardrails. Physical barriers adequate to prevent a site hazard shall be provided at all remote excavations, trenches, wells or pits. Such barriers may consist of barricades or coverings. All temporary trenches, wells or pits shall be backfilled on completion.

5.1.11 Overhead Utilities

The excavation site and surrounding areas shall be inspected for overhead utilities prior to any excavation activities.

5.1.12 Protective Systems

Site workers shall be protected by cave-ins in accordance with OSHA Regulation 29 CFR 1926.652. These include sloping, benching support systems, shield systems or other protective systems.

5.1.13 Excavation Hazard Identification

The following warning signs indicate the potential failure of an excavation sidewall. The competent person will monitor these warning signs and implement safety precautions when necessary.

- Tension cracks in an excavation sidewall or above the excavation face
- Ground settlement or subsidence adjacent to an excavation
- An increase in strut loads to protective systems
- Bowing of struts used in protective systems
- Falling of soil from unsupported sidewalls into the excavation
- Upper layer of soil sliding off a lower layer into the excavation
- Excessive groundwater infiltration or surface water inflow into an excavation
- Softening of excavation sidewalls
- Creaking or popping sounds which indicate an imminent failure of the excavation
- Visual deformation of a support system or excavation sidewall.

Section 6
Heavy Equipment Safety

6.1 Inspections

At the beginning of each shift all vehicles and equipment being used shall be thoroughly inspected to ensure all parts and accessories are in working order. This may include checks on windshields and wipers, brakes, tires, mirrors, steering, operating controls, leaking fluids, headlights, taillights, brake lights, turn signals, seat belts, horn and backup alarms, and roll-over protection structures.

6.2 General Operating Procedures

Listed below are several general guidelines that shall be followed while operating heavy equipment:

- Seat belts must be worn at all times while operating any type of vehicle, whether it's a truck, bulldozer, loader, etc
- Speed limits shall never be exceeded
- Passengers shall not be allowed on equipment unless it is designed for them
- Refueling shall be conducted when the vehicle is turned off and there are not ignition sources nearby
- Vehicles shall not be driven in reverse with an obstructed rear view, unless it has an audible reverse alarm, or another worker signals that it is safe
- Vehicles or equipment shall be driven only on roadways or grades that are safety constructed
- Before using a lifting device, measures shall be made to determine that all personnel are in the clear
- Parking breaks shall be set when vehicles or equipment are in park
- The load or lift capacity of vehicles or equipment shall not be exceeded.

6.3 Safety Guidelines for Working Near Heavy Equipment

Listed below are several guidelines that shall be followed while working near heavy equipment:

- Stay alert at all times
- Keep a safe distance from heavy equipment if not directly involved in the work
- Keep off of the equipment unless authorized
- Wear a bright vest or jacket if working near moving vehicles or heavy equipment
- Stay clear of dumping or lifting devices.

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APPENDIX A

Appendix A

Modifications to Health & Safety Plan

Changes to the Health and Safety Plan (HASP) must be documented and communicated to all affected personnel. The following pages provide documentation, which must accompany any HASP change. This documentation summarizes the changes made and must include the following information.

- The date of the change
- The reason for the change
- The affected sections of the HASP
- The person responsible for the change

As this HASP is updated, the SHSO must ensure that all distributed copies of the HASP are updated in-kind.

Date	Reason	Affected Sections	Initials

Tighe&Bond

APPENDIX B

Appendix B

PPE Action Level Summary

LEVEL	TRIGGER (FIELD MONITORING) (1)	EXCLUSION ZONE	SAMPLING (2)	PPE
Level **D**	• 0 -5 ppm above background (PID)(1) • Ethyl Mercaptan <0.5 ppm (Ceiling) • Metals Lead - <0.05 mg/m^3 (PEL) • 0 – <10 ppm Hydrogen Sulfide • 0 – <10 % Combustible Gas • 19.5 – 23.5% Oxygen • < 2.5 mg/m^3 particulates (Worker) (15) • < 0.15 mg/m^3 particulates (Perimeter) (15) • Potential for skin contact	• Perimeter at least 20 feet around excavation area or soil pile and engineering controls. (5) • Identify area through pylons, signage and contractor orientation. • SHSO shall patrol the area to exclude unauthorized personnel. (6) • HAZWOPER Site work training required within the Exclusion Zone.	• Perimeter – Downwind continuous • Worker – if perimeter > 0.15 mg/m^3	Minimal Protection and including: • Hard hat • Safety shoes (Steel toed) • Safety glasses • Chemical protective gloves (9) • Chemical protective boots (10) • Chemical protective suit (9)
Level **C**	• 5 - 50 ppm above background (PID) (1) • Ethyl Mercaptan - >0.5 -5 ppm • Metals Lead - >0.05 mg/m^3 (PEL) • > 2.5 mg/m^3 particulates (Worker) (15) • > 0.15 mg/m^3 particulates (Perimeter) (15) • 10 – 100 ppm Hydrogen Sulfide • 0 – 10 % Combustible Gas • 19.5 – 23.5% Oxygen • IDLH (4)	• Perimeter at least 40 feet around excavation area or soil pile and engineering controls. (5) • Identify area through pylons, signage and contractor orientation. (7) • SHSO shall patrol the area to exclude unauthorized personnel. (6) • HAZWOPER Site work training required within the Exclusion Zone. • Implementation of dust control plan	• Personal: Periodic monitoring of representative employees (3) • Area: Daily monitoring upwind and downwind of the exclusion zone or project boundary.	Minimal Protection and including: • (5 - 10 ppm) Half face air purifying respirator with multipurpose cartridges(18) • (10 - 50 ppm) Full face air purifying respirator with multipurpose cartridges(18) • Chemical protective gloves (9) • Chemical protective boots (10) • Chemical protective suit (9)
Level **A/B**	• 50 – 500 ppm (Level B) or • 500 – 1,000 ppm (Level A) • Ethyl Mercaptan - >12.5 ppm • Metals Lead >2.5 mg/m^3 • >100 ppm Hydrogen Sulfide • > 10% LEL (CGI) (16) • < 19.5% Oxygen (17) • > 23.5% Oxygen • Unknown Chemicals • IDLH (4)	• Perimeter at least 60 feet around excavation area or soil pile and engineering controls. (5) • Restrict access to area through barrier fencing. • Provide access control and contamination reduction zone. • Identify area through signage and contractor orientation. (7) • SHSO shall be available at all times in the support zone while personnel are working in the exclusion zone. • HAZWOPER Site work training required within the Exclusion Zone. • Implement fire prevention plan.	• Personal: Daily monitoring of representative employees. • Area: Daily perimeter monitoring at project compass points immediately outside of the exclusion zone. Also, periodic duplicate downwind sample. (8)	Minimal Protection and including: • Positive pressure full face supplied air respirator or self contained breathing apparatus (11) • Chemical protective gloves - required • Chemical protective boots - required • Chemical protective suit - required (12)

NOTES

(1): Using direct reading instruments. Periodic spikes above 1 ppm for less than five minutes shall not be considered upgrade criteria. Spikes exceeding 1 ppm for 5 minutes or more require Dräger tube monitoring for ethyl mercaptan.
(2): Including both perimeter and personal monitoring. Passive sampling shall be through passive dosimeter badges or charcoal tubes. All samples shall be analyzed by an AIHA accredited laboratory.
(3): Dräger color indicator tube or equivalent system for specific contaminants.
(4): Up to a maximum IDLH limit.
(5): The exclusion zone may extend beyond the stated perimeter when monitoring shows air concentration above the trigger level. In such cases, the perimeter of the exclusion zone shall be determined by air monitoring and all areas above the trigger level shall be excluded.
(6): Unauthorized personnel include all individuals without HAZWOPER Site worker training in accordance with 29 CFR 1910.120.
(7): Signage shall conform to OSHA requirements.
(8): To validate reproducibility of sample results. The sampling period will be determined by the SHSO.
(9): If contact with contaminated soil, equipment or materials is likely.
(10): If foot contact with contaminated groundwater or storm water is likely.
(11): Supplied air (air-line) respirators shall be provided with an emergency escape bottle with a minimum five minute breathing capacity.
(12): All seams interfacing gloves and boots with the chemical suit and zippers shall be secured using duct tape or equivalent.
(13): Per Quick selection guide to chemical protective clothing for ethyl mercaptan / Krister Forsberg, S.A. Mansdorf. – 2nd ed.
(14): Recommended for brief incidental contact with contaminated soil or equipment (less than 15 minutes). This material is not recommended for long-term exposures or instances where the glove material will come in contact with liquid contaminants.
(15): Particulate triggers for <u>workers</u> are 2.5 mg/m^3 above background over a fifteen minute period monitored with a respirable particulate meter (e.g., PDM MINIRAM or TSI). Spikes exceeding 2.5 mg/m^3 for 15 minutes or more require air sampling for metals e.g., lead. Perimeter levels of 0.15 mg/m^3 (150 $\mu g/m^3$) above background over 15 minutes require immediate implementation of dust control plan.
(16): Combustible gases are greater than 10% of the lower explosive limit using a combustible gas indicator.
(17): Oxygen atmospheres less than 19.5% are oxygen deficient. Levels above 23.5% are oxygen enriched. Acceptable levels are 19.5 – 23.5%.
(18): Multipurpose cartridge shall include organic vapor, Hydrogen Sulfide, and HEPA P100.

ACRONYMS

HAZWOPER: Hazardous Waste Operations and Emergency Response
IDLH: Immediately Dangerous to Life and Health
PEL: Permissible Exposure Limit
PID: Photo Ionization Detector
SHSO: Site Health and Safety Officer
HEPA: High Efficiency Particulate Air
STEL: Short Term Exposure Limit

CHEMICAL COMPATIBILITY (13)

Recommended	**Not Recommended**
Nitrile (incidental) (14)	Butyl Rubber
Polyvinyl Alcohol	Natural Rubber (Latex)
Teflon	Neoprene
Viton	Chemtrel
Barricade	Saranex
Coated Tyvek (14)	Tychem QC
Responder	
Tychem7500	

Zefon INTERNATIONAL

TOLL FREE: 1-800-282-0073

Sampling Equipment Specialists

Sensidyne #165SA Ethyl Mercaptan Detector Tube

Sensidyne-Kitagawa detector tubes are single stroke detector tubes for easy, low cost spot detection of a wide range of hazardous gases and vapors

Tube Number	Chemical	Range
165SA	Ethyl Mercaptan	1-160ppm

Download Product Data Sheet
Download Tubes Selection Guide
Download Detector Tubes Cross Reference

Details

Manufacturer	Sensidyne Kitagawa
Product #	165SA
Shipping Weight	0.25 lbs
U/M	Box of 10
Stock Status	Normally Ships within 24 hours
Zefon Price:	**$58.00**

Options

Quantity 1

Quantity: **5+ Items**
Price: $56.25

Add to cart

All products and prices posted are valid for sale in the USA only
If you are not from the USA, **CLICK HERE** to locate
an Authorized Zefon Distributor in your area.

Accessories & Related Products

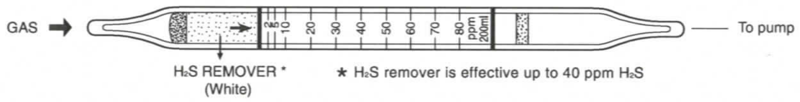
Sensidyne Gas Detection Pump Kit

5 Meter Extension Hose

10 Meter Extension Hose

Tube No.
165SA

ETHYL MERCAPTAN



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1. PERFORMANCE

1) Measuring range	：4-160 ppm 2-80 ppm 1-40 ppm
Number of pump strokes	：1 (100mℓ) 2 (200mℓ) 4 (400mℓ)
2) Sampling time	：3 minutes/2 pump strokes
3) Detectable limit	：0.2 ppm (200mℓ)
4) Shelf life	：2 years
5) Operating temperature	：0 ~ 40 ℃
6) Temperature compensation	：Necessary (0 ~ 20 ℃) (See "TEMPERATURE CORRECTION TABLE")
7) Reading	：Direct reading from the scale calibrated by 2 pump strokes
8) Colour change	：White → Yellow

2. RELATIVE STANDARD DEVIATION

RSD-low：10%   RSD-mid.：10%   RSD-high：5%

3. CHEMICAL REACTION

Ethyl mercaptan reacts with Palladium sulphate.

$C_2H_5SH + PdSO_4 \rightarrow (C_2H_5S)_2Pd + H_2SO_4$

4. CALIBRATION OF THE TUBE

STANDARD GAS CYLINDER METHOD

5. INTERFERENCE AND CROSS SENSITIVITY

Substance	ppm	Interference	ppm	Coexistence
Carbon monoxide	150	Dark grey stain is produced.		
Ethylene	200			
Hydrogen sulphide	40	Dark brown stain is produced.		
Acetylene		Pale brown stain is produced		
Methyl mercaptan		Reddish yellow stain is produced.		
Methyl sulphide			1	Lower readings are given.
Nitrogen dioxide			1	〃
Chlorine			0.2	〃

(NOTE)

1) Max. 40 ppm of Hydrogen sulphide is eliminated by pretreat reagent.

2) In case of 1 or 4 pump strokes, following formula is available for the actual concentration.

$$\text{Actual concentration} = \text{Temperature corrected value} \times \frac{2}{\text{Number of strokes}}$$

TEMPERATURE CORRECTION TABLE

Scale Readings (ppm)	True Concentration (ppm)		
	0 ℃ (32 °F)	10 ℃ (50 °F)	20-40 ℃ (68-104 °F)
80	91	85	80
70	80	75	70
60	69	64	60
50	57	53	50
40	45	42	40
30	33	31	30
20	21	20	20

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- » Homeland Security /First Response-HazMat Testing
- » Surface and Skin Chemical Detection
- » Water and Soil Analysis

Gas Detection » Inline Sampling Tubes » Ethyl mercaptan: Ethyl mercaptan

Tube Name: Ethyl mercaptan / Chemical: Ethyl mercaptan

Tube Data	
Tube Number:	72P
Gastec Tube Name:	Ethyl mercaptan
Chemical:	Ethyl mercaptan
Range:	2.5-30 ppm
Shelf Life (years):	2

Gastec Inline Sampling Tubes for testing LP-gas (liquid petroleum gas) are simple and economical to use. Simply place a tube into the inline sampling point and allow the gas to flow through the tube. Sampling for ethyl mercaptan is complete in just 1 minute. Gastec's detector tubes offer advanced technology, providing more accurate and reliable analysis with lower standard deviation. A direct-read scale printed on each tube means faster sampling time with no confusion, dual scales, or concentration charts.

Gastec Inline Sampling Tubes are intrinsically safe and ready to use anytime, anywhere. No extra equipment, lab analysis, or testing is necessary. To ensure the highest level of quality, Gastec operates an ISO-9001 certified facility. Gastec systems are designed, manufactured, and calibrated to work together to produce accurate results.

NOTE: A Gastec Data Sheet is not available for this tube.

Associated Files:	
Instructions	72p.pdf
MSDS	72p_msds.pdf

« Back to Search Results

Legal Notice & Privacy Policy

GASTEC No.72L

Instructions for Ethyl Mercaptan Detector Tube

FOR SAFE OPERATION :

Read this manual and the instruction manual of your Gastec Gas Sampling Pump carefully.

⚠ WARNING:

1. Use only Gastec detector tubes in a Gastec pump.
2. Do not interchange or use non-Gastec parts or components in Gastec's detector tube and pump system.
3. The use of non-Gastec parts or components in Gastec's detector tube and pump system or use of a non-Gastec detector tube with a Gastec pump or use of a Gastec detector tube with a non-Gastec pump may result in property damage, serious bodily injury, and death; voids all warranties; and voids all performance and data accuracy guaranties.

⚠ CAUTION: If not observed, injuries to the operator or damage to the product may result.

1. When breaking the tube ends, keep away from eyes.
2. Do not touch the broken glass tubes, pieces and reagent with bare hand(s).
3. The sampling time represents the time necessary to draw the air sample through the tube. The tube must be positioned in the desired sampling area for the entire sampling time or until the flow finish indicator indicates the end of the sample.

△NOTES : For maintaining performance and reliability to the test results.

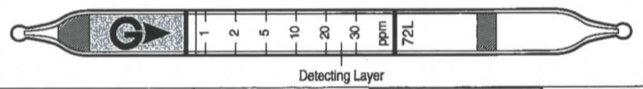
1. Use Gastec Gas Sampling Pump together with Gastec Detector Tubes only for the purposes specified in the instruction manual of the detector tube.
2. Use this tube under the temperature range of 0 - 40℃(32 - 104℉).
3. Use this tube under the relative humidity range of 0 - 90%.
4. This tube may be interfered with by the coexisting gases. Please refer to the "INTERFERENCES".
5. Shelf life and storage condition of the tube is marked on the label of the box of tube.

APPLICATION OF THE TUBE :

Use this tube for the detection of Ethyl Mercaptan in air or the industrial areas and environmental atmospheric condition.

SPECIFICATION :

(As a result of Gastec's commitment to continued improvement, specifications are subject to change without notice.)



Measuring Range	0.2 - 0.5 ppm	0.5 - 30 ppm	30 - 75 ppm
Number of Pump Strokes	2	1	1/2
Correction Factor	0.4	1	2.5
Sampling Time	1.5 minute per pump stroke		45 seconds
Detecting Limit	0.15 ppm (n = 2)		
Color Change	Yellow → Red		
Reaction Principle	Ethyl mercaptan react with acid reagent to produce red stain.		

Coefficient of Variation : 10% (for 0.5 to 5 ppm), 5% (for 5 to 30 ppm).

**** Shelf Life : Please refer to the Validity Date printed on the box of tube.**

**** Store the tubes in dark and cool place.**

CORRECTION FOR TEMPERATURE, HUMIDITY AND PRESSURE :

Temperature : Correct for temperature by the table below :

Temperature℃(℉)	0(32)	10(50)	20(68)	30(86)	40(104)
Correction Factor	1.7	1.4	1.0	0.85	0.7

Humidity : No correction is required .

Pressure : To correct for pressure, multiply the tube reading by

$$\frac{\text{Tube Reading (ppm)} \times 1013\ \text{(hPa)}}{\text{Atmospheric Pressure (hPa)}}$$

MEASUREMENT PROCEDURE :

1. For leak tight check of the pump insert a fresh sealed detector tube into pump. Follow instructions provided with the pump operating manual.
2. Break tips off a fresh detector tube in the tube tip breaker of the pump.
3. Insert the analyzer tube securely into pump inlet with arrow (G▶) on the tube pointing toward pump.
4. Make certain pump handle is all the way in. Align guide makes on pump body and handle.
5. Pull handle all the way out until it locks on 1 pump stroke (100ml). Wait 1.5 minutes and confirm the completion sampling.
6. For lower than 0.5 ppm measurement, repeat the above sampling procedure 1 more time until the stain attains to the first calibration mark. For higher than 30 ppm measurement, prepare fresh tube and take 1/2 pump stroke.
7. Read concentration at the interface of the stained-to-unstained reagent.
8. If correction is needed, multiply the correction factors of temperature, pump strokes and pressure.

INTERFERENCES :

Substance	Interference	Changes color by itself to
Hydrogen Sulfide	Plus error	Red
Mercaptans	Plus error	Red
Acetylene	No effect	No discoloration
Carbon Monoxide	No effect	No discoloration
Ethylene	No effect	No discoloration

The table of this interference gases primarily expresses the interference of each coexisting gas in the gas concentration range, equivalent to the gas concentration. Therefore, the test result may be given positive result by the other substances not listed in the table. For more information is needed, please contact us or our distributors in your territory.

DANGEROUS AND HAZARDOUS PROPERTIES :

Threshold Limit Value-Time Weighted Average by ACGIH (2004): 0.5 ppm
Explosive Range : 2.8 - 18.2%

DISPOSAL INSTRUCTION :

This tube contains 0.44mg of inorganic mercury. When disposing the tube regardless of used or unused, follow the rules and regulations of the local government.

WARRANTY :

If you have any questions regarding gas detection and quality of the tubes, please feel free to contact your Gastec representatives.

Manufacturer : Gastec Corporation
6431 Fukaya, Ayase-City, 252-1103, Japan
http://www.gastec. co.jp/
Telephone +81-467-79-3910 Facsimile +81-467-79-3979

IM0072LE1
Printed in Japan
05C1Z

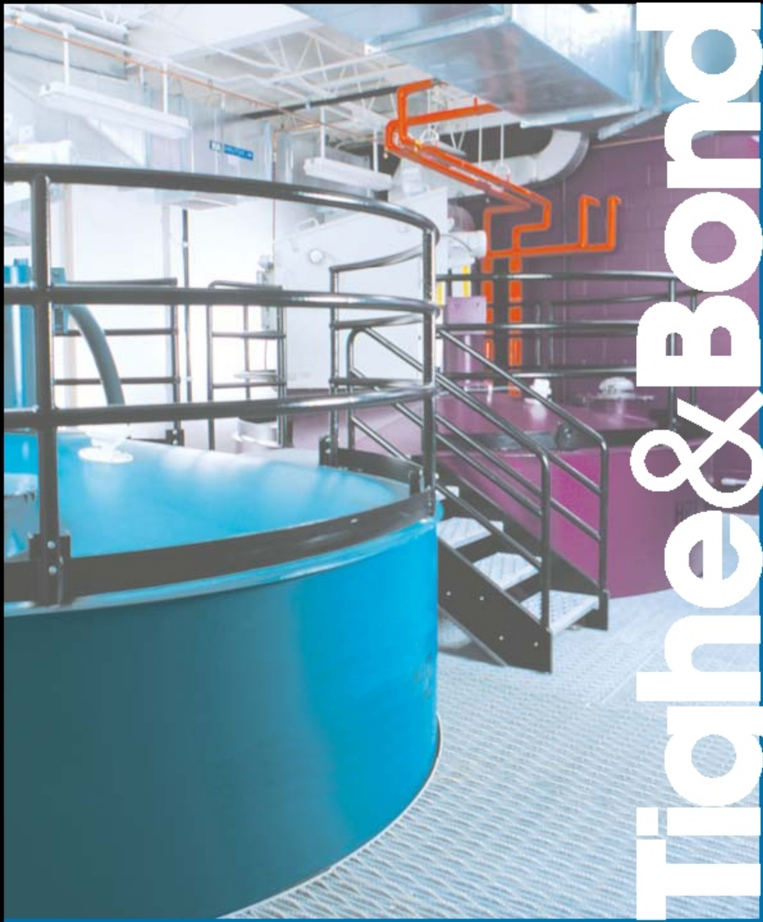
APPENDIX C

SITE NAME: Former NL Industries Facility, City of Depew, New York

I have reviewed a copy of the Health and Safety Plan (HASP) for the site and understand the information provided herein. I understand that all employees working within the controlled Exclusion Zone at this site must follow the guidance provided in the HASP summary and follow the instructions provided by the Site Health and Safety Officer (SHSO). Failure to follow these requirements may subject personnel to disciplinary action.

Printed Name/Company	**Signature**	**Date**

APPENDIX D



Appendix D

Site Specific Information

The following is site specific information for the Former NL Industries Facility, City of Depew, New York construction project.

Personnel

The following supervisory structure has been identified for the implementation and management of the Health & Safety Plan.

Project Management:

Project Superintendent
- (Name): ____________________ (Phone Number): __________________

Alternate Project Superintendent
- (Name): ____________________ (Phone Number): __________________

Health & Safety:

- Michael Matilainen, CIH, CSP (413) 572-3225
  Certified Industrial Hygienist/Certified Safety Professional
- Laura Hale, CET, OHST (860) 704-4776
  Certified Environmental Trainer, Occupational Health & Safety Technologist
- Site Health & Safety Officer (SHSO): __________________________________
- Alternate SHSO: _________________________

Environmental Coordination

Owner's Professional Engineer
- (Name): ____________________ (Phone Number): __________________

External Assistance

The following is a list of emergency and regulatory agencies that may be of assistance in the event of an emergency response action, spill or release of hazardous material:

Depew Fire Department	911
Depew Police Department	911 or (716) 683-1123
Ambulance Service	911
St. Joseph Hospital 2605 Harlem Road Cheektowaga, NY 14225	(716) 891-2400
New York Poison Control Center	(800) 222-1222
Hazardous Materials Release Responder:	

NYSDEC 24-Hour Spill Hotline	(800) 457-7362
Chemical Transportation Emergency Center (CHEMTREC):	(800) 424-9300
U.S EPA Region 2 Regional Office	(212) 637-3660
U. S. Dept. of Labor/OSHA 130 S. Elmwood Avenue, Suite 500 Buffalo, NY 14202-2465	(716) 551-3053
Agency for Toxic Substances and Disease Registry (ATSDR) EPA Region 2 290 Broadway, North 28th Floor New York, NY 10007	(212) 637-4305
National Animal Poison Control Center	(888) 426-4435
National Response Center	(800) 424-8802

Directions to Nearest Hospital - Attached

Emergency Procedures

Initial Actions – Alert all site personnel to the emergency. Sound a site alarm to:

- Notify personnel and authorities of an emergency situation;
- Stop work activities
- Proceed to the Contamination Reduction Zone (CRZ) if working in the Exclusion Zone
- Lower background noise in order to speed communication
- Initiate emergency procedures and secure area where the incident has occurred
- Develop release information and make regulatory modifications

MAPQUEST.

St. Joseph Hospital
(716) 891 - 2400

Total Time: 9 minutes **Total Distance: 4.84 miles**

A: 3241 Walden Ave, Depew, NY 14043-2848

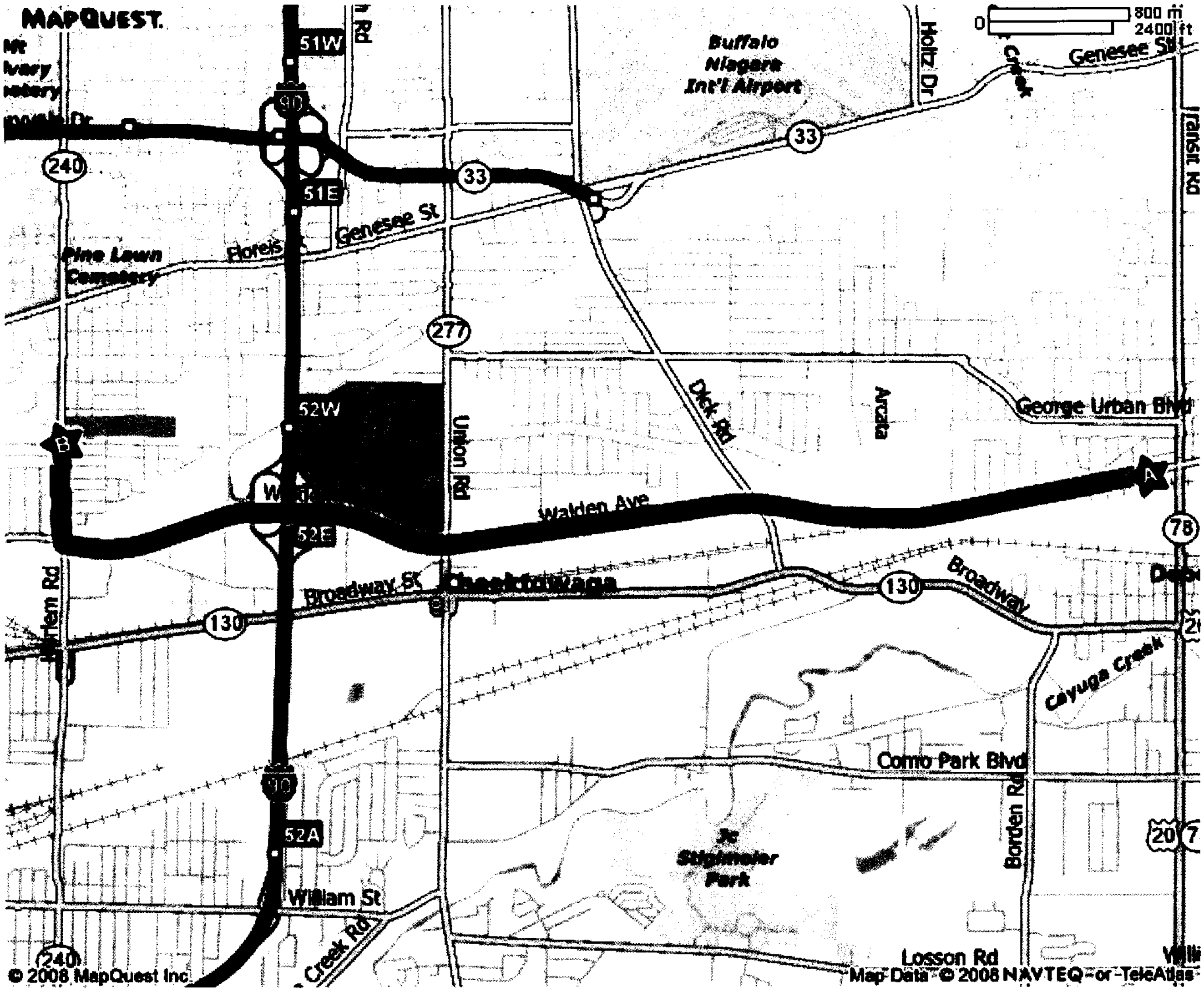
START 1: Start out going WEST on WALDEN AVE toward W 3RD ST. 4.4 mi

2: Turn RIGHT onto HARLEM RD/NY-240. 0.4 mi

END 3: End at 2605 Harlem Rd Cheektowaga, NY 14225-4018

B: 2605 Harlem Rd, Cheektowaga, NY 14225-4018

Total Time: 9 minutes **Total Distance: 4.84 miles**



MAPQUEST
800 m
2400 ft
0
Buffalo Niagara Int'l Airport
Genesee St
Holtz Dr
Transit Rd
51W
90
33
240
51E
Genesee St
Floreis
Pine Lawn Cemetery
277
Dick Rd
Arcata
George Urban Blvd
52W
B
A
Union Rd
Walden Ave
52E
78
Harlem Rd
Broadway St
Cheektowaga
130
Broadway
Cayuga Creek
Como Park Blvd
Borden Rd
90
52A
20
Stiglmeier Park
William St
Creek Rd
240
Losson Rd
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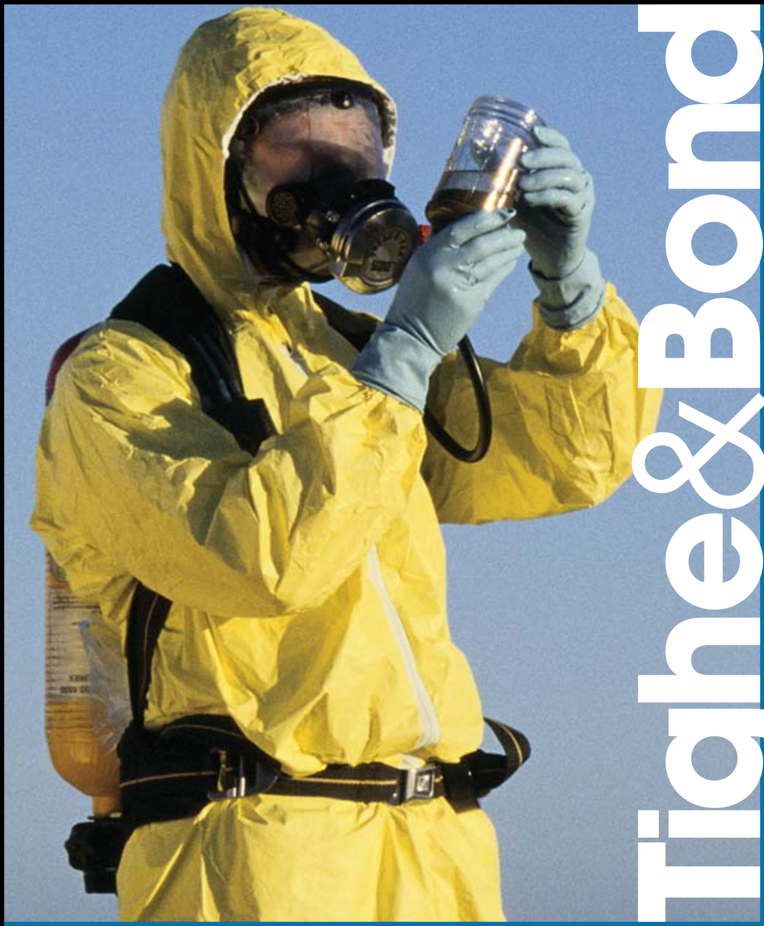


APPENDIX E

Appendix E

Chemical Hazards

Right to Know
Hazardous Substance Fact Sheet

Common Name: **LEAD**

Synonym: Metallic Lead
Chemical Name: Lead
Date: September 2001 Revision: September 2007

CAS Number: 7439-92-1
RTK Substance Number: 1096
DOT Number: UN 3077

Description and Use

Lead is a heavy, soft, silvery-gray metal. It is used in the production of storage batteries, ammunition, cable covering, pigments, glass, ceramic glazes, casting metals, and solders.

Reasons for Citation

- **Lead** is on the Right to Know Hazardous Substance List because it is cited by OSHA, ACGIH, DOT, NIOSH, NTP, DEP, IARC, IRIS and EPA.
- This chemical is on the Special Health Hazard Substance List.

SEE GLOSSARY ON PAGE 5.

FIRST AID

Eye Contact

- Immediately flush with large amounts of cool water for at least 15 minutes, lifting upper and lower lids. Remove contact lenses, if worn, while rinsing.

Skin Contact

- Remove contaminated clothing. Wash contaminated skin with soap and water.

Inhalation

- Remove the person from exposure.
- Begin rescue breathing (using universal precautions) if breathing has stopped and CPR if heart action has stopped.
- Transfer promptly to a medical facility.

EMERGENCY NUMBERS

Poison Control: 1-800-222-1222
CHEMTREC: 1-800-424-9300
NJDEP Hotline: 1-877-927-6337
National Response Center: 1-800-424-8802

EMERGENCY RESPONDERS >>>> SEE PAGE 6

Hazard Summary

Hazard Rating	NJDHSS	NFPA
HEALTH	4	-
FLAMMABILITY	0	-
REACTIVITY	0	-
CARCINOGEN TERATOGEN POISONOUS FUMES ARE PRODUCED IN FIRE DOES NOT BURN		

Hazard Rating Key: 0=minimal; 1=slight; 2=moderate; 3=serious; 4=severe

- **Lead** can affect you when inhaled or swallowed.
- **Lead** is a CARCINOGEN and may be a TERATOGEN. HANDLE WITH EXTREME CAUTION.
- Contact can irritate the eyes.
- Exposure can cause headache, irritability, and muscle and joint pain.
- Repeated exposure can cause *Lead poisoning* with metallic taste, colic and muscle cramps.
- **Lead** may damage the nervous system.
- Exposure may cause kidney and brain damage, and anemia.

Workplace Exposure Limits

OSHA:	The legal airborne permissible exposure limit (PEL) is **0.05 mg/m^3** averaged over an 8-hour workshift.
NIOSH:	The recommended airborne exposure limit (REL) is **0.05 mg/m^3** averaged over a 10-hour workshift. Air concentrations should be maintained so that blood **Lead** is less than **0.06 mg per 100 grams** of whole blood.
ACGIH:	The threshold limit value (TLV) is **0.05 mg/m^3** averaged over an 8-hour workshift.

- **Lead** is a PROBABLE CARCINOGEN in humans and may be a TERATOGEN in humans. There may be <u>no</u> safe level of exposure to a carcinogen, so all contact should be reduced to the lowest possible level.

Determining Your Exposure

- Read the product manufacturer's Material Safety Data Sheet (MSDS) and the label to determine product ingredients and important safety and health information about the product mixture.
- For each individual hazardous ingredient, read the New Jersey Department of Health and Senior Services Hazardous Substance Fact Sheet, available on the RTK Program website (www.nj.gov/health/eoh/rtkweb) or in your facility's RTK Central File or Hazard Communication Standard file.
- You have a right to this information under the New Jersey Worker and Community Right to Know Act, the Public Employees Occupational Safety and Health (PEOSH) Act if you are a public worker in New Jersey, and under the federal Occupational Safety and Health Act (OSHA) if you are a private worker.
- The New Jersey Right to Know Act requires most employers to label chemicals in the workplace and requires public employers to provide their employees with information concerning chemical hazards and controls. The federal OSHA Hazard Communication Standard (29 CFR 1910.1200) requires private employers to provide similar information and training to their employees.

This Fact Sheet is a summary of available information regarding the health hazards that may result from exposure. Duration of exposure, concentration of the substance and other factors will affect your susceptibility to any of the potential effects described below.

Health Hazard Information

Acute Health Effects
The following acute (short-term) health effects may occur immediately or shortly after exposure to **Lead**:

- Contact can irritate the eyes.
- **Lead** can cause headache, irritability, reduced memory, disturbed sleep, and mood and personality changes.
- Exposure can cause upset stomach, poor appetite, weakness and fatigue.

Chronic Health Effects
The following chronic (long-term) health effects can occur at some time after exposure to **Lead** and can last for months or years:

Cancer Hazard

- **Lead** is a PROBABLE CARCINOGEN in humans. There is some evidence that **Lead** and *Lead compounds* cause lung, stomach, brain and kidney cancers in humans and they have been shown to cause kidney cancer in animals.
- Many scientists believe there is no safe level of exposure to a carcinogen.

Reproductive Hazard

- **Lead** may be a TERATOGEN in humans since it is a teratogen in animals.
- It may decrease fertility in males and females, and damage the developing fetus and the testes (male reproductive glands).

Other Effects

- Repeated exposure to **Lead** can cause *Lead poisoning*. Symptoms include metallic taste, poor appetite, weight loss, colic, nausea, vomiting, and muscle cramps.
- Higher levels can cause muscle and joint pain, and weakness.
- High or repeated exposure may damage the nerves causing weakness, "pins and needles," and poor coordination in the arms and legs.
- **Lead** exposure increases the risk of high blood pressure.
- **Lead** may cause kidney and brain damage, and damage to the blood cells causing anemia.
- Repeated exposure causes **Lead** to accumulate in the body. It can take years for the body to get rid of excess **Lead**.

Medical

Medical Testing
Before first exposure, and every six (6) months thereafter, OSHA requires your employer to provide (for persons exposed to **30 micrograms** or more of *Lead* **per cubic meter** of air):

- Blood *Lead* test
- ZPP (a special test for the effects of *Lead* on blood cells)

For employees with blood *Lead* levels above **40 micrograms per 100 grams** of whole blood (**40 micrograms per deciliter**), OSHA requires blood *Lead* level monitoring every two months until two consecutive blood *Lead* levels are below **40 micrograms per 100 grams** of whole blood. These employees must undergo a medical evaluation, which should include:

- Complete work and medical history
- Thorough physical examination, including examination of the central nervous system
- Blood *Lead* test
- ZPP
- Hemoglobin, hematocrit with complete blood count
- Urinalysis with microscopic examination
- Any other tests determined necessary by the examining physician

This evaluation should be performed at least annually.

OSHA requires your employer to provide you and your doctor with a copy of the OSHA Lead Standards (29 CFR 1910.1025 and 1926.62).

Any evaluation should include a careful history of past and present symptoms with an exam. Medical tests that look for damage already done are not a substitute for controlling exposure.

Request copies of your medical testing. You have a legal right to this information under the OSHA Access to Employee Exposure and Medical Records Standard (29 CFR 1910.1020).

Mixed Exposures

Body exposures to *Lead* from hobbies using *Lead* solder or pigments, target practice, and drinking moonshine made in *Leaded* containers will increase *Lead* levels. Repeated breathing or handling of *Leaded* gasoline may also add to body *Lead* levels.

Workplace Controls and Practices

Very toxic chemicals, or those that are reproductive hazards or sensitizers, require expert advice on control measures if a less toxic chemical cannot be substituted. Control measures include: (1) enclosing chemical processes for severely irritating and corrosive chemicals, (2) using local exhaust ventilation for chemicals that may be harmful with a single exposure, and (3) using general ventilation to control exposures to skin and eye irritants. For further information on workplace controls, consult the NIOSH document on Control Banding at www.cdc.gov/niosh/topics/ctrlbanding/.

The following work practices are also recommended:

- Label process containers.
- Provide employees with hazard information and training.
- Monitor airborne chemical concentrations.
- Use engineering controls if concentrations exceed recommended exposure levels.
- Provide eye wash fountains and emergency showers.
- Wash or shower if skin comes in contact with a hazardous material.
- Always wash at the end of the workshift.
- Change into clean clothing if clothing becomes contaminated.
- Do not take contaminated clothing home.
- Get special training to wash contaminated clothing.
- Do not eat, smoke, or drink in areas where chemicals are being handled, processed or stored.
- Wash hands carefully before eating, smoking, drinking, applying cosmetics or using the toilet.

In addition, the following may be useful or required:

- Specific engineering controls are required for this chemical by OSHA. Refer to the OSHA **Lead** Standards (29 CFR 1910.1025 and 1926.62).
- Use a vacuum or a wet method to reduce dust during clean-up. DO NOT DRY SWEEP.
- Use a high efficiency particulate air (HEPA) filter when vacuuming. Do not use a standard shop vacuum.

Personal Protective Equipment

The OSHA Personal Protective Equipment Standard (29 CFR 1910.132) requires employers to determine the appropriate personal protective equipment for each hazard and to train employees on how and when to use protective equipment.

The following recommendations are only guidelines and may not apply to every situation.

Gloves and Clothing

- Avoid skin contact with **Lead**. Wear personal protective equipment made from material which can not be permeated and/or degraded by this substance. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation.
- Safety equipment manufacturers recommend *Nitrile*, *Latex*, or *Rubber* for gloves and DuPont *Tyvek®* as protective material for clothing.
- All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Eye Protection

- Wear non-vented, impact resistant goggles when working with fumes, gases, or vapors.
- For impact hazards (such as flying fragments, chips or particles), wear safety glasses with side shields or safety goggles.
- Wear a face shield along with goggles when working with corrosive, highly irritating or toxic substances.

Respiratory Protection

Improper use of respirators is dangerous. Respirators should only be used if the employer has a written program that takes into account workplace conditions, requirements for worker training, respirator fit testing, and medical exams, as described in the OSHA Respiratory Protection Standard (29 CFR 1910.134).

- Where the potential exists for exposure not higher than **0.5 mg/m^3**, use a half-mask air purifying respirator equipped with high efficiency filters.
- Where the potential exists for exposure not higher than **2.5 mg/m^3**, use a full facepiece, air purifying respirator with high efficiency filters.
- Where the potential exists for exposure not higher than **50 mg/m^3**, use any powered-air purifying respirator with high efficiency filters or a half-mask supplied-air respirator operated in a positive pressure mode.
- Leave the area immediately if (1) while wearing a filter or cartridge respirator you can smell, taste, or otherwise detect **Lead**, (2) while wearing particulate filters abnormal resistance to breathing is experienced, or (3) eye irritation occurs while wearing a full facepiece respirator. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter or cartridge. If the seal is no longer good, you may need a new respirator.
- Be sure to consider all potential sources of exposure in your workplace. You may need a combination of filters, prefilters or cartridges to protect against different forms of a chemical (such as vapor and mist) or against a mixture of chemicals.
- Where the potential exists for exposure greater than **50 mg/m^3** but less than **100 mg/m^3**, use supplied-air respirators with full facepiece, hood, helmet or suit, operated in a positive pressure mode.
- Where the potential exists for exposure greater than **100 mg/m^3**, use full facepiece, self-contained breathing apparatus operated in a positive pressure mode.

Fire Hazards

If employees are expected to fight fires, they must be trained and equipped as stated in the OSHA Fire Brigades Standard (29 CFR 1910.156).

- ▸ Extinguish fire using an agent suitable for type of surrounding fire. **Lead** itself does not burn.
- ▸ POISONOUS FUMES ARE PRODUCED IN FIRE, including *Lead Oxides*.
- ▸ Use water spray to keep fire-exposed containers cool.

Spills and Emergencies

If employees are required to clean-up spills, they must be properly trained and equipped. The OSHA Hazardous Waste Operations and Emergency Response Standard (29 CFR 1910.120) may apply.

If **Lead** is spilled, take the following steps:

- ▸ Evacuate personnel and secure and control entrance to the area.
- ▸ Eliminate all ignition sources.
- ▸ Collect spilled material using a HEPA-filter vacuum and deposit into sealed containers.
- ▸ Ventilate and wash area after clean-up is complete.
- ▸ It may be necessary to contain and dispose of **Lead** as a HAZARDOUS WASTE. Contact your state Department of Environmental Protection (DEP) or your regional office of the federal Environmental Protection Agency (EPA) for specific recommendations.

Handling and Storage

Prior to working with **Lead** you should be trained on its proper handling and storage.

- ▸ A regulated, marked area should be established where **Lead** is handled, used, or stored.
- ▸ **Lead** reacts violently with HYDROGEN PEROXIDE; AMMONIUM NITRATE; ZIRCONIUM; SODIUM AZIDE; SODIUM ACETYLIDE; and CHLORINE TRIFLUORIDE.
- ▸ **Lead** is not compatible with OXIDIZING AGENTS (such as PERCHLORATES, PEROXIDES, PERMANGANATES, CHLORATES, NITRATES, CHLORINE, BROMINE and FLUORINE) and STRONG ACIDS (such as HYDROCHLORIC, SULFURIC and NITRIC).
- ▸ Store in tightly closed containers in a cool, well-ventilated area.

Occupational Health Services Resources

The New Jersey Department of Health and Senior Services, Occupational Health Service, offers multiple services in occupational health. These services include providing informational resources, educational materials, public presentations, and industrial hygiene and medical investigations and evaluations.

For more information, please contact:

New Jersey Department of Health & Senior Services
Right to Know Program
PO Box 368
Trenton, NJ 08625-0368
Phone: 609-984-2202
Fax: 609-984-7407
E-mail: rtk@doh.state.nj.us
Web address: http://www.nj.gov/health/eoh/rtkweb

The Right to Know Hazardous Substance Fact Sheets are not intended to be copied and sold for commercial purposes.

GLOSSARY

ACGIH is the American Conference of Governmental Industrial Hygienists. They publish guidelines called Threshold Limit Values (TLVs) for exposure to workplace chemicals.

Boiling point is the temperature at which a substance can change its physical state from a liquid to a gas.

A **carcinogen** is a substance that causes cancer.

The **CAS number** is unique, identifying number, assigned by the Chemical Abstracts Service, to a specific chemical.

CFR is the Code of Federal Regulations, which are the regulations of the United States government.

A **combustible** substance is a solid, liquid or gas that will burn.

A **corrosive** substance is a gas, liquid or solid that causes destruction of human skin or severe corrosion of containers.

DEP is the New Jersey Department of Environmental Protection.

DOT is the Department of Transportation, the federal agency that regulates the transportation of chemicals.

EPA is the Environmental Protection Agency, the federal agency responsible for regulating environmental hazards.

A **fetus** is an unborn human or animal.

A **flammable** substance is a solid, liquid, vapor or gas that will ignite easily and burn rapidly.

The **flash point** is the temperature at which a liquid or solid gives off vapor that can form a flammable mixture with air.

IARC is the International Agency for Research on Cancer, a scientific group.

Ionization Potential is the amount of energy needed to remove an electron from an atom or molecule. It is measured in electron volts.

IRIS is the Integrated Risk Information System database by federal EPA. The database contains information on human health effects that may result from exposure to various chemicals in the environment.

LEL or **Lower Explosive Limit**, is the lowest concentration of a combustible substance (gas or vapor) in the air capable of continuing an explosion.

mg/m^3 means milligrams of a chemical in a cubic meter of air. It is a measure of concentration (weight/volume).

A **mutagen** is a substance that causes mutations. A **mutation** is a change in the genetic material in a body cell. Mutations can lead to birth defects, miscarriages, or cancer.

NAERG is the North American Emergency Response Guidebook. It is a guide for emergency responders for transportation emergencies involving hazardous substances.

NFPA is the National Fire Protection Association. It classifies substances according to their fire and explosion hazard.

NIOSH is the National Institute for Occupational Safety and Health. It tests equipment, evaluates and approves respirators, conducts studies of workplace hazards, and proposes standards to OSHA.

NTP is the National Toxicology Program which tests chemicals and reviews evidence for cancer.

OSHA is the federal Occupational Safety and Health Administration, which adopts and enforces health and safety standards.

PEOSHA is the New Jersey Public Employees Occupational Safety and Health Act, which adopts and enforces health and safety standards in public workplaces.

Permeated is the movement of chemicals through protective materials.

PIH is a DOT designation for chemicals which are Poison Inhalation Hazards.

ppm means parts of a substance per million parts of air. It is a measure of concentration by volume in air.

A **reactive** substance is a solid, liquid or gas that releases energy under certain conditions.

STEL is a Short Term Exposure Limit which is usually a 15-minute exposure that should not be exceeded at any time during a work day.

A **teratogen** is a substance that causes birth defects by damaging the fetus.

UEL or **Upper Explosive Limit** is the highest concentration in air above which there is too much fuel (gas or vapor) to begin a reaction or explosion.

Vapor Density is the ratio of the weight of a given volume of one gas to the weight of another (usually *Hydrogen*), at the same temperature and pressure.

The **vapor pressure** is a measure of how readily a liquid or a solid mixes with air at its surface. A higher vapor pressure indicates a higher concentration of the substance in air and therefore increases the likelihood of breathing it in.

Common Name: **LEAD**

Synonym: Metallic Lead
CAS No: 7439-92-1
Molecular Formula: Pb_2
RTK Substance No: 1096
Description: Heavy, soft, silvery-gray metal

HAZARD DATA

Hazard Rating	Firefighting	Reactivity
4 - Health **0 - Fire** **0 - Reactivity** **DOT#:** UN 3077 **ERG Guide #:** 171 **Hazard Class:** 9 (Environmentally Hazardous Substance)	Extinguish fire using an agent suitable for type of surrounding fire. **Lead** itself does not burn. POISONOUS FUMES ARE PRODUCED IN FIRE, including *Lead Oxides*. Use water spray to keep fire-exposed containers cool.	**Lead** reacts violently with HYDROGEN PEROXIDE; AMMONIUM NITRATE; ZIRCONIUM; SODIUM AZIDE; SODIUM ACETYLIDE; and CHLORINE TRIFLUORIDE. **Lead** is not compatible with OXIDIZING AGENTS (such as PERCHLORATES, PEROXIDES, PERMANGANATES, CHLORATES, NITRATES, CHLORINE, BROMINE and FLUORINE) and STRONG ACIDS (such as HYDROCHLORIC, SULFURIC and NITRIC).

SPILL/LEAKS

Isolation Distance: 10 to 25 meters (30 to 80 feet)

Use a HEPA-filter vacuum for clean-up.

Toxic to aquatic organisms.

Hazardous to the environment and persists in the environment.

PHYSICAL PROPERTIES

Odor Threshold:	No odor
Flash Point:	Not combustible
LEL:	N/A
UEL:	N/A
Specific Gravity:	11.35 at 68°F (20°C)
Vapor Pressure:	0 mm Hg at 68°F (20°C)
Water Solubility:	Insoluble
Boiling Point:	3,164°F (1,740°C)
Melting Point:	621.5°F (327.5°C)

EXPOSURE LIMITS

OSHA:	0.05 mg/m^3, 8-hr TWA
NIOSH:	0.05 mg/m^3, 10-hr TWA
ACGIH:	0.05 mg/m^3, 8-hr TWA
IDLH LEVEL:	100 mg/m^3

PROTECTIVE EQUIPMENT

Gloves:	Nitrile, Latex, Rubber
Coveralls:	DuPont *Tyvek*®
Boots:	Latex, Butyl, Neoprene
Respirator:	<0.5 mg/m^3 - N100 >0.5 mg/m^3 - full facepiece APR with High Efficiency filters >50 mg/m^3 but $\leq$100 mg/m^3 Supplied Air

HEALTH EFFECTS

Eyes:	Irritation
Skin:	No Information
Acute:	Headache, irritability, upset stomach, and weakness
Chronic:	*Lead* may cause lung, brain, stomach, and kidney cancer in humans. Metallic taste, colic, muscle cramps Damage to the nervous system

FIRST AID AND DECONTAMINATION

Remove the person from exposure.

Flush eyes with large amounts of water for at least 15 minutes. Remove contact lenses if worn.

Remove contaminated clothing and wash contaminated skin with soap and water.

Transfer to a medical facility.

SEVERN TRENT **STL**

Date: 12/15/04
Time: 13:10:36
(Mountain Time)

From: Jesse Bacwaden
STL Los Angeles
1721 South Grand Aveune
Santa Ana, CA 92705

voice: 714-258-8610
fax: 714-258-0921

To:

Number of Pages
Including Cover Sheet: 03

SEVERN TRENT LABORATORIES, INC.

PRELIMINARY DATA SUMMARY

Lot #: E4L140307

Date Reported: 12/15/04

Client Sample ID: MW-CAN-01
Sample #: 001 Date Sampled: 12/10/04 13:15 Date Received: 12/14/04 Matrix: AIR

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD	
Volatile Organics by TO15					In Review
Dichlorodifluoromethane	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Chloromethane	ND	4.0	ppb(v/v)	EPA-2 TO-15	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Vinyl chloride	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Bromomethane	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Chloroethane	ND	4.0	ppb(v/v)	EPA-2 TO-15	
Trichlorofluoromethane	ND	2.0	ppb(v/v)	EPA-2 TO-15	
1,1-Dichloroethene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Carbon disulfide	ND	10	ppb(v/v)	EPA-2 TO-15	
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Acetone	ND	10	ppb(v/v)	EPA-2 TO-15	
trans-1,2-Dichloroethene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
1,1-Dichloroethane	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Vinyl acetate	ND	10	ppb(v/v)	EPA-2 TO-15	
cis-1,2-Dichloroethene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
2-Butanone (MEK)	ND	10	ppb(v/v)	EPA-2 TO-15	
Chloroform	10	2.0	ppb(v/v)	EPA-2 TO-15	
1,1,1-Trichloroethane	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Carbon tetrachloride	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Benzene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
1,2-Dichloroethane	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Trichloroethene 24.7 ug/m3	4.6	2.0	ppb(v/v)	EPA-2 TO-15	
1,2-Dichloropropane	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Bromodichloromethane	ND	2.0	ppb(v/v)	EPA-2 TO-15	
cis-1,3-Dichloropropene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
4-Methyl-2-pentanone (MIBK)	ND	10	ppb(v/v)	EPA-2 TO-15	
Toluene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
trans-1,3-Dichloropropene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
1,1,2-Trichloroethane	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Tetrachloroethene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
2-Hexanone	ND	10	ppb(v/v)	EPA-2 TO-15	
Dibromochloromethane	ND	2.0	ppb(v/v)	EPA-2 TO-15	
1,2-Dibromoethane (EDB)	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Chlorobenzene	ND	2.0	ppb(v/v)	EPA-2 TO-15	

DAR-1
Guideline
5000
(2) –

(Continued on next page)

The results shown below may still require additional laboratory review and are subject to change. Actions taken based on these results are the responsibility of the data user.

Lot #: E4L140307

Date Reported: 12/15/04

Client Sample ID: MW-CAN-01
Sample #: 001 Date Sampled: 12/10/04 13:15 Date Received: 12/14/04 Matrix: AIR

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD	
Volatile Organics by TO15					In Review
Ethylbenzene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Xylenes (total)	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Styrene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Bromoform	ND	2.0	ppb(v/v)	EPA-2 TO-15	
1,1,2,2-Tetrachloroethane	ND	2.0	ppb(v/v)	EPA-2 TO-15	
Benzyl chloride	ND	10	ppb(v/v)	EPA-2 TO-15	
4-Ethyltoluene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
1,3,5-Trimethylbenzene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
1,2,4-Trimethylbenzene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
1,3-Dichlorobenzene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
1,4-Dichlorobenzene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
1,2-Dichlorobenzene	ND	2.0	ppb(v/v)	EPA-2 TO-15	
1,2,4-Trichloro-benzene	ND	5.0	ppb(v/v)	EPA-2 TO-15	
Hexachlorobutadiene	ND	4.0	ppb(v/v)	EPA-2 TO-15	
Volatile Organics by TO15					In Review
Methylene chloride	11000	110	ppb(v/v)	EPA-2 TO-15	
dichloromethane	38200 µg/m³				
	DAR-1 guideline = 14 000 (D)				

Conversion from ppbv to µg/m³ ⇒ $\frac{[\text{ppbv}] \times \text{MW}}{24.46}$

MC. MW = 84.93
TCE: MW = 131.39

Report Number: 5177-4347

SET Environmental, Inc

ANALYTICAL REPORT

Prepared For:

WASTE TECHNOLOGY SERVICES, INC.
FOR
METRO WASTE PAPER RECOVERY

Attention: THOMAS DOBMEIER

Analysis Completed: 8/29/06

Description of Samples Received: 1 Sample for Analysis

Description of Services Rendered: Unknown Identification

Results furnished on attached pages

If you have any questions regarding this report, please contact the SET Laboratory staff at (847) 537-9221.

Bijan Saeedi
Laboratory Manager

Integrity • Innovation • Excellence
450 Sumac Road · Wheeling, IL 60090 · (847) 537-9221 (800) 942-9020 · FAX (847) 537-9265
Visit our website @ www.setenv.com

Sample Number	Size	Chemical Name	Sample Disposition
	5 tubes 0.5" * 8"	Diethyl disulfide / Aliphatic hydrocarbons: Nonane / Decane / Undecane / Dodecane Note: Samples are sealed copper tubes slightly leaking. Vapor analyzed using SPME (Solid phase micro extraction & GC-MS)	R

-END OF REPORT-

Method: Chromatography (SPME-GC/MS)

Sample Disposition Codes
- R = Remaining sample to be returned to generator
- D = Remaining sample to be disposed
- U = Entire sample used for analysis
- I = Insufficient Sample to complete analysis

Report Number. 5183-4361

SET Environmental, Inc

ANALYTICAL REPORT

Prepared For:

WASTE TECHNOLOGY SERVICES, INC.
FOR
METRO WASTE PAPER RECOVERY

Attention: THOMAS DOBMEIER

Analysis Completed: 9/21/06

Description of Samples Received: 1 Sample for Analysis

Description of Services Rendered: Unknown Identification

Results furnished on attached pages

If you have any questions regarding this report, please contact the SET Laboratory staff at (847) 537-9221.

Bijan Saeedi
Laboratory Manager

Integrity • Innovation • Excellence
450 Sumac Road · Wheeling, IL 60090 · (847) 537-9221 (800) 942-9020 · FAX (847) 537-9265
Visit our website @ www.setenv.com

Report Number: 5183-4361

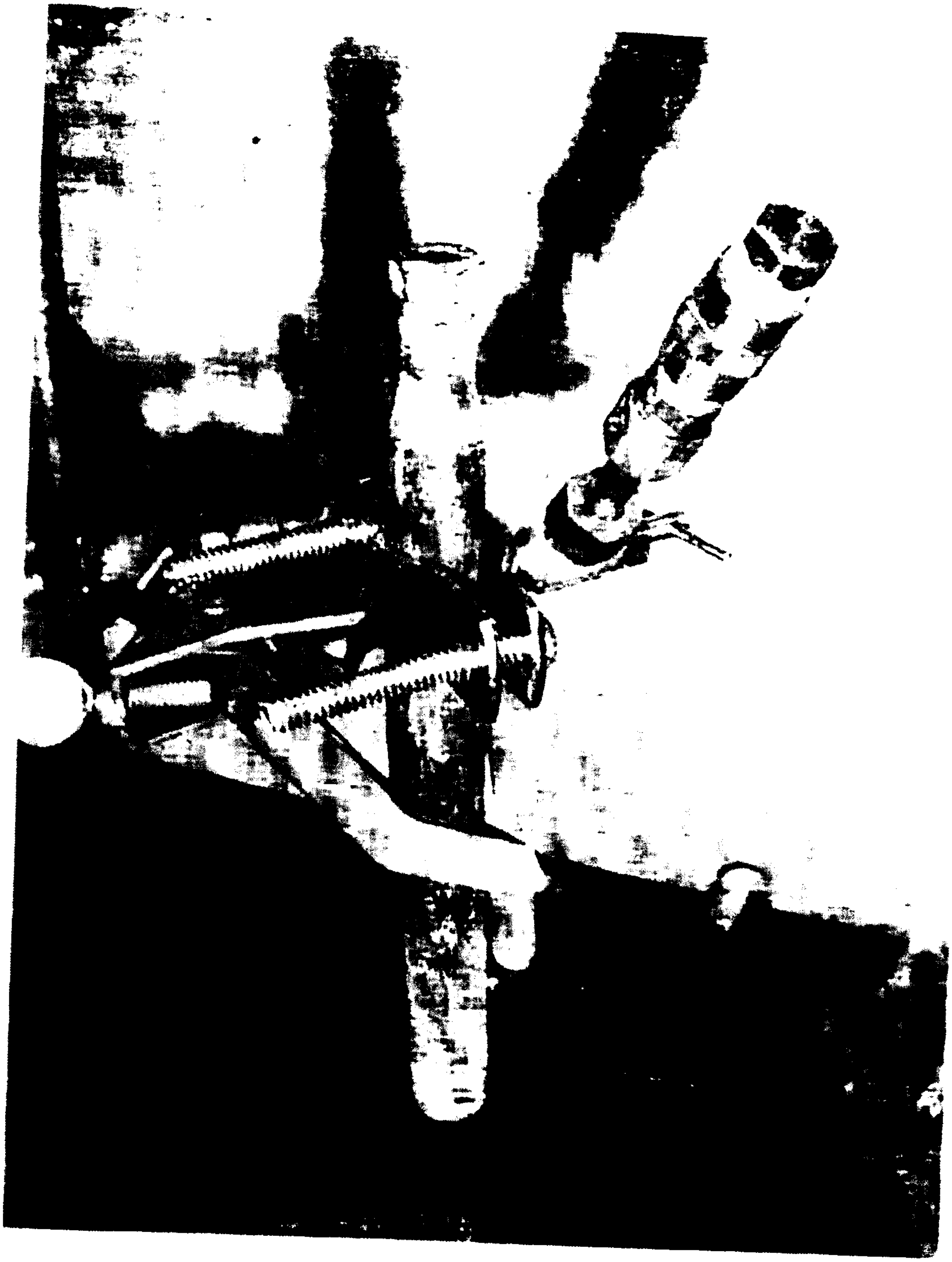
Sample Number	Size	Chemical Name	Sample Disposition
	5 tubes 0.5" x 8"	Ethanethiol (Ethyl mercaptan) / trace: Diethyl disulfide Note: sealed copper tube was tapped in order to sample.	R

-END OF REPORT-

Method: FT-IR / Chromatography (GC/MS)

Sample Disposition Codes

R - Remaining sample to be returned to generator
D - Remaining sample to be disposed
E - Entire sample used for analysis
I - Insufficient Sample to complete analysis



MATHESON
TRI•GAS
ask. . .The Gas Professionals™

MATERIAL SAFETY DATA SHEET

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1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MATHESON TRI-GAS, INC.
150 Allen Road Suite 302
Basking Ridge, New Jersey 07920
Information: 1-800-416-2505

Emergency Contact:
CHEMTREC 1-800-424-9300
Calls Originating Outside the US:
703-527-3887 (Collect Calls Accepted)

SUBSTANCE: ETHYL MERCAPTAN

TRADE NAMES/SYNONYMS:
MTG MSDS 207; ETHANETHIOL; ETHYL SULFHYDRATE; MERCAPTOETHANE; ETHYL HYDROSULFIDE; ETHYL THIOALCOHOL; THIOETHANOL; THIOETHYL ALCOHOL; LPG ETHYL MERCAPTAN 1010; UN 2363; O-2712; 958-T; 7171-T; C2H6S; MAT09070; RTECS KI9625000

CHEMICAL FAMILY: mercaptans

CREATION DATE: Jan 24 1989
REVISION DATE: Jun 14 2007

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2. COMPOSITION, INFORMATION ON INGREDIENTS

COMPONENT: ETHYL MERCAPTAN
CAS NUMBER: 75-08-1
PERCENTAGE: 100

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3. HAZARDS IDENTIFICATION

NFPA RATINGS (SCALE 0-4): HEALTH=1 FIRE=4 REACTIVITY=1

EMERGENCY OVERVIEW:
COLOR: colorless
PHYSICAL FORM: liquid
ODOR: garlic odor
MAJOR HEALTH HAZARDS: central nervous system depression
PHYSICAL HAZARDS: Extremely flammable liquid and vapor. Vapor may cause flash fire. Contact with water or moist air may generate flammable and/or toxic gases.

POTENTIAL HEALTH EFFECTS:
INHALATION:

SHORT TERM EXPOSURE: irritation, cough, lack of sense of taste, changes in body temperature, nausea, vomiting, diarrhea, difficulty breathing, irregular heartbeat, headache, drowsiness, dizziness, loss of coordination, bluish skin color, lung congestion, heart disorders, kidney damage, liver damage, brain damage, convulsions, unconsciousness, coma
LONG TERM EXPOSURE: no information is available
SKIN CONTACT:
SHORT TERM EXPOSURE: irritation
LONG TERM EXPOSURE: irritation
EYE CONTACT:
SHORT TERM EXPOSURE: irritation
LONG TERM EXPOSURE: irritation
INGESTION:
SHORT TERM EXPOSURE: irritation, sore throat, nausea, stomach pain, headache, drowsiness, dizziness, loss of coordination
LONG TERM EXPOSURE: no information is available

4. FIRST AID MEASURES

INHALATION: If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. Get immediate medical attention.

SKIN CONTACT: Wash skin with soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention, if needed. Thoroughly clean and dry contaminated clothing and shoes before reuse.

EYE CONTACT: Flush eyes with plenty of water for at least 15 minutes. Then get immediate medical attention.

INGESTION: If a large amount is swallowed, get medical attention.

NOTE TO PHYSICIAN: For inhalation, consider oxygen.

5. FIRE FIGHTING MEASURES

FIRE AND EXPLOSION HAZARDS: Severe fire hazard. The vapor is heavier than air. Vapors or gases may ignite at distant ignition sources and flash back. Vapor/air mixtures are explosive.

EXTINGUISHING MEDIA: regular dry chemical, carbon dioxide, water, regular foam

Large fires: Use regular foam or flood with fine water spray.

FIRE FIGHTING: Move container from fire area if it can be done without risk. Dike for later disposal. Do not scatter spilled material with high-pressure water streams. Cool containers with water spray until well after the fire is out. Stay away from the ends of tanks. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tanks due to fire. For tank, rail car or tank truck, evacuation radius: 800 meters (1/2 mile). Do not attempt to extinguish fire unless flow of material can be stopped first. Flood with fine water spray. Do not scatter spilled material with high-pressure water streams. Cool containers with water spray until well after the fire is out. Apply water from a protected location or from a safe distance. Avoid inhalation of material or combustion by-products. Stay upwind and keep out of low areas.

FLASH POINT: -54.9 F (-48.3 C) (CC)
LOWER FLAMMABLE LIMIT: 2.8%
UPPER FLAMMABLE LIMIT: 18%
AUTOIGNITION: 570.0 F (298.9 C)
FLAMMABILITY CLASS (OSHA): IA

HAZARDOUS COMBUSTION PRODUCTS:
Thermal decomposition or combustion products: oxides of sulfur, oxides of carbon

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6. ACCIDENTAL RELEASE MEASURES

OCCUPATIONAL RELEASE:
Avoid heat, flames, sparks and other sources of ignition. Stop leak if possible without personal risk. Reduce vapors with water spray. Small spills: Absorb with sand or other non-combustible material. Collect spilled material in appropriate container for disposal. Large spills: Dike for later disposal. Remove sources of ignition. Keep unnecessary people away, isolate hazard area and deny entry.

---

7. HANDLING AND STORAGE

STORAGE: Store and handle in accordance with all current regulations and standards. Avoid heat, flames, sparks and other sources of ignition. Store in a cool, dry place. Keep container tightly closed and in a well-ventilated place. Avoid direct sunlight. Subject to storage regulations: U.S. OSHA 29 CFR 1910.106. Grounding and bonding required. Keep separated from incompatible substances.

HANDLING: When using, do not eat, drink or smoke.

---

8. EXPOSURE CONTROLS, PERSONAL PROTECTION

EXPOSURE LIMITS:
ETHYL MERCAPTAN:
10 ppm (25 mg/m3) OSHA ceiling
0.5 ppm (1.3 mg/m3) OSHA TWA (vacated by 58 FR 35338, June 30, 1993)
0.5 ppm ACGIH TWA
0.5 ppm (1.3 mg/m3) NIOSH recommended ceiling 15 minute(s)

VENTILATION: Ventilation equipment should be explosion-resistant if explosive concentrations of material are present. Provide local exhaust ventilation system. Ensure compliance with applicable exposure limits.

EYE PROTECTION: Wear splash resistant safety goggles. Provide an emergency eye wash fountain and quick drench shower in the immediate work area.

CLOTHING: Wear appropriate chemical resistant clothing.

GLOVES: Wear appropriate chemical resistant gloves.

RESPIRATOR: The following respirators and maximum use concentrations are drawn from NIOSH and/or OSHA.
5 ppm
Any air-purifying half-mask respirator equipped with organic vapor cartridge(s).
Any supplied-air respirator.
12.5 ppm
Any supplied-air respirator operated in a continuous-flow mode.
Any powered, air-purifying respirator with organic vapor cartridge(s).
25 ppm
Any air-purifying respirator with a full facepiece and an organic vapor canister.
Any air-purifying full-facepiece respirator (gas mask) with a chin-style, front-mounted or back-mounted organic vapor canister.
Any supplied-air respirator with a tight-fitting facepiece that is operated in a continuous-flow mode.
Any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s).
Any self-contained breathing apparatus with a full facepiece.
Any supplied-air respirator with a full facepiece.
500 ppm
Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode.
Emergency or planned entry into unknown concentrations or IDLH conditions -
Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode.
Any supplied-air respirator with a full facepiece that is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive-pressure mode.
Escape -
Any air-purifying full-facepiece respirator (gas mask) with a chin-style, front-mounted or back-mounted organic vapor canister.
Any appropriate escape-type, self-contained breathing apparatus.

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9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: liquid
COLOR: colorless
ODOR: garlic odor

MOLECULAR WEIGHT: 62.14
MOLECULAR FORMULA: C2-H6-S
BOILING POINT: 95.2 F (35.1 C)
FREEZING POINT: -234.0 F (-147.8 C)
VAPOR PRESSURE: 442 mmHg @ 20 C
VAPOR DENSITY (air=1): 2.14
SPECIFIC GRAVITY (water=1): 0.8315 @ 25 C
WATER SOLUBILITY: 6.7% @ 20 C (reacts)
PH: Not available
VOLATILITY: Not available
ODOR THRESHOLD: 0.001 ppm
EVAPORATION RATE: Not available
VISCOSITY: 0.3155 cP @ 20 C
COEFFICIENT OF WATER/OIL DISTRIBUTION: Not available
SOLVENT SOLUBILITY:
Soluble: alcohol, ether, naphtha, acetone, dilute alkali

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10. STABILITY AND REACTIVITY

REACTIVITY: Contact with water or moist air may form flammable and/or toxic gases or vapors.

CONDITIONS TO AVOID: Avoid heat, flames, sparks and other sources of ignition. Containers may rupture or explode if exposed to heat. Keep out of water supplies and sewers.

INCOMPATIBILITIES: acids, oxidizing materials, combustible materials

HAZARDOUS DECOMPOSITION:
Thermal decomposition or combustion products: oxides of sulfur, oxides of carbon

POLYMERIZATION: Will not polymerize.

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11. TOXICOLOGICAL INFORMATION

ETHYL MERCAPTAN:
IRRITATION DATA: 500 mg/24 hour(s) skin-rabbit mild; 84 mg eyes-rabbit; 100 mg/24 hour(s) eyes-rabbit moderate
TOXICITY DATA: 4420 ppm/4 hour(s) inhalation-rat LC50; 682 mg/kg oral-rat LD50
ACUTE TOXICITY LEVEL:
Moderately Toxic: inhalation, ingestion
TARGET ORGANS: central nervous system

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12. ECOLOGICAL INFORMATION

ECOTOXICITY DATA:
FISH TOXICITY: 20000 ug/L 0.033 hour(s) (Behavior) Aholehole (Kuhlia sandvicensis)

INVERTEBRATE TOXICITY: 170 ug/L 48 hour(s) LC50 (Mortality) Water flea (Daphnia magna)

FATE AND TRANSPORT:
KOW: 1202.26 (log = 3.08) (estimated from water solubility)

KOC: 22 (log = 1.34) estimated

HENRY'S LAW CONSTANT: 4.5 E -3

BIOCONCENTRATION: 1.17 (estimated from water solubility)

ENVIRONMENTAL SUMMARY: Leaches through the soil or the sediment at a very rapid rate. Accumulates very little in the bodies of living organisms. Highly volatile from water.

13. DISPOSAL CONSIDERATIONS

Dispose in accordance with all applicable regulations. Subject to disposal regulations: U.S. EPA 40 CFR 262. Hazardous Waste Number(s): D001. D003. Dispose in accordance with all applicable regulations.

14. TRANSPORT INFORMATION

U.S. DOT 49 CFR 172.101:
PROPER SHIPPING NAME: Ethyl mercaptan
ID NUMBER: UN2363
HAZARD CLASS OR DIVISION: 3
PACKING GROUP: I
LABELING REQUIREMENTS: 3
QUANTITY LIMITATIONS:
PASSENGER AIRCRAFT OR RAILCAR: Forbidden
CARGO AIRCRAFT ONLY: 30 L
MARINE POLLUTANT: ETHYL MERCAPTAN

CANADIAN TRANSPORTATION OF DANGEROUS GOODS:
SHIPPING NAME: Ethyl mercaptan
UN NUMBER: UN2363
CLASS: 3
PACKING GROUP/RISK GROUP: I

15. REGULATORY INFORMATION

U.S. REGULATIONS:
CERCLA SECTIONS 102a/103 HAZARDOUS SUBSTANCES (40 CFR 302.4): Not regulated.

SARA TITLE III SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.30): Not regulated.

SARA TITLE III SECTION 304 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.40): Not regulated.

SARA TITLE III SARA SECTIONS 311/312 HAZARDOUS CATEGORIES (40 CFR 370.21):
ACUTE: Yes
CHRONIC: No
FIRE: Yes
REACTIVE: Yes
SUDDEN RELEASE: No

SARA TITLE III SECTION 313 (40 CFR 372.65): Not regulated.

OSHA PROCESS SAFETY (29CFR1910.119): Not regulated.

STATE REGULATIONS:
California Proposition 65: Not regulated.

CANADIAN REGULATIONS:
WHMIS CLASSIFICATION: B2.

NATIONAL INVENTORY STATUS:
U.S. INVENTORY (TSCA): Listed on inventory.

TSCA 12(b) EXPORT NOTIFICATION: Not listed.

CANADA INVENTORY (DSL/NDSL): Listed on DSL.

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16. OTHER INFORMATION

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AAA Environmental Inc.
Job Safety Analysis (JSA)

Date 5/21/2008 **Job Site** Depew / Metro Recycling
Supervisor Mike Pickering **Job #** 22460
Job Activity Collect and containerize Ethyl mertcaptan cylinders

Job Step	Hazards Associated	Actions to Eliminate Hazard
1) Protecting Personnel from potential exposure	Ethyl mercaptan Exposure Inhalation, digestion, skin exposure	**Eye** - full face respirator **Clothing** - Coated tyveks **Hands** - chemical resistant gloves **Respirator** - air purifying full face respirator & organic vapor canister... Ethyl mercaptan sample tubes will be used to show proper protection factor of Respirator
2) Remove plastic covering over Cylinders	Slips and falls	caution will be taken to not walk on plastic sheeting…
	Breaking of Cylinders	Plastic sheeting will be removed by hand… Heavy equipment will not be used…
	Exposure to Ethyl mercaptan Inhalation, digestion, skin exposure	**Eye** - full face respirator **Clothing** - Coated tyveks **Hands** - chemical resistant gloves **Respirator** - air purifying full face respirator & organic vapor canister... Ethyl mercaptan sample tubes will be used to show proper protection factor of Respirator
3) Removing Cylinders from Excavation	Exposure to Ethyl mercaptan Inhalation, digestion, skin exposure	**Eye** - full face respirator **Clothing** - Coated tyveks **Hands** - chemical resistant gloves **Respirator** - air purifying full face respirator & organic vapor canister... Ethyl mercaptan sample tubes will be used to show proper protection factor of Respirator
	Fire	A person will be in the area with a Fire extinguisher

AAA Environmental Inc.
Job Safety Analysis (JSA)

Job Step	Hazards Associated	Actions to Eliminate Hazard
4) Placing cylinders into 5 gal pails	Exposure to Ethyl mercaptan	**Eye** - full face respirator
	Fire / reaction	A person will be in the area with a Fire extinguisher
	Placement of cylinders	Cylinders will be placed into 5 gal pails… A expanding foam will be sprayed into the pails to assure no movement of the cylinders… tops will be placed on the 5 gal pails…
5) Placing pails onto pallets	back strains	proper lifting technique will be discussed during the tool box talk
	slips and falls	a clean walk way between excavation and pallet area will achieved prior to movement of pails
	pails falling from pallets	shrink wrap will be used to secure pails to pallet
	construction safety	Level "D" PPE will be used

Contaminate	**Action levels**	**Response**
Ethyl mecaptan	0-100 ppm	full face air purifying respirator
	100 ppm	upgrade to air supplied respirator

INTERIM 1: 7/2007

ACUTE EXPOSURE GUIDELINE LEVELS (AEGLs) FOR

ETHYL MERCAPTAN

(CAS Reg. No.75-08-1)

PREFACE

Under the authority of the Federal Advisory Committee Act (FACA) P. L. 92-463 of 1972, the National Advisory Committee for Acute Exposure Guideline Levels for Hazardous Substances (NAC/AEGL Committee) has been established to identify, review and interpret relevant toxicologic and other scientific data and develop AEGLs for high priority, acutely toxic chemicals.

AEGLs represent threshold exposure limits for the general public and are applicable to emergency exposure periods ranging from 10 minutes to 8 hours. Three levels — AEGL-1, AEGL-2 and AEGL-3 — are developed for each of five exposure periods (10 and 30 minutes, 1 hour, 4 hours, and 8 hours) and are distinguished by varying degrees of severity of toxic effects. The three AEGLs are defined as follows:

AEGL-1 is the airborne concentration (expressed as parts per million or milligrams per cubic meter [ppm or mg/m^3]) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

AEGL-2 is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

AEGL-3 is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

Airborne concentrations below the AEGL-1 represent exposure levels that could produce mild and progressively increasing but transient and nondisabling odor, taste, and sensory irritation or certain asymptomatic, non-sensory effects. With increasing airborne concentrations above each AEGL, there is a progressive increase in the likelihood of occurrence and the severity of effects described for each corresponding AEGL. Although the AEGL values represent threshold levels for the general public, including susceptible subpopulations, such as infants, children, the elderly, persons with asthma, and those with other illnesses, it is recognized that individuals, subject to unique or idiosyncratic responses, could experience the effects described at concentrations below the corresponding AEGL.

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SUMMARY

Ethyl mercaptan (C_2H_5SH) is an odorous, colorless liquid. The disagreeable odor has been described as penetrating, persistent, and garlic- or leek-like, similar to decaying cabbage. It is found in illuminating gas, in "sour" gas in West Texas oil fields, and in petroleum distillates from which it may be separated by chemical or physical methods. It is used as an intermediate and starting material in the manufacture of plastics, insecticides, and antioxidants, and as an odorant to serve as a warning property for natural gas (O'Neil et al., 2001).

Ethyl mercaptan depresses the central nervous system and affects the respiratory center, similar to hydrogen sulfide, producing death by respiratory paralysis. Clinical signs of exposure are eye and mucous membrane irritation, headache, dizziness, staggering gait, nausea, and vomiting. Paralysis of the locomotor muscles has also been observed. Its primary mechanism of action appears to be interference with cytochrome oxidase.

The AEGL-1 values were based on a NOEL for irritation in rabbits exposed to 10 ppm for 20 minutes (Shibata, 1966b). Uncertainty factors of 3 each were applied to account for interspecies and intraspecies variability, and are considered sufficient because use of the full factor of 10 for either interspecies or intraspecies variability would yield AEGL-1 values ≤ 0.3 ppm which is inconsistent with the available human data. No mucosal irritation was noted in humans exposed to 0.4 ppm ethyl mercaptan 3 hours/day for 5 or 10 days (Blinova,1965). The AEGL-1 value was held constant across the 10- and 30-minute, and 1-, 4-, and 8-hour exposure times because mild irritancy generally does not vary greatly over time, and because it is not expected that prolonged exposure will result in an enhanced effect.

The level of distinct odor awareness (LOA) for ethyl mercaptan is 0.00014 ppm (see Appendix C for LOA derivation). The LOA represents the concentration above which it is predicted that more than half of the exposed population will experience at least a distinct odor intensity, about 10 % of the population will experience a strong odor intensity. The LOA should help chemical emergency responders in assessing the public awareness of the exposure due to odor perception.

No robust data consistent with the definition of AEGL-2 were available. Therefore, the AEGL-2 values for ethyl mercaptan were based upon a 3-fold reduction in the AEGL-3 values; this is considered an estimate of a threshold for irreversible effects and is appropriate because of the steep concentration-response curve for ethyl mercaptan toxicity (a 4 hour exposure to 2600 ppm caused 40% lethality in mice, the 4-hr mouse LC_{50} value was 2770 ppm and at 3573 ppm for 4 hours 100% of mice died; the 4-hr rat LC_{01} value was 3808 ppm and the 4-hr rat LC_{50} value was 4740 ppm).

AEGL-3 values were based on a calculated LC_{01} (2250 ppm) in mice exposed to ethyl mercaptan for 4 hours (Fairchild and Stokinger, 1958). An intraspecies uncertainty factor of 3 was applied and is considered sufficient due to the steepness of the lethal response curve (a 4 hour exposure to 2600 ppm caused 40% lethality in mice, the 4-hr mouse LC_{50} value was 2770 ppm and at 3573 ppm for 4 hours 100% of mice died; the 4-hr rat LC_{01} value was 3808 ppm and the 4-hr rat LC_{50} value was 4740 ppm) which implies limited individual variability. An interspecies uncertainty factor of 3 was also be applied because the limited data suggest that the mouse is the most sensitive species. Although an interspecies uncertainty factor of 10 might normally be applied due to limited data, AEGL-3 values calculated utilizing a total UF of 30 would yield AEGL-3 values approaching or equivalent to the AEGL-3 values derived for hydrogen sulfide (8-hr H_2S AEGL-3 is 31 ppm; 8-hr ethyl mercaptan AEGL-3 would be 37 ppm). Because a robust database exists for hydrogen sulfide and because data suggest that ethyl mercaptan is less toxic than hydrogen sulfide, [the 4-hour rat LC_{50} value for ethyl mercaptan was 4740 ppm (Fairchild and Stokinger, 1958), whereas, the 4-hour LC_{50} value for hydrogen sulfide was 444 ppm (Tansy et al., 1981)], it would be inconsistent with the total data set to derive AEGL-3 values for ethyl mercaptan that are in the range of the AEGL-3 values for hydrogen sulfide. Furthermore, use of a total UF of 30 would yield a 30-minute AEGL-3 of 150 ppm, which is inconsistent with available human data. Humans exposed to 112 ppm ethyl mercaptan for 20 minutes exhibited only a slightly irregular, and decreased breathing rate (Shibata, 1966a). Thus, the total uncertainty factor is 10. The concentration-exposure time relationship for many irritant and systemically-acting vapors and gases may be described by $c^n \times t = k$, where the exponent, n, ranges from 0.8 to 3.5 (ten Berge et al., 1986). To obtain conservative and protective AEGL values in the absence of an empirically derived chemical-specific scaling exponent, temporal scaling will be performed using n=3 when extrapolating to shorter time points (30-minutes, 1-hour, and 4-hours) and n = 1 when extrapolating to longer time points (8-hours) using the $c^n \times t = k$ equation. The 30-minute AEGL-3 value is adopted as the 10-minute value because the point-of-departure was 4-hours

Summary of AEGL Values for Ethyl Mercaptan

Classification	10-minutes	30-minutes	1-hour	4-hour	8-hour	Endpoint (Reference)
AEGL-1	1 ppm (2.5 mg/m^3)	1 ppm (2.5 mg/m^3)	1 ppm (2.5 mg/m^3)	1 ppm (2.5 mg/m^3)	1 ppm (2.5 mg/m^3)	NOEL for irritation in rabbits (Shibata, 1966b)
AEGL-2	150 ppm (360 mg/m^3)	150 ppm (360 mg/m^3)	120 ppm (290 mg/m^3)	77 ppm (190 mg/m^3)	37 ppm (89 mg/m^3)	3-fold reduction of AEGL-3 values
AEGL-3	450 ppm (1100 mg/m^3)	450 ppm (1100 mg/m^3)	360 ppm (860 mg/m^3)	230 ppm (550 mg/m^3)	110 ppm (260 mg/m^3)	LC_{01} in mice (Fairchild and Stokinger, 1958)

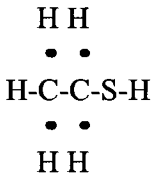
1. INTRODUCTION

Ethyl mercaptan (C_2H_5SH) is used as an intermediate and starting material in the manufacture of plastics, insecticides, and antioxidants, and as an odorant to serve as a warning property for natural gas (O'Neil et al., 2001).

Ethyl mercaptan is an odorous, colorless liquid. The disagreeable odor has been described as penetrating, persistent, and garlic- or leek-like, similar to decaying cabbage (O'Neil et al., 2001). It is found in illuminating gas, in "sour" gas in West Texas oil fields, and in petroleum distillates from which it may be separated by chemical or physical methods (O'Neil et al., 2001).

Ethyl mercaptan is produced commercially by the reaction of sodium ethyl sulfate with potassium hydrosulfide, or catalytically from ethanol and hydrogen sulfide (O'Neil et al., 2001). The total production of methane, ethane, propane, butane, octane, nonane, decane, hexadecane, and miscellaneous thiols was 264,797,000 pounds in 1976, and an estimated 23,130 U.S. workers were exposed to ethyl mercaptan from 1972-74 (NIOSH, 1978).

The physicochemical properties of ethyl mercaptan are presented in Table 1, and the chemical structure is depicted below.



$$\begin{array}{c} \mathrm{H\ H} \\ \bullet\ \bullet \\ \mathrm{H{-}C{-}C{-}S{-}H} \\ \bullet\ \bullet \\ \mathrm{H\ H} \end{array}$$

TABLE 1. Physical and Chemical Values of Ethyl Mercaptan

Common Name	Ethyl Mercaptan	Reference
Synonyms	Ethanethiol, Ethyl Sulfhydrate, Ethylthiolalcohol, Thioethanol, Thioethyl alcohol, Mercaptoethane, ethyl hydrosulfide	ACGIH, 1991
CAS Registry No.	75-08-1	ACGIH, 1991
Chemical Formula	C_2H_5SH	ACGIH, 1991
Molecular Weight	62.13	ACGIH, 1991
Physical State	Colorless liqiud	O'Neil, 2001
Vapor Pressure	442 torr at 20°C	ACGIH, 1991
Specific Gravity	0.83907 at 20°C	ACGIH, 1991
Melting/Boiling/Flash Point	-147.97 to -144.4°C/36°C/ -48.3°C(closed cup)	ACGIH, 1991
Solubility	Slightly soluble in water, soluble in alcohol, ether, and petroleum naphtha	ACGIH, 1991
Conversion factors in air	1 mg/m^3 = 0.39 ppm 1 ppm = 2.54 mg/m^3	
Incompatibility	Strong oxidizers	ACGIH, 1991
Odor	garlic- or leek-like, penetrating, persistent, similar to decayed cabbage	ACGIH, 1991

2. HUMAN TOXICITY DATA

2.1 Acute Lethality

No information concerning human lethality from acute exposure to ethyl mercaptan was located.

2.2 Nonlethal Toxicity

2.2.1. Odor Threshold/Odor Awareness

Katz and Talbert (1930) conducted two trials each exposing six human subjects to a range of ethyl mercaptan concentrations via a nosepiece. The subjects described the odor as that of decayed cabbage and very disagreeable and the rated ethyl mercaptan odor intensity as presented in Table 2.

TABLE 2*: Ethyl Mercaptan Odor Intensity

Intensity	Description	Concentration (ppm)	
		Trial 1	Trial 2
0	No odor	0.000021	0.000006
1	Detectable	0.00097	0.00026
2	Faint	0.045	0.011
3	Median, easily noticeable	2.10	0.49
4	Strong	97	21
5	Most intense	4500	920

*Katz and Talbert, 1930

Wilby (1969) exposed 3 individuals to ethyl mercaptan at 12 concentrations representing a 100-fold range. For each subject an odor recognition threshold was determined on the basis of three trials. The mean odor threshold concentration for ethyl mercaptan was 0.0004 ppm with a standard deviation of 0.00026 ppm and a coefficient of variation of 0.65. No other effects were noted.

Blinova (1965) conducted a series of experiments whereby a total of 9 human subjects inhaled ethyl mercaptan through a mask connected to a 1000-liter chamber in which a known concentration of ethyl mercaptan had been established. No other information on atmosphere generation or analytical methods were provided. The range of minimum perceptible odor concentration was reported as 0.0022 to 0.011 ppm, and the range of imperceptible odor concentration (olfactory fatigue) was reported as 0.0018 to 0.0072 ppm Other experimental protocols and results from this study are summarized in Table 3.

TABLE 3*: Summary of Ethyl Mercaptan Exposure in Humans

Concentration (ppm)	Duration	Subjects	Effects
4.0	3 hours/day for 10 days	1 Female	Odor, olfactory fatigue, mucosal irritation
0.4	3 hours/day for 10 days (one month after above exposure)	1 Female	None
4.0	3 hours/day for 5 days	2 Subjects (sex not reported)	Odor, olfactory fatigue, mucosal irritation
4.0	3 hours/day for 5 days (one month after above exposure)	2 Subjects (sex not reported)	Same as above, but less pronounced
0.4	3 hours/day for 5 days	2 Subjects (sex not reported)	None
0.4	3 hours/day for 5 days (one month after above exposure)	2 Subjects (sex not reported)	None

*Blinova, 1965

Amoore and Hautala (1983) reported an odor threshold of 0.00076 ppm for ethyl mercaptan. This value is the geometric mean of reliable published odor threshold values.

Nagata (2004) reported an odor threshold of 0.0000087 ppm for ethyl mercaptan. This value was determined by a validated method and included a butanol standard for comparison. Therefore, it is considered most appropriate for calculation of the Level of Distinct Odor Awareness (LOA).

The level of distinct odor awareness (LOA) for ethyl mercaptan is 0.00014 ppm (see Appendix C for LOA derivation). The LOA represents the concentration above which it is predicted that more than half of the exposed population will experience at least a distinct odor intensity, about 10 % of the population will experience a strong odor intensity. The LOA should help chemical emergency responders in assessing the public awareness of the exposure due to odor perception.

2.2.2. Case Report

Twenty-eight male and two female high school students (16 to 18 years-old), whose classroom was connected by a door to a chemical storeroom, were accidentally exposed to ethyl mercaptan vapor during morning classes (Pichler, 1918). The class was dismissed approximately 1 hour after the students began complaining about a bad odor emanating from the adjacent room. Ten students (8 male and 2 female) complained of dull headache, general discomfort, and abdominal pain, and three students vomited and had diarrhea. All symptoms had resolved by the afternoon, and the students reportedly slept normally that night. The class met in the same room the next day for three hours, and even though the classroom and storeroom had been ventilated, eight of the students that had experienced symptoms the previous day developed headaches, but to a lesser degree. Two of these students did not return to school for several days. Examination of one male student showed "changes" around the eyes, a palpable liver, and protein, erythrocytes, and a few leukocytes in the urine. There were no epithelial cells or casts noted in the urine and the other urinary parameters had returned to normal within 5-6 weeks. It was estimated that 3 grams of ethyl mercaptan had vaporized in 325 m^3 rooms resulting in an approximate concentration of 4 ppm ethyl mercaptan.

2.2.3. Experimental Study

Shibata (1966a) exposed two adult males to 50 ppm ethyl mercaptan for 20 minutes and one adult male to 112 ppm for 20 minutes. Respiration frequency, pulse rate, and blood pressure were monitored continuously for 10-minutes prior to and throughout exposure. In one subject exposed to 50 ppm, breathing frequency decreased immediately upon exposure and returned to the preinhalation level following termination of exposure. The second subject exposed to 50 ppm showed no change in breathing rate. The subject exposed to 112 ppm showed a slightly irregular and decreased breathing rate. Minute volume and tidal volume increased in all three subjects. Pulse rate increased slightly in only one subject (50 ppm exposure), and there was no effect on blood pressure and no electrocardiographic abnormalities in any subject. The only subjective response was odor recognition only during the first few breaths, suggesting that olfactory fatigue/accommodation occurred.

2.3 Developmental/Reproductive Toxicity

Developmental and reproductive studies regarding human exposure to ethyl mercaptan were not available.

2.4 Genotoxicity

Genotoxicity studies regarding human exposure to ethyl mercaptan were not available.

2.5 Carcinogenicity

Carcinogenic studies regarding human exposure to ethyl mercaptan were not available.

2.6 Summary

Data concerning human exposure to ethyl mercaptan are limited. Case reports of deaths from accidental exposure to ethyl mercaptan were not available. Nonlethal toxicity data are limited and include a case report where high school students accidentally exposed to ethyl mercaptan experienced reversible dull headache, general discomfort, abdominal pain, vomiting and diarrhea. Also available were odor detection/identification and olfactory fatigue data with no accompanying health effects information, and a study showing slight changes in breathing rate in three individuals exposed to ethyl mercaptan for 20 minutes. It should be noted that atmosphere generation and exposure concentration parameters were not described in detail for any of the human studies. Data on developmental/reproductive toxicity, genotoxicity, and carcinogenicity in humans were not available.

3. ANIMAL TOXICITY DATA

3.1 Acute Lethality

3.1.1 Mice

Fairchild and Stokinger (1958) exposed groups of 10 Swiss-derived male mice (body weight 25-28 g) to 2600, 3150, 3573, 4438, or 4832 ppm ethyl mercaptan for 4-hours, followed by a 15-day observation period. Vapor generation was achieved by either bubbling a stream of nitrogen gas through a midget fritted-glass bubbler, which contained liquid ethyl mercaptan, or by passage of nitrogen into a borosilicate glass nebulizer containing the ethyl mercaptan. Desired exposure concentrations were maintained in a 18-L glass chamber by varying the ratio of volume flow of compressed air and compressed nitrogen. Ethyl mercaptan concentrations during exposure periods were measured by absorption of vapors in either isopropyl alcohol or acetone containing an excess of silver nitrate and titrating the uncombined silver amperometrically. Chamber concentrations during tests were uniform after the first 30 minutes; mean variation for all exposures was approximately 4%. Clinical signs included increased respiration and restlessness (hyperactivity), incoordinated movement, staggering gait, muscular weakness, partial skeletal muscle paralysis beginning in the hind limbs, light to severe cyanosis, tolerance of a prone position, and mild to heavy sedation. Animals exposed to "maximal lethal concentrations" typically died from respiratory arrest during exposure or shortly after removal from the chamber. Animals exposed to "minimal lethal concentrations" typically died while in a semiconscious condition of "long duration." Surviving animals often remained in a semi-conscious state of sedation and lethargy 4- to 6-hours post-exposure before showing signs of recovery. An LC_{50} value of 2770 ppm, LC_{05} value of 2489 ppm, and LC_{01} value of 2250 ppm were calculated by the method of Litchfield and Wilcoxon. A BMC_{01} of 1921 ppm and $BMCL_{05}$ of 1545 were also calculated. Mortality data are summarized in Table 4.

3.1.2 Rats

Fairchild and Stokinger (1958) exposed groups of 5 or 6 Wistar-derived male rats (body weight 180-220g) to 2600, 3150, 3573, 4438, 4832, 4868, 5100, or 5125 ppm ethyl mercaptan for 4-hours, followed by a 15-day observation period. Vapor generation and test chamber analysis is similar to that described for the mouse exposure in section 3.1.1. Clinical signs included increased respiration and restlessness (hyperactivity), incoordinated movement, staggering gait, muscular weakness, partial skeletal muscle paralysis beginning in the hind limbs, light to severe cyanosis, tolerance of a prone position, and mild to heavy sedation. Animals exposed to "maximal lethal concentrations" typically died from respiratory arrest during exposure or shortly after removal from the chamber. Animals exposed to "minimal lethal concentrations" typically died while in a semiconscious condition of "long duration." Surviving animals often remained in a semi-conscious state of sedation and lethargy 4- to 6-hours post-exposure before showing signs of recovery. An LC_{50} value of 4740 ppm, LC_{05} value of 4120 ppm, and LC_{01} value of 3808 ppm were calculated by the method of Litchfield and Wilcoxon. Mortality data are summarized in Table 4.

TABLE 4. Mortality of Mice and Rats Exposed to Ethyl Mercaptan for 4 Hours*

Concentration (ppm)	Mice	Rats
2600	4/10	0/5
3150	7/10	0/5
3573	10/10	0/5
4438	10/10	1/5
4832	10/10	4/6
4868	-	2/5
5100	-	5/5
5125	-	2/6
LC_{01}	2250 ppm	3808 ppm
LC_{05}	2498 ppm	4120 ppm
LC_{50}	2770 ppm	4740 ppm

*Fairchild and Stokinger, 1958

Fairchild and Stokinger (1958) also administered ethyl mercaptan by oral gavage or intraperitoneal injection to Wistar-derived male rats, followed by 15-day observation periods. An oral LD_{50} of 682 mg/kg and an i.p. LD_{50} of 226 mg/kg were reported.

3.2 Nonlethal Toxicity

3.2.1 Rats

Male Holtzman or Sprague-Dawley rats (3-5 per concentration) weighing 285 to 325 grams were singly exposed in a 4-liter glass desiccator to ethyl mercaptan concentrations ranging from 2.7 to 3.8 % (approximately 27,000 to 38,000 ppm) for 15 minutes or less (Zieve et al., 1974). The desired exposure concentrations were achieved by injecting the required amount of ethyl mercaptan through a rubber septum in the lid of the chamber. The ethyl mercaptan concentration of the exposure atmosphere was not analyzed, rather concentrations were calculated from the dose injected. A CD_{50} (coma induction in 50% of subjects; defined as the concentration where rats had completely lost the righting reflex) value of 3.3% (33,000 ppm) was determined. At approximately 3.0% (30,000 ppm), no rats lost the righting reflex, and at approximately 3.7% (37,000 ppm) ethyl mercaptan, all rats had lost the righting reflex. The rats exhibited a brief excitement phase before becoming "groggy." At the CD_{50} concentration, the excitement phase lasted approximately 2 minutes, followed by a groggy and lethargic phase lasting approximately 1 minute, and finally frank coma ensued within 1 to 2 minutes. At lower concentrations, the excitement and pre-coma phases were prolonged and at higher concentrations, the entire sequence occurred more quickly. When rats were removed from the exposure chamber as soon a they became comatose, the coma generally did not last more than 30 minutes, and upon recovery, the rat appeared and remained alert and active. Blood concentrations of ethyl mercaptan found in comatose animals were greater than 200 nmoles/ml; however, there was no clear concentration-response relationship with regard to inhaled concentration and ethyl mercaptan blood level.

No mortality was observed in rats exposed head-only to 991 ppm ethyl mercaptan for 4-hours or in rats exposed whole body to 27 ppm for 4-hours (Clayton and Clayton, 1991).

3.2.2 Rabbits

Shibata (1966b) exposed six male rabbits weighing 3 kg to 10, 100, or 1000 ppm ethyl mercaptan through a breathing mask for 20 minutes. Breathing rate (measured by observed thorax movement) and minute expiratory volume (measured by wet spirometry) were monitored throughout the exposure periods. Tidal volume was then calculated by dividing the minute expiratory volume by the breathing rate. At 100 and 1000 ppm, respiratory rate and expiratory volume were decreased and tidal volume was increased. Approximate changes in respiratory function parameters (estimated from graphs) at the end of the exposure period in the 1000 ppm group were: 20% decrease in expiratory volume, 40% decrease in respiratory rate, 40% increase in tidal volume. Approximate changes at 100 ppm were: 10% decrease in expiratory volume, 10% decrease in respiratory rate, 20% increase in tidal volume. At 10 ppm, respiratory rate and ventilation rate showed unstable fluctuation, and tidal volume was increased slightly (approximately 3%) during the last half of the exposure period. All respiratory indicators had returned to pre-exposure levels by the end of the 35-minute observation period, except for respiratory rate of animals exposed to 1000 ppm, which was still decreased by approximately 25%.

Fairchild and Stokinger (1958) administered 0.1mL ethyl mercaptan into the right conjunctival sac of the right eye of one male New Zealand white rabbit. The left eye served as a control. Slight to moderate irritation was observed and had resolved within 48-hours.

3.3 Repeated- Exposure Study

Shibata (1966b) exposed four male rabbits weighing 3 kg to 1000 ppm ethyl mercaptan through a breathing mask 20 minutes/day for 9 days in a 10-day period. There were no significant treatment-related effects on urinary sulfate, urine volume, red or white blood cell count, or body weight.

3.4 Developmental/Reproductive Toxicity

Developmental/reproductive studies regarding animal exposure to ethyl mercaptan were not available.

3.5 Genotoxicity

Ethyl mercaptan was negative in an Ames *Salmonella typhimurium* assay (Hazleton, 1984). It was positive both with and without metabolic activation in a Sister Chromatid Exchange (SCE) assay in cultured Chinese hamster ovary cells (Hazleton, 1984), and without activation in a forward mutation assay in cultured mouse lymphoma cells (Hazleton, 1983).

3.6 Carcinogenicity

Carcinogenicity studies in animals were not available.

3.7 Summary

Animal toxicity data for ethyl mercaptan are limited. Lethality studies are available for rats and mice. Lethality data suggest a steep concentration-response curve for ethyl mercaptan: a 4-hour exposure to 2600 ppm caused 40% lethality in mice and at 3573 ppm for 4 hours 100% of mice died. The 4-hr mouse LC_{50} value was 2770 ppm; whereas, the 4-hr mouse LC_{01} value was 2250 ppm (Fairchild and Stokinger, 1958). Also, the 4-hr rat LC_{50} value was 4740 ppm, whereas the 4-hr rat LC_{01} value was 3808 ppm (Fairchild and Stokinger, 1958). Observed clinical signs were indicative of central nervous system depression and respiratory arrest and included changes in respiration, restlessness (hyperactivity), incoordinated movement, staggering gait, muscular weakness, skeletal muscle paralysis, light to severe cyanosis, and coma. Coma-induction data also suggest a steep-concentration-response curve for ethyl mercaptan: no coma-induction was observed in rats exposed to 30,000 ppm for up to 15-min, whereas, coma was induced in 50% of rats exposed to 33,000 ppm and coma was induced in 100% of rats at 37,000 ppm (Zieve et al., 1974). The limited genotoxicity data are equivocal. No reproductive/developmental toxicity data or carcinogenicity studies were located.

4. SPECIAL CONSIDERATIONS

4.1 Metabolism and Disposition

Snow (1957) showed that ethyl mercaptan was rapidly absorbed and distributed evenly throughout the body tissues in both mice and guinea pigs after oral or subcutaneous administration. Excretion occurred mainly via the kidney as inorganic sulfate. Organic metabolites, ethyl methyl sulfone, and an unidentified product accounted for 10-20% of the sulfur excreted in the urine. There was little fecal excretion; however approximately 14% of the dose was excreted in the breath. It was hypothesized that oxidation converted the thiol to the sulfide and then to the sulfone.

Ethyl mercaptan is a metabolite of the human body and is excreted in the breath of normal individuals (Chen et al., 1970) and in higher concentrations of patients with advanced liver disease. Chen et al. (1970) determined the concentration of ethyl mercaptan in the breath of normal subjects (fasting and after ingestion of methionine) and in patients with liver cirrhosis or in hepatic coma. Ethyl mercaptan concentrations in the breath ranged from 1.1-12.3 ng/L in 7 normal, fasting subjects and increased approximately 1.5-fold after daily ingestion of 8-12 g methionine for 7 days. In cirrhotic patients, the average ethyl mercaptan concentration was 11.5 ng/L. After ingestion of methionine, there was no significant increase in the amount of ethyl mercaptan in the breath of patients with liver disease.

4.2 Mechanism of Toxicity

Ethyl mercaptan acts similarly to hydrogen sulfide and cyanide by interrupting electron transport through inhibition of cytochrome oxidase. Ethyl mercaptan decreased Na,K-ATPase in rat brain (Foster et al., 1974). Vahlkamp et al. (1979) investigated the effects of ethyl mercaptan *in vitro* in isolated rat hepatocytes, isolated mitochondria from rat liver and brain, and submitochondrial particles from ox heart. Ethyl mercaptan inhibited glucogenesis and ureogenesis from various substrates in rat hepatocytes, decreased cellular ATP content and caused an increased reduction in the mitochondria. It also inhibited respiration in rat-liver mitochondria with several substrates, both in the presence of ADP and phosphate or in the presence of an uncoupling agent, and inhibited respiration in rat-brain mitochondria. In the ox heart submitochondrial particles, ethyl mercaptan inhibited electron transfer between cytochrome *c* and oxygen, and purified cytochrome *c* oxidase was inhibited by ethyl mercaptan in a non-competetive manner.

As a result of the electron transfer blockage, oxidative phosphorylation and aerobic metabolism are compromised, peripheral tissue P_{O2} increases, and the unloading gradient for oxyhemoglobin decreases. High concentrations of oxyhemoglobin are thus found in the venous return, resulting in flushed skin and mucous membranes. Lactic acidemia occurs as a result of the increased demand placed on glycolysis.

4.3 Structure-Activity Relationships

Rat lethality data suggest that the acute toxicity of ethyl mercaptan is much less than that of methyl mercaptan (approximately 6-fold) or hydrogen sulfide (approximately 10-fold), whereas; the acute toxicity of methyl mercaptan is similar to or slightly less than that of hydrogen sulfide. For example, the 4-hour LC_{50} value for ethyl mercaptan was 4740 ppm, whereas, the 4-hour LC_{50} value for methyl mercaptan was 675 ppm, and the 4-hour LC_{50} value for hydrogen sulfide was 444 ppm (Tansy et al., 1981).

4.4 Concurrent Exposure Issues

Because cyanide, hydrogen sulfide, methyl mercaptan, and ethyl mercaptan are all cytochrome oxidase inhibitors, an interaction might be possible if individuals were simultaneously exposed to hydrogen sulfide, methyl mercaptan, and/or hydrogen cyanide (Smith, 1991). These interactions could result in lower lethal exposure concentrations for ethyl mercaptan.

Ethyl mercaptan may also have a role in facilitating the toxic effects of ammonia and fatty acids relative to hepatic failure in humans (Zieve et al., 1974).

4.5 Species Differences

Based upon the limited available data, a definitive assessment of species variability is not possible. However, the limited data suggest that mice are approximately 1.6-fold more sensitive than rats to lethality from inhalation exposure to ethyl mercaptan.

4.6 Concentration-Exposure Duration Relationship

The concentration-exposure time relationship for many irritant and systemically-acting vapors and gases may be described by $c^n \times t = k$, where the exponent, n, ranges from 0.8 to 3.5 (ten Berge et al., 1986). Data were inadequate for derivation of an empirically derived-chemical specific scaling exponent for ethyl mercaptan. To obtain conservative and protective AEGL values in the absence of an empirically derived chemical-specific scaling exponent, temporal scaling will be performed using $n=3$ when extrapolating to shorter time points and $n = 1$ when extrapolating to longer time points using the $c^n \times t = k$ equation.

5. RATIONALE AND AEGL-1

5.1 Human Data Relevant to AEGL-1

One of two adult males exposed to 50 ppm ethyl mercaptan for 20 minutes showed decreased respiratory frequency (Shibata, 1966a). Mucosal irritation occurred in 1 female exposed to 4 ppm 3 hours/day for 10 days and in 2 males exposed to 4 ppm ethyl mercaptan, 3 hours/day for 5 days (Blinova, 1965).

5.2 Animal Data Relevant to AEGL-1

Rabbits exposed to 100 and 1000 ppm ethyl mercaptan for 20 minutes, showed decreased respiratory rate and expiratory volume, indicative of irritation; whereas, no significant effect was noted at 10 ppm (Shibata, 1966b).

5.3 Derivation of AEGL-1

The AEGL-1 values were based on a NOEL for irritation in rabbits exposed to 10 ppm for 20 minutes (Shibata, 1966b). Uncertainty factors of 3 each were applied to account for interspecies and intraspecies variability, and are considered sufficient because use of the full factor of 10 for either interspecies or intraspecies variability would yield AEGL-1 values ≤ 0.3 ppm which is inconsistent with the available human data. No mucosal irritation was noted in humans exposed to 0.4 ppm ethyl mercaptan 3 hours/day for 5 or 10 days (Blinova,1965). The AEGL-1 value was held constant across the 10- and 30-minute, and 1-, 4-, and 8-hour exposure times because mild irritancy generally does not vary greatly over time, and because it is not expected that prolonged exposure will result in an enhanced effect. The AEGL-1 values are for ethyl mercaptan are presented in Table 5 and calculations are presented in Appendix A.

TABLE 5. AEGL-1 Values for Ethyl Mercaptan

	10-minutes	30-minutes	1-hour	4-hour	8-hour
AEGL-1	1 ppm (2.5 mg/m^3)	1 ppm (2.5 mg/m^3)	1 ppm (2.5 mg/m^3)	1 ppm (2.5 mg/m^3)	1 ppm (2.5 mg/m^3)

6. RATIONALE AND AEGL-2

6.1 Human Data Relevant to AEGL-2

Ten students complained of dull headache, general discomfort, and abdominal pain, and three students vomited and had diarrhea after accidentally being exposed to methyl mercaptan at school (Pichler, 1914). However, no definitive concentration or duration parameters were available.

6.2 Animal Data Relevant to AEGL-2

Animal data were not available for deriving AEGL-2 values.

6.3 Derivation of AEGL-2

No inhalation data, with concentration and duration parameters, consistent with the definition of AEGL-2 with were available. Therefore, the AEGL-2 values will be based upon a 3-fold reduction in the AEGL-3 values; this is considered an estimate of a threshold for irreversible effects and is considered appropriate given the steep concentration-response curve (a 4 hour exposure to 2600 ppm caused 40% lethality in mice, the 4-hr mouse LC_{50} value was 2770 ppm and at 3573 ppm for 4 hours 100% of mice died; the 4-hr rat LC_{01} value was 3808 ppm and the 4-hr rat LC_{50} value was 4740 ppm). AEGL-2 values appear in Table 6 below and calculations are in Appendix A.

TABLE 6. AEGL-2 Values for Ethyl Mercaptan

	10-minutes	30-minutes	1-hour	4-hours	8-hours
AEGL-2	150 ppm (360 mg/m^3)	150 ppm (360 mg/m^3)	120 ppm (290 mg/m^3)	77 ppm (190 mg/m^3)	37 ppm (89 mg/m^3)

7. RATIONALE AND AEGL-3

7.1 Human Data Relevant to AEGL-3

No human data are available for calculation of AEGL-3 values.

7.2 Animal Data Relevant to AEGL-3

A 4-hour LC_{50} value of 2770 ppm, LC_{05} value of 2489 ppm, and LC_{01} value of 2250 ppm were calculated for mice, and a 4-hour LC_{50} value of 4740 ppm, LC_{05} value of 4120 ppm, and LC_{01} value of 3808 ppm were calculated for rats (Fairchild and Stokinger, 1958).

7.3 Derivation of AEGL-3

The LC_{01} (2250 ppm) in mice exposed to ethyl mercaptan for 4 hours (Fairchild and Stokinger, 1958) will be used to derive AEGL-3 values. The mouse data, rather than the rat data, are selected for derivation of AEGL-3 values because more mice were tested and yielded a better concentration-response curve. An intraspecies uncertainty factor of 3 will be applied and is considered sufficient due to the steepness of the lethal response curve (a 4 hour exposure to 2600 ppm caused 40% lethality in mice, the 4-hr mouse LC_{50} value was 2770 ppm and at 3573 ppm for 4 hours 100% of mice died; the 4-hr rat LC_{01} value was 3808 ppm and the 4-hr rat LC_{50} value was 4740 ppm) which implies limited individual variability. An interspecies uncertainty factor of 3 will also be applied because the limited data suggest that the mouse is the most sensitive species. Although an interspecies uncertainty factor of 10 might normally be applied due to limited data, AEGL-3 values calculated utilizing a total UF of 30 would yield AEGL-3 values approaching or equivalent to the AEGL-3 values derived for hydrogen sulfide (8-hr H_2S AEGL-3 is 31 ppm; 8-hr ethyl mercaptan AEGL-3 would be 37 ppm). Because a robust database exists for hydrogen sulfide and because data suggest that ethyl mercaptan is less toxic than hydrogen sulfide, [the 4-hour rat LC_{50} value for ethyl mercaptan was 4740 ppm (Fairchild and Stokinger, 1958), whereas, the 4-hour LC_{50} value for hydrogen sulfide was 444 ppm (Tansy et al., 1981)], it would be inconsistent with the total data set to derive AEGL-3 values for ethyl mercaptan that are in the range of the AEGL-3 values for hydrogen sulfide. Furthermore, use of a total UF of 30 would yield a 30-minute AEGL-3 of 150 ppm, which is inconsistent with available human data. Humans exposed to 112 ppm ethyl mercaptan for 20 minutes exhibited only a slightly irregular, and decreased breathing rate (Shibata, 1966a). Thus, the total uncertainty factor is 10. The concentration-exposure time relationship for many irritant and systemically-acting vapors and gases may be described by $c^n \times t = k$, where the exponent, n, ranges from 0.8 to 3.5 (ten Berge et al., 1986). To obtain conservative and protective AEGL values in the absence of an empirically derived chemical-specific scaling exponent, temporal scaling will be performed using n=3 when extrapolating to shorter time points (30-minutes, 1-hour, and 4-hours) and n = 1 when extrapolating to longer time points (8-hours) using the $c^n \times t = k$ equation. The 30-minute AEGL-3 value is adopted as the 10-minute value because the point-of-departure was 4-hours. AEGL-3 values appear in Table 7 below and calculations are in Appendix A.

TABLE 7. AEGL-3 Values for Ethyl Mercaptan

	10-minute	30-minute	1-hour	4-hour	8-hour
AEGL-3	450 ppm (1100 mg/m^3)	450 ppm (1100 mg/m^3)	360 ppm (860 mg/m^3)	230 ppm (550 mg/m^3)	110 ppm (260 mg/m^3)

8. SUMMARY OF AEGLS

8.1. AEGL Values and Toxicity Endpoints

Table 8 summarizes the proposed AEGL values. AEGL-1 values were based on a NOEL for irritation in rabbits. In the absence of data, AEGL-2 values are one-third of the AEGL-3 values; this is considered a threshold for the inability to escape and is appropriate due to the steep concentration-response curve for ethyl mercaptan. The AEGL-3 values are based on the LC_{01} (2250 ppm) in mice exposed to ethyl mercaptan for 4 hours (Fairchild and Stokinger, 1958).

TABLE 8. Summary of AEGL Values for Ethyl Mercaptan

Classification	10-minute	30-minute	1-hour	4-hour	8-hour
AEGL-1	1 ppm (2.5 mg/m^3)	1 ppm (2.5 mg/m^3)	1 ppm (2.5 mg/m^3)	1 ppm (2.5 mg/m^3)	1 ppm (2.5 mg/m^3)
AEGL-2	150 ppm (360 mg/m^3)	150 ppm (360 mg/m^3)	120 ppm (290 mg/m^3)	77 ppm (190 mg/m^3)	37 ppm (89 mg/m^3)
AEGL-3	450 ppm (1100 mg/m^3)	450 ppm (1100 mg/m^3)	360 ppm (860 mg/m^3)	230 ppm (550 mg/m^3)	110 ppm (260 mg/m^3)

8.2 Comparisons with Other Standards and Guidelines

TABLE 9. Extant Standards and Guidelines for Ethyl Mercaptan

Guideline	Exposure Duration				
	10 minute	30 minute	1 hour	4 hour	8 hour
AEGL-1	1 ppm	1 ppm	1 ppm	1 ppm	1 ppm
AEGL-2	150 ppm	150 ppm	120 ppm	77 ppm	37 ppm
AEGL-3	450 ppm	450 ppm	360 ppm	230 ppm	110 ppm
[a]NIOSH IDLH		500 ppm			
[b]NIOSH REL	0.5 ppm				
[c]OSHA PEL					10 ppm (ceiling)
[d]ACGIH-TLV TWA					0.5 ppm
[e]MAK (German)					0.5 ppm
[f]MAC (Dutch)					0.5 ppm

[a] NIOSH (2004) Immediately Dangerous to Life and Health (IDLH) is defined by the NIOSH/OSHA Standard Completions Program only for the purpose of respirator selection and represents a maximum concentration from which, in the event of respiratory failure, one could escape within 30 minutes without experiencing any escape-impairing or irreversible health effects. (Basis: Acute inhalation toxicity in animals, Fairchild and Stokinger, 1958).

[b] NIOSH (2004) REL is a 15-minute TWA exposure that should not be exceeded at any time during a workday.

[C] OSHA (Occupational Safety and Health Administration). 1999. Air Contaminants Rule. 29 CFR Part 1910. Fed. Reg. 58: 355345.

[d] ACGIH (2003).(American Conference of Governmental Industrial Hygienists, Threshold Limit Value - Time Weighted Average) (ACGIH 2003) is the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

[e] MAK (Maximale Argeitsplatzkonzentration [Maximum Workplace Concentration]) Deutsche Forschungsgemeinschaft (German Research Association) 2002 is defined analogous to the ACGIH-TLV-TWA.

[f] MAC (Maximaal Aanvaaarde Concentratie [Maximal Accepted Concentration]). SDU Uitgevers (under the auspices of the Ministry of Social Affairs and Employment), The Hague, The Netherlands 2000, is defined analogous to the ACGIH-TLV-TWA.

8.3 Data Adequacy and Research Needs

The data base for single inhalation-exposure animal studies is sparse and many of the studies that do exist are dated and poorly reported. There are no clear data on human exposure concentrations for short inhalation exposure durations. There were insufficient data to establish a chemical-specific time-scaling relationship for ethyl mercaptan.

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APPENDIX A: Time Scaling Calculations For Ethyl Mercaptan

AEGL-1 for Ethyl Mercaptan

Key study: Shibata, 1966b

Toxicity endpoint: NOEL for irritation in Rabbits: 10 ppm for a 20-minute exposure

Scaling: Values held constant across time

Uncertainty factor: 3 for intraspecies variability
3 for interspecies variability

<u>10-min, 30-min, 1-hr, 4-hr, and 8-hr AEGL-1</u>

10 ppm ÷ 10 = 1 ppm

AEGL-2 for Ethyl Mercaptan

Key study: Fairchild and Stokinger, 1958

Toxicity endpoint: ⅓ of the AEGL-3 values

10-min AEGL-2 10-min AEGL-2= 450/3 = 150 ppm

30-min AEGL-2 30-min AEGL-2 = 450/3 = 150 ppm

1-hr AEGL-2 1-hr AEGL-2 = 360/3 = 120 ppm

4-hr AEGL-2 4-hr AEGL-2 = 230/3 = 77 ppm

8-hr AEGL-2 8-hr AEGL-2 = 110/3 = 37 ppm

AEGL-3 for Ethyl Mercaptan

Key study: Fairchild and Stokinger (1958)

Toxicity endpoint: LC_{01} (2250 ppm) for a 4-hour exposure of used as an estimate of the lethality threshold in mice.

Scaling:

$C^3 \times t = k$ (default for long- to short- time extrapolation)

$(2250\ \text{ppm})^3 \times 4\ \text{hr} = 4.56 \times 10^{10}\ \text{ppm}^3{\cdot}\text{hr}$

$C^1 \times t = k$ (default for short- to long- time extrapolation)

$(2250\ \text{ppm})^1 \times 4\ \text{hr} = 9000\ \text{ppm}{\cdot}\text{hr}$

Uncertainty factors: 3 for interspecies variability
3 for intraspecies variability

<u>10-min AEGL-3</u> 30-minute value adopted as 10-minute value = 450 ppm

<u>30-min AEGL-3</u>

$C^3 \times 0.5\ \text{hr} = 4.56 \times 10^{10}\ \text{ppm}^3{\cdot}\text{hr}$
$C^3 = 9.12 \times 10^{10}\ \text{ppm}^3$
$C = 4501\ \text{ppm}$
30-min AEGL-3 = 4501 ppm/10 = 450 ppm

<u>1-hr AEGL-3</u>

$C^3 \times 1\ \text{hr} = 4.56 \times 10^{10}\ \text{ppm}^3{\cdot}\text{hr}$
$C^3 = 4.56 \times 10^{10}\ \text{ppm}^3$
$C = 3572\ \text{ppm}$
1-hr AEGL-3 = 3572 ppm/10 = 360 ppm

<u>4-hr AEGL-3</u>

$C^3 \times 4\ \text{hrs} = 4.56 \times 10^{10}\ \text{ppm}^3{\cdot}\text{hr}$
$C^3 = 1.14 \times 10^{10}\ \text{ppm}^3$
$C = 2251\ \text{ppm}$
4-hr AEGL-3 = 2251 ppm/10 = 230 ppm

<u>8-hr AEGL-3</u>

$C^1 \times 8\ \text{hrs} = 9000\ \text{ppm.hr}$
$C^1 = 1125\ \text{ppm}$
$C = 1125\ \text{ppm}$
8-hr AEGL-3 = 1125 ppm/10 = 110 ppm

APPENDIX B:
Derivation Summary Tables for Ethyl Mercaptan

ACUTE EXPOSURE GUIDELINES FOR ETHYL MERCAPTAN
(CAS NO. 75-08-1)

<table>
<tr><th colspan="5">AEGL-1 VALUES</th></tr>
<tr><th>10 minute</th><th>30 minute</th><th>1 hour</th><th>4 hour</th><th>8 hour</th></tr>
<tr><td>1 ppm</td><td>1 ppm</td><td>1 ppm</td><td>1 ppm</td><td>1 ppm</td></tr>
<tr><td colspan="5">Key References: Shibata, Y. 1966b. Studies on the influence of ethylmercaptan upon the living body: II. On the respiratory function and clinical findings in rabbits which inhaled ethyl mercaptan gas. Shikoku Acta. Med. 22: 136-145.</td></tr>
<tr><td colspan="5">Test Species/Strain/Number: rabbit/ male/6</td></tr>
<tr><td colspan="5">Exposure Route/Concentrations/Durations: Inhalation/10, 100, 1000 ppm/20 minutes</td></tr>
<tr><td colspan="5">Effects:
10 ppm: Unstable fluctuation in respiratory rate
100 ppm: Decreased respiratory rate (10%) and expiratory volume (10%). Increased tidal volume (20%)
1000 ppm: Decreased respiratory rate (40%) and expiratory volume (20%). Increased tidal volume (40%)</td></tr>
<tr><td colspan="5">Endpoint/Concentration/Rationale: NOEL for irritation, decreased respirator rate/10 ppm</td></tr>
<tr><td colspan="5">Uncertainty Factors/Rationale: Interspecies: 3.
Intraspecies: 3
Use of the full factor of 10 for either interspecies or intraspecies variability would yield AEGL-1 values ≤0.3 ppm which is inconsistent with the available human data. No mucosal irritation was noted in humans exposed to 0.4 ppm ethyl mercaptan 3 hours/day for 5 or 10 days (Blinova,1965).</td></tr>
<tr><td colspan="5">Modifying Factor: Not applicable (1)</td></tr>
<tr><td colspan="5">Animal to Human Dosimetric Adjustment: Not applicable</td></tr>
<tr><td colspan="5">Time Scaling: Values held constant across time because minor irritation does not vary greatly over time.</td></tr>
<tr><td colspan="5">Data Adequacy:</td></tr>
</table>

ACUTE EXPOSURE GUIDELINES FOR ETHYL MERCAPTAN (CAS NO. 75-08-1)

AEGL-2 VALUES				
10 minute	**30 minute**	**1 hour**	**4 hour**	**8 hour**
150 ppm	**150 ppm**	**120 ppm**	**77 ppm**	**37 ppm**

Key Reference: Fairchild, E. J. and Stokinger, H.E. (1958) Toxicologic studies on organic sulfur compounds. I. Acute toxicity of some aliphatic and aromatic thiols (Mercaptans). Am. Ind. Hyg. Assoc. J. 19:171-189.
Test Species/Strain/Number: See AEGL-3 Derivation summary table
Exposure Route/Concentrations/Durations: See AEGL-3 Derivation summary table
Effects: See AEGL-3 Derivation summary table
Endpoint/Concentration/Rationale: 3-fold reduction of AEGL-3 values. Considered threshold for the inability to escape. Supported by steep concentration-response curve (a 4 hour exposure to 2600 ppm caused 40% lethality in mice, the 4-hr mouse LC_{50} value was 2770 ppm and at 3573 ppm for 4 hours 100% of mice died; the 4-hr rat LC_{01} value was 3808 ppm and the 4-hr rat LC_{50} value was 4740 ppm).
Uncertainty Factors/Rationale: See AEGL-3 Derivation summary table Total uncertainty factor: Interspecies: Intraspecies:
Modifying Factor: NA
Animal to Human Dosimetric Adjustment: NA
Time Scaling: See AEGL-3 Derivation summary table.

ACUTE EXPOSURE GUIDELINES FOR ETHYL MERCAPTAN
(CAS NO. 75-08-1)

AEGL-3 VALUES

10 minutes	30 minutes	1 hour	4 hours	8 hours
450 ppm	450 ppm	360 ppm	230 ppm	110 ppm

Reference: Fairchild, E. J. and Stokinger, H.E. (1958) Toxicologic studies on organic sulfur compounds. I. Acute toxicity of some aliphatic and aromatic thiols (Mercaptans). Am. Ind. Hyg. Assoc. J. 19:171-189.

Test Species/Strain/Sex/Number: Swiss-derived mice, 10 males/exposure group

Exposure Route/Concentrations/Durations: Inhalation: 4-hr exposure to 0, 2600, 3150, 3573, 4438, or 4832 ppm

Effects:

Concentration	Mortality
0 ppm	0/10
2600 ppm	4/10
3150 ppm	7/10
3573 ppm	10/10
4438 ppm	10/10
4832 ppm	10/10

LC_{50} = 2770 ppm.
LC_{01} = 2250 ppm (Determinant for AEGL-3)

Endpoint/Concentration/Rationale: 4-hr LC_{01} of 2250 ppm considered an estimate of the lethality threshold in mice

Uncertainty Factors/Rationale:
Intraspecies: 3- considered sufficient due to the steepness of the lethal response curve (a 4 hour exposure to 2600 ppm caused 40% lethality in mice, the 4-hr mouse LC_{50} value was 2770 ppm and at 3573 ppm for 4 hours 100% of mice died; the 4-hr rat LC_{01} value was 3808 ppm and the 4-hr rat LC_{50} value was 4740 ppm) which implies limited individual variability.

Interspecies: 3. The mouse is the most sensitive species. Also, although an interspecies uncertainty factor of 10 might normally be applied due to limited data, AEGL-3 values calculated utilizing a total UF of 30 would yield AEGL-3 values approaching or equivalent to the AEGL-3 values derived for hydrogen sulfide (8-hr H_2S AEGL-3 is 31 ppm; 8-hr ethyl mercaptan AEGL-3 would be 37 ppm). Because a robust database exists for hydrogen sulfide and because data suggest that ethyl mercaptan is less toxic than hydrogen sulfide, [the 4-hour rat LC_{50} value for ethyl mercaptan was 4740 ppm (Fairchild and Stokinger, 1958), whereas, the 4-hour LC_{50} value for hydrogen sulfide was 444 ppm (Tansy et al., 1981)], it would be inconsistent with the total data set to derive AEGL-3 values for ethyl mercaptan that are in the range of the AEGL-3 values for hydrogen sulfide. Furthermore, use of a total UF of 30 would yield a 30-minute AEGL-3 of 150 ppm, which is inconsistent with available human data. Humans exposed to 112 ppm ethyl mercaptan for 20 minutes exhibited only a slightly irregular, and decreased breathing rate (Shibata, 1966a).
Total uncertainty factor : 10.

Modifying Factor: Not applicable

Animal to Human Dosimetric Adjustment: Insufficient data

Time Scaling: $c^n \times t = k$, where the exponent, n, is the conservative default of 1 (8-hr) or 3 (30-min, 1-hr, 4-hr). The 30-min value is adopted as the 10-min AEGL-3 value.

Data Adequacy: The study was well conducted and used a sufficient number of animals. The selected endpoint represents an estimate of an exposure threshold for lethality.

APPENDIX C:

Derivation of the Level of Distinct Odor Awareness (LOA) for Ethyl Mercaptan

Derivation of the Level of Distinct Odor Awareness (LOA)

The level of distinct odor awareness (LOA) represents the concentration above which it is predicted that more than half of the exposed population will experience at least a distinct odor intensity, about 10 % of the population will experience a strong odor intensity. The LOA should help chemical emergency responders in assessing the public awareness of the exposure due to odor perception. The LOA derivation follows the guidance given by Van Doorn et al. (2002).

The odor detection threshold (OT_{50}) for ethyl mercaptan was reported to be 0.0000087 ppm (Nagata, 2004).

The concentration (C) leading to an odor intensity (I) of distinct odor detection (I=3) is derived using the Fechner function:

$I = k_w \times \log (C / OT_{50}) + 0.5$

For the Fechner coefficient, the default of $k_w = 2.33$ will be used due to the lack of chemical-specific data:

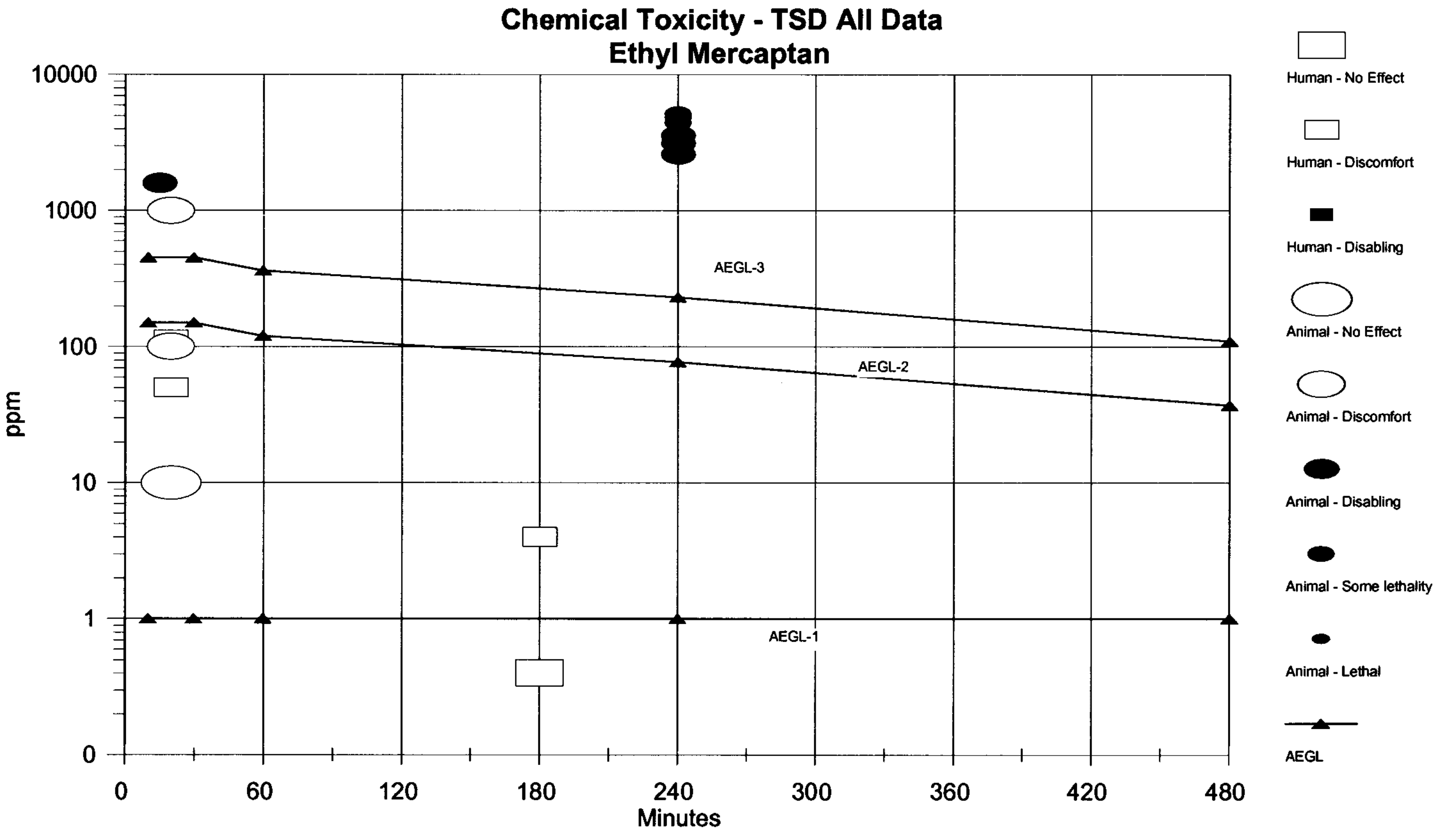
$3 = 2.33 \times \log (C / 0.0000087) + 0.5$ which can be rearranged to
$\log (C / 0.0000087) = (3 - 0.5) / 2.33 = 1.07$ and results in
$C = (10^{1.07}) \times 0.0000087 = 0.000102$ ppm

The resulting concentration is multiplied by an empirical field correction factor. It takes into account that in every day life factors, such as sex, age, sleep, smoking, upper airway infections and allergy as well as distraction, increase the odor detection threshold by a factor of 4. In addition, it takes into account that odor perception is very fast (about 5 seconds) which leads to the perception of concentration peaks. Based on the current knowledge, a factor of 1/3 is applied to adjust for peak exposure. Adjustment for distraction and peak exposure lead to a correction factor of 4 / 3 = 1.33

LOA = C x 1.33 = 0.000102 ppm x 1.33 = 0.00014 ppm

The LOA for ethyl mercaptan is 0.00014 ppm.

APPENDIX D: CATEGORY PLOT FOR ETHYL MERCAPTAN


Chemical Toxicity - TSD All Data
Ethyl Mercaptan
10000
1000
100
10
1
0
ppm
0
60
120
180
240
300
360
420
480
Minutes
AEGL-3
AEGL-2
AEGL-1
Human - No Effect
Human - Discomfort
Human - Disabling
Animal - No Effect
Animal - Discomfort
Animal - Disabling
Animal - Some lethality
Animal - Lethal
AEGL

Appendix E - Ethyl Mercaptan Supplemental Information

Bottles of gas were encountered at the site that were confirmed to contain ethyl mercaptan gas. See attached analysis. The purpose of this information is to supplement Appendix E of the existing Community Air Monitoring Plan (CAMP) with this new information. The contractor will follow safe work practices identified in their attached job safety assessment for ethyl mercaptan, as well as the health and safety plan for the site.

Our review is based on information found in the attached ethyl mercaptan Material Safety Data Sheet (MSDS) from Matheson and the Acute Exposure Guideline Levels for this chemical. Please note that the Matheson MSDS is for liquid ethyl mercaptan, and may not be representative of the actual material on-site.

Upgrade levels and other pertinent information are shown on the attached table. Monitoring for ethyl mercaptan will be conducted by three methods:

1) A Photo Ionizing Detector (PID) will be used to measure concentrations in the parts per billion (ppb) range. Analysis will be done on-site.
2) Pumps and glass filters will be used following National Institute of Occupational Safety and Health (NIOSH) method 2452. Cartridges will be sent to a certified laboratory off-site for analysis.
3) Drager tubes will be used as an option for monitoring concentrations on-site.

Additionally, ethyl mercaptan is explosive in gaseous form at a concentration of 2.8-18.0%. The lower explosive limit will be monitored throughout the project to help ensure levels remain at a safe concentration.

Engineering controls (i.e. water, salt, plastic, foam, etc.) will also be used to keep ethyl mercaptan levels at a minimum. Please note that liquid ethyl mercaptan is reactive with water. Care should be exercised when using water near this material. Other safe and proper handling guidelines for ethyl mercaptan are further described on the attached documents and should be followed during any work at the site.

Please contact Michael Matilainen CIH, CSP if you have any questions concerning this information.

Parameter	Location	Frequency 8-hr	Equipment	Estimated # Days	Analysis	Action Level	Corrective Action
Ethyl Mercaptan	One Upwind Two Downwind	During Removal	PID (ppb range)	~ 10	On – site	0.5 ppm for 8-hr Not to exceed 10 ppm Ceiling limit for 15 min	Dust suppression with foam, water, salt, cover dirt piles in plastic
Ethyl Mercaptan	One Upwind Two Downwind	During Removal	NIOSH 2452 Pumps and Glass filters; Or Drager Tubes	~ 10	Off – site Lab On - site	0.5 ppm for 8-hr Not to exceed 10 ppm Ceiling limit for 15 min	Dust suppression with foam, water, salt, cover dirt piles in plastic
Ethyl Mercaptan	Workers	Throughout Project	PID (ppb range)	~ 10	On – site	0.5 ppm for 8-hr Not to exceed 10 ppm Ceiling limit for 15 min	Dust suppression with foam, water, salt, cover dirt piles in plastic
Ethyl Mercaptan	Workers	Throughout Project	NIOSH 2452 Pumps and Glass filters; Or Drager Tubes	~ 10	Off – site Lab On - site	0.5 ppm for 8-hr Not to exceed 10 ppm Ceiling limit for 15 min	Dust suppression with foam, water, salt, cover dirt piles in plastic
Ethyl Mercaptan	Workers	Throughout Project	Combustible Gas Indicator	~ 10	On – site	10% Lower Explosive Limit	Stop work Eliminate Ignition Sources Dust suppression with foam, water, salt, cover dirt piles in plastic

APPENDIX F

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities

Prepared by:

National Institute for Occupational Safety and Health (NIOSH)
Occupational Safety and Health Administration (OSHA)
U.S. Coast Guard (USCG)
U.S. Environmental Protection Agency (EPA)

U.S. Department of Health and Human Services
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

October 1985

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Contents

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The *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* is a result of the collaborative efforts of individuals representing the National Institute for Occupational Safety and Health (NIOSH), the lead agency, and the Occupational Safety and Health Administration (OSHA), the U.S. Coast Guard (USCG), and the U.S. Environmental Protection Agency (EPA). Agency representatives on the steering committee for this project were:

Gail Kleiner (OSHA)
Sheldon Rabinovitz (NIOSH)
David Weitzman (EPA)
Glenn Wiltshire (USCG)

Jan Connery of Eastern Research Group, Arlington, Massachusetts, edited and coordinated production of the manual. Over 100 individuals and organizations also contributed substantially to the development of this manual by providing technical information and review. Although they are too numerous to name individually, the steering committee gratefully acknowledges their valuable contributions.

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DHHS (NIOSH) Publication No. 85-115

1. Introduction

In the past decade, industry, government, and the general public have become increasingly aware of the need to respond to the hazardous waste problem, which has grown steadily over the past 40 years. In 1980, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)—the Superfund law—to provide for "liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive waste disposal sites."

This manual is a guidance document for managers responsible for occupational safety and health programs at inactive hazardous waste sites. It assumes a basic knowledge of science and experience in occupational safety and health. It is the product of a four-agency committee (the National Institute for Occupational Safety and Health [NIOSH], the Occupational Safety and Health Administration [OSHA], the U.S. Coast Guard [USCG], and the U.S. Environmental Protection Agency [EPA]) mandated by CERCLA section 301(f) to study the problem of protecting the safety and health of workers at hazardous waste sites, and by CERCLA section 111(c)(6) to develop a program to protect the health and safety of employees involved in response to hazardous substance releases, removals, or remedial actions.

This manual is intended for federal, state, and local officials and their contractors. It may be used:

- As a planning tool by government or private individuals.
- As a management tool by upper level or field managers.
- As an educational tool to provide a comprehensive overview of all aspects of safety and health protection at hazardous waste sites.
- As a reference document for site personnel who need to review important aspects of health and safety.

This document is *not* a detailed industrial hygiene textbook or a comprehensive source book on occupational safety and health. It provides general guidance and should be used as a preliminary basis for developing a specific health and safety program. The appropriateness of the information presented should always be evaluated in light of site-specific conditions. Other sources and experienced individuals should be consulted as necessary for the detail needed to design and implement occupational safety and health programs at specific hazardous waste sites.

Although this manual cites federal regulations, it is not a definitive legal document and should not be taken as such. While it represents a cooperative effort of the four agencies to develop a document that blends their widely differing mandates, policies, and procedures in specific areas, the manual may not include elements of each agency's policies that should be considered when developing occupational safety and health programs for hazardous waste sites. Individuals who are responsible for the health and safety of workers at hazardous waste sites should obtain and comply with the most recent federal, state, and local regulations relevant to these sites, and are urged to consult with OSHA, EPA, and other appropriate federal, state, and local agencies.

This manual will be updated regularly. Please send comments and suggested revisions to any of these four organizations:

NIOSH
Hazardous Waste Program (C-17)
4676 Columbia Parkway
Cincinnati, OH 45226

OSHA
Directorate of Technical Support
200 Constitution Avenue, NW
Washington, DC 20210

USCG
Environmental Response Division (G-WER-2)
2100 Second Street, SW
Washington, DC 20593

EPA
Occupational Health and Safety Staff (PM-273)
401 M Street, SW
Washington, DC 20460

A separate manual that specifically addresses response to hazardous substances emergencies will be published at a later date. In the meantime, much of the information in this manual can be used in planning for response to emergencies involving hazardous substances.

2. Hazards

Contents

Introduction

Hazardous waste sites pose a multitude of health and safety concerns, any one of which could result in serious injury or death. These hazards are a function of the nature of the site as well as a consequence of the work being performed. They include:

- Chemical exposure.
- Fire and explosion.
- Oxygen deficiency.
- Ionizing radiation.
- Biologic hazards.
- Safety hazards.
- Electrical hazards.
- Heat stress.
- Cold exposure.
- Noise.

Several factors distinguish the hazardous waste site environment from other occupational situations involving hazardous substances. One important factor is the uncontrolled condition of the site. Even extremely hazardous substances do not endanger human health or safety if they are properly handled. However, improper control of these substances can result in a severe threat to site workers and to the general public.

Another factor is the large variety and number of substances that may be present at a site. Any individual location may contain hundreds or even thousands of chemicals. Frequently, an accurate assessment of all chemical hazards is impossible due to the large number of substances and the potential interactions among the substances. In addition, the identity of the substances on site is frequently unknown, particularly in the initial stages of an investigation. The Project Team Leader (see Chapter 3, *Planning and Organization*) will often be forced to select protective measures based on little or no information. Finally, workers are subject not only to the hazards of direct exposure, but also to dangers posed by the disorderly physical environment of hazardous waste sites and the stress of working in protective clothing.

The combination of all these conditions results in a working environment that is characterized by numerous and varied hazards which:

- May pose an immediate danger to life or health.
- May not be immediately obvious or identifiable.
- May vary according to the location on site and the task being performed.
- May change as site activities progress.

General categories of hazards that may be present at a site are described in this chapter. In approaching a site, it is prudent to assume that all these hazards are present until site characterization has shown otherwise. A site health and safety program, as described in the subsequent chapters of this manual, must provide comprehensive protection against all potential hazards and specific protection against individual known hazards. It should be continuously adapted to new information and changing site conditions.

Chemical Exposure

Preventing exposure to toxic chemicals is a primary concern at hazardous waste sites. Most sites contain a variety of chemical substances in gaseous, liquid, or solid form. These substances can enter the unprotected body by inhalation, skin absorption, ingestion, or through a puncture wound (injection). A contaminant can cause damage at the point of contact or can act systemically, causing a toxic effect at a part of the body distant from the point of initial contact.

Chemical exposures are generally divided into two categories: acute and chronic. Symptoms resulting from acute exposures usually occur during or shortly after exposure to a sufficiently high concentration of a contaminant. The concentration required to produce such effects varies widely from chemical to chemical. The term "chronic exposure" generally refers to exposures to "low" concentrations of a contaminant over a long period of time. The "low" concentrations required to produce symptoms of chronic exposure depend upon the chemical, the duration of each exposure, and the number of exposures. For a given contaminant, the symptoms of an acute exposure may be completely different from those resulting from chronic exposure.

For either chronic or acute exposure, the toxic effect may be temporary and reversible, or may be permanent (disability or death). Some chemicals may cause obvious symptoms such as burning, coughing, nausea, tearing eyes, or rashes. Other chemicals may cause health damage without any such warning signs (this is a particular concern for chronic exposures to low concentrations). Health effects such as cancer or respiratory disease may not become manifest for several years or decades after exposure. In addition, some toxic chemicals may be colorless and/or odorless, may dull the sense of smell, or may not produce any immediate or obvious physiological sensations. Thus, a worker's senses or feelings cannot be relied upon in all cases to warn of potential toxic exposure.

The effects of exposure not only depend on the chemical, its concentration, route of entry, and duration of exposure, but may also be influenced by personal factors such as the individual's smoking habits, alcohol consumption, medication use, nutrition, age, and sex (see Chapter 5, *Medical Program*).

An important exposure route of concern at a hazardous waste site is inhalation. The lungs are extremely vulnerable to chemical agents. Even substances that do not directly affect the lungs may pass through lung tissue into the bloodstream, where they are transported to other vulnerable areas of the body. Some toxic chemicals present in the atmosphere may not be detected by human senses, i.e., they may be colorless, odorless, and their toxic effects may not produce any immediate symptoms. Respiratory protection is therefore extremely important if there is a possibility that the work-site atmosphere may contain such hazardous substances. Chemicals can also enter the respiratory tract through punctured eardrums. Where this is a hazard, individuals with punctured eardrums should be medically evaluated specifically to determine if such a condition would place them at unacceptable risk and preclude their working at the task in question.

Direct contact of the skin and eyes by hazardous substances is another important route of exposure. Some chemicals directly injure the skin. Some pass through the skin into the bloodstream where they are transported to vulnerable organs. Skin absorption is enhanced by abrasions, cuts, heat, and moisture. The eye is particularly vulnerable because airborne chemicals can dissolve in its moist surface and be carried to the rest of the body through the bloodstream (capillaries are very close to the surface of the eye). Wearing protective equipment, not using contact lenses in contaminated atmospheres (since they may trap chemicals against the eye surface), keeping hands away from the face, and minimizing contact with liquid and solid chemicals can help protect against skin and eye contact.

Although ingestion should be the least significant route of exposure at a site, it is important to be aware of how this type of exposure can occur. Deliberate ingestion of chemicals is unlikely, however, personal habits such as chewing gum or tobacco, drinking, eating, smoking cigarettes, and applying cosmetics on site may provide a route of entry for chemicals.

The last primary route of chemical exposure is injection, whereby chemicals are introduced into the body through puncture wounds (for example, by stepping or tripping and falling onto contaminated sharp objects). Wearing safety shoes, avoiding physical hazards, and taking common sense precautions are important protective measures against injection.

Explosion and Fire

There are many potential causes of explosions and fires at hazardous waste sites:

- Chemical reactions that produce explosion, fire, or heat.
- Ignition of explosive or flammable chemicals.
- Ignition of materials due to oxygen enrichment.
- Agitation of shock- or friction-sensitive compounds.
- Sudden release of materials under pressure.

Explosions and fires may arise spontaneously. However, more commonly, they result from site activities, such as moving drums, accidentally mixing incompatible chemicals, or introducing an ignition source (such as a spark from equipment) into an explosive or flammable environment. At hazardous waste sites, explosions and fires not only pose the obvious hazards of intense heat, open flame, smoke inhalation, and flying objects, but may also cause the release of toxic chemicals into the environment. Such releases can threaten both personnel on site and members of the general public living or working nearby. To protect against the hazard: have qualified personnel field monitor for explosive atmospheres and flammable vapors; keep all potential ignition sources away from an explosive or flammable environment; use non-sparking, explosion-proof equipment; and follow safe practices when performing any task that might result in the agitation or release of chemicals.

Oxygen Deficiency

The oxygen content of normal air at sea level is approximately 21 percent. Physiological effects of oxygen deficiency in humans are readily apparent when the oxygen concentration in the air decreases to 16 percent. These effects include impaired attention, judgment and coordination, and increased breathing and heart rate. Oxygen concentrations lower than 16 percent can result in nausea and vomiting, brain damage, heart damage, unconsciousness, and death. To take into account individual physiological responses and errors in measurement, concentrations of 19.5 percent oxygen or lower are considered to be indicative of oxygen deficiency.

Oxygen deficiency may result from the displacement of oxygen by another gas, or the consumption of oxygen by a chemical reaction. Confined spaces or low-lying areas are particularly vulnerable to oxygen deficiency and should always be monitored prior to entry. Qualified field personnel should always monitor oxygen levels and should use atmosphere-supplying respiratory equipment (see Chapter 8, *Personal Protective Equipment*) when oxygen concentrations drop below 19.5 percent by volume.

Ionizing Radiation

Radioactive materials emit one or more of three types of harmful radiation: alpha, beta, and gamma. Alpha radiation has limited penetration ability and is usually stopped by clothing and the outer layers of the skin. Alpha radiation poses little threat outside the body, but can be hazardous if materials that emit alpha radiation are inhaled or ingested. Beta radiation can cause harmful "beta burns" to the skin and damage the subsurface blood system. Beta radiation is also hazardous if materials that emit beta radiation are inhaled or ingested. Use of protective clothing, coupled with scrupulous personal hygiene and decontamination, affords good protection against alpha and beta radiation.

Gamma radiation easily passes through clothing and human tissue and can also cause serious permanent damage to the body. Chemical-protective clothing affords no protection against gamma radiation itself; however, use of respiratory and other protective equipment can help keep radiation-emitting materials from entering the body by inhalation, ingestion, injection, or skin absorption.

If levels of radiation above natural background are discovered (see Table 6-2 in Chapter 6), consult a health physicist. At levels greater than 2 mrem/hr, all site activities should cease until the site has been assessed by health physicists.

Biologic Hazards

Wastes from hospitals and research facilities may contain disease-causing organisms that could infect site personnel. Like chemical hazards, etiologic agents may be dispersed in the environment via water and wind. Other biologic hazards that may be present at a hazardous waste site include poisonous plants, insects, animals, and indigenous pathogens. Protective clothing and respiratory equipment can help reduce the chances of exposure. Thorough washing of any exposed body parts and equipment will help protect against infection.

Safety Hazards

Hazardous waste sites may contain numerous safety hazards such as:

- Holes or ditches.
- Precariously positioned objects, such as drums or boards that may fall.
- Sharp objects, such as nails, metal shards, and broken glass.
- Slippery surfaces.
- Steep grades.
- Uneven terrain.
- Unstable surfaces, such as walls that may cave in or flooring that may give way.

Some safety hazards are a function of the work itself. For example, heavy equipment creates an additional hazard for workers in the vicinity of the operating equipment. Protective equipment can impair a worker's agility, hearing, and vision, which can result in an increased risk of an accident.

Accidents involving physical hazards can directly injure workers and can create additional hazards, for example, increased chemical exposure due to damaged protective equipment, or danger of explosion caused by the mixing of chemicals. Site personnel should constantly look out for potential safety hazards, and should immediately inform their supervisors of any new hazards so that mitigative action can be taken.

Electrical Hazards

Overhead power lines, downed electrical wires, and buried cables all pose a danger of shock or electrocution if workers contact or sever them during site operations. Electrical equipment used on site may also pose a hazard to workers. To help minimize this hazard, low-voltage equipment with ground-fault interrupters and water-tight, corrosion-resistant connecting cables should be used on site. In addition, lightning is a hazard during outdoor operations, particularly for workers handling metal containers or equipment. To eliminate this hazard, weather conditions should be monitored and work should be suspended during electrical storms. An additional electrical hazard involves capacitors that may retain a charge. All such items should be properly grounded before handling. OSHA's standard 29 CFR Part 1910.137 describes clothing and equipment for protection against electrical hazards.

Heat Stress

Heat stress is a major hazard, especially for workers wearing protective clothing. The same protective materials that shield the body from chemical exposure also limit the dissipation of body heat and moisture. Personal protective clothing can therefore create a hazardous condition. Depending on the ambient conditions and the work being performed, heat stress can occur very rapidly —within as little as 15 minutes. It can pose as great a danger to worker health as chemical exposure. In its early stages, heat stress can cause rashes, cramps, discomfort and drowsiness, resulting in impaired functional ability that threatens the safety of both the individual and coworkers. Continued heat stress can lead to heat stroke and death. Avoiding overprotection, careful training and frequent monitoring of personnel who wear protective clothing, judicious scheduling of work and rest periods, and frequent replacement of fluids can protect against this hazard. For further information on heat stress, see Chapter 8, *Personal Protective Equipment*.

Cold Exposure

Cold injury (frostbite and hypothermia) and impaired ability to work are dangers at low temperatures and when the wind-chill factor is low. To guard against them: wear appropriate clothing; have warm shelter readily available; carefully schedule work and rest periods, and monitor workers' physical conditions.

Noise

Work around large equipment often creates excessive noise. The effects of noise can include:

- Workers being startled, annoyed, or distracted.
- Physical damage to the ear, pain, and temporary and/or permanent hearing loss.
- Communication interference that may increase potential hazards due to the inability to warn of danger and the proper safety precautions to be taken.

If employees are subjected to noise exceeding an 8-hour, time-weighted average sound level of 90 dBA (decibels on the A-weighted scale), feasible administrative or engineering controls must be utilized. In addition, whenever employee noise exposures equal or exceed an 8-hour, time-weighted average sound level of 85 dBA, employers must administer a continuing, effective hearing conservation program as described in OSHA regulation 29 CFR Part 1910.95.

3. Planning and Organization

Contents

Introduction

Adequate planning is the first and the most critical element of hazardous waste site activities. By anticipating and taking steps to prevent potential hazards to health and safety, work at a waste site can proceed with minimum risk to workers and the public.

Three aspects of planning are discussed in this chapter: developing an overall organizational structure for site operations; establishing a comprehensive Work Plan that considers each specific phase of the operation; and developing and implementing a Site Safety and Health Plan (hereinafter referred to as Site Safety Plan in accordance with common usage). The organizational structure should identify the personnel needed for the overall operation, establish the chain-of-command, and specify the overall responsibilities of each employee. The Work Plan should establish the objectives of site operations and the logistics and resources required to achieve the goals. The Site Safety Plan should determine the health and safety concerns for each phase of the operation and define the requirements and procedures for worker and public protection.

A fourth important aspect of planning is coordinating with the existing response community. A national response organization was established by a Congressionally mandated National Contingency Plan to implement procedures for coordinating response to releases of hazardous substances into the environment. This National Contingency Plan establishes response teams composed of representatives of federal agencies and state and local governments [1]. A particularly important contact for hazardous waste site activities is the EPA-designated official responsible for coordinating federal activities related to site cleanup.

Planning should be viewed as an ongoing process: the cleanup activities and Site Safety Plan must be continuously adapted to new site conditions and new information. Thus, this chapter is intended to serve as a starting point for planning the response activities at hazardous waste sites.

Organizational Structure

An organizational structure that supports the overall objectives of the project should be developed in the first stage of planning. This structure should:

- Identify a leader who has the authority to direct all activities.
- Identify the other personnel needed for the project, and assign their general functions and responsibilities.
- Show lines of authority, responsibility, and communication.
- Identify the interface with the response community.

As the project progresses, it may be necessary to modify some organizational aspects of the project, such as personnel responsibilities and authorities, so that individual tasks can be performed as efficiently and safely as possible. Any changes to the overall organizational structure must be recorded in the appropriate parts of the Work or Site Safety Plans that are developed for individual phases or tasks and must be communicated to all parties involved.

Figure 3-1 presents one example of an organizational framework for a hazardous waste site response team. It shows the lines of authority for 24 categories of offsite and onsite personnel. The responsibilities and functions of each category are described in Tables 3-1 through 3-4. The onsite categories are divided into personnel that are essential for a safe and efficient response, and optional personnel that may be desirable in a large operation where responsibilities can be delegated to a greater number of people. As-needed personnel are specialists that are called upon for specific tasks, either off-site or on site.

This example is intended to illustrate the scope of responsibilities and functions that must be covered. The personnel categories described can be used as a starting point for designing an organizational structure appropriate to a particular situation. For smaller investigative and response efforts, single individuals may perform several of the functions described.

Regardless of the size of the effort, all response teams should include a Site Safety and Health Officer (hereinafter referred to as Site Safety Officer in accordance with common usage) responsible for implementing health and safety requirements. The Site Safety Officer should have ready access to other occupational health and safety professionals, particularly an industrial hygienist. Once an organizational system has been developed, all individuals responsible for establishing and enforcing health and safety requirements should be identified and their respective authorities clearly explained to all members of the response team.

One of the most critical elements in worker safety is the attitude of all levels of project management. A strong and visible commitment to worker safety must be present from the beginning of a project. This initial attitude sets the tone for the entire operation. The Site Safety Officer and the Project Team Leader must have the clear support of senior-level management for establishing, implementing, and enforcing safety programs from the outset of the project. The importance of management's attitude toward safety throughout the project cannot be overemphasized; site personnel are more likely to cooperate with safety programs if they sense a genuine concern on the part of management.

Several organizational factors are indicators of successful worker safety programs. These factors include:

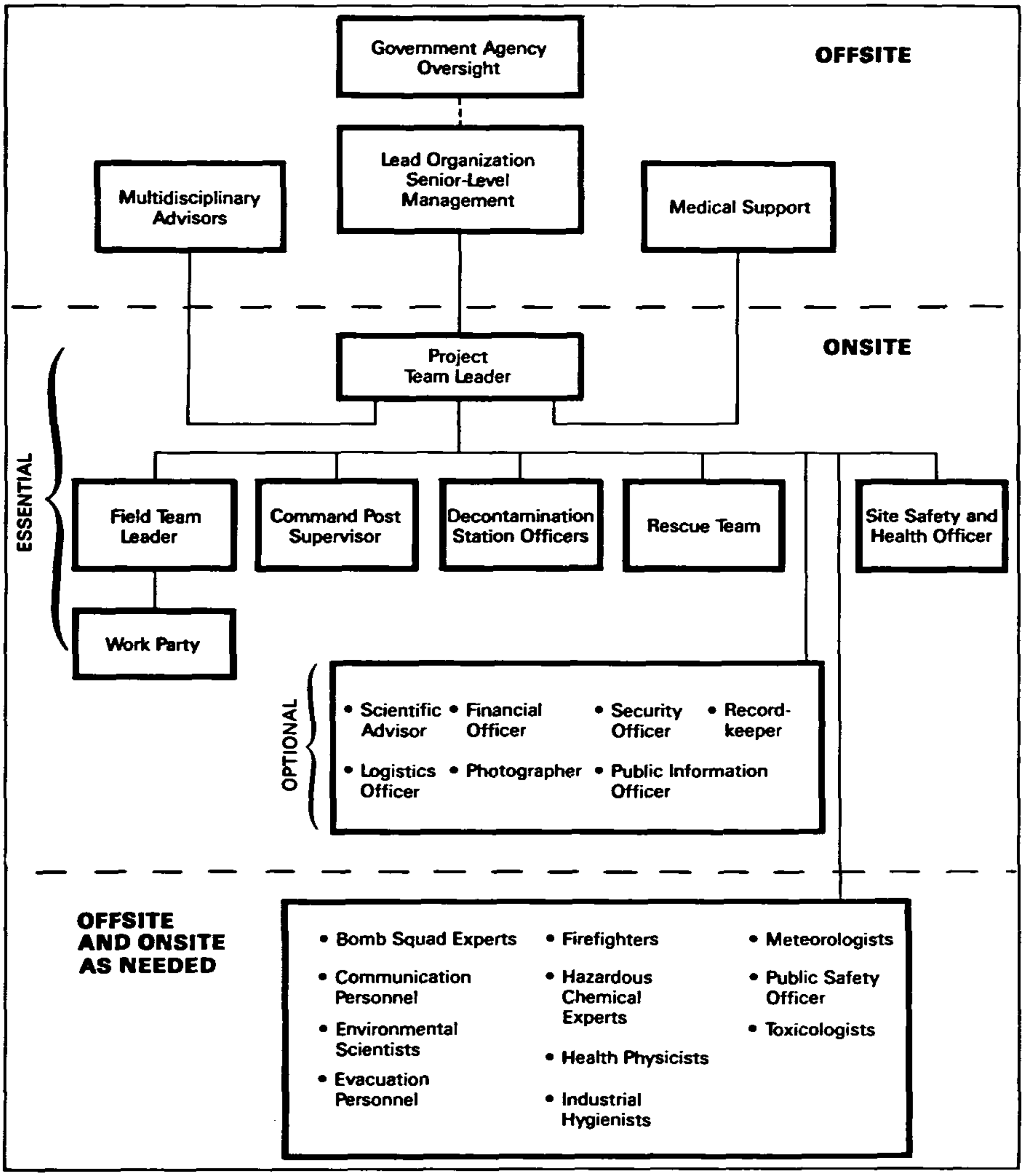

Figure 3-1. Generalized Approach to Personnel Organization for Site Investigation and Response.

- Strong management commitment to safety, as defined by various actions reflecting management's support and involvement in safety activities.
- Close contact and interaction among workers, supervisors, and management enabling open communication on safety as well as other job-related matters.
- A high level of housekeeping, orderly workplace conditions, and effective environmental quality control.
- Well-developed selection, job placement, and advancement procedures plus other employee support services.
- Training practices emphasizing early indoctrination and followup instruction in job safety procedures.
- Added features or variations in conventional safety practices that enhance the effectiveness of those practices.
- Effective disciplinary plan to encourage employees to adhere to safety practices.

Overall, the most effective industrial safety programs are successful in dealing with "people" variables. Open communication among workers, supervisors, and management concerning worksite safety is essential.

The effective management of response actions at hazardous waste sites requires a commitment to the health and safety of the general public as well as to the onsite personnel. Prevention and containment of contaminant release into the surrounding community should be addressed in the planning stages of a project. Not only must the public be protected, they must also be made aware of the health and safety program and have confidence in it. To accomplish these goals, the Project Team Leader, or Public Information Officer under the supervision of the Project Team Leader, should establish community liaison well before any response action is begun, and should be in continuous contact with community leaders.

Work Plan

To ensure a safe response, a Work Plan describing anticipated cleanup activities must be developed before beginning onsite response actions. The Work Plan should be periodically reexamined and updated as new information about site conditions is obtained.

The following steps should be taken in formulating a comprehensive Work Plan:

- Review available information, including:
  Site records.
  Waste inventories.
  Generator and transporter manifests.
  Previous sampling and monitoring data.
  Site photos.
  State and local environmental and health agency records.
- Define work objectives.
- Determine methods for accomplishing the objectives, e.g., sampling plan, inventory, disposal techniques.
- Determine personnel requirements.
- Determine the need for additional training of personnel. Evaluate their current knowledge/skill level against the tasks they will perform and situations they may encounter (see Chapter 4, *Training*).

Table 3-1. Offsite Personnel

TITLE	GENERAL DESCRIPTION	SPECIFIC RESPONSIBILITIES
Senior-Level Management	Responsible for defining project objectives, allocating resources, determining the chain-of-command, and evaluating program outcome.	• Provide the necessary facilities, equipment, and money. • Provide adequate personnel and time resources to conduct activities safely. • Support the efforts of onsite management. • Provide appropriate disciplinary action when unsafe acts or practices occur.
Multi-Disciplinary Advisors	Includes representatives from upper-level management and onsite management, a field team member, and experts in such fields as: Chemistry Engineering Industrial hygiene Information/public relations Law Medicine Pharmacology Physiology Radiation health physics Toxicology	• Provide advice on the design of the Work Plan and the Site Safety Plan.
Medical Support	Consulting physicians.	• Become familiar with the types of materials on site, the potential for worker exposures, and recommend the medical program for the site.
	Medical personnel at local hospitals and clinics.	• Provide emergency treatment and decontamination procedures for the specific type of exposures that may occur at the site. Obtain special drugs, equipment, or supplies necessary to treat such exposures.
	Ambulance personnel.	• Provide emergency treatment procedures appropriate to the hazards on site.

Table 3-2. Onsite Essential Personnel

TITLE	GENERAL DESCRIPTION	SPECIFIC RESPONSIBILITIES
Project Team Leader	Reports to upper-level management. Has authority to direct response operations. Assumes total control over site activities.	• Prepares and organizes the background review of the situation, the Work Plan, the Site Safety Plan, and the field team. • Obtains permission for site access and coordinates activities with appropriate officials. • Ensures that the Work Plan is completed and on schedule. • Briefs the field teams on their specific assignments. • Uses the Site Safety and Health Officer to ensure that safety and health requirements are met. • Prepares the final report and support files on the response activities. • Serves as the liaison with public officials.
Site Safety and Health Officer (hereinafter referred to as Site Safety Officer in accordance with common usage)	Advises the Project Team Leader on all aspects of health and safety on site. Recommends stopping work if any operation threatens worker or public health or safety.	• Selects protective clothing and equipment. • Periodically inspects protective clothing and equipment. • Ensures that protective clothing and equipment are properly stored and maintained. • Controls entry and exit at the Access Control Points. • Coordinates safety and health program activities with the Scientific Advisor. • Confirms each team member's suitability for work based on a physician's recommendation. • Monitors the work parties for signs of stress, such as cold exposure, heat stress, and fatigue. • Monitors onsite hazards and conditions. • Participates in the preparation of and implements the Site Safety Plan. • Conducts periodic inspections to determine if the Site Safety Plan is being followed. • Enforces the "buddy" system. • Knows emergency procedures, evacuation routes, and the telephone numbers of the ambulance, local hospital, poison control center, fire department, and police department. • Notifies, when necessary, local public emergency officials. • Coordinates emergency medical care.
Field Team Leader	May be the same person as the Project Team Leader and may be a member of the work party. Responsible for field team operations and safety.	• Manages field operations. • Executes the Work Plan and schedule. • Enforces safety procedures. • Coordinates with the Site Safety Officer in determining protection level. • Enforces site control. • Documents field activities and sample collection. • Serves as a liaison with public officials.
Command Post Supervisor	May be the same person as the Field Team Leader. Responsible for communications and emergency assistance.	• Notifies emergency response personnel by telephone or radio in the event of an emergency. • Assists the Site Safety Officer in a rescue, if necessary. • Maintains a log of communication and site activities. • Assists other field team members in the clean areas, as needed. • Maintains line-of-sight and communication contact with the work parties via walkie-talkies, signal horns, or other means.
Decontamination Station Officer(s)	Responsible for decontamination procedures, equipment, and supplies.	• Sets up decontamination lines and the decontamination solutions appropriate for the type of chemical contamination on site. • Controls the decontamination of all equipment, personnel, and samples from the contaminated areas. • Assists in the disposal of contaminated clothing and materials. • Ensures that all required equipment is available. • Advises medical personnel of potential exposures and consequences.
Rescue Team	Used primarily on large sites with multiple work parties in the contaminated area.	• Stands by, partially dressed in protective gear, near hazardous work areas. • Rescues any worker whose health or safety is endangered.
Work Party	Depending on the size of the field team, any or all of the field team may be in the Work Party, but the Work Party should consist of at least two people.	• Safely completes the onsite tasks required to fulfill the Work Plan. • Complies with Site Safety Plan. • Notifies Site Safety Officer or supervisor of unsafe conditions.

Table 3-3. Onsite Optional Personnel

TITLE	GENERAL DESCRIPTION	SPECIFIC RESPONSIBILITIES
Scientific Advisor	Guides the Project Team Leader in scientific matters.	• Provides advice for: Field monitoring Sample collection Sample analysis Scientific studies Data interpretation Remedial plans
Logistics Officer		• Plans and mobilizes the facilities, materials, and personnel required for the response.
Photographer		• Photographs site conditions. • Archives photographs.
Financial/Contracting Officer		• Provides financial and contractual support.
Public Information Officer		• Releases information to the news media and the public concerning site activities.
Security Officer		• Manages site security.
Recordkeeper		• Maintains the official records of site activities.

- Determine equipment requirements. Evaluate the need for special equipment or services, such as drilling equipment or heavy equipment and operators.

Preparation of the Work Plan requires a multidisciplinary approach, and may therefore require input from all levels of onsite and offsite management. Consultants may also be useful in developing sections of the Work Plan; for example, chemists, occupational health and safety professionals, and statisticians may be needed to develop the sampling plan.

Site Safety Plan

A Site Safety Plan, which establishes policies and procedures to protect workers and the public from the potential hazards posed by a hazardous waste site, must be developed before site activities proceed. The Site Safety Plan must provide measures to minimize accidents and injuries that may occur during normal daily activities or during adverse conditions such as hot or cold weather. This section describes the planning process for health and safety during normal site operations, i.e., non-emergency situations. Chapter 12 describes planning and response to site emergencies.

Development of a written Site Safety Plan helps ensure that all safety aspects of site operations are thoroughly examined prior to commencing field work. The Site Safety Plan should be modified as needed for every stage of site activity.

Because planning requires information, planning and site characterization should be coordinated. An initial Site Safety Plan should be developed so that the preliminary site assessment can proceed in a safe manner. The information from this assessment can then be used to refine the Site Safety Plan so that further site activities can proceed safely. Plans should be revised whenever new information about site hazards is obtained.

Development of a Site Safety Plan should involve both the offsite and onsite management and be reviewed by occupational and industrial health and safety experts, physicians, chemists, or other appropriate personnel.

At a minimum, the plan should:

- Name key personnel and alternates responsible for site safety (see Tables 3-1 through 3-4).
- Describe the risks associated with each operation conducted (see Chapter 6, *Site Characterization*).
- Confirm that personnel are adequately trained to perform their job responsibilities and to handle the specific hazardous situations they may encounter (see Chapter 4, *Training*).
- Describe the protective clothing and equipment to be worn by personnel during various site operations (see Chapter 8, *Personal Protective Equipment*).
- Describe any site-specific medical surveillance requirements (see Chapter 5, *Medical Program*).
- Describe the program for periodic air monitoring, personnel monitoring, and environmental sampling, if needed (see Chapter 6, *Site Characterization*, and Chapter 11, *Handling Drums and Other Containers*).
- Describe the actions to be taken to mitigate existing hazards (e.g., containment of contaminated materials) to make the work environment less hazardous.
- Define site control measures and include a site map (see Chapter 9, *Site Control*).
- Establish decontamination procedures for personnel and equipment (see Chapter 10, *Decontamination*).
- Set forth the site's Standard Operating Procedures (SOPs). SOPs are those activities that can be standardized (such as decontamination and respirator fit testing), and where a checklist can be used. These procedures should be:

  Prepared in advance.

  Based on the best available information, operational principles, and technical guidance.

  Field-tested by qualified health and safety professionals, and revised as appropriate.

  Appropriate to the types of risk at that site.

  Formulated to be easy to understand and practice.

Table 3-4. As-Needed Personnel

TITLE	GENERAL DESCRIPTION	SPECIFIC RESPONSIBILITIES
Bomb Squad Explosion Experts		• Advise on methods of handling explosive materials. • Assist in safely detonating or disposing of explosive materials.
Communication Personnel	Civil Defense organizations; local radio and television stations. Local emergency service networks.	• Provide communication to the public in the event of an emergency. • Provide communication links for mutual aid.
Environmental Scientists	Consultants from industry, government, universities, or other groups.	• Predict the movement of released hazardous materials through the atmospheric, geologic, and hydrologic environment. • Assess the effect of this movement on air, groundwater, and surface water quality. • Predict the exposure of people and the ecosystem to the materials.
Evacuation Personnel	Federal, state, and local public safety organizations.	• Help plan for public evacuation. • Mobilize transit equipment. • Assist in public evacuation.
Firefighters		• Respond to fires that occur on site. • Stand by for response to potential fires. • Perform rescue.
Hazardous Chemical Experts	Consultants from industry, government, universities, or other groups.	• Advise on the properties of the materials on site. • Advise on contaminant control methods. • Advise on the dangers of chemical mixtures that may result from site activities. • Provide immediate advice to those at the scene of a chemical-related emergency.
Health Physicists		• Evaluate radiation health hazards and recommend appropriate action.
Industrial Hygienists		• Conduct health hazard assessments. • Advise on adequate health protection. • Conduct monitoring tests to determine worker exposures to hazardous substances.
Meteorologists		• Provide meteorological information.
Public Safety Personnel	The County Sheriff, industrial security forces, National Guard, police, etc.	• Control access to the site.
Toxicologists		• Advise on toxicological properties and health effects of substances on site. • Provide recommendations on protection of worker health.

Provided in writing to all site personnel, who should be briefed on their use.

Included in training programs for site personnel.

- Set forth a Contingency Plan for safe and effective response to emergencies.

Appendix B provides a generic Site Safety Plan that can be adapted for hazardous waste site cleanup operations. The generic plan should be used as a guide, *not a standard*, for designing a Site Safety Plan.

Safety Meetings and Inspections

To ensure that the Site Safety Plan is being followed, the Site Safety Officer should conduct a safety meeting prior to initiating any site activity and before and after each work day. The purpose of these safety meetings is to:

- Describe the assigned tasks and their potential hazards.
- Coordinate activities.
- Identify methods and precautions to prevent injuries.
- Plan for emergencies.
- Describe any changes in the Site Safety Plan.
- Get worker feedback on conditions affecting safety and health.
- Get worker feedback on how well the Site Safety Plan is working.

The Site Safety Officer should also conduct frequent inspections of site conditions, facilities, equipment, and activities to determine whether the Site Safety Plan is adequate and being followed.

At a hazardous waste site, risks to workers can change quickly and dramatically when there are changes in:

- Work and other site activities.
- State of degradation of containers and containment structures.

- State of equipment maintenance.
- Weather conditions.

In order to make safety inspections effective, the following guidelines should be observed:

- Develop a checklist for each site, listing the items that should be inspected.
- Review the results of these inspections with supervisors and workers.
- Reinspect any identified problems to ensure that they have been corrected.
- Document all inspections and subsequent followup actions. Retain these records until site activities are completed and as as long as required by regulatory agencies.

The minimum frequency at which inspections should occur varies with the characteristics of the site and the equipment used on site. Factors that need to be considered are:

- The severity of risk on site.
- Regulatory requirements.
- Operation and maintenance requirements.
- The expected effective lifetime of clothing, equipment, vehicles, and other items.
- Recommendations based on professional judgment, laboratory test results, and field experience.

References

1. National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300.

4. Training

Contents

Introduction

Anyone who enters a hazardous waste site must recognize and understand the potential hazards to health and safety associated with the cleanup of that site. Personnel actively involved in cleanup must be thoroughly familiar with programs and procedures contained in the Site Safety Plan (see Chapter 3, *Planning and Organization*) and must be trained to work safely in contaminated areas. Visitors to a site must receive adequate training on hazard recognition and on the site's Standard Operating Procedures to enable them to conduct their visit safely.

The objectives of training programs for employees involved in hazardous waste site activities are:

- To make workers aware of the potential hazards they may encounter.
- To provide the knowledge and skills necessary to perform the work with minimal risk to worker health and safety.
- To make workers aware of the purpose and limitations of safety equipment.
- To ensure that workers can safely avoid or escape from emergencies.

The level of training provided should be consistent with the worker's job function and responsibilities. The training program should involve both classroom instruction in a wide range of health and safety topics and "hands-on" practice. Hands-on instruction should consist of drills in the field that simulate site activities and conditions. Any training program for work around hazardous substances should also incorporate onsite experience under the direct supervision of trained, experienced personnel.

All training information should be presented in clear, concise language. Particularly important information, such as the Standard Operating Procedures, should be provided in writing. A variety of teaching aids (i.e., films, tapes, slides, etc.) should be used, and lecture sessions should be interspersed with class participation and hands-on training. All employees should also complete refresher training, at least annually, to reemphasize the initial training and to update workers on any new policies or procedures.

Training Programs

Employees should not engage in field activities until they have been trained to a level commensurate with their job function and responsibilities and with the degree of anticipated hazards. Specific recommendations for the areas to be covered in training sessions are given in Table 4-1.

The training program should involve field drills that simulate emergency situations. Here workers wearing Level A personal protective equipment repair a leaking pipe as part of a training exercise.

General site workers, such as equipment operators, general laborers, technicians, and other supervised personnel, should attend training sessions that apply to their individual jobs and responsibilities, as well as training sessions that provide an overview of the site hazards and the means of controlling those hazards. Their training should include classroom instruction in the following subject areas, depending on their individual jobs:

- Site Safety Plan.
- Safe work practices.
- Nature of anticipated hazards.
- Handling emergencies and self-rescue.
- Rules and regulations for vehicle use.
- Safe use of field equipment.
- Handling, storage, and transportation of hazardous materials.
- Employee rights and responsibilities.
- Use, care, and limitations of personal protective clothing and equipment (see *Training* section of Chapter 8).
- Safe sampling techniques.

Table 4-1. Recommended Training by Job Category[a]

TRAINING TOPIC	EMPHASIS OF TRAINING	GENERAL SITE WORKER	ONSITE MANAGEMENT AND SUPERVISORS	HEALTH AND SAFETY STAFF	VISITORS
Biology, Chemistry, and Physics of Hazardous Materials	Chemical and physical properties; chemical reactions; chemical compatibilities.	R	R	R	
Toxicology	Dosage, routes of exposure, toxic effects, immediately dangerous to life or health (IDLH) values, permissible exposure limits (PELs), recommended exposure limits (RELs), threshold limit values (TLVs).	R	R	R	
Industrial Hygiene	Selection and monitoring of personal protective clothing and equipment.		R	R	
	Calculation of doses and exposure levels; evaluation of hazards; selection of worker health and safety protective measures.		R	R	
Rights and Responsibilities of Workers Under OSHA	Applicable provisions of Title 29 of the Code of Federal Regulations (the OSH Act).	R	R	R	
Monitoring Equipment	Functions, capabilities, selection, use, limitations, and maintenance.	R	R	R	
Hazard Evaluation	Techniques of sampling and assessment.		R	R	
	Evaluation of field and lab results.		R	R	
	Risk assessment.		O	R	
Site Safety Plan	Safe practices, safety briefings and meetings, Standard Operating Procedures, site safety map.	R	R	R	R
Standard Operating Procedures (SOPs)	Hands-on practice.	R	R	R	
	Development and compliance.		R	R	
Engineering Controls	The use of barriers, isolation, and distance to minimize hazards.	R	R	R	
Personal Protective Clothing and Equipment (PPE)	Assignment, sizing, fit-testing, maintenance, use, limitations, and hands-on training.	R	R	R	R
	Selection of PPE.		O	R	
	Ergonomics.			R	
Medical Program	Medical monitoring, first aid, stress recognition.	R	R	R	
	Advanced first aid, cardiopulmonary resuscitation (CPR); emergency drills.	O	R	R	
	Design, planning, and implementation.			R	
Decontamination	Hands-on training using simulated field conditions.	R	R	R	
	Design and maintenance.	R	R	R	
Legal and Regulatory Aspects	Applicable safety and health regulations (OSHA, EPA, etc.)	O	R	R	
Emergencies	Emergency help and self-rescue; emergency drills.	R	R	R	
	Response to emergencies; follow-up investigation and documentation.		R	R	

[a] R = Recommended.
O = Optional.

In addition to classroom instruction, general site workers should engage in actual field activities under the direct supervision of a trained, experienced supervisor.

Some general site workers who may be exposed to unique hazards or who may occasionally supervise others should receive additional training in the following subject areas:

- Site surveillance.
- Site Safety Plan development.
- Use and decontamination of fully encapsulating personal protective clothing and equipment.
- Use of instruments to measure explosivity, radioactivity, etc.
- Safe use of specialized equipment.
- Topics specific to identified site activities.

Onsite management and supervisors, such as Project Team Leaders, who are responsible for directing others, should receive the same training as the general site workers for whom they are responsible, as well as additional training to enhance their ability to provide guidance and make informed decisions. This additional training should include:

- Management of hazardous waste site cleanup operations.
- Management of the site work zones (see Chapter 9, *Site Control*).
- How to communicate with the press and local community.

Health and safety staff with specific responsibilities for health and safety guidance on site should be familiar with the training provided to general site workers and their supervisors, and should receive advanced training in health and safety issues, policies, and techniques.

Visitors to the site (including elected and appointed officials, reporters, senior-level management, and other interested parties) must also receive a briefing on safety. These visitors should not be permitted in the Exclusion Zone (see Chapter 9, *Site Control*) unless they have been trained, fit-tested, and medically approved for respirator use. All other visitors should not enter the Exclusion Zone; rather, they should observe site conditions from the clean area, e.g., using binoculars.

Record of Training

A record of training should be maintained in each employee's personnel file to confirm that every person assigned to a task has had adequate training for that task, and that every employee's training is up-to-date.

5. Medical Program

Contents

Introduction

Workers handling hazardous wastes can experience high levels of stress. Their daily tasks may expose them to toxic chemicals, safety hazards, biologic hazards, and radiation. They may develop heat stress while wearing protective equipment or working under temperature extremes, or face life-threatening emergencies such as explosions and fires. Therefore, a medical program is essential to assess and monitor workers' health and fitness both prior to employment and during the course of work; to provide emergency and other treatment as needed; and to keep accurate records for future reference. In addition, OSHA recommends a medical evaluation for employees required to wear a respirator (29 CFR Part 1910.134[b][10]), and certain OSHA standards include specific medical requirements (e.g., 29 CFR Part 1910.95 and 29 CFR Parts 1910.1001 through 1910.1045). Information from a site medical program may also be used to conduct future epidemiological studies; to adjudicate claims; to provide evidence in litigation; and to report workers' medical conditions to federal, state, and local agencies, as required by law.

This chapter presents general guidelines for designing a medical program for personnel at hazardous waste sites. It includes information and sample protocols for pre-employment screening and periodic medical examinations, guidelines for emergency and non-emergency treatment, and recommendations for program recordkeeping and review. In addition, it supplies a table of some common chemical toxicants found at hazardous waste sites with recommended medical monitoring procedures.

The recommendations in this chapter assume that workers will have adequate protection from exposures through administrative and engineering controls, and appropriate personal protective equipment and decontamination procedures, as described elsewhere in this manual. Medical surveillance should be used to complement other controls.

Developing a Program

A medical program should be developed for each site based on the specific needs, location, and potential exposures of employees at the site. The program should be designed by an experienced occupational health physician or other qualified occupational health consultant in conjunction with the Site Safety Officer. The director of a site medical program should be a physician who is board-certified in occupational medicine or a medical doctor who has had extensive experience managing occupational health services. A director and/or examining physician with such qualifications may be difficult to find, due to the shortage of doctors trained in occupational medicine in remote geographic areas where many hazardous waste sites are located. If an occupational health physician is not available, the site medical program may be managed, and relevant examinations performed, by a local physician with assistance from an occupational medicine consultant. These functions may also be performed by a qualified Registered Nurse, preferably an Occupational Health Nurse, under the direction of a suitably qualified physician who has responsibility for the program.[1]

All medical test analyses should be performed by a laboratory that has demonstrated satisfactory performance in an established interlaboratory testing program [1]. The clinical or diagnostic laboratory to which samples are sent should meet either (1) minimum requirements under the Clinical Laboratories Improvement Act of 1967 (42 CFR Part 74 Subpart M Section 263[a]), or (2) the conditions for coverage under Medicare. These programs are administered by the Health Care Financing Administration (HCFA), U.S. Department of Health and Human Services (DHHS).

A site medical program should provide the following components:

- Surveillance:
  - Pre-employment screening.
  - Periodic medical examinations (and followup examinations when appropriate).
  - Termination examination.
- Treatment:
  - Emergency
  - Non-emergency (on a case-by-case basis)
- Recordkeeping.
- Program review.

Table 5-1 outlines a recommended medical program; screening and examination protocols are described in the following sections. These recommendations are based on known health risks for hazardous waste workers, a review of available data on their exposures, and an assessment of several established medical programs. Because conditions and hazards vary considerably at each site, only general guidelines are given.

The effectiveness of a medical program depends on active worker involvement. In addition, management should have a firm commitment to worker health and

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[1] Certified, state-licensed (where required) Physician's Assistants may also perform these examinations if a physician is available on the premises.

Table 5-1. Recommended Medical Program

COMPONENT	RECOMMENDED	OPTIONAL
Pre-Employment Screening	• Medical history. • Occupational history. • Physical examination. • Determination of fitness to work wearing protective equipment. • Baseline monitoring for specific exposures.	• Freezing pre-employment serum specimen for later testing (limited to specific situations, see *Baseline Data for Future Exposures* in this chapter).
Periodic Medical Examinations	• Yearly update of medical and occupational history; yearly physical examination; testing based on (1) examination results, (2) exposures, and (3) job class and task. • More frequent testing based on specific exposures.	• Yearly testing with routine medical tests.
Emergency Treatment	• Provide emergency first aid on site. • Develop liaison with local hospital and medical specialists. • Arrange for decontamination of victims. • Arrange in advance for transport of victims. • Transfer medical records; give details of incident and medical history to next care provider.	
Non-Emergency Treatment	• Develop mechanism for non-emergency health care.	
Recordkeeping and Review	• Maintain and provide access to medical records in accordance with OSHA and state regulations. • Report and record occupational injuries and illnesses. • Review Site Safety Plan regularly to determine if additional testing is needed. • Review program periodically. Focus on current site hazards, exposures, and industrial hygiene standards.	

safety, and is encouraged to express this commitment not only by medical surveillance and treatment, but also through management directives and informal encouragement of employees to maintain good health through exercise, proper diet, and avoidance of tobacco, alcohol abuse and drug abuse. In particular, management should:

- Urge prospective employees to provide a complete and detailed occupational and medical history.
- Assure employees of confidentiality.
- Require workers to report any suspected exposures, regardless of degree.
- Require workers to bring any unusual physical or psychological conditions to the physician's attention. Employee training should emphasize that vague disturbances or apparently minor complaints (such as skin irritation or headaches) may be important.

When developing an individual program, site conditions must be considered and the monitoring needs of each worker should be determined based on the worker's medical and occupational history, as well as current and potential exposures on site. The routine job tasks of each worker should be considered. For instance, a heavy equipment operator exposed to significant noise levels would require a different monitoring protocol from a field sample collector with minimal noise exposure. Likewise, an administrator may only need a pre-employment screening for ability to wear personal protective equipment—if this is an occasional requirement—rather than a more comprehensive program.

The potential exposures that may occur at a site must also be considered. While it is often impossible to identify every toxic substance that exists at each hazardous waste site, certain types of hazardous substances or chemicals are more likely to be present than others. Some of these are:

- Aromatic hydrocarbons.
- Asbestos (or asbestiform particles).
- Dioxin.
- Halogenated aliphatic hydrocarbons.
- Heavy metals.
- Herbicides.
- Organochlorine insecticides.
- Organophosphate and carbamate insecticides.
- Polychlorinated biphenyls (PCBs).

Table 5-2 lists these groups, with representative compounds, uses, health effects, and available medical monitoring procedures.

Table 5-2. Common Chemical Toxicants Found at Hazardous Waste Sites, Their Health Effects and Medical Monitoring

HAZARDOUS SUBSTANCE OR CHEMICAL GROUP	COMPOUNDS	USES	TARGET ORGANS	POTENTIAL HEALTH EFFECTS	MEDICAL MONITORING
Aromatic Hydrocarbons	Benzene Ethyl benzene Toluene Xylene	Commercial solvents and intermediates for synthesis in the chemical and pharmaceutical industries.	Blood Bone marrow CNS[a] Eyes Respiratory system Skin Liver Kidney	All cause: CNS[a] depression: decreased alertness, headache, sleepiness, loss of consciousness. Defatting dermatitis. Benzene suppresses bone-marrow function, causing blood changes. Chronic exposure can cause leukemia. Note: Because other aromatic hydrocarbons may be contaminated with benzene during distillation, benzene-related health effects should be considered when exposure to any of these agents is suspected.	Occupational/general medical history emphasizing prior exposure to these or other toxic agents. Medical examination with focus on liver, kidney, nervous system, and skin. Laboratory testing: CBC[b] Platelet count Measurement of kidney and liver function.
Asbestos (or asbestiform particles)		A variety of industrial uses, including: Building Construction Cement work Insulation Fireproofing Pipes and ducts for water, air, and chemicals Automobile brake pads and linings	Lungs Gastrointestinal system	Chronic effects: Lung cancer Mesothelioma Asbestosis Gastrointestinal malignancies Asbestos exposure coupled with cigarette smoking has been shown to have a synergistic effect in the development of lung cancer.	History and physical examination should focus on the lungs and gastrointestinal system. Laboratory tests should include a stool test for occult blood evaluation as a check for possible hidden gastrointestinal malignancy. A high quality chest X-ray and pulmonary function test may help to identify long-term changes associated with asbestos diseases; however, early identification of low-dose exposure is unlikely.
Dioxin (see Herbicides)					
Halogenated Aliphatic Hydrocarbons	Carbon tetrachloride Chloroform Ethyl bromide Ethyl chloride Ethylene dibromide Ethylene dichloride Methyl chloride Methyl chloroform Methylene chloride Tetrachloroethane Tetrachloroethylene (perchloroethylene) Trichloroethylene Vinyl chloride	Commercial solvents and intermediates in organic synthesis.	CNS[a] Kidney Liver Skin	All cause: CNS[a] depression: decreased alertness, headaches, sleepiness, loss of consciousness. Kidney changes: decreased urine flow, swelling (especially around eyes), anemia. Liver changes: fatigue, malaise, dark urine, liver enlargement, jaundice. Vinyl chloride is a known carcinogen; several others in this group are potential carcinogens.	Occupational/general medical history emphasizing prior exposure to these or other toxic agents. Medical examination with focus on liver, kidney, nervous system, and skin. Laboratory testing for liver and kidney function; carboxyhemoglobin where relevant.

Table 5-2. (cont.)

HAZARDOUS SUBSTANCE OR CHEMICAL GROUP	COMPOUNDS	USES	TARGET ORGANS	POTENTIAL HEALTH EFFECTS	MEDICAL MONITORING
Heavy Metals	Arsenic Beryllium Cadmium Chromium Lead Mercury	Wide variety of industrial and commercial uses.	Multiple organs and systems including: Blood Cardiopulmonary Gastrointestinal Kidney Liver Lung CNS[a] Skin	All are toxic to the kidneys. Each heavy metal has its own characteristic symptom cluster. For example, lead causes decreased mental ability, weakness (especially hands), headache, abdominal cramps, diarrhea, and anemia. Lead can also affect the blood-forming mechanism, kidneys, and the peripheral nervous system. Long-term effects[c] also vary. Lead toxicity can cause permanent kidney and brain damage; cadmium can cause kidney or lung disease. Chromium, beryllium, arsenic, and cadmium have been implicated as human carcinogens.	History-taking and physical exam: search for symptom clusters associated with specific metal exposure, e.g., for lead look for neurological deficit, anemia, and gastrointestinal symptoms. Laboratory testing: Measurements of metallic content in blood, urine, and tissues (e.g., blood lead level; urine screen for arsenic, mercury, chromium, and cadmium). CBC[b] Measurement of kidney function, and liver function where relevant. Chest X-ray or pulmonary function testing where relevant.
Herbicides	Chlorophenoxy compounds: 2,4-dichlorophenoxyacetic acid (2,4-D) 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) Dioxin (tetrachlorodibenzo-p-dioxin, TCDD), which occurs as a trace contaminant in these compounds, poses the most serious health risk.	Vegetation control.	Kidney Liver CNS[a] Skin	Chlorophenoxy compounds can cause chloracne, weakness or numbness of the arms and legs, and may result in long-term nerve damage. Dioxin causes chloracne and may aggravate pre-existing liver and kidney diseases.	History and physical exam should focus on the skin and nervous system. Laboratory tests include: Measurement of liver and kidney function, where relevant. Urinalysis.
Organochlorine Insecticides	Chlorinated ethanes: DDT Cyclodienes: Aldrin Chlordane Dieldrin Endrin Chlorocyclohexanes: Lindane	Pest control.	Kidney Liver CNS[a]	All cause acute symptoms of apprehension, irritability, dizziness, disturbed equilibrium, tremor, and convulsions. Cyclodienes may cause convulsions without any other initial symptoms. Chlorocyclohexanes can cause anemia. Cyclodienes and chlorocyclohexanes cause liver toxicity and can cause permanent kidney damage.	History and physical exam should focus on the nervous system. Laboratory tests include: Measurement of kidney and liver function. CBC[b] for exposure to chlorocyclohexanes.

Table 5-2. (cont.)

HAZARDOUS SUBSTANCE OR CHEMICAL GROUP	COMPOUNDS	USES	TARGET ORGANS	POTENTIAL HEALTH EFFECTS	MEDICAL MONITORING
Organo-phosphate and Carbamate Insecticides	Organophosphate: Diazinon Dichlorovos Dimethoate Trichlorfon Malathion Methyl parathion Parathion Carbamate: Aldicarb Baygon Zectran	Pest control.	CNS[a] Liver Kidney	All cause a chain of internal reactions leading to neuromuscular blockage. Depending on the extent of poisoning, acute symptoms range from headaches, fatigue, dizziness, increased salivation and crying, profuse sweating, nausea, vomiting, cramps, and diarrhea to tightness in the chest, muscle twitching, and slowing of the heartbeat. Severe cases may result in rapid onset of unconsciousness and seizures. A delayed effect may be weakness and numbness in the feet and hands. Long-term, permanent nerve damage is possible.	Physical exam should focus on the nervous system. Laboratory tests should include: RBC[d] cholinesterase levels for recent exposure (plasma cholinesterase for acute exposures). Measurement of delayed neurotoxicity and other effects.
Polychlorinated Biphenyls (PCBs)		Wide variety of industrial uses.	Liver CNS[a] (speculative) Respiratory system (speculative) Skin	Various skin ailments, including chloracne; may cause liver toxicity; carcinogenic to animals.	Physical exam should focus on the skin and liver. Laboratory tests include: Serum PCB levels. Triglycerides and cholesterol. Measurement of liver function.

[a] CNS = Central nervous system.
[b] CBC = Complete blood count.
[c] Long-term effects generally manifest in 10 to 30 years.
[d] RBC = Red blood count.

In compiling a testing protocol, bear in mind that standard occupational medical tests were developed in factories and other enclosed industrial environments, and were based on the presence of specific identifiable toxic chemicals and the possibility of a significant degree of exposure. Some of these tests may not be totally appropriate for hazardous waste sites, since available data suggest that site workers have low-level exposures to many chemicals concurrently, plus brief high-level exposure to some chemicals [2]. In addition, most testing recommendations, even those for specific toxic substances, have not been critically evaluated for efficacy.

Another important factor to consider is that risk can vary, not only with the type, amount and duration of exposure, but also with individual factors such as age, sex, weight, stress, diet, susceptibility to allergic-type reactions, medications taken, and offsite exposures (e.g., in hobbies such as furniture refinishing and automotive body work).

Pre-Employment Screening

Pre-employment screening has two major functions: (1) determination of an individual's fitness for duty, including the ability to work while wearing protective equipment, and (2) provision of baseline data for comparison with future medical data. These functions are discussed below. In addition, a sample pre-employment examination is described.

Determination of Fitness for Duty

Workers at hazardous waste sites are often required to perform strenuous tasks (e.g., moving 55-gallon drums) and wear personal protective equipment, such as respirators and protective clothing, that may cause heat stress and other problems (see Chapter 8 for details). To ensure that prospective employees are able to meet work requirements, the pre-employment screening should focus on the following areas:

Occupational and Medical History

- Make sure the worker fills out an occupational and medical history questionnaire. Review the questionnaire before seeing the worker. In the examining room, discuss the questionnaire with the worker, paying special attention to prior occupational exposures to chemical and physical hazards.
- Review past illnesses and chronic diseases, particularly atopic diseases such as eczema and asthma, lung diseases, and cardiovascular disease.

- Review symptoms, especially shortness of breath or labored breathing on exertion, other chronic respiratory symptoms, chest pain, high blood pressure, and heat intolerance.
- Identify individuals who are vulnerable to particular substances (e.g., someone with a history of severe asthmatic reaction to a specific chemical).
- Record relevant lifestyle habits (e.g., cigarette smoking, alcohol and drug use) and hobbies.

Physical Examination

- Conduct a comprehensive physical examination of all body organs, focussing on the pulmonary, cardiovascular, and musculoskeletal systems.
- Note conditions that could increase susceptibility to heat stroke, such as obesity and lack of physical exercise.
- Note conditions that could affect respirator use, such as missing or arthritic fingers, facial scars, dentures, poor eyesight, or perforated ear drums.

Ability to Work While Wearing Protective Equipment [3]

- Disqualify individuals who are clearly unable to perform based on the medical history and physical exam (e.g., those with severe lung disease, heart disease, or back or orthopedic problems).
- Note limitations concerning the worker's ability to use protective equipment (e.g., individuals who must wear contact lenses cannot wear full-facepiece respirators).
- Provide additional testing (e.g., chest X-ray, pulmonary function testing, electrocardiogram) for ability to wear protective equipment where necessary.
- Base the determination on the individual worker's profile (e.g., medical history and physical exam, age, previous exposures and testing).
- Make a written assessment of the worker's capacity to perform while wearing a respirator, if wearing a respirator is a job requirement. Note that the Occupational Safety and Health Administration (OSHA) respirator standard (29 CFR Part 1910.134) states that no employee should be assigned to a task that requires the use of a respirator unless it has been determined that the person is physically able to perform under such conditions.

Baseline Data for Future Exposures

Pre-employment screening can be used to establish baseline data to subsequently verify the efficacy of protective measures and to later determine if exposures have adversely affected the worker. Baseline testing may include both medical screening tests and biologic monitoring tests. The latter (e.g., blood lead level) may be useful for ascertaining pre-exposure levels of specific substances to which the worker may be exposed and for which reliable tests are available. Given the problem in predicting significant exposures for these workers, there are no clear guidelines for prescribing specific tests. The following approach identifies the types of tests that may be indicated:

- A battery of tests based on the worker's past occupational and medical history and an assessment of significant potential exposures. See Table 5-3 for examples of tests frequently performed by occupational physicians.
- Standard established testing for specific toxicants in situations where workers may receive significant exposures to these agents. For example, long-term exposure during cleanup of a polychlorinated biphenyls (PCB) waste facility can be monitored with pre-employment and periodic serum PCB testing [4]. Standard procedures are available for determining levels of other substances, e.g., lead, cadmium, arsenic, and organophosphate pesticides.
- Where applicable, pre-employment blood specimens and serum frozen for later testing. (PCBs and some pesticides are examples of agents amenable to such monitoring.)

Table 5-3. Tests Frequently Performed by Occupational Physicians

FUNCTION	TEST	EXAMPLE
Liver:		
General	Blood tests	Total protein, albumin, globulin, total bilirubin (direct bilirubin if total is elevated).
Obstruction	Enzyme test	Alkaline phosphatase.
Cell Injury	Enzyme tests	Gamma glutamyl transpeptidase (GGTP), lactic dehydrogenase (LDH), serum glutamic-oxaloacetic transaminase (SGOT), serum glutamic-pyruvic transaminase (SGPT).
Kidney:		
General	Blood tests	Blood urea nitrogen (BUN), creatinine, uric acid.
Multiple Systems and Organs	Urinalysis	Including color; appearance; specific gravity; pH; qualitative glucose, protein, bile, and acetone; occult blood; microscopic examination of centrifuged sediment.
Blood-Forming Function	Blood tests	Complete blood count (CBC) with differential and platelet evaluation, including white cell count (WBC), red blood count (RBC), hemoglobin (HGB), hematocrit or packed cell volume (HCT), and desired erythrocyte indices. Reticulocyte count may be appropriate if there is a likelihood of exposure to hemolytic chemicals.

Sample Pre-Employment Examination

Occupational and Medical History

- Do a complete medical history emphasizing these systems: nervous, skin, lung, blood-forming, cardiovascular, gastrointestinal, genitourinary, reproductive, ear, nose, and throat.

Physical Examination

Include at least the following:

- Height, weight, temperature, pulse, respiration, and blood pressure.
- Head, nose, and throat.
- Eyes. Include vision tests that measure refraction, depth perception, and color vision. These tests should be administered by a qualified technician or physician. Vision quality is essential to safety, the accurate reading of instruments and labels, the avoidance of physical hazards, and for appropriate response to color-coded labels and signals.
- Ears. Include audiometric tests, performed at 500, 1,000, 2,000, 3,000, 4,000, and 6,000 hertz (Hz) pure tone in an approved booth (see requirements listed in 29 CFR Part 1910.95, Appendix D). Tests should be administered by a qualified technician, and results read by a certified audiologist or a physician familiar with audiometric evaluation. The integrity of the eardrum should be established since perforated eardrums can provide a route of entry for chemicals into the body. The physician evaluating employees with perforated eardrums should consider the environmental conditions of the job and discuss possible specific safety controls with the Site Safety Officer, industrial hygienist, and/or other health professionals before deciding whether such individuals can safely work on site.
- Chest (heart and lungs).
- Peripheral vascular system.
- Abdomen and rectum (including hernia exam).
- Spine and other components of the musculoskeletal system.
- Genitourinary system.
- Skin.
- Nervous system.

Tests

- Blood.
- Urine.
- A 14 x 17-inch posterior/anterior view chest X-ray, with lateral or oblique views only if indicated or if mandated by state regulations. The X-ray should be taken by a certified radiology technician and interpreted by a board-certified or board-eligible radiologist. Chest X-rays taken in the last 12-month period, as well as the oldest chest X-ray available, should be obtained and used for comparison. Chest X-rays should not be repeated more than once a year, unless otherwise determined by the examining physician.

Ability to Perform While Wearing Protective Equipment

To determine a worker's capacity to perform while wearing protective equipment, additional tests may be necessary, for example:

- Pulmonary function testing. Measurement should include forced expiratory volume in 1 second (FEV_1), forced vital capacity (FVC), and FEV_1—to-FVC ratio, with interpretation and comparison to normal predicted values corrected for age, height, race, and sex. Other factors such as FEF, MEFR, MVV, FRC, RV, and TLC[1] may be included for additional information. A permanent record of flow curves should be placed in the worker's medical records. The tests should be conducted by a certified technician and the results interpreted by a physician.
- Electrocardiogram (EKG). At least one standard, 12-lead resting EKG should be performed at the discretion of the physician. A "stress test" (graded exercise) may be administered at the discretion of the examining physician, particularly where heat stress may occur.

Baseline Monitoring

If there is likelihood of potential onsite exposure to a particular toxicant, specific baseline monitoring should be performed to establish data relating to that toxicant.

Periodic Medical Examinations

Periodic Screening

Periodic medical examinations should be developed and used in conjunction with pre-employment screening examinations. Comparison of sequential medical reports with baseline data is essential to determine biologic trends that may mark early signs of adverse health effects, and thereby facilitate appropriate protective measures.

The frequency and content of examinations will vary, depending on the nature of the work and exposures. Generally, medical examinations have been recommended at least yearly. More frequent examinations may be necessary, depending on the extent of potential or actual exposure, the type of chemicals involved, the duration of the work assignment, and the individual worker's profile. For example, workers participating in the cleanup of a PCB-contaminated building were initially examined monthly for serum PCB levels. Review of the data from the first few months revealed no appreciable evidence of PCB exposure. The frequency of PCB testing was then reduced [4]. Periodic screening exams can include:

- Interval medical history, focusing on changes in health status, illnesses, and possible work-related symptoms. The examining physician should have information about the worker's interval exposure history, including exposure monitoring at the job site, supplemented by worker-reported exposure history and general information on possible exposures at previously worked sites.
- Physical examination.

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[1] FEF = forced expiratory flow; MEFR = maximal expiratory flow rate; MVV = maximal voluntary ventilation; FRC = functional residual capacity; RV = residual volume; TLC = total lung capacity.

- Additional medical testing, depending on available exposure information, medical history, and examination results. Testing should be specific for the possible medical effects of the worker's exposure. Multiple testing for a large range of potential exposures is not always useful; it may involve invasive procedures (e.g., tissue biopsy), be expensive, and may produce false-positive results.

  Pulmonary function tests should be administered if the individual uses a respirator, has been or may be exposed to irritating or toxic substances, or if the individual has breathing difficulties, especially when wearing a respirator.

  Audiometric tests. Annual retests are required for personnel subject to high noise exposures (an 8-hour, time-weighted average of 85 dBA[1] or more), those required to wear hearing protection, or as otherwise indicated.

  Vision tests. Annual retests are recommended to check for vision degradation.

  Blood and urine tests when indicated.

Sample Periodic Medical Examination

The basic periodic medical examination is the same as the pre-employment screening (see previous section, *Sample Pre-Employment Examination*), modified according to current conditions, such as changes in the worker's symptoms, site hazards, or exposures.

Termination Examination

At the end of employment at a hazardous waste site, all personnel should have a medical examination as described in the previous sections (see *Sample Pre-Employment Examination*). This examination may be limited to obtaining an interval medical history of the period since the last full examination (consisting of medical history, physical examination, and laboratory tests) if all three following conditions are met:

- The last full medical examination was within the last 6 months.
- No exposure occurred since the last examination.
- No symptoms associated with exposure occurred since the last examination.

If any of these criteria are not met, a full examination is medically necessary at the termination of employment.

Emergency Treatment

Provisions for emergency treatment and acute non-emergency treatment should be made at each site. Preplanning is vital.

When developing plans, procedures, and equipment lists, the range of actual and potential hazards specific to the site should be considered, including chemical, physical (such as heat and/or cold stress, falls and trips), and biologic hazards (animal bites and plant poisoning as well as hazardous biological wastes). Not only site workers, but also contractors, visitors, and other personnel (particularly firefighters) may require emergency treatment.

Emergency medical treatment should be integrated with the overall site emergency response program (see Chapter 12). The following are recommended guidelines for establishing an emergency treatment program.

- Train a team of site personnel in emergency first aid. This should include a Red Cross or equivalent certified course in cardiopulmonary resuscitation (CPR), and first-aid training that emphasizes treatment for explosion and burn injuries, heat stress, and acute chemical toxicity. In addition, this team should include an emergency medical technician (EMT) if possible. Table 5-4 lists signs and symptoms of exposure and heat stress that indicate potential medical emergencies.
- Train personnel in emergency decontamination procedures in coordination with the Emergency Response Plan (see Chapter 12 for details).
- Predesignate roles and responsibilities to be assumed by personnel in an emergency.
- Establish an emergency/first-aid station on site, capable of providing (1) stabilization for patients requiring offsite treatment, and (2) general first aid (e.g., minor cuts, sprains, abrasions).

  Locate the station in the clean area adjacent to the decontamination area to facilitate emergency decontamination.

  Provide a standard first-aid kit or equivalent supplies, plus additional items such as emergency/deluge showers, stretchers, portable water, ice, emergency eyewash, decontamination solutions, and fire-extinguishing blankets.

  Restock supplies and equipment immediately after each use and check them regularly.
- Arrange for a physician who can be paged on a 24-hour basis.
- Set up an on-call team of medical specialists for emergency consultations, e.g., a toxicologist, dermatologist, hematologist, allergist, opthalmologist, cardiologist, and neurologist.
- Establish a protocol for monitoring heat stress (see *Monitoring* section of Chapter 8).
- Make plans in advance for emergency transportation to, treatment at, and contamination control procedures for a nearby medical facility.

  Educate local emergency transport and hospital personnel about possible medical problems on site; types of hazards and their consequences; potential for exposure; scope and function of the site medical program.

  Assist the hospital in developing procedures for site-related emergencies. This will help to protect hospital personnel and patients, and to minimize delays due to concerns about hospital safety or contamination.

  For specific illnesses or injuries, provide details of the incident and the worker's past medical history to the appropriate hospital staff. This is especially crucial when specific medical treatment is required, e.g., for exposure to cyanide or organophosphate pesticides.

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[1] dBA = decibels on A-weighted scale (29 CFR Part 1910.95).

Table 5-4. Signs and Symptoms of Chemical Exposure and Heat Stress that Indicate Potential Medical Emergencies

TYPE OF HAZARD	SIGNS AND SYMPTOMS
Chemical Hazard	Behavioral changes Breathing difficulties Changes in complexion or skin color Coordination difficulties Coughing Dizziness Drooling Diarrhea Fatigue and/or weakness Irritability Irritation of eyes, nose, respiratory tract, skin, or throat Headache Light-headedness Nausea Sneezing Sweating Tearing Tightness in the chest
Heat Exhaustion	Clammy skin Confusion Dizziness Fainting Fatigue Heat rash Light-headedness Nausea Profuse sweating Slurred speech Weak pulse
Heat Stroke (may be fatal)	Confusion Convulsions Hot skin, high temperature (yet may feel chilled) Incoherent speech Convulsions Staggering gait Sweating stops (yet residual sweat may be present) Unconsciousness

Depending on the site's location and potential hazards, it may be important to identify additional medical facilities capable of sophisticated response to chemical or other exposures.

- Post conspicuously (with duplicates near the telephones) the names, phone numbers, addresses, and procedures for contacting:
  - On-call physicians.
  - Medical specialists.
  - Ambulance services.
  - Medical facility(ies).
  - Emergency, fire, and police services.
  - Poison control hotline.
- Provide maps and directions.
- Make sure at least all managers and all individuals involved in medical response know the way to the nearest emergency medical facility.
- Establish a radiocommunication system for emergency use.
- Review emergency procedures daily with all site personnel at safety meetings before beginning the work shift.

Non-Emergency Treatment

Arrangements should be made for non-emergency medical care for hazardous waste site workers who are experiencing health effects resulting from an exposure to hazardous substances. In conjunction with the medical surveillance program, offsite medical care should ensure that any potential job-related symptoms or illnesses are evaluated in the context of the worker's exposure. Offsite medical personnel should also investigate and treat non-job-related illnesses that may put the worker at risk because of task requirements (e.g., a bad cold or flu that might interfere with respirator use). A copy of the worker's medical records should be kept at the site (with provisions for security and confidentiality) and, when appropriate, at a nearby hospital. Treating physicians should have access to these records.

Medical Records

Proper recordkeeping is essential at hazardous waste sites because of the nature of the work and risks: employees may work at a large number of geographically separate sites during their careers, and adverse effects of long-term exposure may not become apparent for many years. Records enable subsequent medical care providers to be informed about workers' previous and current exposures.

Occupational Safety and Health Administration (OSHA) regulations mandate that, unless a specific occupational safety and health standard provides a different time period, the employer must:

- Maintain and preserve medical records on exposed workers for 30 years after they leave employment (29 CFR Part 1910.20).

- Make available to workers, their authorized representatives, and authorized OSHA representatives the results of medical testing and full medical records and analyses (29 CFR Part 1910.20).
- Maintain records of occupational injuries and illnesses and post a yearly summary report (29 CFR Part 1904).

Program Review

Regular evaluation of the medical program is important to ensure its effectiveness. Maintenance and review of medical records and test results aid medical personnel, site officers, and the parent company and/or agency managers in assessing the effectiveness of the health and safety program. The Site Safety Officer, medical consultant, and/or management representative should, at least annually:

- Ascertain that each accident or illness was promptly investigated to determine the cause and make necessary changes in health and safety procedures.
- Evaluate the efficacy of specific medical testing in the context of potential site exposures.
- Add or delete medical tests as suggested by current industrial hygiene and environmental data.
- Review potential exposures and Site Safety Plans at all sites to determine if additional testing is required.
- Review emergency treatment procedures and update lists of emergency contacts.

References

1. Proficiency Testing Programs

Division of Technology Evaluation and Assistance
Laboratory Program Office
Center for Disease Control
Atlanta, GA 30333

College of American Pathologists
7400 N. Skokie Blvd.
Skokie, IL 60077

American Association for Bioanalysts
205 W. Levee Street
Brownsville, TX 78520

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6. Site Characterization

Contents

Introduction

Site characterization provides the information needed to identify site hazards and to select worker protection methods. The more accurate, detailed, and comprehensive the information available about a site, the more the protective measures can be tailored to the actual hazards that workers may encounter.

The person with primary responsibility for site characterization and assessment is the Project Team Leader. In addition, outside experts, such as chemists, health physicists, industrial hygienists, and toxicologists, may be needed to accurately and fully interpret all the available information on site conditions.

Site characterization generally proceeds in three phases:

- Prior to site entry, conduct offsite characterization: gather information away from the site and conduct reconnaissance from the site perimeter.
- Next, conduct onsite surveys. During this phase, restrict site entry to reconnaissance personnel.
- Once the site has been determined safe for commencement of other activities, perform ongoing monitoring to provide a continuous source of information about site conditions.

It is important to recognize that site characterization is a continuous process. At each phase of site characterization, information should be obtained and evaluated to define the hazards that the site may pose. This assessment can then be used to develop a safety and health plan for the next phase of work. In addition to the formal information gathering that takes place during the phases of site characterization described here, all site personnel should be constantly alert for new information about site conditions.

The sections below detail the three phases of site characterization and provide a general guide which should be adapted to meet the specific situation. Within each phase of information gathering, the most appropriate sequence of steps should be determined, particularly if there are time or budget considerations that limit the scope of the work. Wherever possible, all information sources should be pursued.

Offsite Characterization

As much information as possible should be obtained *before* site entry so that the hazards can be evaluated and preliminary controls instituted to protect initial entry personnel. Initial information-gathering missions should focus on identifying all potential or suspected conditions that may pose inhalation hazards that are immediately dangerous to life or health (IDLH)[1] or other conditions that may cause death or serious harm (see Table 6-1).

Offsite information can be obtained by two methods: interview/records research and perimeter reconnaissance.

Table 6-1. Visible Indicators of Potential IDLH and Other Dangerous Conditions

- Large containers or tanks that must be entered.
- Enclosed spaces such as buildings or trenches that must be entered.
- Potentially explosive or flammable situations (indicated by bulging drums, effervescence, gas generation, or instrument readings).
- Extremely hazardous materials (such as cyanide, phosgene, or radiation sources).
- Visible vapor clouds.
- Areas where biological indicators (such as dead animals or vegetation) are located.

Interview/Records Research

As much data as possible should be collected before any personnel go on site. Where possible, the following information should be obtained:

- Exact location of the site.
- Detailed description of the activity that occurred at the site.
- Duration of the activity.
- Meteorologic data, e.g., current weather and forecast, prevailing wind direction, precipitation levels, temperature profiles.
- Terrain, e.g., historical and current site maps, site photographs, aerial photographs, U.S. Geological Survey topographic quadrangle maps, land use maps, and land cover maps.

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[1] IDLH conditions refer to inhalation hazards (see section on *IDLH Concentrations* later in this chapter).

- Geologic and hydrologic data.
- Habitation—population centers, population at risk.
- Accessibility by air and roads.
- Pathways of dispersion.
- Present status of response and who has responded.
- Hazardous substances involved and their chemical and physical properties. Information sources include:
  - Company records, receipts, logbooks, or ledgers.
  - Records from state and federal pollution control regulatory and enforcement agencies, state Attorney General's office, state occupational safety and health agencies, state Fire Marshal's office.
  - Waste storage inventories and manifests or shipping papers.
  - Interviews with personnel and their families (all interview information should be verified).
  - Generator and transporter records.
  - Water department and sewage district records.
  - Interviews with nearby residents (note possible site-related medical problems and verify all information from interviews).
  - Local fire and police department records.
  - Court records.
  - Utility company records.
  - Media reports (verify all information from the media).
- Previous surveying (including soil, ground-penetrating radar, and magnetometer surveys), sampling, and monitoring data.

Perimeter Reconnaissance

At a site in which the hazards are largely unknown or there is no need to go on site immediately, visual observations should be made, atmospheric concentrations of airborne pollutants at the site perimeter should be monitored (see Chapter 7, *Air Monitoring*), and samples should be collected near the site. While these data are not definitive indicators of onsite conditions, they can assist in the preliminary evaluation. Perimeter reconnaissance of a site should involve the following actions:

- Develop a preliminary site map, with the locations of buildings, containers, impoundments, pits, ponds, and tanks.
- Review historical and current aerial photographs. Note:
  - Disappearance of natural depressions, quarries, or pits.
  - Variation in reforestation of disturbed areas.
  - Mounding or uplift in disturbed areas or paved surfaces, or modifications in grade.
  - Changes in vegetation around buildings.
  - Changes in traffic patterns at the site.
- Note any labels, markings, or placards on containers or vehicles.
- Note the amount of deterioration or damage of containers or vehicles.
- Note any biologic indicators, such as dead animals or plants.
- Note any unusual conditions, such as clouds, discolored liquids, oil slicks, vapors, or other suspicious substances.
- Monitor the ambient air at the site perimeter (see Chapter 7, *Air Monitoring*) for:
  - Toxic substances.
  - Combustible and flammable gases or vapors.
  - Oxygen deficiency.
  - Ionizing radiation.
  - Specific materials, if known.
- Note any unusual odors.
- Collect and analyze offsite samples, including (see reference [1] for methods):
  - Soil.
  - Drinking water.
  - Ground water.
  - Site run-off.
  - Surface water.

Protection of Entry Personnel

The information from interview/records research and perimeter reconnaissance is used as the basis for selecting the protective equipment for the initial site survey. In addition, the proposed work to be accomplished must be considered. For example, if the purpose of the survey is to inspect onsite conditions, count containers, measure the ambient air for "hot spots" (i.e., areas with high concentrations of toxic chemicals), and generally become familiar with the site, the level of protection may be less stringent than if containers are to be opened and samples taken. (Chapter 8, *Personal Protective Equipment*, provides more detail on the selection of protective items.)

The ensemble of clothing and equipment referred to as Level B protection is generally the minimum level recommended for an initial entry until the site hazards have been further identified and the most appropriate protective clothing and equipment chosen. Level B equipment is described in Table 8-7, Chapter 8.

Onsite Survey

The purpose of an onsite survey is to verify and supplement information from the offsite characterization. Prior to going on site, the offsite characterization should be used to develop a Site Safety Plan for site entry that addresses the work to be accomplished and prescribes the procedures to protect the health and safety of the entry team. Priorities should be established for hazard assessment and site activities after careful evaluation of probable conditions. Because team members may be entering a largely unknown environment, caution and conservative actions are appropriate. The composition of the entry team depends on the site characteristics but should always consist of at least four persons: two workers who will enter the site and two outside support persons, suited in personal protective equipment and prepared to enter the site in case of emergency. Upon entering the site, entry personnel should:

- Monitor the air for IDLH and other conditions that may cause death or serious harm (combustible or

As part of site characterization, workers suited in Level A protective ensembles work in pairs when investigating confined spaces.

explosive atmospheres, oxygen deficiency, toxic substances). Chapter 7 provides detailed information on air monitoring.

- Monitor for ionizing radiation. Survey for gamma and beta radiation with a Geiger-Mueller detection tube or a gamma scintillation tube; if alpha radiation is expected, use a proportional counter.
- Visually observe for signs of actual or potential IDLH or other dangerous conditions (see Table 6-1).

Any indication of IDLH hazards or other dangerous conditions should be regarded as a sign to proceed with care and deliberation. *Extreme caution* should be exercised in continuing the site survey when such hazards are indicated. Table 6-2 provides some basic guidelines for decision-making. If IDLH or other dangerous conditions are not present, or if proper precautions can be taken, continue the survey:

- Conduct further air monitoring as necessary (see Chapter 7).
- Note the types of containers, impoundments, or other storage systems:

  Paper or wood packages.
  Metal or plastic barrels or drums.
  Underground tanks.
  Aboveground tanks.
  Compressed gas cylinders.
  Pits, ponds, or lagoons.
  Other.

- Note the condition of waste containers and storage systems:

  Sound (undamaged).
  Visibly rusted or corroded.
  Leaking.
  Bulging.
  Types and quantities of material in containers.
  Labels on containers indicating corrosive, explosive, flammable, radioactive, or toxic materials.

- Note the physical condition of the materials:

  Gas, liquid, or solid.
  Color and turbidity.
  Behavior, e.g., corroding, foaming, or vaporizing.
  Conditions conducive to splash or contact.

- Identify natural wind barriers:

  Buildings.
  Hills.
  Tanks.

- Determine the potential pathways of dispersion:

  Air.
  Biologic routes, such as animals and food chains.
  Ground water.
  Land surface.
  Surface water.

- If necessary, use one or more of the following remote sensing or subsurface investigative methods to locate buried wastes or contaminant plumes:

  Electromagnetic resistivity.
  Seismic refraction.
  Magnetometry.
  Metal detection.
  Ground-penetrating radar.

- Note any indicators of potential exposure to hazardous substances:

  Dead fish, animals or vegetation.
  Dust or spray in the air.
  Fissures or cracks in solid surfaces that expose deep waste layers.
  Pools of liquid.
  Foams or oils on liquid surfaces.
  Gas generation or effervescence.
  Deteriorating containers.
  Cleared land areas or possible landfilled areas.

- Note any safety hazards. Consider:

  Conditions of site structures.
  Obstacles to entry and exit.
  Terrain homogeneity.
  Terrain stability.
  Stability of stacked material.

- Identify any reactive, incompatible, flammable, or highly corrosive wastes.
- Note land features.
- Note the presence of any potential naturally occurring skin irritants or dermatitis-inducing agents, for example:

  Poison ivy.
  Poison oak.
  Poison sumac.

- Note any tags, labels, markings, or other identifying indicators.

Table 6-2. Guidelines for Some Atmospheric Hazards[a]

HAZARD[b]	MONITORING EQUIPMENT[c]	MEASURED LEVEL	ACTION
Explosive atmosphere	Combustible gas indicator	<10% LEL[d]	Continue investigation.
		10%-25% LEL	Continue onsite monitoring with extreme caution as higher levels are encountered.
		>25% LEL	Explosion hazard. Withdraw from area immediately.
Oxygen	Oxygen concentration meter	<19.5%	Monitor wearing self-contained breathing apparatus. NOTE: Combustible gas readings are not valid in atmospheres with <19.5% oxygen.
		19.5%-25%	Continue investigation with caution. Deviation from normal level may be due to the presence of other substances.
		>25%	Fire hazard potential. Discontinue investigation. Consult a fire safety specialist.
Radiation	Radiation survey equipment	≤2 mrem/hr[e,f]	Radiation above background levels (normally 0.01-0.02 mrem/hr)[g] signifies the possible presence of radiation sources. Continue investigation with caution. Perform thorough monitoring. Consult with a health physicist.
		>2 mrem/hr	Potential radiation hazard. Evacuate site. Continue investigation only upon the advice of a health physicist.
Inorganic and organic gases and vapors	Colorimetric tubes Chemical-specific instruments, including halide meter, hydrogen sulfide detector, carbon monoxide monitor, and mercury meter	Depends on chemical	Consult standard reference manuals for air concentration/toxicity data. Action level depends on PEL/REL/TLV.[h]
Organic gases and vapors	Portable photoionizer Organic vapor analyzer 1) Operated in gas chromatography (GC) mode 2) Operated in survey mode	Depends on chemical	Consult standard reference manuals for air concentration/toxicity data. Action level depends on PEL/REL/TLV.[h]

[a] Based on *Standard Operating Guides*. U.S EPA. December, 1984.

[b] These are general classes of hazards. Not all components of these classes can be measured.

[c] Consult manufacturers' literature for use limitations associated with the specific equipment and for the specific substances the equipment can detect. See Tables 7-1 and 7-2 for more complete descriptions.

[d] LEL = lower explosive limit.

[e] mrem/hr = milliroentgen equivalent in man per hour.

[f] Source: U.S. Nuclear Regulatory Commission Rules and Regulations, 10 CFR Chapter 1, Part 20.105.

[g] Source: Sax, I.N. 1979. Dangerous Properties of Industrial Materials. Fifth Edition. p. 167. Van Nostrand Reinhold Company, New York.

[h] PEL = OSHA permissible exposure limit.
REL = NIOSH recommended exposure limit.
TLV = threshold limit value.
See Table 6-4.

- Collect samples [1]:
  - Air (see Chapter 7, *Air Monitoring*).
  - Drainage ditches.
  - Soil (surface and subsurface).
  - Standing pools of liquids.
  - Storage containers.
  - Streams and ponds.
  - Ground water (upgradient, beneath site, downgradient).
- Sample for or otherwise identify:
  - Biologic or pathologic hazards.
  - Radiologic hazards.

Information Documentation

Proper documentation and document control are important for ensuring accurate communication; ensuring the quality of the data collected; providing the rationale for safety decisions; and substantiating possible legal actions. Documentation can be accomplished by recording information pertinent to field activities, sample analysis, and site conditions in one of several ways, including:

- Logbooks.
- Field data records.
- Graphs.
- Photographs.
- Sample labels.

- Chain-of-custody forms.
- Analytical records.

These documents should be controlled to ensure that they are all accounted for when the project is completed. The task of document control should be assigned to one individual on the project team and should include the following responsibilities:

- Numbering each document (including sample labels) with a unique number.
- Listing each document in a document inventory.
- Recording the whereabouts of each document in a separate document register so that any document can be readily located. In particular, the name and location of site personnel that have documents in their possession should be recorded.
- Collecting all documents at the end of each work period.
- Making sure that all document entries are made in waterproof ink.
- Filing all documents in a central file at the completion of the site response.

Field personnel should record all onsite activities and observations in a field logbook—a bound book with consecutively numbered pages. Entries should be made during or just after completing a task to ensure thoroughness and accuracy. Table 6-3 shows the level of detail that should be recorded during sampling.

Photographs can be an accurate, objective addition to a field worker's written observations. For each photograph taken, the following information should be recorded in the field logbook:

- Date, time, and name of site.
- Name of the photographer.
- Location of the subject within the site.
- General compass direction of the orientation of the photograph.
- General description of the subject.
- Sequential number of the photograph and the film roll number.
- Camera, lens, and film type used for photography.

Serially numbered sample labels or tags should be assigned to sampling team personnel and recorded in the field logbook. Lost, voided, or damaged labels should be noted in the logbook. Labels should be firmly affixed to the sample containers using either gummed labels or tags attached by string or wire. Information should be recorded on the tag in waterproof ink and should include items such as:

- The unique sample log number.
- Date and time that the sample was collected.
- Source of the sample, e.g., name, location, and type of sample.
- Preservative used.
- Analysis required.
- Name of collector.
- Pertinent field data.

Sample jars are labelled prior to sampling as part of site documentation procedures.

In addition to supporting litigation, written records of sample collection, transfer, storage, analysis, and destruction help ensure the proper interpretation of analytical test results. Information describing the chain of custody should be recorded on a form that accompanies the sample from collection to destruction.

Hazard Assessment

Once the presence and concentrations of specific chemicals or classes of chemicals have been established, the hazards associated with these chemicals must be determined. This is done by referring to standard reference sources for data and guidelines on permissible levels of exposure, flammability, etc. Some key guidelines are listed in Table 6-4 and are described below.

Threshold Limit Value (TLV)®

TLVs can be used as a guideline for determining the appropriate level of worker protection. These values have been derived for many substances and can be found in *Threshold Limit Values for Chemical Substances and Physical Agents*, which is published annually by the American Conference of Governmental Industrial Hygienists (ACGIH) [2]. The ACGIH defines three categories of TLVs: time-weighted average (TWA); short-term exposure limit (STEL); and ceiling (C). All three categories may be useful in selecting levels of protection at a hazardous waste site. Refer to the *Threshold Limit Values for Chemical Substances and Physical Agents* [2] for additional details.

Permissible Exposure Limit (PEL)

Permissible exposure limits are enforceable standards promulgated by OSHA. In many cases they are derived from TLVs published in 1968. The PEL for a substance is the 8-hour time-weighted average or ceiling concentration

Table 6-3. Example of Field Logbook Entries to Describe Sampling

- Date and time of entry.
- Purpose of sampling.
- Name, address, and affiliation of personnel performing sampling.
- Name and address of the material's producer, if known.
- Type of material, e.g., sludge or wastewater.
- Description of material container.
- Description of sample.
- Chemical components and concentrations, if known.
- Number and size of samples taken.
- Description and location of the sampling point.
- Date and time of sample collection.
- Difficulties experienced in obtaining sample (e.g., is it representative of the bulk material?).
- Visual references, such as maps or photographs of the sampling site.
- Field observations, such as weather conditions during sampling periods.
- Field measurements of the materials, e.g., explosiveness, flammability, or pH.
- Whether chain-of-custody forms have been filled out for the samples.

above which workers may not be exposed. Although personal protective equipment may not be required for exposures below the PEL, its use may be advisable where there is a potential for overexposure. See the tables and substance-specific standards in 29 CFR Part 1910, Subpart Z, for additional details.

Recommended Exposure Limit (REL)

A NIOSH recommended exposure limit (REL) is the workplace exposure concentration recommended by NIOSH for promulgation by OSHA as a PEL, but is not enforceable as is the OSHA PEL. In some cases, NIOSH has described time-weighted average concentrations in terms of 10-hour, rather than 8-hour, averages.

IDLH Concentrations

IDLH exposure concentrations have been established by the NIOSH/OSHA Standards Completion Program (SCP) as a guideline for selecting respirators for some chemicals. The definition of IDLH varies depending on the source. For example, the Mine Safety and Health Administration Standard (30 CFR Part 11.3[t]) defines IDLH conditions as those that pose an immediate threat to life or health or that pose an immediate threat of severe exposure to contaminants such as radioactive materials that are likely to have adverse cumulative or delayed effects on health. The NIOSH *Pocket Guide to Chemical Hazards* [3] defines IDLH concentration as the "...maximum level from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects...." The American National Standards Institute, Inc. (ANSI) defines IDLH as "...any atmosphere that poses an immediate hazard to life or produces immediate irreversible debilitating effects on health..." [4]. Regardless of their exact definition, all IDLH values indicate those concentrations of toxic substances from which escape is possible without irreversible harm should a worker's respiratory protective equipment fail. At hazardous waste sites, IDLH concentrations should be assumed to represent concentrations above which only workers wearing respirators that provide the maximum protection (i.e., a positive-pressure, full-facepiece, self-contained breathing apparatus [SCBA] or a combination positive-pressure, full-facepiece, supplied-air respirator with positive-pressure SCBA [see Chapter 8]) are permitted. Specific IDLH values for many substances can be found in the NIOSH *Pocket Guide to Chemical Hazards* [3].

Potential Skin Absorption and Irritation

Information on skin absorption is provided in the ACGIH publication, *Threshold Limit Values for Chemical Substances and Physical Agents* [2] and in OSHA standard 29 CFR Part 1910.1000 and other standard references. These documents identify substances that can be readily absorbed through the skin, mucous membranes, and/or eyes by either airborne exposure or direct contact with a liquid. This information, like most available information on skin absorption is qualitative. It indicates whether, but not to what extent, a substance may pose a dermal hazard. Thus decisions made concerning skin hazards are necessarily judgmental.

In addition, many chemicals, although not absorbed through the skin, may cause skin irritation at the point of contact. Signs of skin irritation range from redness, swelling, or itching to burns that destroy skin tissue. Standard references can be used to determine whether a chemical may act as an irritant.

Potential Eye Irritation

Quantitative data on eye irritation are not always available. Where a review of the literature indicates that a substance causes eye irritation, but no threshold is specified, have a competent health professional evaluate the data to determine the level of personal protection needed for onsite workers.

Explosion and Flammability Ranges

The lower explosive limit (LEL) or lower flammable limit (LFL) of a substance is the minimum concentration of gas or vapor in air below which the substance will not burn when exposed to a source of ignition. This concentration is usually expressed in percent by volume. Below this concentration, the mixture is too "lean" to burn or explode.

The upper explosive limit (UEL) or upper flammable limit (UFL) of a substance is the maximum concentration of gas or vapor above which the substance will not burn when exposed to a source of ignition. Above this concentration, the mixture is too "rich" to burn or explode.

The flammable range is the range of concentrations between the LFL and UFL where the gas-air mixture will support combustion.

The flashpoint of a substance is the minimum temperature at which it gives off sufficient vapor to form an ignitable mixture with the air just above the surface of the substance. Ignition of a substance at the flashpoint is not continuous.

Table 6-4. Guidelines for Assessing Chemical and Physical Hazards

HAZARD	GUIDELINE		EXPLANATION	SOURCES FOR VALUES[a]
Inhalation of airborne contaminants	TLV	Threshold Limit Value	One of three categories of chemical exposure levels, defined as follows:	
	TLV-TWA	Threshold Limit Value–Time-Weighted Average	The time-weighted average concentration for a normal 8-hour workday and a 40-hour work week, to which nearly all workers may be repeatedly exposed without adverse effect. Should be used as an exposure guide rather than an absolute threshold.	ACGIH
	TLV-STEL	Threshold Limit Value–Short-Term Exposure Limit	A 15-minute time-weighted average exposure that should not be exceeded at any time during the work day.	ACGIH
	TLV-C	Threshold Limit Value–Ceiling	The concentration that should not be exceeded even instantaneously.	ACGIH
	PEL	Permissible Exposure Limit	Time-weighted average and ceiling concentrations similar to (and in many cases derived from) the threshold limit values published in 1968.	OSHA
	REL	Recommended Exposure Limit	Time-weighted averages and ceiling concentrations based on NIOSH evaluations.	NIOSH
	IDLH	Immediately Dangerous to Life or Health	The maximum level from which a worker could escape without any escape-impairing symptoms or any irreversible health effects.[b]	NIOSH
Dermal absorption of chemicals through airborne or direct contact	Designation "skin"		The designation "skin" in the ACGIH, OSHA, and NIOSH references[a] indicates that a substance may be readily absorbed through the intact skin; however, it is not a threshold for safe exposure. Direct contact with a substance designated "skin" should be avoided.	ACGIH/ OSHA/ NIOSH
Dermal irritation			Many substances irritate the skin. Consult standard references.	
Carcinogens	TLV	Threshold Limit Value	Some carcinogens have an assigned TLV.	ACGIH
	PEL	Permissible Exposure Limit	OSHA has individual standards for some specific carcinogens.	OSHA
	REL	Recommended Exposure Limit	NIOSH makes recommendations regarding exposures to carcinogens.	NIOSH
Noise	TLV	Threshold Limit Value	Sound pressure levels and durations of exposure that represent conditions to which it is believed that nearly all workers may be repeatedly exposed without an adverse effect on their ability to hear and understand normal speech.	ACGIH
	PEL	Permissible Exposure Limit	Limits for acceptable noise exposure.	OSHA
	REL	Recommended Exposure Limit	Limits for acceptable noise exposure.	NIOSH
Ionizing Radiation	Maximum permissible body burden and maximum permissible concentrations of radionuclides in air and in water.			NCRP
	PEL	Permissible Exposure Limit	Dose in rems per calendar quarter.	OSHA

The ignition temperature or autoignition temperature is the minimum temperature required to initiate or cause self-sustained combustion without an ignition source.

When evaluating the fire or explosion potential at a hazardous waste site, all equipment used should be intrinsically safe or explosion-proof. Where flammable or explosive atmospheres are detected, ventilation may dilute the mixture to below the LEL/LFL. However, ventilation is generally not recommended if concentrations exceed the UFL/UEL, since the mixture will pass through the flammable/explosive range as it is diluted. Note that combustible gas indicator readings may not be accurate when oxygen concentrations are less than 19.5 percent.

Hazardous Substance Information Form

Information on the chemical, physical, and toxicologic properties of each compound known or expected to occur on site should be recorded on a Hazardous Substance Information Form (see Appendix C). Response personnel will then have the necessary health and safety information in one place, and new personnel can be quickly briefed. As many reference sources as possible should be used to fill out the sheets because the information may vary from one source to another. Material Safety Data Sheets provided by chemical manufacturers are one source for this information.

Table 6-4. (cont.)

HAZARD	GUIDELINE		EXPLANATION	SOURCES FOR VALUES[a]
Explosion	LEL	Lower Explosive Limit	The minimum concentration of vapor in air below which propagation of a flame will not occur in the presence of an ignition source.	NFPA
	UEL	Upper Explosive Limit	The maximum concentration of a vapor in air above which propagation of a flame will not occur in the presence of an ignition source.	NFPA
Fire	Flash point		The lowest temperature at which the vapor of a combustible liquid can be made to ignite momentarily in air.	NFPA

[a] Sources:

ACGIH. 1984-85. Threshold Limit Values for Chemical Substances and Physical Agents in the Workplace Environment and Biological Exposure Indices with Intended Changes for 1985-86. American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

NIOSH. Centers for Disease Control. 1983. NIOSH Recommendations for Occupational Health Standards. Morbidity and Mortality Weekly Report Supplement. Vol. 32, No. 1S, October 7, 1983.

NIOSH. 1985. Pocket Guide to Chemical Hazards. National Institute for Occupational Safety and Health, Cincinnati, Ohio.

NCRP. Basic Radiation Protection Criteria. NCRP Report No. 39. National Council on Radiation Protection and Measurements, Washington, D.C.

NCRP. Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and Water for Occupational Exposure. NCRP Report No. 22. National Council on Radiation Protection and Measurements, Washington, D.C.

NFPA. 1985. Fire Protection Guide on Hazardous Materials. Eighth Edition. National Fire Protection Association, Boston, Massachusetts.

OSHA. 29 CFR Part 1910. (OSHA standards are legally binding.)

[b] Other sources have slightly different definitions of IDLH (see *IDLH Concentrations* in this chapter).

Monitoring

Because site activities and weather conditions change, an ongoing air monitoring program should be implemented after characterization has determined that the site is safe for the commencement of operations.

The ongoing monitoring of atmospheric chemical hazards should be conducted using a combination of stationary sampling equipment, personnel monitoring devices, and periodic area monitoring with direct-reading instruments (see Chapter 7, *Air Monitoring*). Data obtained during offsite and onsite surveys can be used to develop a plan that details the procedures to be used for monitoring ambient conditions during cleanup operations. Where necessary, routes of exposure other than inhalation should be monitored. For example, skin swipe tests may be used to determine the effectiveness of personal protective clothing (see Chapter 10, *Decontamination*). Depending on the physical properties and toxicity of the onsite materials, community exposures resulting from hazardous waste site operations may need to be assessed [5].

Monitoring also includes continual evaluation of any changes in site conditions or work activities that could affect worker safety. When a significant change occurs, the hazards should be reassessed. Some indicators of the need for reassessment are:

- Commencement of a new work phase, such as the start of drum sampling.
- Change in job tasks during a work phase.
- Change of season.
- Change in weather.
- Change in ambient levels of contaminants.

References

1. U.S. EPA. 1984. Characterization of Hazardous Waste Sites—A Methods Manual: Volume II. Available Sampling Methods. Second edition. EPA 600/4-84-076.

2. ACGIH. 1984-85. Threshold Limit Values for Chemical Substances and Physical Agents in the Workplace Environment and Biological Exposure Indices with Intended Changes for 1985-86. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

3. NIOSH. 1985. Pocket Guide to Chemical Hazards. National Institute for Occupational Safety and Health, Cincinnati, OH.

4. ANSI. 1980. Practices for Respiratory Protection. ANSI Z88.2-1980. American National Standards Institute, 1430 Broadway, New York, NY 10018.

5. U.S. Department of Health and Human Services. 1984. A System for Prevention, Assessment and Control of Exposures and Health Effects from Hazardous Sites (S.P.A.C.E. for Health), U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, Atlanta, GA.

7. Air Monitoring

Contents

Introduction

Airborne contaminants can present a significant threat to worker health and safety. Thus, identification and quantification of these contaminants through air monitoring is an essential component of a health and safety program at a hazardous waste site. Reliable measurements of airborne contaminants are useful for:

- Selecting personal protective equipment.
- Delineating areas where protection is needed.
- Assessing the potential health effects of exposure.
- Determining the need for specific medical monitoring.

This chapter delineates the factors to consider when conducting air monitoring at a hazardous waste site. It presents strategies for assessing airborne contamination at hazardous waste sites and describes instruments and methods for measuring exposures.

Measuring Instruments

The purpose of air monitoring is to identify and quantify airborne contaminants in order to determine the level of worker protection needed. Initial screening for identification is often qualitative, i.e., the contaminant, or the class to which it belongs, is demonstrated to be present but the determination of its concentration (quantification) must await subsequent testing. Two principal approaches are available for identifying and/or quantifying airborne contaminants:

- The onsite use of direct-reading instruments.
- Laboratory analysis of air samples obtained by gas sampling bag, filter, sorbent, or wet-contaminant collection methods.

Direct-Reading Instruments

Direct-reading instruments were developed as early warning devices for use in industrial settings, where a leak or an accident could release a high concentration of a known chemical into the ambient atmosphere. Today, some direct-reading instruments can detect contaminants in concentrations down to one part contaminant per million parts of air (ppm), although quantitative data are difficult to obtain when multiple contaminants are present. Unlike air sampling devices, which are used to collect samples for subsequent analysis in a laboratory, direct-reading instruments provide information at the time of sampling, enabling rapid decision-making.

Direct-reading instruments may be used to rapidly detect flammable or explosive atmospheres, oxygen deficiency, certain gases and vapors, and ionizing radiation. They are the primary tools of initial site characterization. The information provided by direct-reading instruments can be used to institute appropriate protective measures (e.g., personal protective equipment, evacuation), to determine the most appropriate equipment for further monitoring, and to develop optimum sampling and analytical protocols.

All direct-reading instruments have inherent constraints in their ability to detect hazards:

- They usually detect and/or measure only specific classes of chemicals.
- Generally, they are not designed to measure and/or detect airborne concentrations below 1 ppm.
- Many of the direct-reading instruments that have been designed to detect one particular substance also detect other substances (interference) and, consequently, may give false readings.

It is imperative that direct-reading instruments be operated, and their data interpreted, by qualified individuals who are thoroughly familiar with the particular device's operating principles and limitations and who have obtained the device's latest operating instructions and calibration curves. At hazardous waste sites, where unknown and multiple contaminants are the rule rather than the exception, instrument readings should be interpreted conservatively. The following guidelines may facilitate accurate recording and interpretation:

- Calibrate instruments according to the manufacturer's instructions before and after every use.
- Develop chemical response curves if these are not provided by the instrument manufacturer.
- Remember that the instrument's readings have limited value where contaminants are unknown. When recording readings of unknown contaminants, report them as "needle deflection" or "positive instrument response" rather than specific concentrations (i.e., ppm). Conduct additional monitoring at any location where a positive response occurs.
- A reading of zero should be reported as "no instrument response" rather than "clean" because quantities of chemicals may be present that are not detectable by the instrument.
- The survey should be repeated with several detection systems to maximize the number of chemicals detected.

Tables 7-1 and 7-2 list several direct-reading instruments and the conditions and/or substances they measure. The flame ionization detector (FID) and the photoionization

Table 7-1. Some Direct-Reading Instruments for General Survey

INSTRUMENT	HAZARD MONITORED	APPLICATION	DETECTION METHOD	LIMITATIONS	EASE OF OPERATION	GENERAL CARE AND MAINTENANCE	TYPICAL OPERATING TIMES
Combustible Gas Indicator (CGI)	Combustible gases and vapors.	Measures the concentration of a combustible gas or vapor.	A filament, usually made of platinum, is heated by burning the combustible gas or vapor. The increase in heat is measured.	Accuracy depends, in part, on the difference between the calibration and sampling temperatures. Sensitivity is a function of the differences in the chemical and physical properties between the calibration gas and the gas being sampled. The filament can be damaged by certain compounds such as silicones, halides, tetraethyl lead, and oxygen-enriched atmospheres. Does not provide a valid reading under oxygen-deficient conditions.	Effective use requires that operator understand the operating principles and procedures.	Recharge or replace battery. Calibrate immediately before use.	Can be used for as long as the battery lasts, or for the recommended interval between calibrations, whichever is less.
Flame Ionization Detector (FID) with Gas Chromatography Option	Many organic gases and vapors.	In survey mode, detects the total concentrations of many organic gases and vapors. In gas chromatography (GC) mode, identifies and measures specific compounds. In survey mode, all the organic compounds are ionized and detected at the same time. In GC mode, volatile species are separated.	Gases and vapors are ionized in a flame. A current is produced in proportion to the number of carbon atoms present.	Does not detect inorganic gases and vapors, or some synthetics. Sensitivity depends on the compound. Should not be used at temperatures less than 40°F (4°C). Difficult to absolutely identify compounds. High concentrations of contaminants or oxygen-deficient atmospheres require system modification. In survey mode, readings can be only reported relative to the calibration standard used.	Requires experience to interpret data correctly, especially in the GC mode. Specific identification requires calibration with the specific analyte of interest.	Recharge or replace battery. Monitor fuel and/or combustion air supply gauges. Perform routine maintenance as described in the manual. Check for leaks.	8 hours; 3 hours with strip chart recorder.
Gamma Radiation Survey Instrument	Gamma radiation.	Environmental radiation monitor.	Scintillation detector.	Does not measure alpha or beta radiation.	Extremely easy to operate, but requires experience to interpret data. Rugged, good in field use.	Must be calibrated annually at a specialized facility.	Can be used for as long as the battery lasts, or for the recommended interval between calibrations, whichever is less.

Table 7-1. (cont.)

INSTRUMENT	HAZARD MONITORED	APPLICATION	DETECTION METHOD	LIMITATIONS	EASE OF OPERATION	GENERAL CARE AND MAINTENANCE	TYPICAL OPERATING TIMES
Portable Infrared (IR) Spectrophotometer	Many gases and vapors.	Measures concentration of many gases and vapors in air. Designed to quantify one- or two-component mixtures.	Passes different frequencies of IR through the sample. The frequencies adsorbed are specific for each compound.	In the field, must make repeated passes to achieve reliable results. Requires 115-volt AC power. Not approved for use in a potentially flammable or explosive atmosphere. Interference by water vapor and carbon dioxide. Certain vapors and high moisture may attack the instrument's optics, which must then be replaced.	Requires personnel with extensive experience in IR spectrophotometry.	As specified by manufacturer.	
Ultraviolet (UV) Photoionization Detector (PID)	Many organic and some inorganic gases and vapors.	Detects total concentrations of many organic and some inorganic gases and vapors. Some identification of compounds is possible if more than one probe is used.	Ionizes molecules using UV radiation; produces a current that is proportional to the number of ions.	Does not detect methane. Does not detect a compound if the probe used has a lower energy level than the compound's ionization potential. Response may change when gases are mixed. Other voltage sources may interfere with measurements. Readings can only be reported relative to the calibration standard used. Response is affected by high humidity.	Effective use requires that the operator understand the operating principles and procedures, and be competent in calibrating, reading, and interpreting the instrument.	Recharge or replace battery. Regularly clean lamp window. Regularly clean and maintain the instrument and accessories.	10 hours; 5 hours with strip chart recorder.

detector (PID) (see Table 7-1) are commonly used at hazardous waste sites. However, some of these devices may not detect some particularly toxic agents, including hydrogen cyanide and hydrogen sulfide. Thus, these devices must be supplemented with other methods of detection.

Laboratory Analysis

Direct-reading personal monitors are available for only a few specific substances and are rarely sensitive enough to measure the minute (i.e., parts of contaminant per billion parts of air) quantities of contaminants which may, nevertheless, induce health changes. Thus to detect relatively low-level concentrations of contaminants, long-term or "full-shift" personal air samples must be analyzed in a laboratory. Full-shift air samples for some chemicals may be collected with passive dosimeters, or by means of a pump which draws air through a filter or sorbent. Table 7-3 lists some sampling and analytical techniques used at hazardous waste sites.

Selection of the appropriate sampling media largely depends on the physical state of the contaminants. For example, chemicals such as PCBs (polychlorinated biphenyls) and PNAs (polynuclear aromatic hydrocarbons) occur as both vapors and particulate-bound contaminants. A dual-media system is needed to measure both

Table 7-2. Some Direct-Reading Instruments for Specific Survey

INSTRUMENT	HAZARD MONITORED	APPLICATION	DETECTION METHOD	LIMITATIONS	EASE OF OPERATION	GENERAL CARE AND MAINTENANCE	TYPICAL OPERATING TIMES
Direct-Reading Colorimetric Indicator Tube	Specific gases and vapors.	Measures concentrations of specific gases and vapors.	The compound reacts with the indicator chemical in the tube, producing a stain whose length or color change is proportional to the compound's concentration.	The measured concentration of the same compound may vary among different manufacturers' tubes. Many similar chemicals interfere. Greatest sources of error are (1) how the operator judges stain's end-point, and (2) the tube's limited accuracy. Affected by high humidity.	Minimal operator training and expertise required.	Do *not* use a previously opened tube even if the indicator chemical is not stained. Check pump for leaks before and after use. Refrigerate prior to use to maintain shelf life of about 2 years. Check expiration date of tubes. Calibrate pump volume at least quarterly. Avoid rough handling which may cause channeling.	
Oxygen Meter	Oxygen (O_2).	Measures the percentage of O_2 in air.	Uses an electrochemical sensor to measure the partial pressure of O_2 in the air and converts that reading to O_2 concentration.	Must be calibrated prior to use to compensate for altitude and barometric pressure. Certain gases, especially oxidants such as ozone, can affect readings. Carbon dioxide (CO_2) poisons the detector cell.	Effective use requires that the operator understand the operating principles and procedures.	Replace detector cell according to manufacturer's recommendations. Recharge or replace batteries prior to expiration of the specified interval. If the ambient air is more than 0.5% CO_2, replace or rejuvenate the O_2 detector cell frequently.	8 to 12 hours.

forms of these substances. The volatile component is collected on a solid adsorbent and the nonvolatile component is collected on a filter. More than two dozen dual-media sampling techniques have been evaluated by NIOSH [1,2].

A major disadvantage of long-term air monitoring is the time required to obtain data. The time lag between sampling and obtaining the analysis results may be a matter of hours, if an onsite laboratory is available, or days, weeks, even months, if a remote laboratory is involved. This can be a significant problem if the situation requires immediate decisions concerning worker safety. Also, by the time samples are returned from a remote laboratory, the hazardous waste site cleanup may have progressed to a different stage or to a location at which different contaminants or different concentrations may exist. Careful planning and/or the use of a mobile laboratory on site may alleviate these problems.

Mobile laboratories may be brought on site to classify hazardous wastes for disposal. A mobile laboratory is generally a trailer truck that houses analytical instruments capable of rapidly classifying contaminants by a variety of techniques. Typical instruments include gas chromatographs, spectrofluorometers, and infrared spectrophotometers. When not in use in the mobile laboratory, these devices can be relocated to fixed-base facilities. Onsite laboratory facilities and practices should meet standards of good laboratory safety.

Usually, a few of the field samples collected are analyzed on site to provide rapid estimates of the concentration of airborne contaminants. These data can be used to determine the initial level of worker personal protection necessary to modify field sampling procedures and to guide the fixed-base laboratory analysis. If necessary, samples screened in the mobile laboratory can be subsequently reanalyzed in sophisticated fixed-base laboratories. The mobile laboratory also provides storage space, countertop staging areas for industrial hygiene equipment, and facilities for recharging self-contained breathing apparatus.

Site Monitoring

Priorities for air monitoring should be based on the information gathered during initial site characterization (see

Table 7-3. Some Sample Collection and Analytical Methods

SUBSTANCE	COLLECTION DEVICE[a]	ANALYTICAL METHOD[b]	TYPICAL DETECTION LIMIT OF ANALYTIC INSTRUMENT (µg)
Anions:	Prewashed silica gel tube	Ion chromatography	
Bromide			10
Chloride			5
Fluoride			5
Nitrate			10
Phosphate			20
Sulfate			10
Aliphatic Amines	Silica gel	GC/NPD	10
Asbestos	MCEF	PCM	100[c]
Metals	MCEF	ICP-AES	0.5
Organics	Charcoal tube	GC/MS	10
Nitrosamines	Thermosorb/N	GC/TEA	0.01
Particulates	MCEF	Gravimetric	
PCBs	GF filter and florisil tube	GC-ECD	0.001
Pesticides	13-mm GF filter and chromosorb 102 Tube	GC/MS	0.05

[a] MCEF = mixed cellulose ester filter.
GF = glass fiber filter.

[b] GC/NPD = gas chromatography and nitrogen/phosphorus detector; PCM = phase contrast microscopy; ICP-AES = inductively coupled plasma atomic emission spectrometry; GM/MS = gas chromatography and mass spectrometry; GC/TEA = gas chromatography using a thermal energy analyzer; GC-ECD = gas chromatography using an electrical conductivity detector.

[c] Units in fibers per mm² of filter (Method No. 7400 from the NIOSH Manual of Analytical Methods. 3rd edition).

Chapter 6). This information serves as the basis for selecting the appropriate monitoring equipment and personal protective equipment (PPE) to use when conducting site monitoring. Depending on site conditions and project goals, four categories of site monitoring may be necessary: monitoring for IDLH and other dangerous conditions, general onsite monitoring, perimeter monitoring, and periodic monitoring.

Monitoring for IDLH and Other Dangerous Conditions

As a first step, air monitoring should be conducted to identify any IDLH and other dangerous conditions, such as flammable or explosive atmospheres, oxygen-deficient environments, and highly toxic levels of airborne contaminants. Direct-reading monitoring instruments will normally include combustible gas indicators, oxygen meters, colorimetric indicator tubes, and organic vapor monitors. Other monitoring instruments may be necessary based on the initial site characterization. When time permits, air samples should be collected for laboratory analysis. Extreme caution should be exercised in continuing a site survey when atmospheric hazards are indicated. Monitoring personnel should be aware that conditions can suddenly change from nonhazardous to hazardous.

Acutely hazardous concentrations of chemicals may persist in confined and low-lying spaces for long periods of time. Look for any natural or artificial barriers, such as hills, tall buildings, or tanks, behind which air might be still, allowing concentrations to build up. Examine any confined spaces such as cargo holds, mine shafts, silos, storage tanks, box cars, buildings, bulk tanks, and sumps where chemical exposures capable of causing acute health effects are likely to accumulate. Low-lying areas, such as hollows and trenches, are also suspect. Monitor these spaces for IDLH and other dangerous conditions. Also consider whether the suspected contaminants are lighter or heavier than air. Then, based on the type of contaminants present, consider sampling on hilltops, under any cover or canopy where workers might work or congregate, and in trenches and low-lying areas.

In open spaces, toxic materials tend to be emitted into the atmosphere, transported away from the source, and dispersed. Thus acutely hazardous conditions are not likely to persist in open spaces for extended periods of time unless there is a very large (and hence, readily identifiable) source, such as an overturned tankcar. Open spaces are therefore generally given a lower monitoring priority.

General Onsite Monitoring

Air sampling should be conducted using a variety of media to identify the major classes of airborne contaminants and their concentrations. The following sampling pattern can be used as a guideline. First, after visually identifying the sources of possible generation, collect air samples downwind from the designated source along the axis of the wind direction. Work upwind, until reaching or getting as close as possible to the source. Level B protection (see Table 8-6 in Chapter 8) should be worn during this initial sampling. Levels of protection for subsequent sampling should be based upon the results obtained and the potential for an unexpected release of chemicals.

After reaching the source, or finding the highest concentration, sample cross-axis of the wind direction to determine the degree of dispersion. Smoke plumes, or plumes of instrument-detectable airborne substances, may be released as an aid in this assessment. To ensure that there is no background interference and that the detected substance(s) are originating at the identified source, also collect air samples upwind of the source.

Perimeter Monitoring

Fixed-location monitoring at the "fenceline" or perimeter, where personal protective equipment is no longer required, measures contaminant migration away from the site and enables the Site Safety Officer to evaluate the integrity of the site's clean areas. Since the fixed-location samples may reflect exposures either upwind or downwind from the site, wind speed and direction data are needed to interpret the sample results.

Periodic Monitoring

Site conditions and thus atmospheric chemical conditions may change following the initial characterization. For this reason, monitoring should be repeated periodically, especially when:

- Work begins on a different portion of the site.
- Different contaminants are being handled.
- A markedly different type of operation is initiated (e.g., barrel opening as opposed to exploratory well drilling).
- Workers are handling leaking drums or working in areas with obvious liquid contamination (e.g., a spill or lagoon).

Personal Monitoring

The selective monitoring of high-risk workers, i.e., those who are closest to the source of contaminant generation, is highly recommended. This approach is based on the rationale that the probability of significant exposure varies directly with distance from the source. If workers closest to the source are not significantly exposed, then all other workers are, presumably, also not significantly exposed and probably do not need to be monitored.

Since occupational exposures are linked closely with active material handling, personal air sampling should not be necessary until site mitigation has begun. Personal monitoring samples should be collected in the breathing zone and, if workers are wearing respiratory protective equipment, outside the facepiece. These samples represent the actual inhalation exposure of workers who are not wearing respiratory protection and the potential exposure of workers who are wearing respirators. It is best to use pumps that automatically maintain a constant flow rate to collect samples, since it is difficult to observe and adjust pumps while wearing gloves, respirators, and other personal protective equipment. Pumps should be protected with disposable coverings, such as small plastic bags, to make decontamination procedures easier.

Personal monitoring may require the use of a variety of sampling media. Unfortunately, single workers cannot carry multiple sampling media because of the added strain and because it is not usually possible to draw air through different sampling media using a single portable, battery-operated pump. Consequently, several days may be required to measure the exposure of a specific individual using each of the media [3,4]. Alternatively, if workers are in teams, a different monitoring device can be assigned to each team member. Another method is to place multiple sampling devices on pieces of heavy equipment. While these are not personal samples, they can be collected very close to the breathing zone of the heavy equipment operator and thus would be reasonably representative of personal exposure. These multimedia samples can yield as much information as several personal samples [5].

When considering employee monitoring, procedures and protocols found in OSHA's *Industrial Hygiene Technical Manual* may be useful [6].

Variables of Hazardous Waste Site Exposure

Complex, multisubstance environments such as those associated with hazardous waste sites pose significant challenges to accurately and safely assessing airborne contaminants. Several independent and uncontrollable variables, most notably temperature and weather conditions, can affect airborne concentrations. These factors must be considered when developing an air monitoring program and when analyzing data. Some demonstrated variables include:

- Temperature. An increase in temperature increases the vapor pressure of most chemicals.
- Windspeed. An increase in wind speed can affect vapor concentrations near a free-standing liquid surface. Dusts and particulate-bound contaminants are also affected.
- Rainfall. Water from rainfall can essentially cap or plug vapor emission routes from open or closed containers, saturated soil, or lagoons, thereby reducing airborne emissions of certain substances.
- Moisture. Dusts, including finely divided hazardous solids, are highly sensitive to moisture content. This moisture content can vary significantly with respect to location and time and can also affect the accuracy of many sampling results.
- Vapor emissions. The physical displacement of saturated vapors can produce short-term, relatively high vapor concentrations. Continuing evaporation and/or diffusion may produce long-term low vapor concentrations and may involve large areas.
- Work activities. Work activities often require the mechanical disturbance of contaminated materials, which may change the concentration and composition of airborne contaminants.

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8. Personal Protective Equipment (PPE)

Contents

Introduction

Anyone entering a hazardous waste site must be protected against potential hazards. The purpose of personal protective clothing and equipment (PPE)[1] is to shield or isolate individuals from the chemical, physical, and biologic hazards that may be encountered at a hazardous waste site. Careful selection and use of adequate PPE should protect the respiratory system, skin, eyes, face, hands, feet, head, body, and hearing. This chapter describes the various types of PPE that are appropriate for use at hazardous waste sites, and provides guidance in their selection and use. The final section discusses heat stress and other key physiological factors that must be considered in connection with PPE use.

Use of PPE is required by Occupational Safety and Health Administration (OSHA) regulations in 29 CFR Part 1910 (see Table 8-1) and reinforced by U.S. Environmental Protection Agency (EPA) regulations in 40 CFR Part 300 which include requirements for all private contractors working on Superfund sites to conform to applicable OSHA provisions and any other federal or state safety requirements deemed necessary by the lead agency overseeing the activities.

No single combination of protective equipment and clothing is capable of protecting against all hazards. Thus PPE should be used in conjunction with other protective methods. The use of PPE can itself create significant worker hazards, such as heat stress, physical and psychological stress, and impaired vision, mobility, and communication. In general, the greater the level of PPE protection, the greater are the associated risks. For any given situation, equipment and clothing should be selected that provide an adequate level of protection. Over-protection as well as under-protection can be hazardous and should be avoided.

Developing a PPE Program

A written PPE program should be established for work at all hazardous waste sites. (OSHA requires a written program for selection and use of respirators [29 CFR Part 1910.134].) Some of the relevant regulations, listed in Table 8-1, are cited throughout the text. The word "shall" is used only when the procedure is mandated by law.

The two basic objectives of any PPE program should be to protect the wearer from safety and health hazards, and to prevent injury to the wearer from incorrect use and/or malfunction of the PPE. To accomplish these goals, a comprehensive PPE program should include hazard identification; medical monitoring; environmental surveillance; selection, use, maintenance, and decontamination of PPE; and training. These subjects are discussed in this chapter and in Chapters 2, 4, 5, 6, 7, and 10.

The written PPE program should include policy statements, procedures, and guidelines. Copies should be made available to all employees, and a reference copy should be available at each work site. Technical data on equipment, maintenance manuals, relevant regulations, and other essential information should also be made available.

Program Review and Evaluation

The PPE program should be reviewed at least annually. Elements which should be considered in the review include:

- A survey of each site to ensure compliance with regulations applicable to the specific site involved.
- The number of person-hours that workers wear various protective ensembles.
- Accident and illness experience.
- Levels of exposure.
- Adequacy of equipment selection.
- Adequacy of the operational guidelines.

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[1] The term PPE is used in this manual to refer to both personal protective clothing and equipment.

Table 8-1. OSHA Standards for Use of PPE

TYPE OF PROTECTION	REGULATION	SOURCE
General	29 CFR Part 1910.132	41 CFR Part 50-204.7 General Requirements for Personal Protective Equipment.
	29 CFR Part 1910.1000	41 CFR Part 50-204.50, except for Table Z-2, the source of which is American National Standards Institute, Z37 series[a].
	29 CFR Part 1910.1001-1045	OSHA Rulemaking.
Eye and Face	29 CFR Part 1910.133(a)	ANSI Z87.1-1968[a] Eye and Face Protection.
Noise Exposure	29 CFR Part 1910.95	41 CFR Part 50-204.10 and OSHA Rulemaking.
Respiratory	29 CFR Part 1910.134	ANSI Z88.2-1969[a] Standard Practice for Respiratory Protection.
Head	29 CFR Part 1910.135	ANSI Z89.1-1969[a] Safety Requirements for Industrial Head Protection.
Foot	29 CFR Part 1910.136	ANSI Z41.1-1967[a] Men's Safety Toe Footwear.
Electrical Protective Devices	29 CFR Part 1910.137	ANSI Z9.4-1968. Ventilation and Safe Practices of Abrasive Blasting Operations.

[a] American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018. ANSI regularly updates its standards. The ANSI standards in this table are those that OSHA adopted in 1971. Since the ANSI standards which were then adopted had been set in 1967-1969, those standards, now required under OSHA, may be less stringent than the most recent ANSI standards.

- Adequacy of decontamination, cleaning, inspection, maintenance, and storage programs.
- Adequacy and effectiveness of training and fitting programs.
- Coordination with overall safety and health program elements.
- The degree of fulfillment of program objectives.
- The adequacy of program records.
- Recommendations for program improvement and modification.
- Program costs.

The results of the program evaluation should be made available to employees and presented to top management so that program adaptations may be implemented.

Selection of Respiratory Equipment

Respiratory protection is of primary importance since inhalation is one of the major routes of exposure to chemical toxicants. Respiratory protective devices (respirators) consist of a facepiece connected to either an air source or an air-purifying device. Respirators with an air source are called atmosphere-supplying respirators (Figure 8-1) and consist of two types:

- *Self-contained breathing apparatus (SCBAs)* which supply air from a source carried by the user.
- *Supplied-air respirators (SARs)* which supply air from a source located some distance away and connected to the user by an air-line hose. Supplied-air respirators are sometimes referred to as air-line respirators.

Air-purifying respirators (Figure 8-2), on the other hand, do not have a separate air source. Instead, they utilize ambient air which is "purified" through a filtering element prior to inhalation.

SCBAs, SARs, and air-purifying respirators are further differentiated by the type of air flow supplied to the facepiece:

- *Positive-pressure respirators* maintain a positive pressure in the facepiece during both inhalation and exhalation. The two main types of positive-pressure respirators are pressure-demand and continuous flow. In pressure-demand respirators, a pressure regulator and an exhalation valve on the mask maintain the mask's positive pressure except during high breathing rates. If a leak develops in a pressure-demand respirator, the regulator sends a continuous flow of clean air into the facepiece, preventing penetration by contaminated ambient air. Continuous-flow respirators (including some SARs and all powered air-purifying respirators [PAPRs]) send a continuous stream of air into the facepiece at all times. With SARs, the continuous flow of air prevents infiltration by ambient air, but uses the air supply much more rapidly than with pressure-demand respirators. Powered air-purifying respirators (PAPRs) are operated in a positive-pressure continuous-flow mode utilizing filtered ambient air. (However, at maximal breathing rates, a negative pressure may be created in the facepiece of a PAPR.)
- *Negative-pressure respirators* draw air into the facepiece via the negative pressure created by user inhalation. The main disadvantage of negative-pressure respirators is that if any leaks develop in the system (i.e., a crack in the hose or an ill-fitting mask or facepiece), the user draws contaminated air into the facepiece during inhalation.

When atmosphere-supplying respirators are used, only those operated in the positive-pressure mode are recommended for work at hazardous waste sites. Table 8-2 lists the relative advantages and disadvantages of SCBAs, SARs, and air-purifying respirators.

Different types of facepieces are available for use with the various types of respirators. The types generally used at hazardous waste sites are full facepieces and half masks.

- *Full-facepiece masks* cover the face from the hairline to below the chin. They provide eye protection.
- *Half masks* cover the face from below the chin to over the nose and do not provide eye protection.

Federal regulations require the use of respirators that have been tested and approved by the Mine Safety and Health Administration (MSHA) and NIOSH. Testing procedures are described in 30 CFR Part 11. Approval numbers are

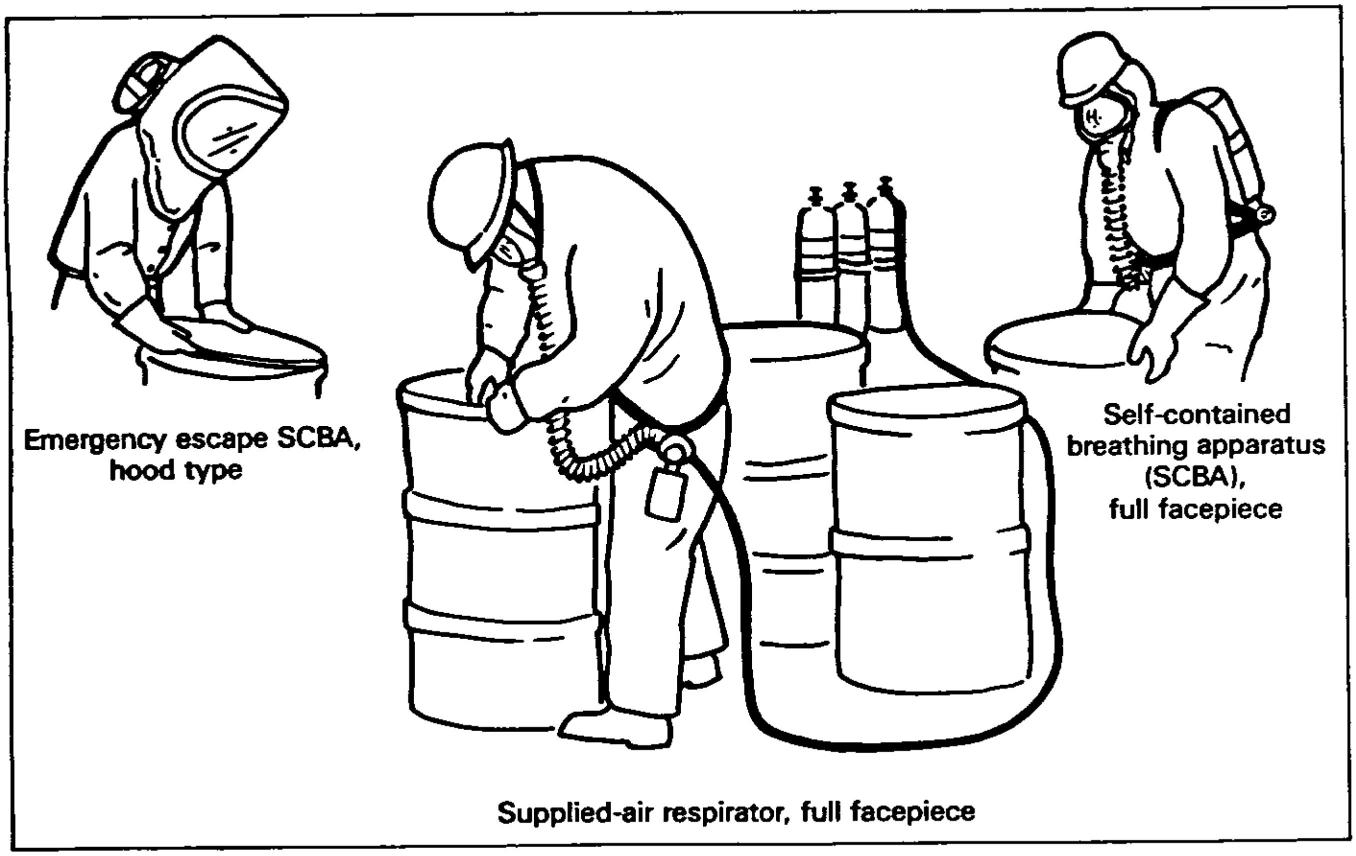

Figure 8-1. Types of Atmosphere-Supplying Respirators.

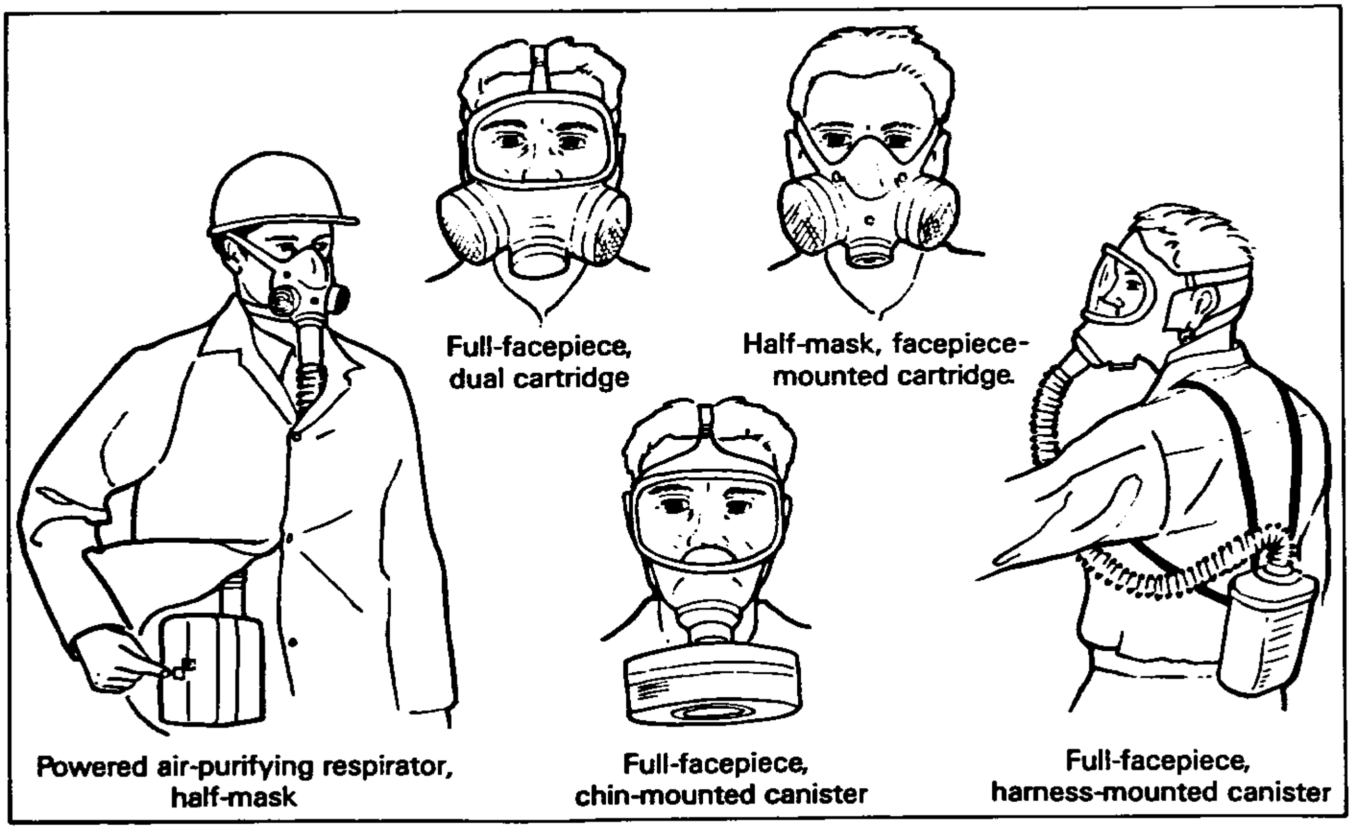

Figure 8-2. Types of Air-Purifying Respirators. .

Table 8-2. Relative Advantages and Disadvantages of Respiratory Protective Equipment

TYPE OF RESPIRATOR	ADVANTAGES	DISADVANTAGES
ATMOSPHERE-SUPPLYING		
Self-Contained Breathing Apparatus (SCBA)	• Provides the highest available level of protection against airborne contaminants and oxygen deficiency. • Provides the highest available level of protection under strenuous work conditions.	• Bulky, heavy (up to 35 pounds). • Finite air supply limits work duration. • May impair movement in confined spaces.
Positive-Pressure Supplied-Air Respirator (SAR) (also called air-line respirator)	• Enables longer work periods than an SCBA. • Less bulky and heavy than a SCBA. SAR equipment weighs less than 5 pounds (or around 15 pounds if escape SCBA protection is included). • Protects against most airborne contaminants.	• Not approved for use in atmospheres immediately dangerous to life or health (IDLH) or in oxygen-deficient atmospheres unless equipped with an emergency egress unit such as an escape-only SCBA that can provide immediate emergency respiratory protection in case of air-line failure. • Impairs mobility. • MSHA/NIOSH certification limits hose length to 300 feet (90 meters). • As the length of the hose is increased, the minimum approved air flow may not be delivered at the facepiece. • Air line is vulnerable to damage, chemical contamination, and degradation. Decontamination of hoses may be difficult. • Worker must retrace steps to leave work area. • Requires supervision/ monitoring of the air supply line.
AIR-PURIFYING		
Air-Purifying Respirator (including powered air-purifying respirators [PAPRs])	• Enhanced mobility. • Lighter in weight than an SCBA. Generally weights 2 pounds (1 kg) or less (except for PAPRs).	• Cannot be used in IDLH or oxygen-deficient atmospheres (less than 19.5 percent oxygen at sea level). • Limited duration of protection. May be hard to gauge safe operating time in field conditions. • Only protects against specific chemicals and up to specific concentrations. • Use requires monitoring of contaminant and oxygen levels. • Can only be used (1) against gas and vapor contaminants with adequate warning properties, or (2) for specific gases or vapors provided that the service is known and a safety factor is applied or if the unit has an ESLI (end-of-service-life indicator).

clearly written on all approved respiratory equipment; however, not all respiratory equipment that is marketed is approved. Periodically, NIOSH publishes a list, entitled *NIOSH Certified Equipment List* of all approved respirators and respiratory components [1].

Protection Factor

The level of protection that can be provided by a respirator is indicated by the respirator's protection factor. This number, which is determined experimentally by measuring facepiece seal and exhalation valve leakage, indicates the relative difference in concentrations of substances outside and inside the facepiece that can be maintained by the respirator. For example, the protection factor for full-facepiece air-purifying respirators is 50. This means, theoretically, that workers wearing these respirators should be protected in atmospheres containing chemicals at concentrations that are up to 50 times higher than the appropriate limits. One source of protection factors for various types of atmosphere-supplying (SCBA and SAR) and air-purifying respirators can be found in American National Standards Institute (ANSI) standard ANSI Z88.2-1980.

At sites where the identity and concentration of chemicals in air are known, a respirator should be selected with a protection factor that is sufficiently high to ensure that the wearer will not be exposed to the chemicals above the applicable limits. These limits include the American Conference of Governmental Industrial Hygienists' Threshold Limit Values (TLVs), OSHA's Permissible Exposure Limits (PELs), and the NIOSH Recommended Exposure Limits (RELs) (see Table 6-4 in Chapter 6). These limits are designed to protect most workers who may be exposed to chemicals day after day throughout their working life. The OSHA PELs are legally enforceable exposure limits, and are the minimum limits of protection that must be met.

It should be remembered that the protection provided by a respirator can be compromised in several situations, most notably, (1) if a worker has a high breathing rate, (2) if the ambient temperature is high or low, or (3) if the worker has a poor facepiece-to-face seal. At high breathing rates, positive-pressure SCBAs and SARs may not maintain positive pressure for brief periods during peak inhalation. Also, at high work rates, exhalation valves may leak. Consequently, positive-pressure respirators working at high flow rates may offer less protection than when working at normal rates.

A similar reduction in protection may result from high or low ambient temperatures. For example, at high temperatures excessive sweat may cause a break in the face-to-facepiece seal. At very low temperatures, the exhalation valve and regulator may become ice-clogged due to moisture in the breath and air. Likewise, a poor facepiece seal —due to such factors as facial hair, missing teeth, scars, lack of or improper fit testing, etc.—can result in the penetration of air contaminants.

Self-Contained Breathing Apparatus (SCBA)

A self-contained breathing apparatus (SCBA) usually consists of a facepiece connected by a hose and a regulator to an air source (compressed air, compressed oxygen, or an oxygen-generating chemical) carried by the wearer (see Figure 8-1). Only positive-pressure SCBAs are recommended for entry into atmospheres that are immediately dangerous to life and health (IDLH). SCBAs offer protection against most types and levels of airborne contaminants. However, the duration of the air supply is an important planning factor in SCBA use (see *PPE Use* later in this chapter). This is limited by the amount of air carried and its rate of consumption. Also, SCBAs are bulky and heavy, thus they increase the likelihood of heat stress and may impair movement in confined spaces. Generally, only workers handling hazardous materials or operating in contaminated zones require SCBAs. Under MSHA regulations in 30 CFR Part 11.70(a), SCBAs may be approved (1) for escape only, or (2) for both entry into and escape from a hazardous atmosphere. The types of SCBAs and their relative advantages and disadvantages are described in Table 8-3.

Table 8-3. Types of Self-Contained Breathing Apparatus (SCBA)

TYPE	DESCRIPTION	ADVANTAGES	DISADVANTAGES	COMMENTS
ENTRY-AND-ESCAPE SCBA				
Open-Circuit SCBA	Supplies clean air to the wearer from a cylinder. Wearer exhales air directly to the atmosphere.	Operated in a positive-pressure mode, open-circuit SCBAs provide the highest respiratory protection currently available. A warning alarm signals when only 20 to 25 percent of the air supply remains.	Shorter operating time (30 to 60 minutes) and heavier weight (up to 35 lbs [13.6 kg]) than a closed-circuit SCBA.	The 30- to 60-minute operating time may vary depending on the size of the air tank and the work rate of the individual.
Closed-Circuit SCBA (Rebreather)	These devices recycle exhaled gases (CO_2, O_2, and nitrogen) by removing CO_2 with an alkaline scrubber and replenishing the consumed oxygen with oxygen from a liquid or gaseous source.	Longer operating time (up to 4 hours), and lighter weight (21 to 30 lbs [9.5 to 13.6 kg]) than open-circuit apparatus. A warning alarm signals when only 20 to 25 percent of the oxygen supply remains. Oxygen supply is depleted before the CO_2 sorbent scrubber supply, thereby protecting the wearer from CO_2 breakthrough.	At very cold temperatures, scrubber efficiency may be reduced and CO_2 breakthrough may occur. Units retain the heat normally exchanged in exhalation and generate heat in the CO_2 scrubbing operations, adding to the danger of heat stress. Auxiliary cooling devices may be required. When worn outside an encapsulating suit, the breathing bag may be permeated by chemicals, contaminating the breathing apparatus and the respirable air. Decontamination of the breathing bag may be difficult.	Positive-pressure closed-circuit SCBAs offer substantially more protection than negative-pressure units, which are not recommended on hazardous waste sites. While these devices may be certified as closed-circuit SCBAs, NIOSH cannot certify closed-circuit SCBAs as positive-pressure devices due to limitations in certification procedures currently defined in 30 CFR Part 11.
ESCAPE-ONLY SCBA	Supplies clean air to the wearer from either an air cylinder or from an oxygen-generating chemical. Approved for escape purposes only.	Lightweight (10 pounds [4.5 kg] or less), low bulk, easy to carry. Available in pressure-demand and continuous-flow modes.	Cannot be used for entry.	Provides only 5 to 15 minutes of respiratory protection, depending on the model and wearer breathing rate.

Escape-only SCBAs are frequently continuous-flow devices with hoods that can be donned to provide immediate emergency protection. Employers should provide and ensure that employees carry an escape SCBA where such emergency protection may be necessary.

Entry-and-escape SCBA respirators give workers untethered access to nearly all portions of the worksite, but decrease worker mobility, particularly in confined areas, due to both the bulk and weight of the units. Their use is particularly advisable when dealing with unidentified and unquantified airborne contaminants. There are two types of entry-and-escape SCBAs: (1) open-circuit and (2) closed-circuit. In an open-circuit SCBA, air is exhaled directly into the ambient atmosphere. In a closed-circuit SCBA, exhaled air is recycled by removing the carbon dioxide with an alkaline scrubber and by replenishing the consumed oxygen with oxygen from a solid, liquid, or gaseous source.

As required by MSHA/NIOSH 30 CFR Part 11.80, all compressed breathing gas cylinders must meet minimum U.S. Department of Transportation requirements for interstate shipment. (For further information, see 49 CFR Parts 173 and 178.) All compressed air, compressed oxygen, liquid air, and liquid oxygen used for respiration shall be of high purity and must meet all requirements of OSHA 29 CFR Part 1910.134(d). In addition, breathing air must meet or exceed the requirements of Grade D breathing air as specified in the Compressed Gas Association pamphlet G-7.1 and ANSI Z86.1-1973.

Key questions to ask when considering whether an SCBA is appropriate are:

- Is the atmosphere IDLH or is it likely to become IDLH? If yes, a positive-pressure SCBA should be used. A positive-pressure SAR with an escape SCBA can also be used.
- Is the duration of air supply sufficient for accomplishing the necessary tasks? If no, a larger cylinder should be used, a different respirator should be chosen, and/or the Work Plan should be modified.
- Will the bulk and weight of the SCBA interfere with task performance or cause unnecessary stress? If yes, use of an SAR may be more appropriate if conditions permit.
- Will temperature effects compromise respirator effectiveness or cause added stress in the worker? If yes, the work period should be shortened or the mission postponed until the temperature changes.

Supplied-Air Respirators (SARs)

Supplied-air respirators (also known as air-line respirators) supply air, never oxygen, to a facepiece via a supply line from a stationary source (see Figure 8-1). SARs are available in positive-pressure and negative-pressure modes. Pressure-demand SARs with escape provisions provide the highest level of protection (among SARs) and are the only SARs recommended for use at hazardous waste sites. SARs are not recommended for entry into IDLH atmospheres (MSHA/NIOSH 30 CFR Part 11) unless the apparatus is equipped with an escape SCBA.

The air source for supplied-air respirators may be compressed air cylinders or a compressor that purifies and delivers ambient air to the facepiece. SARs suitable for use with compressed air are classified as "Type C" supplied-air respirators as defined in MSHA/NIOSH 30 CFR Part 11. All SAR couplings must be incompatible with the outlets of other gas systems used on site to prevent a worker from connecting to an inappropriate compressed gas source (OSHA 29 CFR 1910.134[d]).

SARs enable longer work periods than do SCBAs and are less bulky. However, the air line impairs worker mobility and requires workers to retrace their steps when leaving the area. Also, the air line is vulnerable to puncture from rough or sharp surfaces, chemical permeation, damage from contact with heavy equipment, and obstruction from falling drums, etc. To the extent possible, all such hazards should be removed prior to use. When in use, air lines should be kept as short as possible (300 feet [91 meters] is the longest approved hose length for SARs), and other workers and vehicles should be kept away from the air line.

The use of air compressors as the air source for an SAR at a hazardous waste site is severely limited by the same concern that requires workers to wear respirators: that is, the questionable quality of the ambient air. Onsite compressor use is limited by OSHA standards (29 CFR Part 1910.134[d]).

Key questions to ask when considering SAR use are:

- Is the atmosphere IDLH or likely to become IDLH? If yes, an SAR/SCBA combination or SCBA should be used.
- Will the hose significantly impair worker mobility? If yes, the work task should be modified or other respiratory protection should be used.
- Is there a danger of the air line being damaged or obstructed (e.g., by heavy equipment, falling drums, rough terrain, or sharp objects) or permeated and/or degraded by chemicals (e.g., by pools of chemicals)? If yes, either the hazard should be removed or another form of respiratory protection should be used.
- If a compressor is the air source, is it possible for airborne contaminants to enter the air system? If yes, have the contaminants been identified and are efficient filters and/or sorbents available that are capable of removing those contaminants? If no, either cylinders should be used as the air source or another form of respiratory protection should be used.
- Can other workers and vehicles that might interfere with the air line be kept away from the area? If no, another form of respiratory protection should be used.

Combination SCBA/SAR

A relatively new type of respiratory protection is available that uses a regulator to combine the features of an SCBA with an SAR. The user can operate the respirator in the SCBA or SAR mode, through either the manual or automatic switching of air sources. This type of respirator allows entry into and exit from an area using the self-contained air supply, as well as extended work periods within a contaminated area while connected to the air line. It is particularly appropriate for sites where workers must travel an extended distance to a work area within a hot zone and remain within that area for relatively long work periods (e.g., drum sampling). In such situations, workers would enter the site using the SCBA mode, connect to the air line during the work period, and shift back to the SCBA mode to leave the site.

The combination SCBA/SAR should not be confused with an SAR with escape provisions. The primary difference is the length of air time provided by the SCBA; the combination system provides up to 60 minutes of self-contained air, whereas the escape SCBA contains much less air, generally enough for only 5 minutes. NIOSH certification of the combination unit allows up to 20 percent of the available air time to be used during entry, while the SAR with escape provision is certified for escape only.

Air-Purifying Respirators

Air-purifying respirators consist of a facepiece and an air-purifying device, which is either a removable component of the facepiece or an air-purifying apparatus worn on a body harness and attached to the facepiece by a corrugated breathing hose (see Figure 8-2). Air-purifying respirators selectively remove specific airborne contaminants (particulates, gases, vapors, fumes) from ambient air by filtration, absorption, adsorption, or chemical reactions. They are approved for use in atmospheres containing specific chemicals up to designated concentrations, *and not for IDLH atmospheres*. Air-purifying respirators have limited use at hazardous waste sites and can be used only when the ambient atmosphere contains sufficient oxygen (19.5 percent) (30 CFR Part 11.90[a]). Table 8-4 lists conditions that may exclude the use of air-purifying respirators.

Table 8-4. Conditions That Exclude or May Exclude Use of Air-Purifying Respirators

- Oxygen deficiency.
- IDLH concentrations of specific substances.
- Entry into an unventilated or confined area where the exposure conditions have not been characterized.
- Presence or potential presence of unidentified contaminants.
- Contaminant concentrations are unknown or exceed designated maximum use concentration(s).
- Identified gases or vapors have inadequate warning properties *and* the sorbent service life is not known *and* the unit has no end-of-service-life (ESLI) indicator.
- High relative humidity (may reduce the protection offered by the sorbent).

Air-purifying respirators usually operate only in the negative-pressure mode except for powered air-purifying respirators (PAPRs) which maintain a positive facepiece pressure (except at maximal breathing rates). There are three types of air-purifying devices: (1) particulate filters; (2) cartridges and canisters, which contain sorbents for specific gases and vapors; and (3) combination devices. Their efficiencies vary considerably even for closely related materials [2].

Cartridges usually attach directly to the respirator facepiece. The larger-volume canisters attach to the chin of the facepiece or are carried with a harness and attached to the facepiece by a breathing tube. Combination canisters and cartridges contain layers of different sorbent materials and remove multiple chemicals or multiple classes of chemicals from the ambient air. Though approved against more than one substance, these canisters and cartridges are tested independently against single substances. Thus, the effectiveness of these canisters against two or more substances has not been demonstrated. Filters may also be combined with cartridges to provide additional protection against particulates. A number of standard cartridges and canisters are commercially available. They are color-coded to indicate the general chemicals or classes of chemicals against which they are effective (29 CFR Part 1910.134[g]).

MSHA and NIOSH have granted approvals for manufacturers' specific assemblies of air-purifying respirators for a limited number of specific chemicals. Respirators should be used only for those substances for which they have been approved. Use of a sorbent shall not be allowed when there is reason to suspect that it does not provide adequate sorption efficiency against a specific contaminant. In addition, it should be noted that approval testing is performed at a given temperature and over a narrow range of flow rates and relative humidities [3]; thus protection may be compromised in nonstandard conditions. The assembly that has been approved by MSHA and NIOSH to protect against organic vapors is tested against only a single challenge substance, carbon tetrachloride; its effectiveness for protecting against other vapors has not been demonstrated.

Most chemical sorbent canisters are imprinted with an expiration date. They may be used up to that date as long as they were not opened previously. Once opened, they begin to sorb humidity and air contaminants whether or not they are in use. Their efficiency and service life decreases and therefore they should be used immediately. Cartridges should be discarded after use but should not be used for longer than one shift or when breakthrough occurs, whichever comes first.

Where a canister or cartridge is being used against gases or vapors, the appropriate device shall be used only if the chemical(s) have "adequate warning properties" (30 CFR Part 11.150). NIOSH considers a substance to have adequate warning properties when its odor, taste, or irritant effects are detectable and persistent at concentrations below the recommended exposure limit (REL) (see Chapter 6). A substance is considered to have poor warning properties when its odor or irritation threshold is above the applicable exposure limit. Warning properties are essential to safe use of air-purifying respirators since they allow detection of contaminant breakthrough, should it occur. While warning properties are not foolproof, because they rely on human senses which vary widely among individuals and in the same individual under varying conditions (e.g., olfactory fatigue), they do provide some indication of possible sorbent exhaustion, poor facepiece fit, or other malfunctions. OSHA permits the use of air-purifying respirators for protection against specific chemicals with poor warning properties provided that (1) the service life of the sorbent is known and a safety factor has been applied or (2) the respirator has an approved end-of-service-life indicator.

Selection of Protective Clothing and Accessories

In this manual, personal protective clothing is considered to be any article offering skin and/or body protection. It includes:

- Fully-encapsulating suits.
- Non-encapsulating suits.
- Aprons, leggings, and sleeve protectors.
- Gloves.
- Firefighters' protective clothing.
- Proximity, or approach, garments.
- Blast and fragmentation suits.
- Cooling garments.
- Radiation-protective suits.

Each type of protective clothing has a specific purpose; many, but not all, are designed to protect against chemical exposure. Examples of protective clothing are shown in Figure 8-3. Table 8-5 describes various types of protective clothing available, details the type of protection they offer, and lists the factors to consider in their selection and use. This table also describes a number of accessories that might be used in conjunction with a PPE ensemble, namely:

- Knife.
- Flashlight or lantern.
- Personal locator beacon.
- Personal dosimeters.
- Two-way radio.
- Safety belts and lines.

Selection of Chemical-Protective Clothing (CPC)

Chemical-protective clothing (CPC) is available in a variety of materials that offer a range of protection against different chemicals. The most appropriate clothing material will depend on the chemicals present and the task to be accomplished. Ideally, the chosen material resists permeation, degradation, and penetration. Permeation is the process by which a chemical dissolves in and/or moves through a protective clothing material on a molecular level. Degradation is the loss of or change in the fabric's chemical resistance or physical properties due to exposure to chemicals, use, or ambient conditions (e.g., sunlight). Penetration is the movement of chemicals through zippers, stitched seams or imperfections (e.g., pinholes) in a protective clothing material.

Selection of chemical-protective clothing is a complex task and should be performed by personnel with training and experience. Under all conditions, clothing is selected by evaluating the performance characteristics of the clothing against the requirements and limitations of the site- and task-specific conditions. If possible, representative garments should be inspected before purchase and their use and performance discussed with someone who has experience with the clothing under consideration. In all cases, the employer is responsible for ensuring that the personal protective clothing (and all PPE) necessary to protect employees from injury or illness that may result from exposure to hazards at the work site is adequate and of safe design and construction for the work to be performed (see OSHA standard 29 CFR Part 1910.132-1910.137).

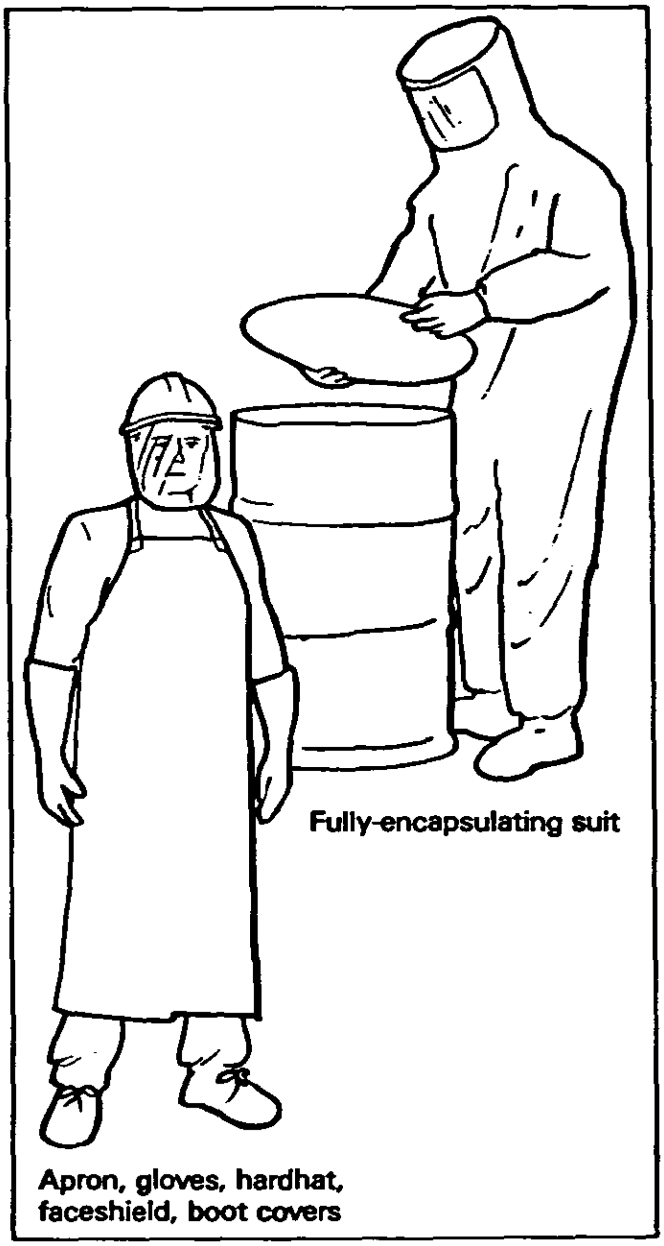

Figure 8-3. Examples of Protective Clothing.

Permeation and Degradation

The selection of chemical-protective clothing depends greatly upon the type and physical state of the contaminants. This information is determined during site characterization (Chapter 6). Once the chemicals have been identified, available information sources should be consulted to identify materials that are resistant to permeation and degradation by the known chemicals. One excellent reference, *Guidelines for the Selection of*

Table 8-5. Protective Clothing and Accessories

BODY PART PROTECTED	TYPE OF CLOTHING OR ACCESSORY	DESCRIPTION	TYPE OF PROTECTION	USE CONSIDERATIONS
Full Body	Fully-encapsulating suit	One-piece garment. Boots and gloves may be integral, attached and replaceable, or separate.	Protects against splashes, dust, gases, and vapors.	Does not allow body heat to escape. May contribute to heat stress in wearer, particularly if worn in conjunction with a closed-circuit SCBA; a cooling garment may be needed. Impairs worker mobility, vision, and communication.
	Non-encapsulating suit	Jacket, hood, pants, or bib overalls, and one-piece coveralls.	Protects against splashes, dust, and other materials but not against gases and vapors. Does not protect parts of head or neck.	Do not use where gas-tight or pervasive splashing protection is required. May contribute to heat stress in wearer. Tape-seal connections between pant cuffs and boots and between gloves and sleeves.
	Aprons, leggings, and sleeve protectors	Fully sleeved and gloved apron. Separate coverings for arms and legs. Commonly worn over non-encapsulating suit.	Provides additional splash protection of chest, forearms, and legs.	Whenever possible, should be used over a non-encapsulating suit (instead of using a fully-encapsulating suit) to minimize potential for heat stress. Useful for sampling, labeling, and analysis operations. Should be used only when there is a low probability of total body contact with contaminants.
	Firefighters' protective clothing	Gloves, helmet, running or bunker coat, running or bunker pants (NFPA No. 1971, 1972, 1973), and boots.	Protects against heat, hot water, and some particles. Does not protect against gases and vapors, or chemical permeation or degradation. NFPA Standard No. 1971 specifies that a garment consist of an outer shell, an inner liner, and a vapor barrier with a minimum water penetration of 25 lbs/in^2 (1.8 kg/cm^2) to prevent the passage of hot water.	Decontamination is difficult. Should not be worn in areas where protection against gases, vapors, chemical splashes, or permeation is required.
	Proximity garment (approach suit)	One- or two-piece overgarment with boot covers, gloves, and hood of aluminized nylon or cotton fabric. Normally worn over other protective clothing, such as chemical-protective clothing, firefighters' bunker gear, or flame-retardant coveralls.	Protects against brief exposure to radiant heat. Does not protect against chemical permeation or degradation. Can be custom-manufactured to protect against some chemical contaminants.	Auxiliary cooling and an SCBA should be used if the wearer may be exposed to a toxic atmosphere or needs more than 2 or 3 minutes of protection.
	Blast and fragmentation suit	Blast and fragmentation vests and clothing, bomb blankets, and bomb carriers.	Provides some protection against very small detonations. Bomb blankets and baskets can help redirect a blast.	Does not provide hearing protection.

Table 8-5. (cont.)

BODY PART PROTECTED	TYPE OF CLOTHING OR ACCESSORY	DESCRIPTION	TYPE OF PROTECTION	USE CONSIDERATIONS
Full Body (cont.)	Radiation-contamination protective suit	Various types of protective clothing designed to prevent contamination of the body by radioactive particles.	Protects against alpha and beta particles. *Does NOT protect against gamma radiation.*	Designed to prevent skin contamination. If radiation is detected on site, consult an experienced radiation expert and evacuate personnel until the radiation hazard has been evaluated.
	Flame/fire retardant coveralls	Normally worn as an undergarment.	Provides protection from flash fires.	Adds bulk and may exacerbate heat stress problems and impair mobility.
	Flotation gear	Life jackets or work vests. (Commonly worn underneath chemical protective clothing to prevent flotation gear degradation by chemicals.)	Adds 15.5 to 25 lbs (7 to 11.3 kg) of buoyancy to personnel working in or around water.	Adds bulk and restricts mobility. Must meet USCG standards (46 CFR Part 160).
	Cooling garment	One of three methods: (1) A pump circulates cool dry air throughout the suit or portions of it via an air line. Cooling may be enhanced by use of a vortex cooler, refrigeration coils, or a heat exchanger. (2) A jacket or vest having pockets into which packets of ice are inserted. (3) A pump circulates chilled water from a water/ice reservoir and through circulating tubes, which cover part of the body (generally the upper torso only).	Removes excess heat generated by worker activity, the equipment, or the environment.	(1) Pumps circulating cool air require 10 to 20 ft³ (0.3 to 0.6 m³) of respirable air per minute, so they are often uneconomical for use at a waste site. (2) Jackets or vests pose ice storage and recharge problems. (3) Pumps circulating chilled water pose ice storage problems. The pump and battery add bulk and weight.
Head	Safety helmet (hard hat)	For example, a hard plastic or rubber helmet.	Protects the head from blows.	Helmet shall meet OSHA standard 29 CFR Part 1910.135.
	Helmet liner		Insulates against cold. Does not protect against chemical splashes.	
	Hood	Commonly worn with a helmet.	Protects against chemical splashes, particulates, and rain.	
	Protective hair covering		Protects against chemical contamination of hair. Prevents the entanglement of hair in machinery or equipment. Prevents hair from interfering with vision and with the functioning of respiratory protective devices.	Particularly important for workers with long hair.
Eyes and Face*	Face shield	Full-face coverage, eight-inch minimum.	Protects against chemical splashes. Does not protect adequately against projectiles.	Face shields and splash hoods must be suitably supported to prevent them from shifting and exposing portions of the face or obscuring vision. Provides limited eye protection.

*All eye and face protection must meet OSHA standard 29 CFR Part 1910.133.

Table 8-5. (cont.)

BODY PART PROTECTED	TYPE OF CLOTHING OR ACCESSORY	DESCRIPTION	TYPE OF PROTECTION	USE CONSIDERATIONS
Eyes and Face (cont.)	**Splash hood**		Protects against chemical splashes. Does not protect adequately against projectiles.	
	Safety glasses		Protect eyes against large particles and projectiles.	If lasers are used to survey a site, workers should wear special protective lenses.
	Goggles		Depending on their construction, goggles can protect against vaporized chemicals, splashes, large particles, and projectiles (if constructed with impact-resistant lenses).	
	Sweat bands		Prevents sweat-induced eye irritation and vision impairment.	
Ears	**Ear plugs and muffs**		Protect against physiological damage and psychological disturbance.	Must comply with OSHA regulation 29 CFR Part 1910.95. Can interfere with communication. Use of ear plugs should be carefully reviewed by a health and safety professional because chemical contaminants could be introduced into the ear.
	Headphones	Radio headset with throat microphone.	Provide some hearing protection while enabling communication.	Highly desirable, particularly if emergency conditions arise.
Hands and Arms	**Gloves and sleeves**	May be integral, attached, or separate from other protective clothing.	Protect hands and arms from chemical contact.	Wear jacket cuffs over glove cuffs to prevent liquid from entering the glove. Tape-seal gloves to sleeves to provide additional protection.
		Overgloves.	Provide supplemental protection to the wearer and protect more expensive undergarments from abrasions, tears, and contamination.	
		Disposable gloves.	Should be used whenever possible to reduce decontamination needs.	
Foot	**Safety boots**	Boots constructed of chemical-resistant material.	Protect feet from contact with chemicals.	
		Boots constructed with some steel materials (e.g., toes, shanks, insoles).	Protect feet from compression, crushing, or puncture by falling, moving, or sharp objects.	All boots must at least meet the specifications required under OSHA 29 CFR Part 1910.136 and should provide good traction.
		Boots constructed from nonconductive, spark-resistant materials or coatings.	Protect the wearer against electrical hazards and prevent ignition of combustible gases or vapors.	

Table 8-5. (cont.)

BODY PART PROTECTED	TYPE OF CLOTHING OR ACCESSORY	DESCRIPTION	TYPE OF PROTECTION	USE CONSIDERATIONS
Foot (cont.)	Disposable shoe or boot covers	Made of a variety of materials. Slip over the shoe or boot.	Protect safety boots from contamination. Protect feet from contact with chemicals.	Covers may be disposed of after use, facilitating decontamination.
General	Knife		Allows a person in a fully-encapsulating suit to cut his or her way out of the suit in the event of an emergency or equipment failure.	Should be carried and used with caution to avoid puncturing the suit.
	Flashlight or lantern		Enhances visibility in buildings, enclosed spaces, and the dark.	Must be intrinsically safe or explosion-proof for use in combustible atmospheres. Sealing the flashlight in a plastic bag facilitates decontamination. Only electrical equipment approved as intrinsically safe, or approved for the class and group of hazard as defined in Article 500 of the National Electrical Code, may be used.
	Personal dosimeter		Measures worker exposure to ionizing radiation and to certain chemicals.	To estimate actual body exposure, the dosimeter should be placed inside the fully-encapsulating suit.
	Personal locator beacon	Operated by sound, radio, or light.	Enables emergency personnel to locate victim.	
	Two-way radio		Enables field workers of communicate with personnel in the Support Zone.	
	Safety belts, harnesses, and lifelines		Enable personnel to work in elevated areas or enter confined areas and prevent falls. Belts may be used to carry tools and equipment.	Must be constructed of spark-free hardware and chemical-resistant materials to provide proper protection. Must meet OSHA standards in 29 CFR Part 1926.104.

Chemical-Protective Clothing [4], provides a matrix of clothing material recommendations for approximately 300 chemicals based on an evaluation of permeation and degradation data from independent tests, vendor literature, and raw material suppliers. Charts indicating the resistance of various clothing materials to permeation and degradation are also available from manufacturers and other sources. It is important to note, however, that no material protects against all chemicals and combinations of chemicals, and that no currently available material is an effective barrier to any prolonged chemical exposure.

In reviewing vendor literature, it is important to be aware that the data provided are of limited value. For example, the quality of vendor test methods is inconsistent; vendors often rely on the raw material manufacturers for data rather than conducting their own tests; and the data may not be updated. In addition, vendor data cannot address the wide variety of uses and challenges to which CPC may be subjected. Most vendors strongly emphasize this point in the descriptive text that accompanies their data.

Another factor to bear in mind when selecting CPC is that the rate of permeation is a function of several factors, including clothing material type and thickness, manufacturing method, the concentration(s) of the hazardous substance(s), temperature, pressure, humidity, the solubility of the chemical in the clothing material, and the diffusion coefficient of the permeating chemical in the clothing material. Thus permeation rates and breakthrough time (the time from initial exposure until hazardous material is detectable on the inside of the CPC) may vary depending on these conditions.

Most hazardous wastes are mixtures, for which specific data with which to make a good CPC selection are not available. Due to a lack of testing, only limited permeation data for multicomponent liquids are currently available.

Mixtures of chemicals can be significantly more aggressive towards CPC materials than can any single component alone. Even small amounts of a rapidly permeating chemical may provide a pathway that accelerates the permeation of other chemicals [4]. Formal research is being conducted on these effects. NIOSH is currently developing methods for evaluating CPC materials against mixtures of chemicals and unknowns in the field. For hazardous waste site operations, CPC should be selected that offers the widest range of protection against the chemicals expected on site. Vendors are now providing CPC material—composed of two or even three different materials laminated together—that is capable of providing the best features of each material.

Heat Transfer Characteristics

The heat transfer characteristics of CPC may be an important factor in selection. Since most chemical-protective clothing is virtually impermeable to moisture, evaporative cooling is limited. The "clo" value (thermal insulation value) of chemical-protective clothing is a measure of the capacity of CPC to dissipate heat loss through means other than evaporation. The larger the clo value, the greater the insulating properties of the garment and, consequently, the lower the heat transfer [5]. Given other equivalent protective properties, clothing with the lowest clo value should be selected in hot environments or for high work rates. Unfortunately, clo values for clothing are rarely available at present.

Other Considerations

In addition to permeation, degradation, penetration, and heat transfer, several other factors must be considered during clothing selection. These affect not only chemical resistance, but also the worker's ability to perform the required task. The following checklist summarizes these considerations.

- Durability:

  Does the material have sufficient strength to withstand the physical stress of the task(s) at hand?

  Will the material resist tears, punctures, and abrasions?

  Will the material withstand repeated use after contamination/decontamination?

- Flexibility:

  Will the CPC interfere with the workers' ability to perform their assigned tasks (this is particularly important to consider for gloves)?

- Temperature effects:

  Will the material maintain its protective integrity and flexibility under hot and cold extremes?

- Ease of decontamination:

  Are decontamination procedures available on site?

  Will the material pose any decontamination problems?

  Should disposable clothing be used?

- Compatibility with other equipment:

  Does the clothing preclude the use of another, necessary piece of protective equipment (e.g., suits that preclude hardhat use in hardhat area)?

- Duration of use:

  Can the required task be accomplished before contaminant breakthrough occurs, or degradation of the CPC becomes significant?

Special Conditions

Fire, explosion, heat, and radiation are considered special conditions that require special-protective equipment. Unique problems are associated with radiation and it is beyond the scope of this manual to discuss them properly. A qualified health physicist should be consulted if a radiation hazard exists. Special-protective equipment is described in Table 8-5 (see *Full Body* section of the table). When using special-protective equipment, it is important to also provide protection against chemicals, since the specialized equipment may provide little or no protection against chemicals which may also be present.

Selection of Ensembles

Level of Protection

The individual components of clothing and equipment must be assembled into a full protective ensemble that both protects the worker from the site-specific hazards and minimizes the hazards and drawbacks of the PPE ensemble itself.

Table 8-6 lists ensemble components based on the widely used EPA Levels of Protection: Levels A, B, C, and D. These lists can be used as a starting point for ensemble creation; however, each ensemble must be tailored to the specific situation in order to provide the most appropriate level of protection. For example, if work is being conducted at a highly contaminated site or if the potential for contamination is high, it may be advisable to wear a disposable covering, such as Tyvek coveralls or PVC splash suits, over the protective ensemble. It may be necessary to slit the back of these disposable suits to fit around the bulge of an encapsulating suit and SCBA [6].

The type of equipment used and the overall level of protection should be reevaluated periodically as the amount of information about the site increases, and as workers are required to perform different tasks. Personnel should be able to upgrade or downgrade their level of protection with concurrence of the Site Safety Officer and approval of the Field Team Leader.

Reasons to upgrade:

- Known or suspected presence of dermal hazards.
- Occurrence or likely occurrence of gas or vapor *emission.*
- Change in work task that will increase contact or potential contact with hazardous materials.
- Request of the individual performing the task.

Reasons to downgrade:

- New information indicating that the situation is less hazardous than was originally thought.
- Change in site conditions that decreases the hazard.
- Change in work task that will reduce contact with hazardous materials.

Table 8-6. Sample Protective Ensembles[a]

LEVEL OF PROTECTION	EQUIPMENT	PROTECTION PROVIDED	SHOULD BE USED WHEN:	LIMITING CRITERIA
A	RECOMMENDED: • Pressure-demand, full-facepiece SCBA or pressure-demand supplied-air respirator with escape SCBA. • Fully-encapsulating, chemical-resistant suit. • Inner chemical-resistant gloves. • Chemical-resistant safety boots/shoes. • Two-way radio communications. OPTIONAL: • Cooling unit. • Coveralls. • Long cotton underwear. • Hard hat. • Disposable gloves and boot covers.	The highest available level of respiratory, skin, and eye protection.	• The chemical substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on either: — measured (or potential for) high concentration of atmospheric vapors, gases, or particulates or — site operations and work functions involving a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to skin or capable of being absorbed through the intact skin. • Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible. • Operations must be conducted in confined, poorly ventilated areas until the absence of conditions requiring Level A protection is determined.	• Fully-encapsulating suit material must be compatible with the substances involved.
B	RECOMMENDED: • Pressure-demand, full-facepiece SCBA or pressure-demand supplied-air respirator with escape SCBA. • Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit). • Inner and outer chemical-resistant gloves. • Chemical-resistant safety boots/shoes. • Hard hat. • Two-way radio communications. OPTIONAL: • Coveralls. • Disposable boot covers. • Face shield. • Long cotton underwear.	The same level of respiratory protection but less skin protection than Level A. It is the minimum level recommended for initial site entries until the hazards have been further identified.	• The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection. This involves atmospheres: — with IDLH concentrations of specific substances that do not represent a severe skin hazard; or — that do not meet the criteria for use of air-purifying respirators. • Atmosphere contains less than 19.5 percent oxygen. • Presence of incompletely identified vapors or gases is indicated by direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the intact skin.	• Use only when the vapor or gases present are not suspected of containing high concentrations of chemicals that are harmful to skin or capable of being absorbed through the intact skin. • Use only when it is highly unlikely that the work being done will generate either high concentrations of vapors, gases, or particulates or splashes of material that will affect exposed skin.

[a] Based on EPA protective ensembles.

PPE Use

PPE can offer a high degree of protection only if it is used properly. This section covers the following aspects of PPE use:

- Training.
- Work mission duration.
- Personal use factors.
- Fit testing.
- Donning.
- In-use monitoring.
- Doffing.
- Inspection.
- Storage.
- Maintenance.

Decontamination is covered in Chapter 10. Inadequate attention to any of these areas could compromise the protection provided by the PPE.

Table 8-6. (cont.)

LEVEL OF PROTECTION	EQUIPMENT	PROTECTION PROVIDED	SHOULD BE USED WHEN:	LIMITING CRITERIA
C	RECOMMENDED: • Full-facepiece, air-purifying, canister-equipped respirator. • Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit). • Inner and outer chemical-resistant gloves. • Chemical-resistant safety boots/shoes. • Hard hat. • Two-way radio communications. OPTIONAL: • Coveralls. • Disposable boot covers. • Face shield. • Escape mask. • Long cotton underwear.	The same level of skin protection as Level B, but a lower level of respiratory protection.	• The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any exposed skin. • The types of air contaminants have been identified, concentrations measured, and a canister is available that can remove the contaminant. • All criteria for the use of air-purifying respirators are met.	• Atmospheric concentration of chemicals must not exceed IDLH levels. • The atmosphere must contain at least 19.5 percent oxygen.
D	RECOMMENDED: • Coveralls. • Safety boots/shoes. • Safety glasses or chemical splash goggles. • Hard hat. OPTIONAL: • Gloves. • Escape mask. • Face shield.	No respiratory protection. Minimal skin protection.	• The atmosphere contains no known hazard. • Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.	• This level should not be worn in the Exclusion Zone. • The atmosphere must contain at least 19.5 percent oxygen.

Training

Training in PPE use is recommended and, for respirators, required by federal regulation in the OSHA standards in 29 CFR Part 1910 Subparts I and Z. This training:

- Allows the user to become familiar with the equipment in a nonhazardous situation.
- Instills confidence of the user in his/her equipment.
- Makes the user aware of the limitations and capabilities of the equipment.
- Increases the efficiency of operations performed by workers wearing PPE.
- May increase the protective efficiency of PPE use.
- Reduces the expense of PPE maintenance.

Training should be completed prior to actual PPE use in a hazardous environment and should be repeated at least annually. At a minimum, the training portion of the PPE program should delineate the user's responsibilities and explain the following, utilizing both classroom and field training when necessary:

- OSHA requirements as delineated in 29 CFR Part 1910 Subparts *I* and *Z*.
- The proper use and maintenance of the selected PPE, including capabilities and limitations.
- The nature of the hazards and the consequences of not using the PPE.
- The human factors influencing PPE performance.
- Instruction in inspecting, donning, checking, fitting, and using PPE.
- Individualized respirator fit testing to ensure proper fit.
- Use of PPE in normal air for a long familiarity period and, finally, wearing PPE in a test atmosphere to evaluate its effectiveness.
- The user's responsibility (if any) for decontamination, cleaning, maintenance, and repair of PPE.
- Emergency procedures and self-rescue in the event of PPE failure.
- The buddy system (see Chapter 9, *Site Control*).
- The Site Safety Plan and the individual's responsibilities and duties in an emergency.

The discomfort and inconvenience of wearing PPE can create a resistance to the conscientious use of PPE. One essential aspect of training is to make the user aware of the need for PPE and to instill motivation for the proper use and maintenance of PPE.

Work Mission Duration

Before the workers actually begin work in their PPE ensembles, the anticipated duration of the work mission should be established. Several factors limit mission length. These include:

- Air supply consumption.
- Suit/ensemble permeation and penetration by chemical contaminants.
- Ambient temperature.
- Coolant supply.

Air Supply Consumption

The duration of the air supply must be considered before planning any SCBA-assisted work activity. The anticipated operating time of an SCBA is clearly indicated on the breathing apparatus. This designated operating time is based on a moderate work rate, e.g., some lifting, carrying, and/or heavy equipment operation. In actual operation, however, several factors can reduce the rated operating time. When planning an SCBA-assisted work mission, the following variables should be considered and work actions and operating time adjusted accordingly:

- Work rate. The actual in-use duration of SCBAs may be reduced by one-third to one-half during strenuous work, e.g., drum handling, major lifting, or any task requiring repetitive speed of motion [7].
- Fitness. Well-conditioned individuals generally utilize oxygen more efficiently and can extract more oxygen from a given volume of air (particularly when performing strenuous tasks) than unfit individuals, thereby slightly increasing the SCBA operating time [8].
- Body size. Larger individuals generally consume air at a higher rate than smaller individuals [8], thereby decreasing the SCBA operating time.
- Breathing patterns. Quick, shallow or irregular breaths use air more rapidly than deep, regularly spaced breaths. Heat-induced anxiety and lack of acclimatization (see *Heat Stress and Other Physiological Factors* in this chapter) may induce hyperventilation, resulting in decreased SCBA operating time [8].

Suit/Ensemble Permeation and Penetration

The possibility of chemical permeation or penetration of CPC ensembles during the work mission is always a matter of concern and may limit mission duration. Possible causes of ensemble penetration are:

- Suit valve leakage, particularly under excessively hot or cold temperatures.
- Suit fastener leakage if the suit is not properly maintained or if the fasteners become brittle at cold temperatures.
- Exhalation valve leakage at excessively hot or cold temperatures.

Also, when considering mission duration, it should be remembered that no single clothing material is an effective barrier to all chemicals or all combinations of chemicals, and no material is an effective barrier to prolonged chemical exposure.

Ambient Temperature

The ambient temperature has a major influence on work mission duration as it affects both the worker and the protective integrity of the ensemble. Heat stress, which can occur even in relatively moderate temperatures, is the greatest immediate danger to an ensemble-encapsulated worker. Methods to monitor for and prevent heat stress are discussed in the final section of this chapter, *Heat Stress and Other Physiological Factors*. Hot and cold ambient temperatures also affect:

- Valve operation on suits and/or respirators.
- The durability and flexibility of suit materials.
- The integrity of suit fasteners.
- The breakthrough time and permeation rates of chemicals.
- The concentration of airborne contaminants.

All these factors may decrease the duration of protection provided by a given piece of clothing or respiratory equipment.

Coolant Supply

Under warm or strenuous work conditions, adequate coolant (ice or chilled air, see Table 8-5) should be provided to keep the wearer's body at a comfortable temperature and to reduce the potential for heat stress (see *Heat Stress and Other Physiological Factors* at the end of this chapter). If coolant is necessary, the duration of the coolant supply will directly affect mission duration.

Personal Use Factors

As described below, certain personal features of workers may jeopardize safety during equipment use. Prohibitive or precautionary measures should be taken as necessary.

Facial hair and long hair interfere with respirator fit and wearer vision. Any facial hair that passes between the face and the sealing surface of the respirator should be prohibited. Even a few days' growth of facial hair will allow excessive contaminant penetration. Long hair must be effectively contained within protective hair coverings.

Eyeglasses with conventional temple pieces (earpiece bars) will interfere with the respirator-to-face seal of a full facepiece. A spectacle kit should be installed in the face masks of workers requiring vision correction.

When a worker must wear corrective lenses as part of the facepiece, the lenses shall be fitted by qualified individuals to provide good vision, comfort, and a gas-tight seal. Contact lenses may trap contaminants and/or particulates between the lens and the eye, causing irritation, damage, absorption, and an urge to remove the respirator. Wearing contact lenses with a respirator in a contaminated atmosphere is prohibited (29 CFR Part 1910.134[e][5][ii]).

Gum and tobacco chewing should be prohibited during respirator use since they may cause ingestion of contaminants and may compromise the respirator fit.

Donning an Ensemble

A routine should be established and practiced periodically for donning a fully-encapsulating suit/SCBA ensemble. Assistance should be provided for donning and doffing since these operations are difficult to perform alone, and solo efforts may increase the possibility of suit damage.

Table 8-7 lists sample procedures for donning a fully-encapsulating suit/SCBA ensemble. These procedures should be modified depending on the particular type of suit and/or when extra gloves and/or boots are used. These procedures assume that the wearer has previous training in SCBA use and decontamination procedures.

Once the equipment has been donned, its fit should be evaluated. If the clothing is too small, it will restrict movement, thereby increasing the likelihood of tearing the suit material and accelerating worker fatigue. If the clothing is too large, the possibility of snagging the material is increased, and the dexterity and coordination of the worker may be compromised. In either case, the worker should be recalled and better fitting clothing provided.

As part of donning operations, an assistant tape seals boots to protective clothing to eliminate routes of entry for chemicals.

Table 8-7. Sample Donning Procedures[a,b,c]

1. Inspect the clothing and respiratory equipment before donning (see *Inspection*).
2. Adjust hard hat or headpiece if worn, to fit user's head.
3. Open back closure used to change air tank (if suit has one) before donning suit.
4. Standing or sitting, step into the legs of the suit; ensure proper placement of the feet within the suit; then gather the suit around the waist.
5. Put on chemical-resistant safety boots over the feet of the suit. Tape the leg cuff over the tops of the boots.
   - —If additional chemical-resistant boots are required, put these on now.
   - —Some one-piece suits have heavy-soled protective feet. With these suits, wear short, chemical-resistant safety boots inside the suit.
6. Put on air tanks and harness assembly of the SCBA. Don the facepiece and adjust it to be secure, but comfortable. Do *not* connect the breathing hose. Open valve on air tank.
7. Perform negative and positive respirator facepiece seal test procedures.
   - —To conduct a negative-pressure test, close the inlet part with the palm of the hand or squeeze the breathing tube so it does not pass air, and gently inhale for about 10 seconds. Any inward rushing of air indicates a poor fit. Note that a leaking facepiece may be drawn tightly to the face to form a good seal, giving a false indication of adequate fit.
   - —To conduct a positive-pressure test, gently exhale while covering the exhalation valve to ensure that a positive pressure can be built up. Failure to build a positive pressure indicates a poor fit.
8. Depending on type of suit:
   - —Put on long-sleeved inner gloves (similar to surgical gloves).
   - —Secure gloves to sleeves, for suits with detachable gloves (if not done prior to entering the suit).
   - —Additional overgloves, worn over attached suit gloves, may be donned later.
9. Put sleeves of suit over arms as assistant pulls suit up and over the SCBA. Have assistant adjust suit around SCBA and shoulders to ensure unrestricted motion.
10. Put on hard hat, if needed.
11. Raise hood over head carefully so as not to disrupt face seal of SCBA mask. Adjust hood to give satisfactory comfort.
12. Begin to secure the suit by closing all fasteners on opening until there is only adequate room to connect the breathing hose. Secure all belts and/or adjustable leg, head, and waistbands.
13. Connect the breathing hose while opening the main valve.
14. Have assistant first ensure that wearer is breathing properly and then make final closure of the suit.
15. Have assistant check all closures.
16. Have assistant observe the wearer for a period of time to ensure that the wearer is comfortable, psychologically stable, and that the equipment is functioning properly.

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[a] Source: Based on reference [9].

[b] Perform the procedures in the order indicated.

[c] When donning a suit, use a moderate amount of a powder to prevent chafing and to increase comfort. Powder will also reduce rubber binding.

Respirator Fit Testing

The "fit" or integrity of the facepiece-to-face seal of a respirator affects its performance. A secure fit is important with positive-pressure equipment, and is essential to the safe functioning of negative-pressure equipment, such as most air-purifying respirators. Most facepieces fit only a certain percentage of the population; thus each facepiece must be tested on the potential wearer in order to ensure a tight seal. Facial features such as scars, hollow temples, very prominent cheekbones, deep skin creases, dentures or missing teeth, and the chewing of gum and tobacco may interfere with the respirator-to-face seal. A respirator shall *not* be worn when such conditions prevent a good seal. The workers' diligence in observing these factors shall be evaluated by periodic checks.

For a qualitative respirator fit testing protocol, see Appendix D of the OSHA lead standard (29 CFR Part 1910.1025). For quantitative fit testing, see the NIOSH publication *A Guide to Industrial Respiratory Protection* [10]. For specific quantitative testing protocols, literature supplied by manufacturers of quantitative fit test equipment should be consulted. Note that certain OSHA standards require quantitative fit testing under specific circumstances (e.g., 29 CFR Parts 1910.1018(h)(3)(iii), 1910.1025(f)(3)(ii), and 1910.1045(h)(3)(iii)(B)).

In-Use Monitoring

The wearer must understand all aspects of the clothing operation and its limitations; this is especially important for fully-encapsulating ensembles where misuse could potentially result in suffocation.

During equipment use, workers should be encouraged to report any perceived problems or difficulties to their supervisor(s). These malfunctions include, but are not limited to:

- Degradation of the protective ensemble.
- Perception of odors.
- Skin irritation.
- Unusual residues on PPE.
- Discomfort.
- Resistance to breathing.
- Fatigue due to respirator use.
- Interference with vision or communication.
- Restriction of movement.
- Personal responses such as rapid pulse, nausea, and chest pain.

If a supplied-air respirator is being used, all hazards that might endanger the integrity of the air line should be removed from the working area prior to use. During use, air lines should be kept as short as possible and other workers and vehicles should be excluded from the area.

Doffing an Ensemble

Exact procedures for removing fully-encapsulating suit/SCBA ensembles must be established and followed in order to prevent contaminant migration from the work area and transfer of contaminants to the wearer's body, the doffing assistant, and others.

Table 8-8. Sample Doffing Procedures[a]

If sufficient air supply is available to allow appropriate decontamination before removal:

1. Remove any extraneous or disposable clothing, boot covers, outer gloves, and tape.
2. Have assistant loosen and remove the wearer's safety shoes or boots.
3. Have assistant open the suit completely and lift the hood over the head of the wearer and rest it on top of the SCBA tank.
4. Remove arms, one at a time, from suit. Once arms are free, have assistant lift the suit up and away from the SCBA backpack—avoiding any contact between the outside surface of the suit and the wearer's body—and lay the suit out flat behind the wearer. Leave internal gloves on, if any.
5. Sitting, if possible, remove both legs from the suit.
6. Follow procedure for doffing SCBA.
7. After suit is removed, remove internal gloves by rolling them off the hand, inside out.
8. Remove internal clothing and thoroughly cleanse the body.

If the low-pressure warning alarm has sounded, signifying that approximately 5 minutes of air remain:

1. Remove disposable clothing.
2. Quickly scrub and hose off, especially around the entrance/exit zipper.
3. Open the zipper enough to allow access to the regulator and breathing hose.
4. Immediately attach an appropriate canister to the breathing hose (the type and fittings should be predetermined). Although this provides some protection against any contamination still present, it voids the certification of the unit.
5. Follow Steps 1 through 8 of the regular doffing procedure above. Take extra care to avoid contaminating the assistant and wearer.

[a]Source = Based on reference [9].

Sample doffing procedures are provided in Table 8-8. These procedures should be performed only after decontamination of the suited worker (see Chapter 10, *Decontamination*). They require a suitably attired assistant. Throughout the procedures, both worker and assistant should avoid any direct contact with the outside surface of the suit.

Clothing Reuse

Chemicals that have begun to permeate clothing during use may not be removed during decontamination and may continue to diffuse through the material towards the inside surface, presenting the hazard of direct skin contact to the next person who uses the clothing.

Where such potential hazards may develop, clothing should be checked inside and out for discoloration or other evidence of contamination (see next section, *Inspection*). This is particularly important for fully-encapsulating suits, which are generally subject to reuse due to their cost. Note, however, that negative (i.e., no chemical found) test results do not necessarily preclude the possibility that some absorbed chemical will reach the suit's interior.

At present, little documentation exists regarding clothing reuse. Reuse decisions must consider the known factors of permeation rates as well as the toxicity of the contaminant(s). In fact, unless extreme care is taken to ensure that clothing is properly decontaminated and that the decontamination does not degrade the material, the reuse of chemical protective clothing that has been contaminated with toxic chemicals is not advisable [4].

Inspection

An effective PPE inspection program will probably feature five different inspections:

- Inspection and operational testing of equipment received from the factory or distributor.
- Inspection of equipment as it is issued to workers.
- Inspection after use or training and prior to maintenance.
- Periodic inspection of stored equipment.
- Periodic inspection when a question arises concerning the appropriateness of the selected equipment, or when problems with similar equipment arise.

Each inspection will cover somewhat different areas in varying degrees of depth. Detailed inspection procedures, where appropriate, are usually available from the manufacturer. The inspection checklists provided in Table 8-9 may also be an aid.

Records must be kept of all inspection procedures. Individual identification numbers should be assigned to all reusable pieces of equipment (respirators may already have ID numbers) and records should be maintained by that number. At a minimum, each inspection should record the ID number, date, inspector, and any unusual conditions or findings. Periodic review of these records may indicate an item or type of item with excessive maintenance costs or a particularly high level of "down-time."

Storage

Clothing and respirators must be stored properly to prevent damage or malfunction due to exposure to dust, moisture, sunlight, damaging chemicals, extreme temperatures, and impact. Procedures must be specified for both pre-issuance warehousing and, more importantly, post-issuance (in-use) storage. Many equipment failures can be directly attributed to improper storage.

Clothing:

- Potentially contaminated clothing should be stored in an area separate from street clothing.
- Potentially contaminated clothing should be stored in a well-ventilated area, with good air flow around each item, if possible.
- Different types and materials of clothing and gloves should be stored separately to prevent issuing the wrong material by mistake.
- Protective clothing should be folded or hung in accordance with manufacturers' recommendations.

Respirators:

- SCBAs, supplied-air respirators, and air-purifying respirators should be dismantled, washed, and disinfected after each use.

Table 8-9. Sample PPE Inspection Checklists

CLOTHING

Before use:

- Determine that the clothing material is correct for the specified task at hand.
- Visually inspect for:
  - —imperfect seams
  - —non-uniform coatings
  - —tears
  - —malfunctioning closures
- Hold up to light and check for pinholes.
- Flex product:
  - —observe for cracks
  - —observe for other signs of shelf deterioration
- If the product has been used previously, inspect inside and out for signs of chemical attack:
  - —discoloration
  - —swelling
  - —stiffness

During the work task, periodically inspect for:

- Evidence of chemical attack such as discoloration, swelling, stiffening, and softening. Keep in mind, however, that chemical permeation can occur without any visible effects.
- Closure failure.
- Tears.
- Punctures.
- Seam discontinuities.

GLOVES

- BEFORE USE, pressurize glove to check for pinholes. Either blow into glove, then roll gauntlet towards fingers or inflate glove and hold under water. In either case, no air should escape.

FULLY-ENCAPSULATING SUITS

Before use:

- Check the operation of pressure relief valves.
- Inspect the fitting of wrists, ankles, and neck.
- Check faceshield, if so equipped, for:
  - —cracks
  - —crazing
  - —fogginess

RESPIRATORS

SCBA

- Inspect SCBAs:
  - —before and after each use
  - —at least monthly when in storage
  - —every time they are cleaned
- Check all connections for tightness.
- Check material conditions for:
  - —signs of pliability
  - —signs of deterioration
  - —signs of distortion
- Check for proper setting and operation of regulators and valves (according to manufacturers' recommendations).
- Check operation of alarm(s).
- Check faceshields and lenses for:
  - —cracks
  - —crazing
  - —fogginess

Table 8-9. (cont.)

Supplied-Air Respirators

- Inspect SARs:
  - daily when in use
  - at least monthly when in storage
  - every time they are cleaned
- Inspect air lines prior to each use for cracks, kinks, cuts, frays, and weak areas.
- Check for proper setting and operation of regulators and valves (according to manufacturers' recommendations).
- Check all connections for tightness.
- Check material conditions for:
  - signs of pliability
  - signs of deterioration
  - signs of distortion
- Check faceshields and lenses for:
  - cracks
  - crazing
  - fogginess

Air-Purifying Respirators

- Inspect air-purifying respirators:
  - before each use to be sure they have been adequately cleaned
  - after each use
  - during cleaning
  - monthly if in storage for emergency use
- Check material conditions for:
  - signs of pliability
  - signs of deterioration
  - signs of distortion
- Examine cartridges or canisters to ensure that:
  - they are the proper type for the intended use
  - the expiration date has not been passed
  - they have not been opened or used previously
- Check faceshields and lenses for:
  - cracks
  - crazing
  - fogginess

- SCBAs should be stored in storage chests supplied by the manufacturer. Air-purifying respirators should be stored individually in their original cartons or carrying cases, or in heat-sealed or resealable plastic bags.

Maintenance

The technical depth of maintenance procedures vary. Manufacturers frequently restrict the sale of certain PPE parts to individuals or groups who are specially trained, equipped, and "authorized" by the manufacturer to purchase them. Explicit procedures should be adopted to ensure that the appropriate level of maintenance is performed only by individuals having this specialized training and equipment. The following classification scheme is often used to divide maintenance into three levels:

- Level 1: User or wearer maintenance, requiring a few common tools or no tools at all.
- Level 2: Shop maintenance that can be performed by the employer's maintenance shop.
- Level 3: Specialized maintenance that can be performed only by the factory or an authorized repair person.

Heat Stress and Other Physiological Factors

Wearing PPE puts a hazardous waste worker at considerable risk of developing heat stress. This can result in health effects ranging from transient heat fatigue to serious illness or death. Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, and the individual characteristics of the worker. Because heat stress is probably one of the most common (and potentially serious) illnesses at hazardous waste sites, regular monitoring and other preventive precautions are vital.

Individuals vary in their susceptibility to heat stress. Factors that may predispose someone to heat stress include:

- Lack of physical fitness.
- Lack of acclimatization.
- Age.
- Dehydration.
- Obesity.
- Alcohol and drug use.
- Infection.
- Sunburn.
- Diarrhea.
- Chronic disease.

Reduced work tolerance and the increased risk of excessive heat stress is directly influenced by the amount and type of PPE worn. PPE adds weight and bulk, severely reduces the body's access to normal heat exchange mechanisms (evaporation, convection, and radiation), and increases energy expenditure. Therefore, when selecting PPE, each item's benefit should be carefully evaluated in relation to its potential for increasing the risk of heat stress. Once PPE is selected, the safe duration of work/rest periods should be determined based on the:

- Anticipated work rate.
- Ambient temperature and other environmental factors.
- Type of protective ensemble.
- Individual worker characteristics and fitness.

Monitoring

Because the incidence of heat stress depends on a variety of factors, all workers, even those not wearing protective equipment, should be monitored.

- For workers wearing permeable clothing (e.g., standard cotton or synthetic work clothes), follow recommendations for monitoring requirements and suggested work/rest schedules in the current American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values for Heat Stress [11]. If the actual clothing worn differs from the ACGIH standard ensemble in insulation value and/or wind and vapor permeability, change the monitoring requirements and work/rest schedules accordingly [12].

- For workers wearing semipermeable or impermeable[1] encapsulating ensembles, the ACGIH standard cannot be used. For these situations, workers should be monitored when the temperature in the work area is above 70°F (21°C) [6].

To monitor the worker, measure:

- Heart rate. Count the radial pulse during a 30-second period as early as possible in the rest period.

  If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.

  If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the following work cycle by one-third [12].

- Oral temperature. Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).

  If oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period.

  If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third [12].

  Do *not* permit a worker to wear a semipermeable or impermeable garment when his/her oral temperature exceeds 100.6°F (38.1°C)[12].

- Body water loss, if possible. Measure weight on a scale accurate to ±0.25 lb at the beginning and end of each work day to see if enough fluids are being taken to prevent dehydration. Weights should be taken while the employee wears similar clothing or, ideally, is nude. *The body water loss should not exceed 1.5 percent total body weight loss in a work day* [12].

Initially, the frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work (see Table 8-10). The length of the work cycle will be governed by the frequency of the required physiological monitoring.

Prevention

Proper training and preventive measures will help avert serious illness and loss of work productivity. Preventing heat stress is particularly important because once someone suffers from heat stroke or heat exhaustion, that person may be predisposed to additional heat injuries. To avoid heat stress, management should take the following steps:

- Adjust work schedules:

  Modify work/rest schedules according to monitoring requirements.

  Mandate work slowdowns as needed.

  Rotate personnel: alternate job functions to minimize overstress or overexertion at one task.

  Add additional personnel to work teams.

  Perform work during cooler hours of the day if possible or at night if adequate lighting can be provided.

- Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods.

- Maintain workers' body fluids at normal levels. This is necessary to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water lost in sweat, i.e., 8 fluid ounces (0.23 liters) of water must be ingested for approximately every 8 ounces (0.23 kg) of weight lost. The normal thirst mechanism is not sensitive enough to ensure that enough water will be drunk to replace lost sweat [14]. When heavy sweating occurs, encourage the worker to drink more. The following strategies may be useful:

  Maintain water temperature at 50° to 60°F (10° to 15.6°C).

  Provide small disposable cups that hold about 4 ounces (0.1 liter).

  Have workers drink 16 ounces (0.5 liters) of fluid (preferably water or dilute drinks) before beginning work.

  Urge workers to drink a cup or two every 15 to 20 minutes, or at each monitoring break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day are recommended, but more may be necessary to maintain body weight.

  Weigh workers before and after work to determine if fluid replacement is adequate.

- Encourage workers to maintain an optimal level of physical fitness:

  Where indicated, acclimatize workers to site work conditions: temperature, protective clothing, and workload (see *Level of Acclimatization* at the end of this chapter).

  Urge workers to maintain normal weight levels.

- Provide cooling devices to aid natural body heat exchange during prolonged work or severe heat exposure. Cooling devices include:

  Field showers or hose-down areas to reduce body temperature and/or to cool off protective clothing.

  Cooling jackets, vests, or suits (see Table 8-5 for details).

- Train workers to recognize and treat heat stress. As part of training, identify the signs and symptoms of heat stress (see Table 8-11).

Other Factors

PPE decreases worker performance as compared to an unequipped individual. The magnitude of this effect varies considerably, depending on both the individual and the PPE ensemble used. This section discusses the demonstrated physiological responses to PPE, the individual human characteristics that play a factor in these

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[1] Although no protective ensemble is "completely" impermeable, for practical purposes an outfit may be considered impermeable when calculating heat stress risk.

Table 8-10. Suggested Frequency of Physiological Monitoring for Fit and Acclimatized Workers[a]

ADJUSTED TEMPERATURE[b]	NORMAL WORK ENSEMBLE[c]	IMPERMEABLE ENSEMBLE
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5°-90°F (30.8°-32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5°-87.5°F (28.1°-30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5°-82.5°F (25.3°-28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5°-77.5°F (22.5°-25.3°C)	After each 150 minutes of work	After each 120 minutes of work

Source: Reference [13].

[a] For work levels of 250 kilocalories/hour.

[b] Calculate the adjusted air temperature (ta adj) by using this equation: ta adj °F = ta °F + (13 × % sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows.)

[c] A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.

Table 8-11. Signs and Symptoms of Heat Stress[a]

- **Heat rash** may result from continuous exposure to heat or humid air.
- **Heat cramps** are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include:
  - muscle spasms
  - pain in the hands, feet, and abdomen
- **Heat exhaustion** occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include:
  - pale, cool, moist skin
  - heavy sweating
  - dizziness
  - nausea
  - fainting
- **Heat stroke** is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury and death occur. Competent medical help must be obtained. Signs and symptoms are:
  - red, hot, usually dry skin
  - lack of or reduced perspiration
  - nausea
  - dizziness and confusion
  - strong, rapid pulse
  - coma

[a] Source: Reference [6].

responses, and some of the precautionary and training measures that need to be taken to avoid PPE-induced injury.

The physiological factors may affect worker ability to function using PPE include:

- Physical condition.
- Level of acclimatization.
- Age.
- Gender.
- Weight.

Physical Condition

Physical fitness is a major factor influencing a person's ability to perform work under heat stress. The more fit someone is, the more work they can safely perform. At a given level of work, a fit person, relative to an unfit person, will have [5,8,15,16]:

- Less physiological strain.
- A lower heart rate.
- A lower body temperature, which indicates less retained body heat (a rise in internal temperature precipitates heat injury).
- A more efficient sweating mechanism.
- Slightly lower oxygen consumption.
- Slightly lower carbon dioxide production.

Level of Acclimatization

The degree to which a worker's body has physiologically adjusted or acclimatized to working under hot conditions affects his or her ability to do work. Acclimatized individuals generally have lower heart rates and body temperatures than unacclimatized individuals [17], and sweat sooner and more profusely. This enables them to maintain lower skin and body temperatures at a given level of environmental heat and work loads than unacclimatized workers [18]. Sweat composition also becomes more dilute with acclimatization, which reduces salt loss [8].

Acclimatization can occur after just a few days of exposure to a hot environment [15,16]. NIOSH recommends a progressive 6-day acclimatization period for the unacclimatized worker before allowing him/her to do full work on a hot job [16]. Under this regimen, the first day of work on site is begun using only 50 percent of the anticipated workload and exposure time, and 10 percent is added each day through day 6 [16]. With fit or trained individuals, the acclimatization period may be shortened 2 or 3 days. However, workers can lose acclimitization in a matter of days, and work regimens should be adjusted to account for this.

When enclosed in an impermeable suit, fit acclimatized individuals sweat more profusely than unfit or unacclimatized individuals and may therefore actually face a greater danger of heat exhaustion due to rapid dehydration. This can be prevented by consuming adequate quantities of water. See previous section on *Prevention* for additional information.

Age
Generally, maximum work capacity declines with increasing age, but this is not always the case. Active, well-conditioned seniors often have performance capabilities equal to or greater than young sedentary individuals. However, there is some evidence, indicated by lower sweat rates and higher body core temperatures, that older individuals are less effective in compensating for a given level of environmental heat and work loads [19]. At moderate thermal loads, however, the physiological responses of "young" and "old" are similar and performance is not affected [19].

Age should not be the sole criterion for judging whether or not an individual should be subjected to moderate heat stress. Fitness level is a more important factor.

Gender
The literature indicates that females tolerate heat stress at least as well as their male counterparts [20]. Generally, a female's work capacity averages 10 to 30 percent less than that of a male [8]. The primary reasons for this are the greater oxygen-carrying capacity and the stronger heart in the male [15]. However, a similar situation exists as with aging: not all males have greater work capacities than all females.

Weight
The ability of a body to dissipate heat depends on the ratio of its surface area to its mass (surface area/weight). Heat loss (dissipation) is a function of surface area and heat production is dependent on mass. Therefore, heat balance is described by the ratio of the two.

Since overweight individuals (those with a low ratio) produce more heat per unit of surface area than thin individuals (those with a high ratio), overweight individuals should be given special consideration in heat stress situations. However, when wearing impermeable clothing, the weight of an individual is not a critical factor in determining the ability to dissipate excess heat.

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9. Site Control

Contents

Introduction

The purpose of site control is to minimize potential contamination of workers, protect the public from the site's hazards, and prevent vandalism. Site control is especially important in emergency situations. This chapter describes the basic components of a program to control the activities and movements of people and equipment at a hazardous waste site.

Several site control procedures can be implemented to reduce worker and public exposure to chemical, physical, biologic, and safety hazards:

- Compile a site map.
- Prepare the site for subsequent activities.
- Establish work zones.
- Use the buddy system when necessary.
- Establish and strictly enforce decontamination procedures for both personnel and equipment (see Chapter 10, *Decontamination*).
- Establish site security measures.
- Set up communication networks.
- Enforce safe work practices.

This chapter, based on EPA's *Standard Operating Safety Guides* [1], discusses general aspects of these eight control measures.

The degree of site control necessary depends on site characteristics, site size, and the surrounding community. The site control program should be established in the planning stages of a project and modified based on new information and site assessments (see Chapter 6, *Site Characterization*). The appropriate sequence for implementing these measures should be determined on a site-specific basis. In many cases, it will be necessary to implement several measures simultaneously.

Site Map

A site map showing topographic features, prevailing wind direction, drainage, and the location of buildings, containers, impoundments, pits, ponds, and tanks is helpful in:

- Planning activities.
- Assigning personnel.
- Identifying access routes, evacuation routes, and problem areas.
- Identifying areas of the site that require use of personal protective equipment.
- Supplementing the daily safety and health briefings of the field teams.

The map should be prepared prior to site entry and updated throughout the course of site operations to reflect:

- Accidents.
- Changes in site activities.
- Emergencies.
- Hazards not previously identified.
- New materials introduced on site.
- Vandalism.
- Weather conditions.

Overlays can be used to help portray information without cluttering the map.

Site Preparation

Time and effort must be spent in preparing a site for the cleanup activity to ensure that response operations go smoothly and that worker safety is protected. Site preparation can be as hazardous as site cleanup. Therefore, safety measures should be afforded the same level of care at this stage as during actual cleanup. Table 9-1 presents the major steps in site preparation prior to any cleanup activities.

Site Work Zones

To reduce the accidental spread of hazardous substances by workers from the contaminated area to the clean area, zones should be delineated on the site where different types of operations will occur, and the flow of personnel among the zones should be controlled. The establishment of work zones will help ensure that: personnel are properly protected against the hazards present where they are working, work activities and contamination are confined to the appropriate areas, and personnel can be located and evacuated in an emergency.

Hazardous waste sites should be divided into as many different zones as needed to meet operational and safety objectives. For illustration, this manual describes three frequently used zones:

- *Exclusion Zone*, the contaminated area.

Table 9-1. Site Preparation

- Construct roadways to provide ease of access and a sound roadbed for heavy equipment and vehicles.
- Arrange traffic flow patterns to ensure safe and efficient operations.
- Eliminate physical hazards from the work area as much as possible, including:
  - ignition sources in flammable hazard areas.
  - exposed or ungrounded electrical wiring, and low overhead wiring that may entangle equipment.
  - sharp or protruding edges, such as glass, nails, and torn metal, which can puncture protective clothing and equipment and inflict puncture wounds.
  - debris, holes, loose steps or flooring, protruding objects, slippery surfaces, or unsecured railings, which can cause falls, slips, and trips.
  - unsecured objects, such as bricks and gas cylinders, near the edges of elevated surfaces, such as catwalks, roof tops, and scaffolding, which may dislodge and fall on workers.
  - debris and weeds that obstruct visibility.
- Install skid-resistant strips and other anti-skid devices on slippery surfaces.
- Construct operation pads for mobile facilities and temporary structures.
- Construct loading docks, processing and staging areas, and decontamination pads.
- Provide adequate illumination for work activities. Equip temporary lights with guards to prevent accidental contact.
- Install all wiring and electrical equipment in accordance with the National Electric Code.

- *Contamination Reduction Zone* (CRZ), the area where decontamination takes place.
- *Support Zone*, the uncontaminated area where workers should not be exposed to hazardous conditions.

Delineation of these three zones should be based on sampling and monitoring results and on an evaluation of potential routes and amount of contaminant dispersion in the event of a release. Movement of personnel and equipment among these zones should be minimized and restricted to specific Access Control Points to prevent cross-contamination from contaminated areas to clean areas. A schematic representation of the layout of work zones is given in Figure 9-1.

Exclusion Zone

The Exclusion Zone is the area where contamination does or could occur. The primary activities performed in the Exclusion Zone are:

- Site characterization, such as mapping, photographing, and sampling.
- Installation of wells for groundwater monitoring.
- Cleanup work, such as drum movement, drum staging, and materials bulking.

The outer boundary of the Exclusion Zone, called the Hotline, should be established according to the criteria listed in Table 9-2. It should be clearly marked by lines, placards, hazard tape and/or signs; or enclosed by physical barriers, such as chains, fences, or ropes. Access Control Points should be established at the periphery of the Exclusion Zone to regulate the flow of personnel and equipment into and out of the zone and to help verify that proper procedures for entering and exiting are followed. If feasible, separate entrances and exits should be established to separate personnel and equipment movement into and out of the Exclusion Zone.

The Exclusion Zone can be subdivided into different areas of contamination based on the known or expected type and degree of hazard or on the incompatibility of waste streams. This allows more flexibility in safety requirements, operations, decontamination procedures, and use of resources.

The personnel working in the Exclusion Zone may include the Field Team Leader, the work parties, and specialized personnel such as heavy equipment operators. All personnel within the Exclusion Zone should wear the level of protection required by the Site Safety Plan. Within the zone, different levels of protection may be justified based on the degree of hazard presented. The level of personal protection required in each subarea (see Chapter 8, *Personal Protective Equipment*) should be specified and marked.

The required level of protection in the Exclusion Zone varies according to job assignment. For example, a worker who collects samples from open containers might require Level B protection, while one that performs walk-through ambient air monitoring might only need Level C protection. When appropriate, different levels of protection within the Exclusion Zone should be assigned to promote a more flexible, effective, and less costly operation, while still maintaining a high degree of safety.

Contamination Reduction Zone

The Contamination Reduction Zone (CRZ) is the transition area between the contaminated area and the clean area. This zone is designed to reduce the probability that the clean Support Zone will become contaminated or affected by other site hazards. The distance between the Exclusion and Support Zones provided by the CRZ, together with decontamination of workers and equipment, limits the physical transfer of hazardous substances into clean areas. The boundary between the CRZ and the Exclusion Zone is called the Hotline. The degree of contamination in the CRZ decreases as one moves from the Hotline to the Support Zone, due both to the distance and the decontamination procedures.

Decontamination procedures take place in a designated area within the CRZ called the Contamination Reduction Corridor (CRC). They begin at the Hotline. At least two lines of decontamination stations should be set up within the CRC: one for personnel and one for heavy equipment. A large operation may require more than two lines. Access into and out of the CRZ from the Exclusion Zone is through Access Control Points: one each for personnel and equipment entrance, one each for personnel and equipment exit, if feasible.

The boundary between the Support Zone and the CRZ, called the Contamination Control Line, separates the possibly low contamination area from the clean Support Zone. Access to the CRZ from the Support Zone is through two Access Control Points if feasible: one each for personnel and equipment. Personnel entering the CRZ

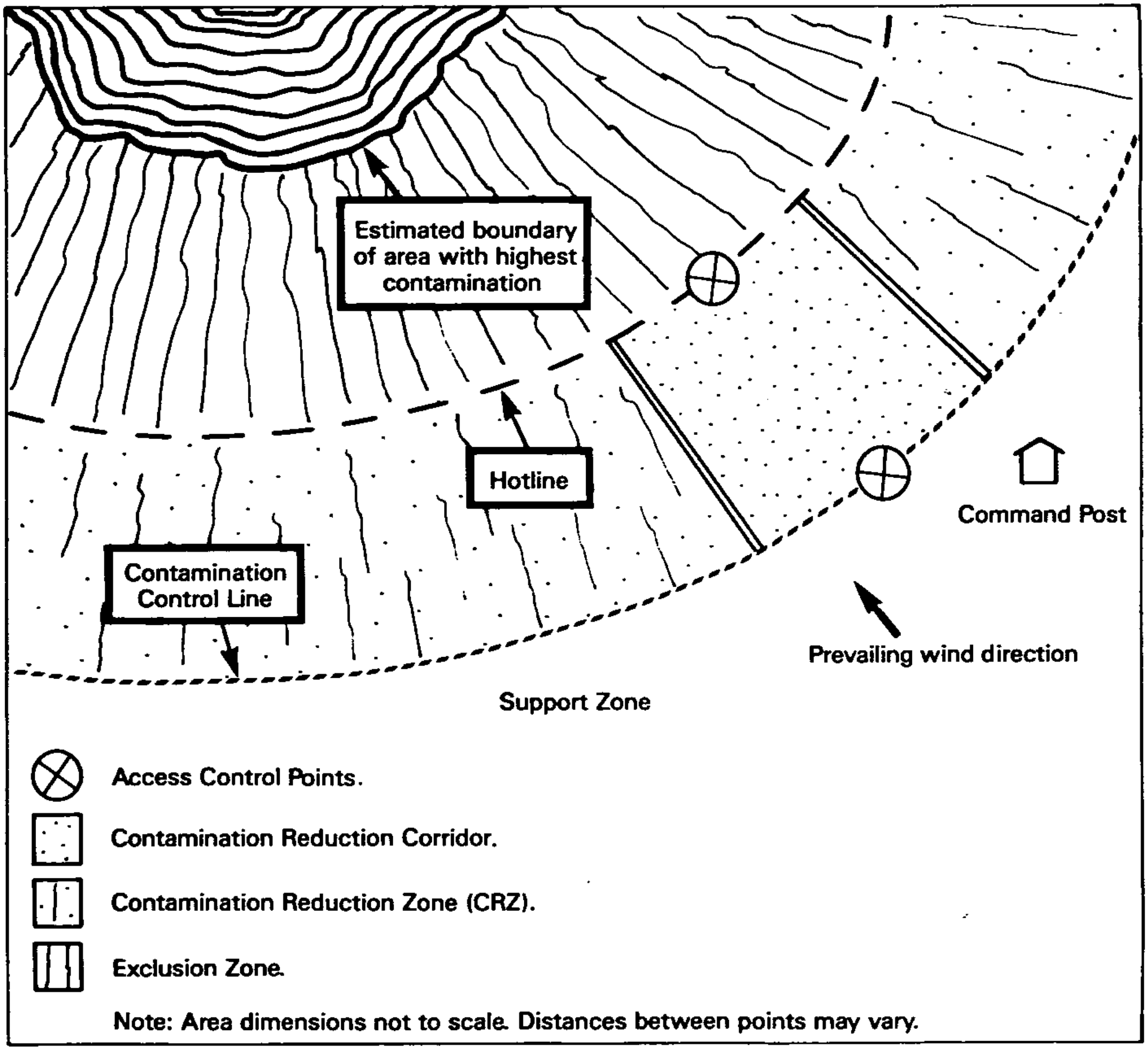


Figure 9-1. Site Work Zones. (Note that decontamination facilities are located in the Contamination Reduction Zone.)

should be required to wear the personal protective clothing and equipment prescribed for working in the CRZ. To reenter the Support Zone, workers should remove any protective clothing and equipment worn in the CRZ, and leave through the personnel exit Access Control Point.

The personnel stationed in the CRZ are usually the Site Safety Officer, a Personnel Decontamination Station (PDS) Operator, and the emergency response personnel. Additional personnel may assist the PDS Operator by conducting abbreviated decontamination procedures for sample containers.

The CRZ must be well designed to facilitate:

- Decontamination of equipment, PDS operators, personnel, and samples.
- Emergency response: transport for injured personnel (safety harness, stretcher), first-aid equipment (such as bandages, blankets, eye wash, splints, and water), containment equipment (absorbent, fire extinguisher).
- Equipment resupply: air tank changes, personal protective clothing and equipment (such as booties and gloves), sampling equipment (such as bottles and glass rods), and tools.
- Sample packaging and preparation for onsite or offsite laboratories.
- Worker temporary rest area: toilet facilities, bench, chair, liquids, and shade. Water and other potable liquids should be clearly marked and stored properly to ensure that all glasses and cups are

Table 9-2. Establishing the Hotline

- Visually survey the immediate site environs.
- Determine the locations of:
  - —hazardous substances
  - —drainage, leachate, and spilled material
  - —visible discolorations
- Evaluate data from the initial site survey indicating the presence of:
  - —combustible gases
  - —organic and inorganic gases, particulates, or vapors
  - —ionizing radiation
- Evaluate the results of soil and water sampling.
- Consider the distances needed to prevent an explosion or fire from affecting personnel outside the Exclusion Zone.
- Consider the distances that personnel must travel to and from the Exclusion Zone.
- Consider the physical area necessary for site operations.
- Consider meteorological conditions and the potential for contaminants to be blown from the area.
- Secure or mark the Hotline.
- Modify its location, if necessary, as more information becomes available.

clean. Wash facilities should be located near drinking facilities to allow employees to wash before drinking. Drinking, washing, and toilet facilities should be located in a safe area where protective clothing can be removed. Facilities should be cleaned and inspected regularly. Appropriate protective measures should be taken by maintenance workers.

- Drainage of water and other liquids that are used during decontamination.

Personnel within the CRZ should be required to maintain internal communications, line-of-sight contact with work parties, work party monitoring (e.g., for air time left, fatigue, heat stress, hypothermia), and site security.

Support Zone

The Support Zone is the location of the administrative and other support functions needed to keep the operations in the Exclusion and Contamination Reduction Zones running smoothly. Any function that need not or cannot be performed in a hazardous or potentially hazardous area is performed here. The Command Post Supervisor should be present in the Support Zone. Other personnel present will depend on the functions being performed, and may include the Project Team Leader and field team members who are preparing to enter or who have returned from the Exclusion Zone.

Personnel may wear normal work clothes within this zone. Any potentially contaminated clothing, equipment, and samples must remain in the CRZ until decontaminated.

Support Zone personnel are responsible for alerting the proper agency in the event of an emergency. All emergency telephone numbers, change for the telephone (if necessary), evacuation route maps, and vehicle keys should be kept in the Support Zone.

Support facilities, listed in Table 9-3, are located in the Support Zone. To place these facilities, consider factors such as:

- Accessibility. Topography, open space available, locations of highways and railroad tracks, ease of access for emergency vehicles.
- Resources. Adequate roads, power lines, telephones, shelter, and water.
- Visibility. Line-of-sight to all activities in the Exclusion Zone.
- Wind direction. Upwind of the Exclusion Zone, if possible.
- Distance. As far from the Exclusion Zone as practicable.

The Buddy System

Most activities in contaminated or otherwise hazardous areas should be conducted with a buddy who is able to:

- Provide his or her partner with assistance.
- Observe his or her partner for signs of chemical or heat exposure.
- Periodically check the integrity of his or her partner's protective clothing.
- Notify the Command Post Supervisor or others if emergency help is needed.

The Access Control Point for personnel entrance to the Exclusion Zone is a convenient location for enforcing the buddy system for two reasons: enforcement is the responsibility of the Project Team Leader, who is stationed in the CRZ, and all personnel who enter the contaminated area must pass through the control point.

The buddy system alone may not be sufficient to ensure that help will be provided in an emergency. At all times, workers in the Exclusion Zone should be in line-of-sight contact or communications contact with the Command Post Supervisor or backup person in the Support Zone.

Site Security

Site security is necessary to:

- Prevent the exposure of unauthorized, unprotected people to site hazards.
- Avoid the increased hazards from vandals or persons seeking to abandon other wastes on the site.
- Prevent theft.
- Avoid interference with safe working procedures.

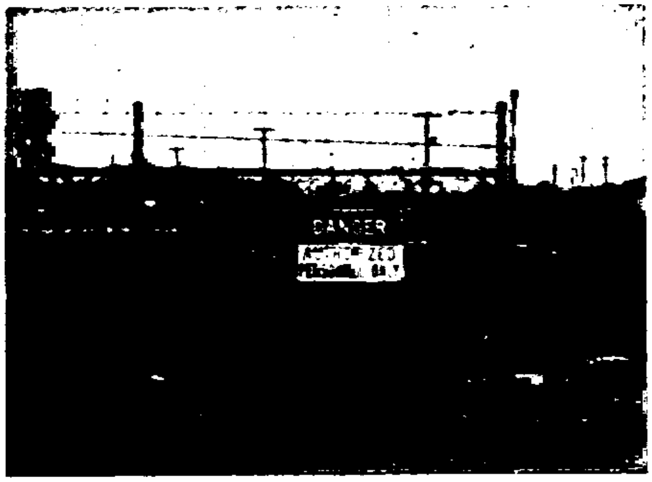
To maintain site security during working hours:

- Maintain security in the Support Zone and at Access Control Points.
- Establish an identification system to identify authorized persons and limitations to their approved activities.
- Assign responsibility for enforcing authority for entry and exit requirements.

- Erect a fence or other physical barrier around the site.
- If the site is not fenced, post signs around the perimeter and use guards to patrol the perimeter. Guards must be fully apprised of the hazards involved and trained in emergency procedures.
- Have the Project Team Leader approve all visitors to the site. Make sure they have a valid purpose for entering the site. Have trained site personnel accompany visitors at all times and provide them with the appropriate protective equipment.

To maintain site security during off-duty hours:

- If possible, assign trained, in-house technicians for site surveillance. They will be familiar with the site, the nature of the work, the site's hazards, and respiratory protection techniques.
- If necessary, use security guards to patrol the site boundary. Such personnel may be less expensive than trained technicians, but will be more difficult to train in safety procedures and will be less confident in reacting to problems around hazardous substances.
- Enlist public enforcement agencies, such as the local police department, if the site presents a significant risk to local health and safety.
- Secure the equipment.



Warning signs and fences help to prevent exposure of unauthorized and unprotected people to site hazards.

Table 9-3. Support Zone Activities

FACILITY	FUNCTION
Command Post	Supervision of all field operations and field teams. Maintenance of communications, including emergency lines of communication. Recordkeeping, including: —accident reports —chain-of-custody records —daily logbooks —manifest directories and orders —medical records —personnel training records —site inventories —site safety map —up-to-date Site Safety Plans Providing access to up-to-date safety and health manuals and other reference materials. Interfacing with the public: government agencies, local politicians, medical personnel, the media, and other interested parties. Monitoring work schedules and weather changes. Maintaining site security. Sanitary facilities.
Medical Station	First-aid administration. Medical emergency response. Medical monitoring activities. Sanitary facilities.
Equipment and Supply Centers	Supply, maintenance, and repair of communications, respiratory, and sampling equipment. Maintenance and repair of vehicles. Replacement of expendable supplies. Storage of monitoring equipment and supplies. Storage may be here or in an onsite field laboratory.
Administration	Sample shipment. Interface with home office. Maintenance of emergency telephone numbers, evacuation route maps, and vehicle keys. Coordination with transporters, disposal sites, and appropriate federal, state, and local regulatory agencies.
Field Laboratory	Coordination and processing of environmental and hazardous waste samples. Copies of the sampling plans and procedures should be available for quick reference in the laboratory. Packaging of materials for analysis following the decontamination of the outsides of the sample containers which should be done in the CRZ. This packaging can also be done in a designated location in the CRZ. Shipping papers and chain-of-custody files should be kept in the Command Post. Maintenance and storage of laboratory notebooks in designated locations in the laboratory while in use, and in the Command Post when not in use.

Communication Systems

Two sets of communication systems should be established: internal communication among personnel on site, and external communication between onsite and offsite personnel.

Internal communication is used to:

- Alert team members to emergencies.
- Pass along safety information, such as the amount of air time left before the next rest period, air change, heat stress check, etc.
- Communicate changes in the work to be accomplished.
- Maintain site control.

Verbal communication at a site can be impeded by onsite background noise and the use of personal protective equipment. For example, speech transmission through a respirator can be poor, and hearing can be impaired by protective hoods and respirator air flow. For effective communication, commands must be pre-arranged. In addition, audio or visual cues can help convey the message. The most important thing is that signals are agreed to in advance.

Table 9-4 lists common internal communication devices. Both a primary and backup system are necessary. A set of signals should be established for use only during emergencies (see Table 12-4 in Chapter 12 for examples).

Effective internal communication also requires the identification of individual workers so that commands can be addressed to the right worker. The worker's name should be marked on the suit and, for long-distance identification, color coding, numbers, or symbols can be added. Flags may be used to help locate personnel in areas where visibility is poor due to obstructions such as accumulated drums, equipment, and waste piles.

All communication devices used in a potentially explosive atmosphere must be intrinsically safe (see footnote in Table 9-4) and not capable of sparking, and should be checked daily to ensure that they are operating.

An external communication system between onsite and offsite personnel is necessary to:

- Coordinate emergency response.
- Report to management.
- Maintain contact with essential offsite personnel.

The primary means of external communication are telephone and radio. If telephone lines are not installed at a site, all team members should know the location of the nearest telephone, and the correct change and necessary telephone numbers should be readily available in the Support Zone.

Table 9-4. Internal Communication Devices

Radio[a]
- Citizen's band
- FM

Noisemakers, including:
- Bell
- Compressed air horn
- Megaphone
- Siren
- Whistle

Visual signals, including:
- Flag
- Flares or smoke[b]
- Hand signals
- Lights
- Signal board
- Whole body movements

[a] All radios used in the Exclusion and Contamination Reduction Zones must be certified as intrinsically safe for the situation of intended use [2,3].

[b] Only from the Support Zone.

Table 9-5. Sample Standing Orders

For Personnel Entering the Contamination Reduction Zone:

No smoking, eating, drinking, or application of cosmetics in this zone.

No matches or lighters in this zone.

Check in at the entrance Access Control Point before you enter this zone.

Check out at the exit Access Control Point before you leave this zone.

For Personnel Entering the Exclusion Zone:

No smoking, eating, drinking, or application of cosmetics in this zone.

No matches or lighters in this zone.

Check in at the entrance Access Control Point before you enter this zone.

Check out at the exit Access Control Point before you leave this zone.

Always have your buddy with you in this zone.

Wear an SCBA in this zone.

If you discover any signs of radioactivity, explosivity, or unusual conditions such as dead animals at the site, exit immediately and report this finding to your supervisor.

Safe Work Practices

To maintain a strong safety awareness and enforce safe procedures at a site, a list of standing orders should be developed which state the practices that must always be followed and those that must never occur in the contaminated areas on site. Separate standing orders should be developed for the Contamination Reduction Zone and the Exclusion Zone if the hazards are sufficiently different. Sample standing orders are given in Table 9-5. To ensure that everyone who enters the site is aware of these orders and that a high degree of familiarity with their content is maintained, the list should be:

- Distributed to everyone who enters the site.
- Posted conspicuously at the Command Post.
- Posted conspicuously at the entrance Access Control Points into the Contamination Reduction Zone and/or the Exclusion Zone.
- Reviewed by the Field Team Leader or Project Team Leader with the field crew at the beginning of each work day. In this way, personnel are immediately informed of any new standing orders

resulting from a change in site conditions or work activities.

In addition to the standing orders, a hazardous substance information form that lists the names and properties of chemicals present on site should be prepared and posted conspicuously. Employees should be briefed on the chemical information at the beginning of the project or whenever they first join the work team. Daily safety meetings should be held for all employees.

Working with tools and heavy equipment is a major hazard at sites. Injuries can result from equipment hitting or running over personnel, impacts from flying objects, burns from hot objects, and damage to protective equipment such as supplied-air respirator systems (see Chapter 8). The following precautions will help preclude injuries due to such hazards:

- Train personnel in proper operating procedures.
- Install adequate onsite roads, signs, lights, and devices.
- Install appropriate equipment guards and engineering controls on tools and equipment. These include rollover protective structures, seat belts, emergency shutoff in case of rollover, and backup warning lights and signals.
- Provide equipment such as cranes, derricks, and power shovels with signs saying "Unlawful to operate this equipment within 10 feet of all power lines."
- Use equipment and tools that are intrinsically safe (see footnote in Table 9-4) and not capable of sparking, and pneumatically and hydraulically driven equipment.
- Where portable electric tools and appliances can be used, (i.e., where there is no potential for flammable or explosive conditions), use three-wire grounded extension cords to prevent electric shocks.
- In hydraulic power tools, use fire-resistant fluid that is capable of retaining its operating characteristics at the most extreme temperatures.
- At the start of each work day, inspect brakes, hydraulic lines, light signals, fire extinguishers, fluid levels, steering, and splash protection.
- Keep all non-essential people out of the work area.
- Prohibit loose-fitting clothing or loose long hair around moving machinery.
- Keep cabs free of all non-essential items and secure all loose items.
- Do *not* exceed the rated load capacity of a vehicle.
- Instruct equipment operators to report to their supervisor(s) any abnormalities such as equipment failure, oozing liquids, unusual odors, etc.
- When an equipment operator must negotiate in tight quarters, provide a second person to ensure adequate clearance.
- Have a signalman direct backing as necessary.
- All onsite internal combustion engines should have spark arrestors that meet requirements for hazardous atmospheres. Refuel in safe areas. Do *not* fuel engines while vehicle is running. Prohibit ignition sources near a fuel area.
- Lower all blades and buckets to the ground and set parking brakes before shutting off the vehicle.
- Implement an ongoing maintenance program for all tools and equipment. Inspect all tools and moving equipment regularly to ensure that parts are secured and intact with no evidence of cracks or areas of weakness, that the equipment turns smoothly with no evidence of wobble, and that it is operating according to manufacturer's specifications. Promptly repair or replace any defective items. Keep maintenance and repair logs.
- Store tools in clean, secure areas so that they will not be damaged, lost, or stolen.
- Keep all heavy equipment that is used in the Exclusion Zone in that zone until the job is done. Completely decontaminate such equipment before moving it into the clean zone.

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10. Decontamination

Contents

Introduction

Decontamination—the process of removing or neutralizing contaminants that have accumulated on personnel and equipment—is critical to health and safety at hazardous waste sites. Decontamination protects workers from hazardous substances that may contaminate and eventually permeate the protective clothing, respiratory equipment, tools, vehicles, and other equipment used on site; it protects all site personnel by minimizing the transfer of harmful materials into clean areas; it helps prevent mixing of incompatible chemicals; and it protects the community by preventing uncontrolled transportation of contaminants from the site.

This chapter describes the types of contamination that workers may encounter at a waste site, the factors that influence the extent of contamination, and methods for preventing or reducing contamination. In addition, this chapter provides general guidelines for designing and selecting decontamination procedures at a site, and it presents a decision aid for evaluating the health and safety aspects of decontamination methods. The chapter does not cover decontamination of radioactively contaminated personnel or equipment. A health physicist should be consulted if this situation arises.

Decontamination Plan

A decontamination plan should be developed (as part of the Site Safety Plan) and set up before any personnel or equipment may enter areas where the potential for exposure to hazardous substances exists. The decontamination plan should:

- Determine the number and layout of decontamination stations.
- Determine the decontamination equipment needed.
- Determine appropriate decontamination methods.
- Establish procedures to prevent contamination of clean areas.
- Establish methods and procedures to minimize worker contact with contaminants during removal of personal protective clothing and equipment (PPE).
- Establish methods for disposing of clothing and equipment that are not completely decontaminated.

The plan should be revised whenever the type of personal protective clothing or equipment changes, the site conditions change, or the site hazards are reassessed based on new information.

Prevention of Contamination

The first step in decontamination is to establish Standard Operating Procedures that minimize contact with waste and thus the potential for contamination. For example:

- Stress work practices that minimize contact with hazardous substances (e.g., do *not* walk through areas of obvious contamination, do *not* directly touch potentially hazardous substances).
- Use remote sampling, handling, and container-opening techniques (e.g., drum grapplers, pneumatic impact wrenches).
- Protect monitoring and sampling instruments by bagging. Make openings in the bags for sample ports and sensors that must contact site materials.
- Wear disposable outer garments and use disposable equipment where appropriate.
- Cover equipment and tools with a strippable coating which can be removed during decontamination.
- Encase the source of contaminants, e.g., with plastic sheeting or overpacks.

In addition, Standard Operating Procedures should be established that maximize worker protection. For example, proper procedures for dressing prior to entering the Exclusion Zone will minimize the potential for contaminants to bypass the protective clothing and escape decontamination. In general, all fasteners should be used (i.e., zippers fully closed, all buttons used, all snaps closed, etc.). Gloves and boots should be tucked under the sleeves and legs of outer clothing, and hoods (if not attached) should be worn outside the collar. Another pair of tough outer gloves is often worn over the sleeves. All junctures should be taped to prevent contaminants from running inside the gloves, boots, and jackets (or suits, if one-piece construction).

Prior to each use, the personal protective equipment (PPE) should be checked to ensure that it contains no cuts or punctures that could expose workers to wastes. Similarly, any injuries to the skin surface, such as cuts and scratches, may enhance the potential for chemicals or infectious agents that directly contact the worker's skin to penetrate into the body. Particular care should be taken to protect these areas. Workers with large areas of damaged skin should be kept from working on site until the skin heals.

All personnel should be trained in the Standard Operating Procedures for minimizing contact and maximizing worker protection, and these procedures should be enforced throughout site operations.

Types of Contamination

Contaminants can be located either on the surface of personal protective equipment or permeated into the PPE material. Surface contaminants may be easy to detect and remove; however, contaminants that have permeated a material are difficult or impossible to detect and remove. If contaminants that have permeated a material are not removed by decontamination, they may continue to permeate to either surface of the material where they can cause an unexpected exposure.

Five major factors affect the extent of permeation:

- Contact time. The longer a contaminant is in contact with an object, the greater the probability and extent of permeation. For this reason, minimizing contact time is one of the most important objectives of a decontamination program.
- Concentration. Molecules flow from areas of high concentration to areas of low concentration. As concentrations of wastes increase, the potential for permeation of personal protective clothing increases.
- Temperature. An increase in temperature generally increases the permeation rate of contaminants.
- Size of contaminant molecules and pore space. Permeation increases as the contaminant molecule becomes smaller, and as the pore space of the material to be permeated increases.
- Physical state of wastes. As a rule, gases, vapors, and low-viscosity liquids tend to permeate more readily than high-viscosity liquids or solids.

Decontamination Methods

All personnel, clothing, equipment, and samples leaving the contaminated area of a site (generally referred to as the Exclusion Zone) must be decontaminated to remove any harmful chemicals or infectious organisms that may have adhered to them. Decontamination methods either (1) physically remove contaminants, (2) inactivate contaminants by chemical detoxification or disinfection/sterilization, or (3) remove contaminants by a combination of both physical and chemical means. Various decontamination methods are listed in Table 10-1.

Physical Removal

In many cases, gross contamination can be removed by physical means involving dislodging/displacement, rinsing, wiping off, and evaporation. Physical methods involving high pressure and/or heat should be used only as necessary and with caution since they can spread contamination and cause burns. Contaminants that can be removed by physical means can be categorized as follows:

- Loose contaminants. Dusts and vapors that cling to equipment and workers or become trapped in small openings, such as the weave of the clothing fabrics, can be removed with water or a liquid rinse (see photograph). Removal of electrostatically attached materials can be enhanced by coating the clothing or equipment with anti-static solutions. These are available commercially as wash additives or anti-static sprays.
- Adhering contaminants. Some contaminants adhere by forces other than electrostatic attraction. Adhesive qualities vary greatly with the specific contaminants and the temperature. For example, contaminants such as glues, cements, resins, and muds have much greater adhesive properties than elemental mercury and, consequently, are difficult to remove by physical means. Physical removal methods for gross contaminants include scraping, brushing, and wiping. Removal of adhesive contaminants can be enhanced through certain methods such as solidifying, freezing (e.g., using dry ice or ice water), adsorption or absorption (e.g., with powdered lime or kitty litter), or melting.
- Volatile liquids. Volatile liquid contaminants can be removed from protective clothing or equipment by evaporation followed by a water rinse. Evaporation of volatile liquids can be enhanced by using steam jets. With any evaporation or vaporization process, care must be taken to prevent worker inhalation of the vaporized chemicals.

Table 10-1. Some Decontamination Methods

REMOVAL

- **Contaminant Removal**
  - Water rinse, using pressurized or gravity flow.
  - Chemical leaching and extraction.
  - Evaporation/vaporization.
  - Pressurized air jets.
  - Scrubbing/scraping. Commonly done using brushes, scrapers, or sponges and water-compatible solvent cleaning solutions.
  - Steam jets.
- **Removal of Contaminated Surfaces**
  - Disposal of deeply permeated materials, e.g., clothing, floor mats, and seats.
  - Disposal of protective coverings/coatings.

INACTIVATION

- **Chemical Detoxification**
  - Halogen stripping.
  - Neutralization.
  - Oxidation/reduction.
  - Thermal degradation.
- **Disinfection/Sterilization**
  - Chemical disinfection.
  - Dry heat sterilization.
  - Gas/vapor sterilization.
  - Irradiation.
  - Steam sterilization.

Gross contaminants can be removed with water or a liquid rinse. Here, a member of the decontamination team rinses and scrubs the boots of a worker with a soft-bristled brush. Both individuals are wearing Level C personal protective equipment.

Chemical Removal

Physical removal of gross contamination should be followed by a wash/rinse process using cleaning solutions. These cleaning solutions normally utilize one or more of the following methods:

- Dissolving contaminants. Chemical removal of surface contaminants can be accomplished by dissolving them in a solvent. The solvent must be chemically compatible with the equipment being cleaned. This is particularly important when decontaminating personal protective clothing constructed of organic materials that could be damaged or dissolved by organic solvents. In addition, care must be taken in selecting, using, and disposing of any organic solvents that may be flammable or potentially toxic. Organic solvents include alcohols, ethers, ketones, aromatics, straight-chain alkanes, and common petroleum products.

  Halogenated solvents generally are incompatible with personal protective equipment and are toxic. They should only be used for decontamination in extreme cases where other cleaning agents will not remove the contaminant.

  Table 10-2 provides a general guide to the solubility of several contaminant categories in four types of solvents: water, dilute acids, dilute bases, and organic solvents. Because of the potential hazards, decontamination using chemicals should be done only if recommended by an industrial hygienist or other qualified health professional.

- Surfactants. Surfactants augment physical cleaning methods by reducing adhesion forces between contaminants and the surface being cleaned, and by preventing redeposit of the contaminants. Household detergents are among the most common surfactants. Some detergents can be used with organic solvents to improve the dissolving and dispersal of contaminants into the solvent [1].
- Solidification. Solidifying liquid or gel contaminants can enhance their physical removal. The mechanisms of solidification are: (1) moisture removal through the use of absorbents such as grounded clay or powdered lime; (2) chemical reactions via polymerization catalysts and chemical reagents; and (3) freezing using ice water.

Table 10-2. General Guide to Solubility of Contaminants in Four Solvent Types

SOLVENT	SOLUBLE CONTAMINANTS
Water	Low-chain hydrocarbons. Inorganic compounds. Salts. Some organic acids and other polar compounds.
Dilute Acids	Basic (caustic) compounds. Amines. Hydrazines.
Dilute Bases For example: —detergent —soap	Acidic compounds. Phenols. Thiols. Some nitro and sulfonic compounds.
Organic Solvents[a] For example: —alcohols —ethers —ketones —aromatics —straight-chain alkanes (e.g., hexane) —common petroleum products (e.g., fuel oil, kerosene)	Nonpolar compounds (e.g., some organic compounds).

[a]WARNING: Some organic solvents can permeate and/or degrade the protective clothing.

- Rinsing. Rinsing removes contaminants through dilution, physical attraction, and solubilization. Multiple rinses with clean solutions remove more contaminants than a single rinse with the same volume of solution. Continuous rinsing with large volumes will remove even more contaminants than multiple rinsings with a lesser total volume.
- Disinfection/Sterilization. Chemical disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization techniques are generally impractical for large equipment and for personal protective clothing and equipment. For this reason, disposable PPE is recommended for use with infectious agents.

Many factors, such as cost, availability, and ease of implementation, influence the selection of a decontamination method. From a health and safety standpoint, two key questions must be addressed:

- Is the decontamination method effective for the specific substances present?
- Does the method itself pose any health or safety hazards?

Testing for the Effectiveness of Decontamination

Decontamination methods vary in their effectiveness for removing different substances. The effectiveness of any decontamination method should be assessed at the beginning of a program and periodically throughout the lifetime of the program. If contaminated materials are not being removed or are penetrating protective clothing, the decontamination program must be revised. The following methods may be useful in assessing the effectiveness of decontamination.

Visual Observation

There is no reliable test to immediately determine how effective decontamination is. In some cases, effectiveness can be estimated by visual observation.

- Natural light. Discolorations, stains, corrosive effects, visible dirt, or alterations in clothing fabric may indicate that contaminants have not been removed. However, not all contaminants leave visible traces; many contaminants can permeate clothing and are not easily observed.
- Ultraviolet light. Certain contaminants, such as polycyclic aromatic hydrocarbons, which are common in many refined oils and solvent wastes, fluoresce and can be visually detected when exposed to ultraviolet light. Ultraviolet light can be used to observe contamination of skin, clothing, and equipment; however, certain areas of the skin may fluoresce naturally, thereby introducing an uncertainty into the test [2,3,4]. In addition, use of ultraviolet light can increase the risk of skin cancer and eye damage; therefore, a qualified health professional should assess the benefits and risks associated with ultraviolet light prior to its use at a waste site.

Wipe Sampling

Wipe testing provides after-the-fact information on the effectiveness of decontamination. In this procedure, a dry or wet cloth, glass fiber filter paper, or swab is wiped over the surface of the potentially contaminated object and then analyzed in a laboratory. Both the inner and outer surfaces of protective clothing should be tested. Skin may also be tested using wipe samples.

Cleaning Solution Analysis

Another way to test the effectiveness of decontamination procedures is to analyze for contaminants left in the cleaning solutions. Elevated levels of contaminants in the final rinse solution may suggest that additional cleaning and rinsing are needed.

Testing for Permeation

Testing for the presence of permeated chemical contaminants requires that pieces of the protective garments be sent to a laboratory for analysis.

Health and Safety Hazards

While decontamination is performed to protect health and safety, it can pose hazards under certain circumstances. Decontamination methods may:

- Be incompatible with the hazardous substances being removed (i.e., a decontamination method may react with contaminants to produce an explosion, heat, or toxic products).
- Be incompatible with the clothing or equipment being decontaminated (e.g., some organic solvents can permeate and/or degrade protective clothing).
- Pose a direct health hazard to workers (e.g., vapors from chemical decontamination solutions may be hazardous if inhaled, or they may be flammable).

The chemical and physical compatibility of the decontamination solutions or other decontamination materials must be determined before they are used. Any decontamination method that permeates, degrades, damages, or otherwise impairs the safe functioning of the PPE is incompatible with such PPE and should not be used. If a decontamination method does pose a direct health hazard, measures must be taken to protect both decontamination personnel and the workers being decontaminated. Figure 10-1 presents a decision aid for evaluating the health and safety aspects of decontamination methods.

Decontamination Facility Design

At a hazardous waste site, decontamination facilities should be located in the Contamination Reduction Zone (CRZ), i.e., the area between the Exclusion Zone (the contaminated area) and the Support Zone (the clean area) as shown in Figure 9-1 in Chapter 9.

The level and types of decontamination procedures required depend on several site-specific factors including:

- The chemical, physical, and toxicological properties of the wastes.
- The pathogenicity of infectious wastes.
- The amount, location, and containment of contaminants.
- The potential for, and location of, exposure based on assigned worker duties, activities, and functions.
- The potential for wastes to permeate, degrade, or penetrate materials used for personal protective clothing and equipment, vehicles, tools, buildings, and structures.
- The proximity of incompatible wastes.
- The movement of personnel and/or equipment among different zones.
- Emergencies.
- The methods available for protecting workers during decontamination.

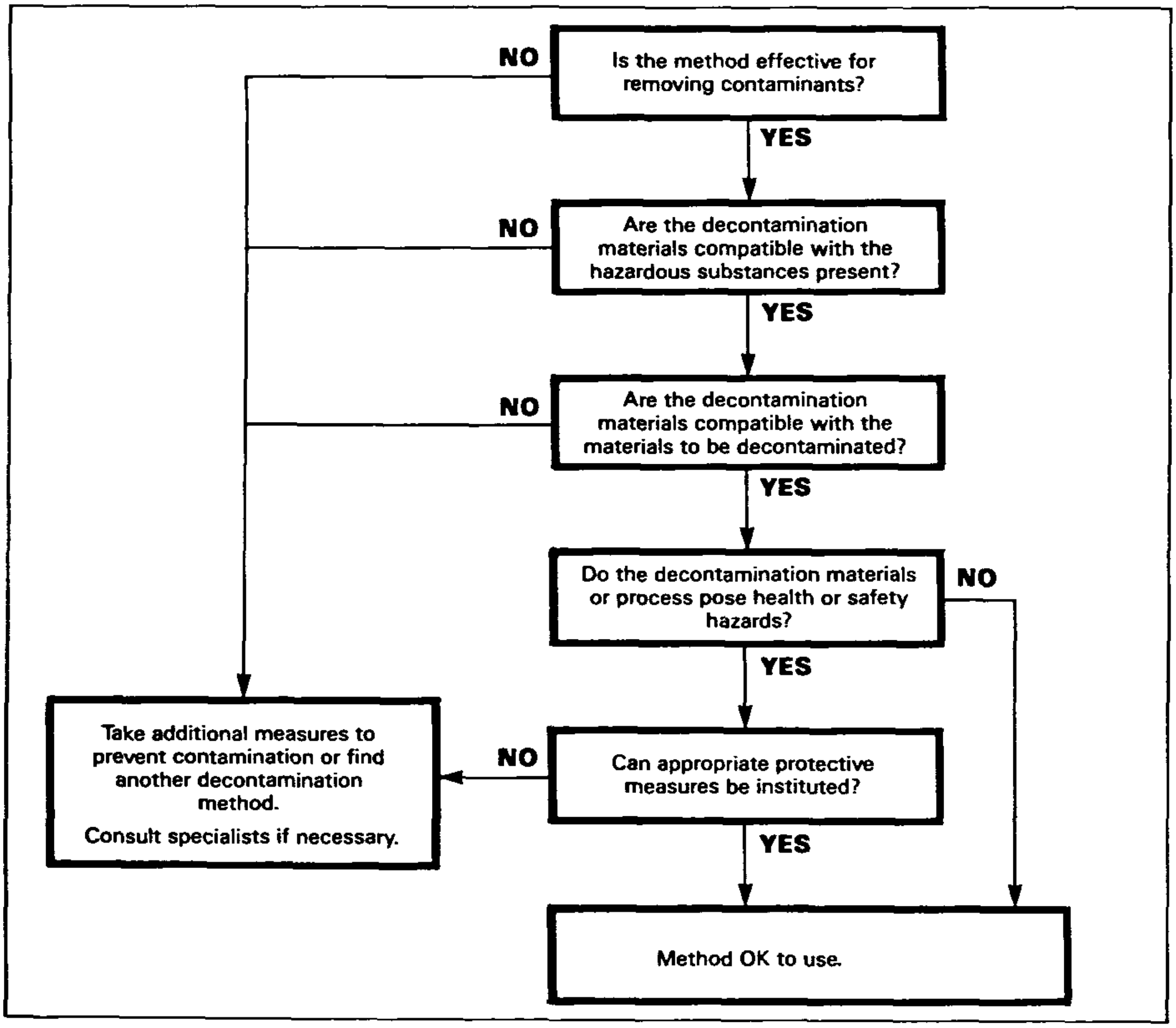

Figure 10-1. Decision Aid for Evaluating Health and Safety Aspects of Decontamination Methods.

- The impact of the decontamination process and compounds on worker safety and health.

Decontamination procedures must provide an organized process by which levels of contamination are reduced. The decontamination process should consist of a series of procedures performed in a specific sequence. For example, outer, more heavily contaminated items (e.g., outer boots and gloves) should be decontaminated and removed first, followed by decontamination and removal of inner, less contaminated items (e.g., jackets and pants). Each procedure should be performed at a separate station in order to prevent cross contamination. The sequence of stations is called the decontamination line.

Stations should be separated physically to prevent cross contamination and should be arranged in order of decreasing contamination, preferably in a straight line. Separate flow patterns and stations should be provided to isolate workers from different contamination zones containing incompatible wastes. Entry and exit points should be conspicuously marked, and the entry to the Contamination Reduction Zone (CRZ) from the Exclusion Zone should be separate from the entry to the Exclusion Zone from the CRZ. Dressing stations for entry to the CRZ should be separate from redressing areas for exit from the CRZ. Personnel who wish to enter clean areas of the decontamination facility, such as locker rooms, should be completely decontaminated.

Examples of decontamination lines and procedures for personnel wearing various levels of protection are provided in Appendix D.

A member of the decontamination team suited in Level B personal protective equipment stands by to scrub down a worker after an initial rinse down in the decontamination shower.

Decontamination Equipment Selection

Table 10-3 lists recommended equipment for decontamination of personnel, personal protective clothing, and equipment. In selecting decontamination equipment, consider whether the equipment itself can be decontaminated for reuse or can be easily disposed of. Table 10-4 lists recommended equipment for decontamination of large equipment and vehicles. Note that other types of equipment not listed in Tables 10-3 and 10-4 may be appropriate in certain situations.

Disposal Methods

All equipment used for decontamination must be decontaminated and/or disposed of properly. Buckets, brushes, clothing, tools, and other contaminated equipment should be collected, placed in containers, and labeled. Also, all spent solutions and wash water should be collected and disposed of properly. Clothing that is not completely decontaminated should be placed in plastic bags, pending further decontamination and/or disposal.

Table 10-3. Some Recommended Equipment for Decontamination of Personnel and Personal Protective Clothing and Equipment

- Drop cloths of plastic or other suitable materials on which heavily contaminated equipment and outer protective clothing may be deposited.
- Collection containers, such as drums or suitably lined trash cans, for storing disposable clothing and heavily contaminated personal protective clothing or equipment that must be discarded.
- Lined box with absorbents for wiping or rinsing off gross contaminants and liquid contaminants.
- Large galvanized tubs, stock tanks, or children's wading pools to hold wash and rinse solutions. These should be at least large enough for a worker to place a booted foot in, and should have either no drain or a drain connected to a collection tank or appropriate treatment system.
- Wash solutions selected to wash off and reduce the hazards associated with the contaminants.
- Rinse solutions selected to remove contaminants and contaminated wash solutions.
- Long-handled, soft-bristled brushes to help wash and rinse off contaminants.
- Paper or cloth towels for drying protective clothing and equipment.
- Lockers and cabinets for storage of decontaminated clothing and equipment.
- Metal or plastic cans or drums for contaminated wash and rinse solutions.
- Plastic sheeting, sealed pads with drains, or other appropriate methods for containing and collecting contaminated wash and rinse solutions spilled during decontamination.
- Shower facilities for full body wash or, at a minimum, personal wash sinks (with drains connected to a collection tank or appropriate treatment system).
- Soap or wash solution, wash cloths, and towels for personnel.
- Lockers or closets for clean clothing and personal item storage.

Personal Protection

Decontamination workers who initially come in contact with personnel and equipment leaving the Exclusion Zone will require more protection from contaminants than decontamination workers who are assigned to the last station in the decontamination line. In some cases, decontamination personnel should wear the same levels of PPE as workers in the Exclusion Zone. In other cases, decontamination personnel may be sufficiently protected by wearing one level lower protection (e.g., wearing Level C protection while decontaminating workers who are wearing Level B).

The level of protection required will vary with the type of decontamination equipment used. For example, workers using a steam jet may need a different type of respiratory protection than other decontamination personnel because of the high moisture levels produced by steam jets. In some situations, the cleaning solutions used and wastes removed during decontamination may generate harmful vapors. Appropriate equipment and clothing for protecting decontamination personnel should be selected by a qualified health and safety expert.

Table 10-4. Some Recommended Equipment for Heavy Equipment and Vehicle Decontamination

- Storage tanks of appropriate treatment systems for temporary storage and/or treatment of contaminated wash and rinse solutions.
- Drains or pumps for collection of contaminated wash and rinse solutions.
- Long-handled brushes for general exterior cleaning.
- Wash solutions selected to remove and reduce the hazards associated with the contamination.
- Rinse solutions selected to remove contaminants and contaminated wash solutions.
- Pressurized sprayers for washing and rinsing, particularly hard-to-reach areas.
- Curtains, enclosures, or spray booths to contain splashes from pressurized sprays.
- Long-handled brushes, rods, and shovels for dislodging contaminants and contaminanted soil caught in tires and the undersides of vehicles and equipment.
- Containers to hold contaminants and contaminated soil removed from tires and the undersides of vehicles and equipment.
- Wash and rinse buckets for use in the decontamination of operator areas inside vehicles and equipment.
- Brooms and brushes for cleaning operator areas inside vehicles and equipment.
- Containers for storage and disposal of contaminated wash and rinse solutions, damaged or heavily contaminated parts, and equipment to be discarded.

All decontamination workers are in a contaminated area and must themselves be decontaminated before entering the clean Support Zone. The extent of their decontamination should be determined by the types of contaminants they may have contacted and the type of work they performed.

Emergency Decontamination

In addition to routine decontamination procedures, emergency decontamination procedures must be established. In an emergency, the primary concern is to prevent the loss of life or severe injury to site personnel. If immediate medical treatment is required to save a life, decontamination should be delayed until the victim is stabilized. If decontamination can be performed without interfering with essential life-saving techniques or first aid, or if a worker has been contaminated with an extremely toxic or corrosive material that could cause severe injury or loss of life, decontamination must be performed immediately. If an emergency due to a heat-related illness develops, protective clothing should be removed from the victim as soon as possible to reduce the heat stress. During an emergency, provisions must also be made for protecting medical personnel and disposing of contaminated clothing and equipment. See Chapter 12 for further information on decontamination during emergencies.

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11. Handling Drums and Other Containers

Contents

Introduction

Accidents may occur during handling of drums and other hazardous waste containers. Hazards include detonations, fires, explosions, vapor generation, and physical injury resulting from moving heavy containers by hand and working around stacked drums, heavy equipment, and deteriorated drums. While these hazards are always present, proper work practices—such as minimizing handling and using equipment and procedures that isolate workers from hazardous substances—can minimize the risks to site personnel.

This chapter defines practices and procedures for safe handling of drums and other hazardous waste containers. It is intended to aid the Project Team Leader in setting up a waste container handling program. In addition to reading this chapter, the Project Team Leader should also be aware of all pertinent regulations. OSHA regulations (29 CFR Parts 1910 and 1926) include general requirements and standards for storing, containing, and handling chemicals and containers, and for maintaining equipment used for handling materials. EPA regulations (40 CFR Part 265) stipulate requirements for types of containers, maintenance of containers and containment structures, and design and maintenance of storage areas. DOT regulations (49 CFR Parts 171 through 178) also stipulate requirements for containers and procedures for shipment of hazardous wastes.

Containers are handled during characterization and removal of their contents and during other operations. A flow chart showing one set of possible procedures for drum handling is given in Figure 11-1. Guidance for safely performing the procedures shown in Figure 11-1 is provided in the following sections of this chapter. The final section, *Special Case Problems*, describes the handling of tanks, vaults, vacuum trucks, elevated tanks, and compressed gas cylinders.

Inspection

The appropriate procedures for handling drums depend on the drum contents. Thus, prior to any handling, drums should be visually inspected to gain as much information as possible about their contents. The inspection crew should look for:

- Symbols, words, or other marks on the drum indicating that its contents are hazardous, e.g., radioactive, explosive, corrosive, toxic, flammable.
- Symbols, words, or other marks on a drum indicating that it contains discarded laboratory chemicals, reagents, or other potentially dangerous materials in small-volume individual containers (see Table 11-1).
- Signs of deterioration such as corrosion, rust, and leaks.
- Signs that the drum is under pressure such as swelling and bulging.
- Drum type (see Table 11-1).
- Configuration of the drumhead (see Table 11-2).

Conditions in the immediate vicinity of the drums may provide information about drum contents and their associated hazards. Monitoring should be conducted around the drums using instruments such as a gamma radiation survey instrument, organic vapor monitors, and a combustible gas meter.

The results of this survey can be used to classify the drums into preliminary hazard categories, for example:

- Radioactive.
- Leaking/deteriorated.
- Bulging.
- Explosive/shock-sensitive.
- Contains small-volume individual containers of laboratory wastes or other dangerous materials.

As a precautionary measure, personnel should assume that unlabelled drums contain hazardous materials until their contents are characterized. Also, they should bear in mind that drums are frequently mislabelled—particularly drums that are reused. Thus, a drum's label may not accurately describe its contents.

If buried drums are suspected, ground-penetrating systems, such as electromagnetic wave, electrical resistivity, ground-penetrating radar, magnetometry, and metal detection, can be used to estimate the location and depth of the drums.

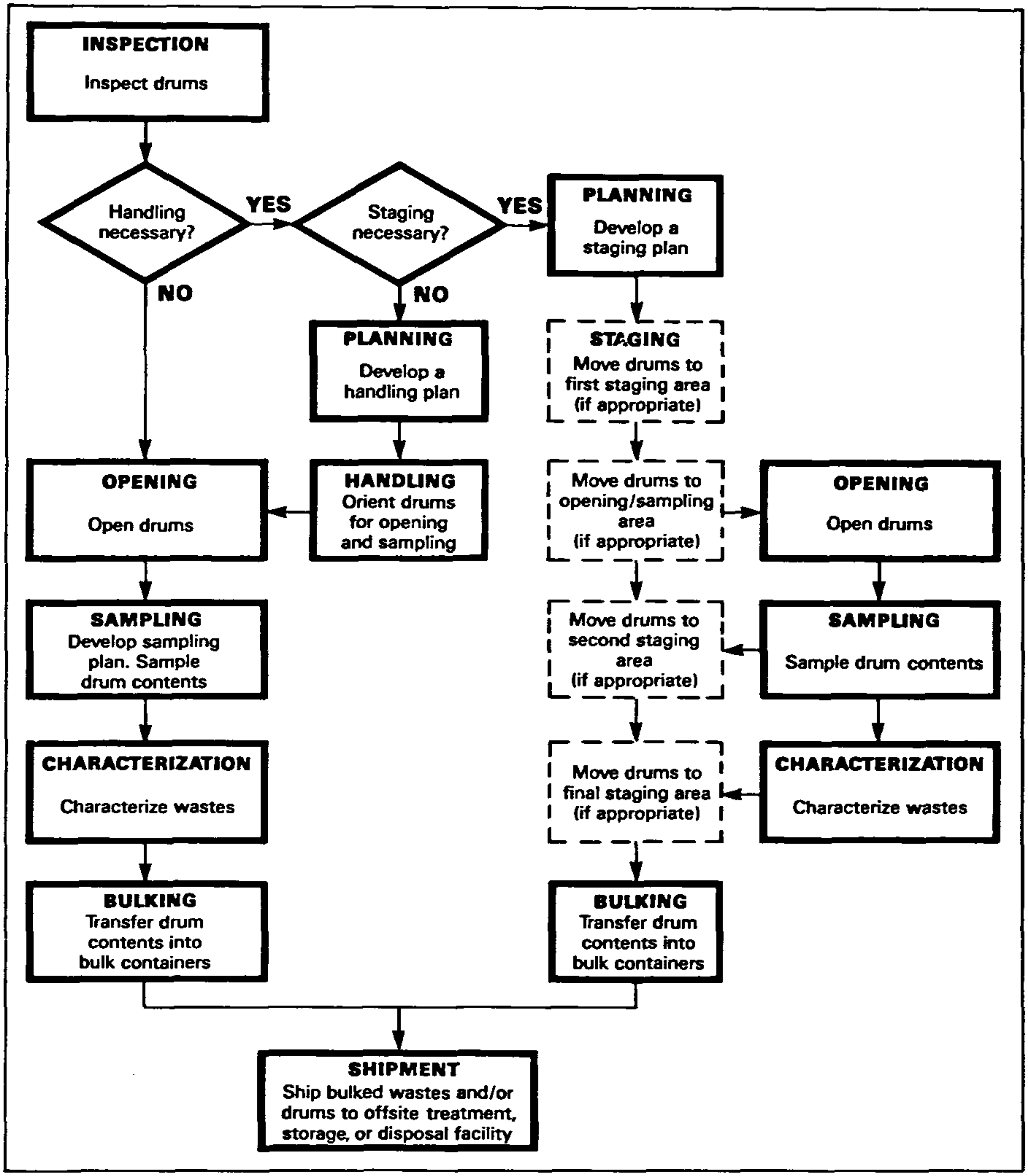


Figure 11-1. Flow Chart for Drum Handling. (Dashed boxes indicate optional steps. Number of staging areas necessary is site specific.)

Table 11-1. Special Drum Types and Their Associated Hazards

Polyethylene or PVC-Lined Drums	Often contain strong acids or bases. If the lining is punctured, the substance usually quickly corrodes the steel, resulting in a significant leak or spill.
Exotic Metal Drums (e.g., aluminum, nickel, stainless, steel, or other unusual metal)	Very expensive drums that usually contain an extremely dangerous material.
Single-Walled Drums Used as a Pressure Vessel	These drums have fittings for both product filling and placement of an inert gas, such as nitrogen. May contain reactive, flammable, or explosive substances.
Laboratory Packs	Used for disposal of expired chemicals and process samples from university laboratories, hospitals, and similar institutions. Individual containers within the lab pack are often not packed in absorbent material. They may contain incompatible materials, radioisotopes, shock-sensitive, highly volatile, highly corrosive, or very toxic exotic chemicals. Laboratory packs can be an ignition source for fires at hazardous waste sites.

Table 11-2. Information Provided by Drumhead Configuration

CONFIGURATION	INFORMATION
Whole lid removable.	Designed to contain solid material.
Has a bung.	Designed to contain a liquid.
Contains a liner.	May contain a highly corrosive or otherwise hazardous material.

Planning

Since drum handling is fraught with danger, every step of the operation should be carefully planned, based on all the information available at the time. The results of the preliminary inspection can be used to determine (1) if any hazards are present and the appropriate response, and (2) which drums need to be moved in order to be opened and sampled. A preliminary plan should be developed which specifies the extent of handling necessary, the personnel selected for the job, and the most appropriate procedures based on the hazards associated with the probable drum contents as determined by visual inspection. This plan should be revised as new information is obtained during drum handling.

Handling

The purpose of handling is to (1) respond to any obvious problems that might impair worker safety, such as radioactivity, leakage, or the presence of explosive substances, (2) unstack and orient drums for sampling, and (3) if necessary, to organize drums into different areas on site to facilitate characterization and remedial action (see *Staging* in this chapter). Handling may or may not be necessary, depending on how the drums are positioned at a site.

Since accidents occur frequently during handling, particularly initial handling, drums should only be handled if necessary. Prior to handling, all personnel should be warned about the hazards of handling, and instructed to minimize handling as much as possible and to avoid unnecessary handling. In all phases of handling, personnel should be alert for new information about potential hazards. These hazards should be responded to before continuing with more routine handling operations. Overpack drums (larger drums in which leaking or damaged drums are placed for storage or shipment [see 49 CFR Part 173.3(c)]) and an adequate volume of absorbent should be kept near areas where minor spills may occur. Where major spills may occur, a containment berm adequate to contain the entire volume of liquid in the drums should be constructed before any handling takes place. If the drum contents spill, personnel trained in spill response should be used to isolate and contain the spill.

Several types of equipment can be used to move drums: (1) A drum grappler attached to a hydraulic excavator; (2) a small front-end loader, which can be either loaded manually or equipped with a bucket sling; (3) a rough terrain forklift; (4) a roller conveyor equipped with solid rollers; and (5) drum carts designed specifically for drum handling. Drums are also sometimes moved manually. The drum grappler is the preferred piece of equipment for drum handling. It keeps the operator removed from the drums so that there is less likelihood of injury if the drums detonate or rupture. If a drum is leaking, the operator can stop the leak by rotating the drum and immediately placing it into an overpack. In case of an explosion, grappler claws help protect the operator by partially deflecting the force of the explosion.

Backhoe with drum grappler.

The following procedures can be used to maximize worker safety during drum handling and movement:

- Train personnel in proper lifting and moving techniques to prevent back injuries.
- Make sure the vehicle selected has sufficient rated load capacity to handle the anticipated loads, and

make sure the vehicle can operate smoothly on the available road surface.

- Air condition the cabs of vehicles to increase operator efficiency; protect the operator with heavy splash shields.
- Supply operators with appropriate respiratory protective equipment when needed. Normally either a combination SCBA/SAR with the air tank fastened to the vehicle, or an airline respirator and an escape SCBA are used because of the high potential hazards of drum handling. This improves operator efficiency and provides protection in case the operator must abandon the equipment.
- Have overpacks ready before any attempt is made to move drums.
- Before moving anything, determine the most appropriate sequence in which the various drums and other containers should be moved. For example, small containers may have to be removed first to permit heavy equipment to enter and move the drums.
- Exercise extreme caution in handling drums that are not intact and tightly sealed.
- Ensure that operators have a clear view of the roadway when carrying drums. Where necessary, have ground workers available to guide the operator's motion.

Drums Containing Radioactive Waste

- If the drum exhibits radiation levels above background (see Table 6-2), immediately contact a health physicist. Do *not* handle any drums that are determined to be radioactive until persons with expertise in this area have been consulted.

Drums that May Contain Explosive or Shock-Sensitive Waste

- If a drum is suspected to contain explosive or shock-sensitive waste as determined by visual inspection, seek specialized assistance before any handling.
- If handling is necessary, handle these drums with *extreme caution.*
- Prior to handling these drums, make sure all non-essential personnel have moved a safe distance away.
- Use a grappler unit constructed for explosive containment for initial handling of such drums.
- Palletize the drums prior to transport. Secure drums to pallets.
- Use an audible siren signal system, similar to that employed in conventional blasting operations, to signal the commencement and completion of explosive waste handling activities.
- Maintain continuous communication with the Site Safety Officer and/or the command post until drum handling operations are complete.

Bulging Drums

- Pressurized drums are extremely hazardous. Wherever possible, do not move drums that may be under internal pressure, as evidenced by bulging or swelling.
- If a pressurized drum has to be moved, whenever possible handle the drum with a grappler unit constructed for explosive containment. Either move the bulged drum only as far as necessary to allow seating on firm ground, or carefully overpack the drum. Exercise extreme caution when working with or adjacent to potentially pressurized drums.

Drums Containing Packaged Laboratory Wastes (Lab Packs)

Laboratory packs (i.e., drums containing individual containers of laboratory materials normally surrounded by cushioning absorbent material) can be an ignition source for fires at hazardous waste sites. They sometimes contain shock-sensitive materials. Such containers should be considered to hold explosive or shock-sensitive wastes until otherwise characterized. If handling is required, the following precautions are among those that should be taken:

- Prior to handling or transporting lab packs, make sure all non-essential personnel have moved a safe distance away.
- Whenever possible, use a grappler unit constructed for explosive containment for initial handling of such drums.
- Maintain continuous communication with the Site Safety Officer and/or the command post until handling operations are complete.
- Once a lab pack has been opened, have a chemist inspect, classify, and segregate the bottles within it, without opening them, according to the hazards of the wastes. An example of a system for classifying lab pack wastes is provided in Table 11-3. The objective of a classification system is to ensure safe segregation of the lab packs' contents. Pack these bottles with sufficient cushioning and absorption materials to prevent excessive movement of the bottles and to absorb all free liquids, and ship them to an approved disposal facility.
- If crystalline material is noted at the neck of any bottle, handle it as a shock-sensitive waste, due to the potential presence of picric acid or other similar material, and get expert advice before attempting to handle it.
- Palletize the repacked drums prior to transport. Secure the drums to pallets.

Leaking, Open, and Deteriorated Drums

- If a drum containing a liquid cannot be moved without rupture, immediately transfer its contents to a sound drum using a pump designed for transfering that liquid.
- Using a drum grappler, place immediately in overpack containers:

  Leaking drums that contain sludges or semi-solids.

  Open drums that contain liquid or solid waste.

  Deteriorated drums that can be moved without rupture.

Table 11-3. Example of Lab Pack Content Classification System for Disposal

CLASSIFICATION	EXAMPLES
Inorganic acids	Hydrochloric Sulfuric
Inorganic bases	Sodium hydroxide Potassium hydroxide
Strong oxidizing agents	Ammonium nitrate Barium nitrate Sodium chlorate Sodium peroxide
Strong reducing agents	Sodium thiosulfate Oxalic acid Sodium sulphite
Anhydrous organics and organometallics	Tetraethyl lead Phenylmercuric chloride
Anhydrous inorganics and metal hydrides	Potassium hydride Sodium hydride Sodium metal Potassium
Toxic organics	PCBs Insecticides
Flammable organics	Hexane Toluene Acetone
Inorganics	Sodium carbonate Potassium chloride
Inorganic cyanides	Potassium cyanide Sodium cyanide Copper cyanide
Organic cyanides	Cyanoacetamide
Toxic metals	Arsenic Cadmium Lead Mercury

Buried Drums

- Prior to initiating subsurface excavation, use ground-penetrating systems to estimate the location and depth of the drums (see *Inspection* in this chapter).
- Remove soil with great caution to minimize the potential for drum rupture.
- Have a dry chemical fire extinguisher on hand to control small fires.

Opening

Drums are usually opened and sampled in place during site investigations. However, remedial and emergency operations may require a separate drum opening area (see *Staging* in this chapter). Procedures for opening drums are the same, regardless of where the drums are opened. To enhance the efficiency and safety of drum-opening personnel, the following procedures should be instituted.

- If a supplied-air respiratory protection system is used, place a bank of air cylinders outside the work area and supply air to the operators via airlines and escape SCBAs. This enables workers to operate in relative comfort for extended periods of time.
- Protect personnel by keeping them at a safe distance from the drums being opened. If personnel must be located near the drums, place explosion-resistant plastic shields between them and the drums to protect them in case of detonation. Locate controls for drum opening equipment, monitoring equipment, and fire suppression equipment behind the explosion-resistant plastic shield.
- If possible, monitor continuously during opening. Place sensors of monitoring equipment, such as colorimetric tubes, dosimeters, radiation survey instruments, explosion meters, organic vapor analyzers, and oxygen meters, as close as possible to the source of contaminants, i.e., at the drum opening.
- Use the following remote-controlled devices for opening drums:

  Pneumatically operated impact wrench to remove drum bungs.

  Hydraulically or pneumatically operated drum piercers (see Figure 11-2).

  Backhoes equipped with bronze spikes for penetrating drum tops in large-scale operations (see Figure 11-3).
- Do *not* use picks, chisels and firearms to open drums.
- Hang or balance the drum opening equipment to minimize worker exertion.
- If the drum shows signs of swelling or bulging, perform all steps slowly. Relieve excess pressure prior to opening and, if possible, from a remote location using such devices as a pneumatic impact wrench or hydraulic penetration device. If pressure must be relieved manually, place a barrier such as explosion-resistant plastic sheeting between the worker and bung to deflect any gas, liquid, or solids which may be expelled as the bung is loosened.

Two drums with rusted bungs were opened by backhoes with bronze spikes and now await sampling. Drum in foreground has been labelled "150" for sample documentation purposes.

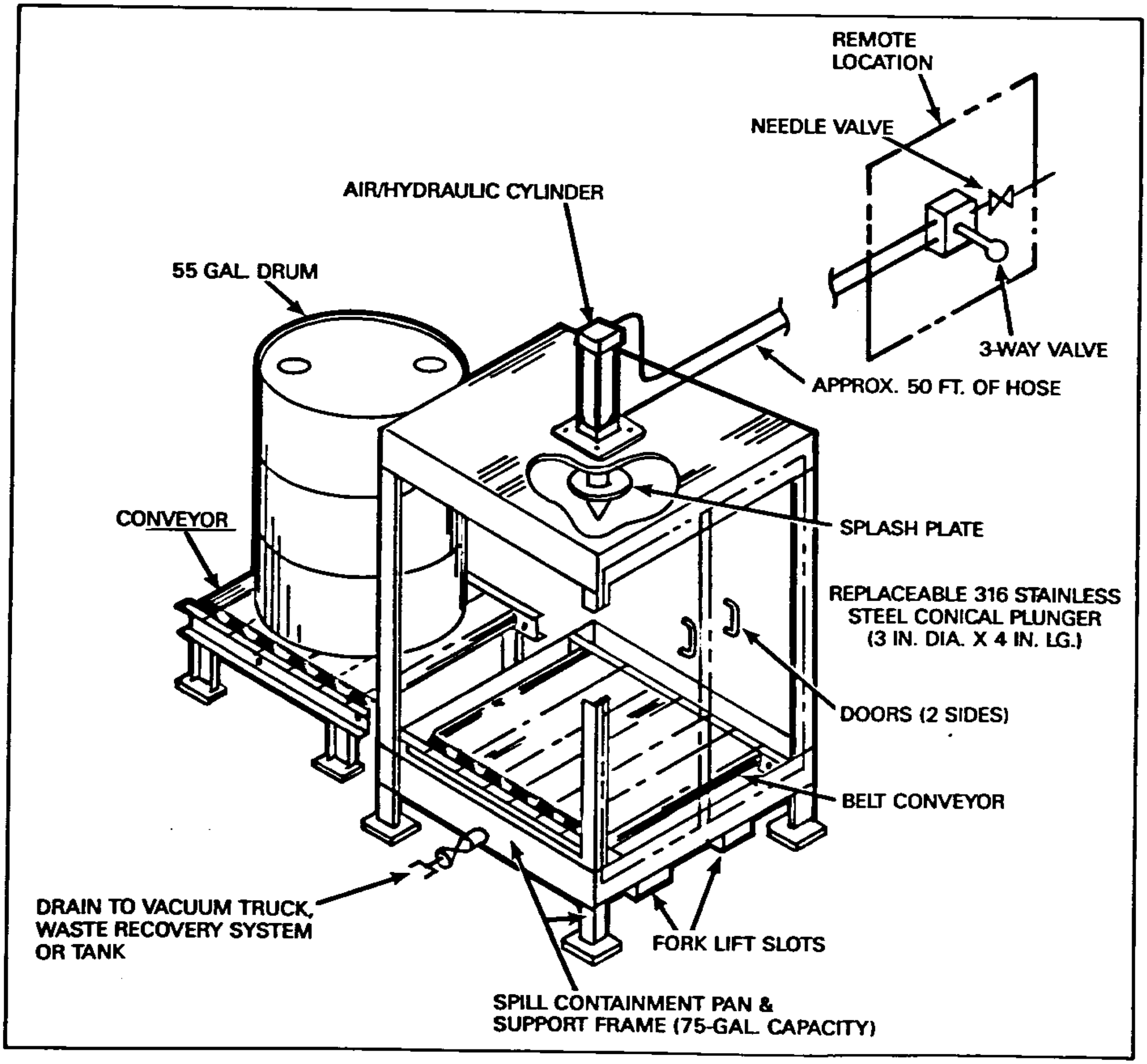


Figure 11-2. Air/Hydraulic-Operated Single-Drum Puncture Device.
Source: Reference [1].

- Open exotic metal drums and polyethylene or polyvinyl chloride-lined (PVC-lined) drums through the bung by removal or drilling. Exercise extreme caution when manipulating these containers.
- Do *not* open or sample individual containers within laboratory packs.
- Reseal open bungs and drill openings as soon as possible with new bungs or plugs to avoid explosions and/or vapor generation. If an open drum cannot be resealed, place the drum into an overpack. Plug any openings in pressurized drums with pressure-venting caps set to a 5-psi (pounds per square inch) release to allow venting of vapor pressure.
- Decontaminate equipment after each use to avoid mixing incompatible wastes.

Sampling

Drum sampling can be one of the most hazardous activities to worker safety and health because it often involves direct contact with unidentified wastes. Prior to collecting any sample, develop a sampling plan:

- Research background information about the waste.
- Determine which drums should be sampled.
- Select the appropriate sampling device(s) and container(s).

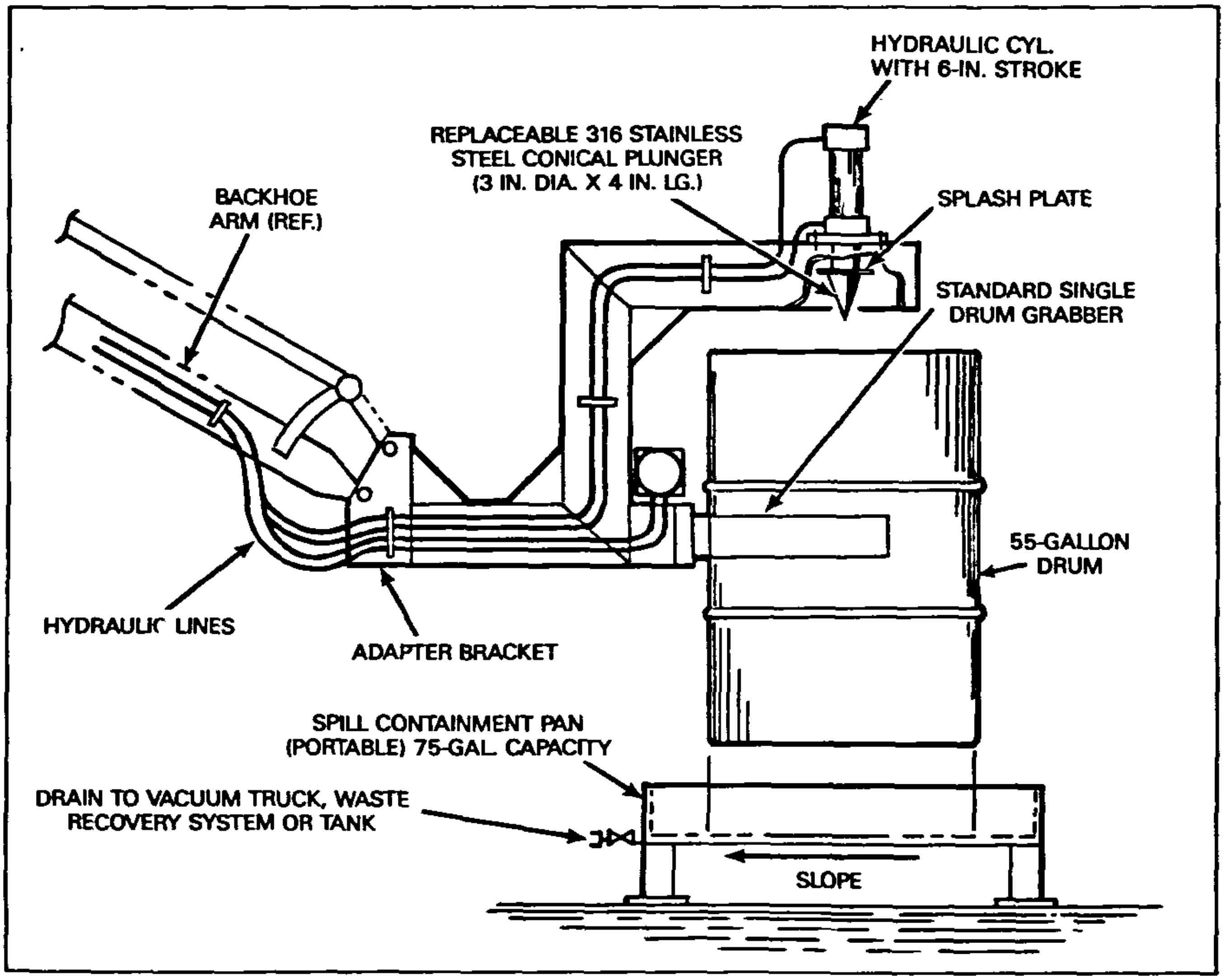


Figure 11-3. Backhoe-Mounted Drum Puncture Device.
Source: Reference [1].

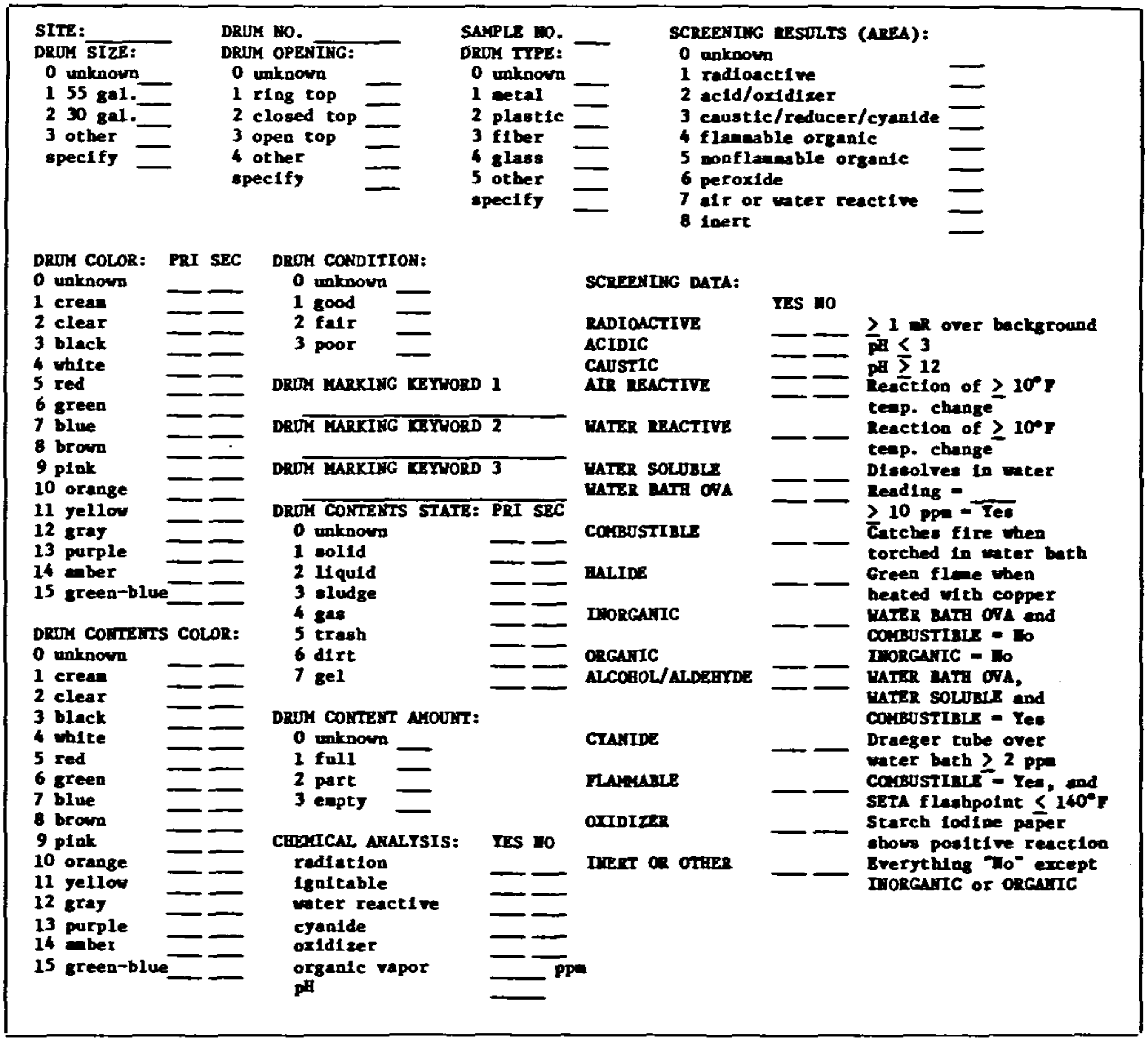
- Develop a sampling plan which includes the number, volume, and locations of samples to be taken.
- Develop Standard Operating Procedures for opening drums, sampling, and sample packaging and transportation. Some guidance in designing proper sampling procedures can be found in References [2] and [3].
- Have a trained health and safety professional determine, based on available information about the wastes and site conditions, the appropriate personal protection to be used during sampling, decontamination, and packaging of the sample.

When manually sampling from a drum, use the following techniques:

- Keep sampling personnel at a safe distance while drums are being opened. Sample only after opening operations are complete.
- Do *not* lean over other drums to reach the drum being sampled, unless absolutely necessary.
- Cover drum tops with plastic sheeting or other suitable noncontaminated materials to avoid excessive contact with the drum tops.
- *Never* stand on drums. This is extremely dangerous. Use mobile steps or another platform to achieve the height necessary to safely sample from the drums.
- Obtain samples with either glass rods or vacuum pumps. Do *not* use contaminated items such as discarded rags to sample. The contaminants may contaminate the sample and may not be compatible with the waste in the drum. Glass rods should be removed prior to pumping to minimize damage to pumps.

Characterization

The goal of characterization is to obtain the data necessary to determine how to safely and efficiently package and transport the wastes for treatment and/or disposal. If wastes are bulked, they must be sufficiently character-



SITE: ________

DRUM SIZE:
0 unknown ___
1 55 gal. ___
2 30 gal. ___
3 other ___
specify ___

DRUM NO. ________

DRUM OPENING:
0 unknown ___
1 ring top ___
2 closed top ___
3 open top ___
4 other ___
specify ___

SAMPLE NO. ___

DRUM TYPE:
0 unknown ___
1 metal ___
2 plastic ___
3 fiber ___
4 glass ___
5 other ___
specify ___

SCREENING RESULTS (AREA):
0 unknown
1 radioactive ___
2 acid/oxidizer ___
3 caustic/reducer/cyanide ___
4 flammable organic ___
5 nonflammable organic ___
6 peroxide ___
7 air or water reactive ___
8 inert ___

DRUM COLOR:	PRI	SEC
0 unknown	___	___
1 cream	___	___
2 clear	___	___
3 black	___	___
4 white	___	___
5 red	___	___
6 green	___	___
7 blue	___	___
8 brown	___	___
9 pink	___	___
10 orange	___	___
11 yellow	___	___
12 gray	___	___
13 purple	___	___
14 amber	___	___
15 green-blue	___	___

DRUM CONTENTS COLOR:		
0 unknown	___	___
1 cream	___	___
2 clear	___	___
3 black	___	___
4 white	___	___
5 red	___	___
6 green	___	___
7 blue	___	___
8 brown	___	___
9 pink	___	___
10 orange	___	___
11 yellow	___	___
12 gray	___	___
13 purple	___	___
14 amber	___	___
15 green-blue	___	___

DRUM CONDITION:
0 unknown ___
1 good ___
2 fair ___
3 poor ___

DRUM MARKING KEYWORD 1 ____________

DRUM MARKING KEYWORD 2 ____________

DRUM MARKING KEYWORD 3 ____________

DRUM CONTENTS STATE:	PRI	SEC
0 unknown	___	___
1 solid	___	___
2 liquid	___	___
3 sludge	___	___
4 gas	___	___
5 trash	___	___
6 dirt	___	___
7 gel	___	___

DRUM CONTENT AMOUNT:
0 unknown ___
1 full ___
2 part ___
3 empty ___

CHEMICAL ANALYSIS:	YES	NO
radiation	___	___
ignitable	___	___
water reactive	___	___
cyanide	___	___
oxidizer	___	___
organic vapor	___ ppm	
pH	___	

SCREENING DATA:

	YES	NO	
RADIOACTIVE	___	___	$\geq$ 1 mR over background
ACIDIC	___	___	pH $\leq$ 3
CAUSTIC	___	___	pH $\geq$ 12
AIR REACTIVE	___	___	Reaction of $\geq$ 10°F temp. change
WATER REACTIVE	___	___	Reaction of $\geq$ 10°F temp. change
WATER SOLUBLE	___	___	Dissolves in water
WATER BATH OVA	___	___	Reading = ___ $\geq$ 10 ppm = Yes
COMBUSTIBLE	___	___	Catches fire when torched in water bath
HALIDE	___	___	Green flame when heated with copper
INORGANIC	___	___	WATER BATH OVA and COMBUSTIBLE = No
ORGANIC	___	___	INORGANIC = No
ALCOHOL/ALDEHYDE	___	___	WATER BATH OVA, WATER SOLUBLE and COMBUSTIBLE = Yes
CYANIDE	___	___	Draeger tube over water bath $\geq$ 2 ppm
FLAMMABLE	___	___	COMBUSTIBLE = Yes, and SETA flashpoint $\leq$ 140°F
OXIDIZER	___	___	Starch iodine paper shows positive reaction
INERT OR OTHER	___	___	Everything "No" except INORGANIC or ORGANIC

Figure 11-4. Sample Drum Characterization Sheet.
Source: EPA Region VII Emergency Planning and Response Branch.
(This figure is provided only as an example. Values were selected by EPA Region VII and should be modified as appropriate.)

ized to determine which of them can be safely combined (see *Bulking* later in this chapter). As a first step in obtaining these data, standard tests should be used to classify the wastes into general categories, including auto-reactives, water reactives, inorganic acids, organic acids, heavy metals, pesticides, cyanides, inorganic oxidizers, and organic oxidizers. In some cases, further analysis should be conducted to more precisely identify the waste materials. See Figure 11-4 for an example of a characterization sheet for drums.

When possible, materials should be characterized using an onsite laboratory. This provides data as rapidly as possible, and minimizes the time lag before appropriate action can be taken to handle any hazardous materials. Also, it precludes any potential problems associated with transporting samples to an offsite laboratory (e.g., sample packaging, waste incompatibility, fume generation).

If samples must be analyzed off site, samples should be packaged on site in accordance with DOT regulations (49 CFR) and shipped to the laboratory for analysis.

Staging

Although every attempt should be made to minimize drum handling, drums must sometimes be staged (i.e., moved in an organized manner to predesignated areas) to facilitate characterization and remedial action, and to protect drums from potentially hazardous site conditions (e.g., movement of heavy equipment and high temperatures that might cause explosion, ignition, or pressure buildup). Staging involves a trade-off between the increased hazards associated with drum movement and the decreased hazards associated with the enhanced organization and accessibility of the waste materials.

The number of staging areas necessary depends on site-specific circumstances such as the scope of the operation, the accessibility of drums in their original positions, and the perceived hazards. Investigation usually involves little, if any, staging; remedial and emergency operations can involve extensive drum staging. The extent of staging must be determined individually for each site, and should always be kept to a minimum. Up to five separate areas have been used (see Figure 11-5):

- An *initial staging area* where drums can be (1) organized according to type, size, and suspected contents, and (2) stored prior to sampling.
- An *opening area* where drums are opened, sampled, and resealed. Locate this area a safe distance from the original waste disposal or storage site and from all staging areas to prevent a chain reaction in case of fire or explosion.
- During large-scale remedial or emergency tasks, a separate *sampling area* may be set up at some distance from the opening area to reduce the number of people present in the opening area, and to limit potential casualties in case of an explosion.
- A *second staging area*, also known as a holding area, where drums are temporarily stored after sampling pending characterization of their contents. Do *not* place unsealed drums with unknown contents in the second staging area in case they contain incompatible materials. (Either remove the contents or overpack the drum.)
- A *final staging area*, also known as a bulking area, where substances that have been characterized are bulked for transport to treatment or disposal facilities.

    Locate the final staging area as close as possible to the site's exit.

    Grade the area and cover it with plastic sheeting.

    Construct approximately 1-foot-high (0.3-m-high) dikes around the entire area.

    Segregate drums according to their basic chemical categories (acids, heavy metals, pesticides, etc.) as determined by characterization. Construct separate areas for each type of waste present to preclude the possibility of intermingling incompatible chemicals when bulking.

In all staging areas, stage the drums two wide in two rows per area (see Figure 11-6), and space these rows 7 to 8 feet (2 to 2.5 m) apart to enable movement of the drum handling equipment.

Bulking

Wastes that have been characterized are often mixed together and placed in bulk containers such as tanks or vacuum trucks for shipment to treatment or disposal facilities. This increases the efficiency of transportation. Bulking should be performed only after thorough waste characterization by trained and experienced personnel. The preliminary tests described earlier under *Characterization* provide only a general indication of the nature of the individual wastes. In most cases, additional sampling and analysis to further characterize the wastes, and compatibility tests (in which small quantities of different wastes are mixed together under controlled conditions and observed for signs of incompatibility such as vapor generation and heat of reaction) should be conducted. Bulking is performed at the final staging area using the following procedures:

Crushed drums awaiting landfill. Note the staging of drums on the left in a row two drums wide.

- Inspect each tank trailer and remove any residual materials from the trailer prior to transferring any bulked materials. This will prevent reactions between incompatible chemicals.
- To move hazardous liquids, use pumps that are properly rated (see National Fire Protection Association [NFPA] 70 Articles 500-503 and NFPA 497M) and that have a safety relief valve with a splash shield. Make sure the pump hoses, casings, fittings, and gaskets are compatible with the material being pumped.
- Inspect hose lines before beginning work to ensure that all lines, fittings, and valves are intact with no weak spots.
- Take special precautions when handling hoses as they often contain residual material that can splash or spill on the personnel operating the hoses. Protect personnel against accidental splashing. Protect lines from vehicular and pedestrian traffic.
- Store flammable liquids in approved containers.

Shipment

Shipment of materials to offsite treatment, storage, or disposal facilities involves the entry of waste hauling vehicles into the site. U.S. Department of Transportation (DOT) regulations (49 CFR Parts 171-178) and EPA regulations (40 CFR Part 263) for shipment of hazardous

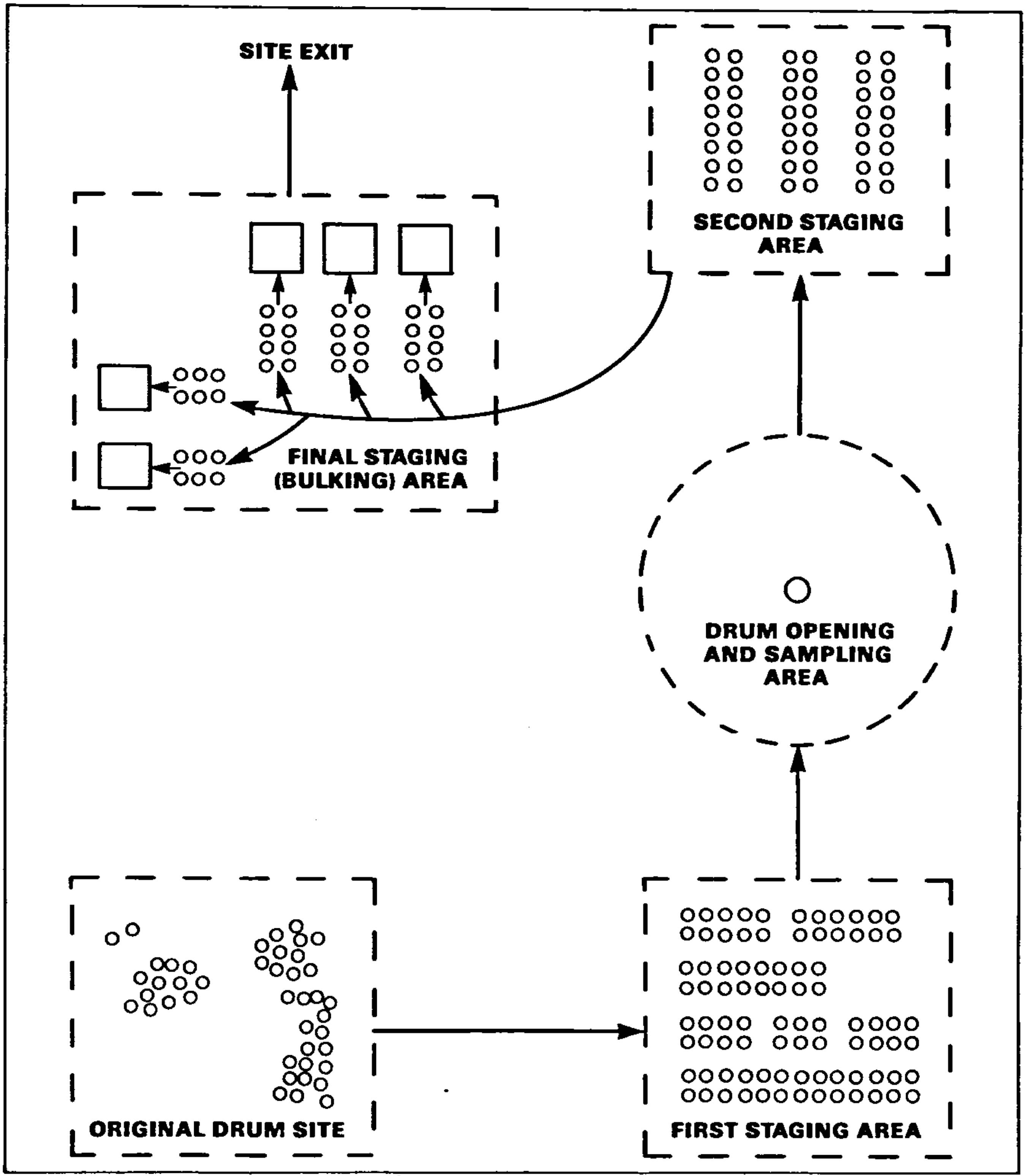


Figure 11-5. Possible Staging Areas at a Hazardous Waste Site.

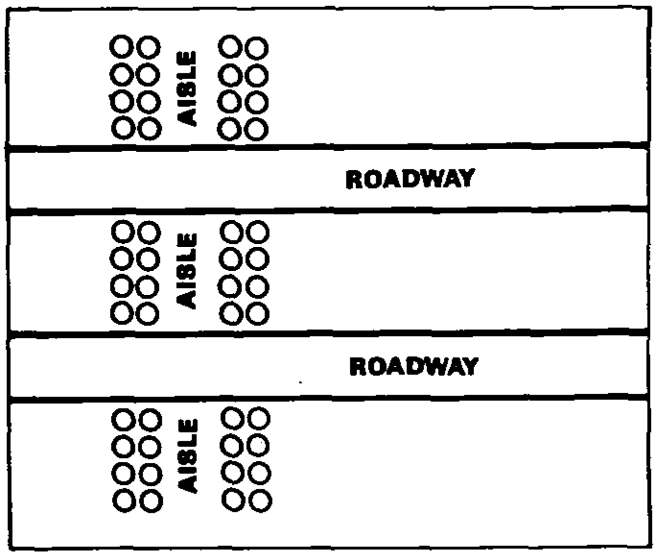


Figure 11-6. Sample Drum Staging Layout.
Source: Reference [1].

Single-stacked overpack drums awaiting transport off site. Worker suited in Level C personal protective equipment will spread a tarp over the drums to protect them during transport.

wastes must be complied with. The following guidelines can enhance the safety of these operations:

- Locate the final staging (bulking) area as close as possible to the site exit.
- Prepare a circulation plan that minimizes conflict between cleanup teams and waste haulers. Install traffic signs, lights, and other control devices as necessary.
- Provide adequate area for onsite and hauling vehicles to turn around. Where necessary, build or improve onsite roads.
- Stage hauling vehicles in a safe area until ready for loading with drivers remaining in cab. Minimize the time that drivers spend in hazardous areas.
- Outfit the driver with appropriate protective equipment.
- If drums are shipped, tightly seal the drums prior to loading. Overpack leaking or deteriorated drums prior to shipment. (Under most circumstances, overpack drums used for hazardous wastes may not be reused [49 CFR Part 173.3(c)]). Make sure that truck bed and walls are clean and smooth to prevent damage to drums. Do *not* double stack drums. Secure drums to prevent shifting during transport.
- Keep bulk solids several inches below the top of the truck container. Cover loads with a layer of clean soil, foam, and/or tarp. Secure the load to prevent shifting or release during transport.
- Weigh vehicles periodically to ensure that vehicle and road weight limits are not exceeded.
- Decontaminate vehicle tires prior to leaving the site to ensure that contamination is not carried onto public roads.
- Check periodically to ensure that vehicles are not releasing dust or vapor emissions off site.
- Develop procedures for responding quickly to offsite vehicle breakdown and accidents to ensure minimal public impact.

Special Case Problems

Tanks and Vaults

For tanks and vaults, which are often found on hazardous waste sites, the following procedures are recommended:

- In general, when opening a tank or vault follow the same procedures as for a sealed drum. If necessary, vent excess pressure if volatile substances are stored. Place deflecting shields between workers and the opening to prevent direct contamination of workers by materials forced out by pressure when the tank is opened.
- Guard manholes or access portals to prevent personnel from falling into the tank.
- Identify the contents through sampling and analysis. If characterization indicates that the contents can be safely moved with the available equipment, vacuum them into a trailer for transportation to a disposal or recycling facility.
- Empty and decontaminate the tank or vault before disposal.
- If it is necessary to enter a tank or vault (i.e., confined spaces) for any reason (e.g., to clean off solid materials or sludges on the bottom or sides of the tank or vault), the following precautions should be taken [4]:

  Ventilate thoroughly prior to entry.

  Disconnect connecting pipelines.

  Prior to entry, take air samples to prove the absence of flammable or other hazardous vapors and to demonstrate that adequate levels of oxygen exist.

Equip the entry team with appropriate respiratory protection, protective clothing, safety harnesses, and ropes.

Equip a safety observer with appropriate respiratory protection, protective clothing, a safety harness, and rope.

Establish lifeline signals prior to entry so that the worker and safety observer can communicate by tugs on the rope.

Have an additional person available in the immediate vicinity to assist the safety observer if needed.

Instruct the safety observer not to enter the space until additional personnel are on scene.

Vacuum Trucks

- Wear appropriate protective clothing and equipment when opening the hatch.
- If possible, use mobile steps or suitable scaffolding consistent with 29 CFR Part 1910, Subpart D. Avoid climbing up the ladder and walking across the tank catwalk.
- If the truck must be climbed, raise and lower equipment and samples in carriers to enable workers to use two hands while climbing.
- If possible, sample from the top of the vehicle. If it is necessary to sample from the drain spigot, take steps to prevent spraying of excessive substances. Have all personnel stand off to the side. Have sorbent materials on hand in the event of a spill.

Elevated Tanks

In general, observe the safety precautions described for vacuum trucks. In addition:

- Use a safety line and harness.
- Maintain ladders and railings in accordance with OSHA requirements (29 CFR Part 1910, Subpart D).

Compressed Gas Cylinders

- Obtain expert assistance in moving and disposing of compressed gas cylinders.
- Handle compressed gas cylinders with extreme caution. The rupture of a cylinder may result in an explosion, and the cylinder may become a dangerous projectile.
- Record the identification numbers on the cylinders to aid in characterizing their contents.

Ponds and Lagoons

- Drowning is a very real danger for personnel suited in protective equipment because the weight of protective equipment increases an individual's overall density and severely impairs their swimming ability. Where there is danger of drowning, provide necessary safety gear such as lifeboats, tag lines, railings, nets, safety harnesses, and flotation gear.
- Wherever possible, stay on shore. Avoid going out over the water.
- Be aware that some solid wastes may float and give the appearance of solid cracked mud. Caution should be exercised when working along shorelines.

References

1. Mayhew, Joe J.; G.M. Sodear; and D.W. Carroll. 1982. A Hazardous Waste Site Management Plan. Chemical Manufacturers Association, Inc., Washington DC.

2. deVera, E.R.; B.P. Simmons; R.D. Stephens; and D.L. Storm. 1980. Samplers and Sampling Procedures for Hazardous Waste Streams. EPA-600/2-80-018. U.S. Environmental Protection Agency, Cincinnati, OH.

3. U.S. EPA. 1984. Characterization of Hazardous Waste Sites—A Methods Manual: Volume II. Available Sampling Methods. Second edition. EPA 600/4-84-076.

4. NIOSH. 1979. Criteria for a Recommended Standard: Working in Confined Spaces. NIOSH No. 80-106. Also available from U.S. Government Printing Office (#017-033-00353-0) and National Technical Information Service (PB-80-183015).

12. Site Emergencies

Contents

Introduction

The nature of work at hazardous waste sites makes emergencies a continual possibility, no matter how infrequently they may actually occur. Emergencies happen quickly and unexpectedly and require immediate response. At a hazardous waste site, an emergency may be as limited as a worker experiencing heat stress, or as vast as an explosion that spreads toxic fumes throughout a community. Any hazard on site can precipitate an emergency: chemicals, biologic agents, radiation or physical hazards may act alone or in concert to create explosions, fires, spills, toxic atmospheres, or other dangerous and harmful situations. Table 12-1 lists common causes of site emergencies.

Site emergencies are characterized by their potential for complexity: uncontrolled toxic chemicals may be numerous and unidentified; their effects may be synergistic. Hazards may potentiate one another—for example, a flammable spill feeding a fire. Rescue personnel attempting to remove injured workers may themselves become victims. This variability means that advance planning, including anticipation of different emergency scenarios and thorough preparation for contingencies, is essential to protect worker and community health and safety.

This chapter outlines important factors to be considered when planning for and responding to emergencies. It defines the nature of site emergencies, lists the types of emergencies that may occur, and outlines a Contingency Plan and its components, which include personnel roles, lines of authority, training, communication systems, site mapping, site security and control, refuges, evacuation routes, decontamination, a medical program, step-by-step emergency response procedures, documentation, and reporting to outside agencies. Backup information is detailed in other chapters of the manual.

Planning

When an emergency occurs, decisive action is required. Rapidly made choices may have far-reaching, long-term consequences. Delays of minutes can create life-threatening situations. Personnel must be ready to immediately rescue or respond; equipment must be on hand and in good working order. In order to handle emergencies effectively, planning is essential. For this purpose, a Contingency Plan should be developed.

A Contingency Plan is a written document that sets forth policies and procedures for responding to site emergencies. It should incorporate the following:

- Personnel:
  - Roles.
  - Lines of authority.
  - Training.
  - Communication.
- Site:
  - Mapping.
  - Security and control.
  - Refuges.
  - Evacuation routes.
  - Decontamination stations.
- Medical/first aid.
- Equipment.
- Emergency procedures.
- Documentation.
- Reporting.

Overall, a Contingency Plan should:

- Be designed as a discrete section of the Site Safety Plan.
- Be compatible and integrated with the pollution response, disaster, fire, and emergency plans of local, state, and federal agencies.
- Be rehearsed regularly using drills and mock situations.
- Be reviewed periodically in response to new or changing site conditions or information.

Table 12-1. Causes of Emergencies at Hazardous Waste Sites

Worker-Related
- Minor accidents (slips, trips, falls).
- Chemical exposure.
- Medical problems (heat stress, heat stroke, aggravation of pre-existing conditions).
- Personal protective equipment failure (air source failure, tearing or permeation of protective clothing, facepiece fogging).
- Physical injury (injuries from hot or flying objects, loose clothing entangling in machinery, serious falls, vehicle accidents).
- Electrical (burns, shock, electrocution).

Waste-Related
- Fire.
- Explosion.
- Leak.
- Release of toxic vapors.
- Reaction of incompatible chemicals.
- Collapse of containers.
- Discovery of radioactive materials.

Personnel

This component of the plan includes not only onsite and offsite personnel with specific emergency response roles, but also others who may be on site, such as contractors, other agency representatives, and visitors. Emergency personnel and their responsibilities are covered in detail in Chapter 3 as part of the overall organizational structure. This information is summarized in Table 12-2.

Emergency personnel may be deployed in a variety of ways. Depending on the nature and scope of the emergency, the size of the site, and the number of personnel, the emergency response cadre can include individuals, small or large teams, or several interacting teams. Although deployment is determined on a site-by-site basis, pertinent general guidelines and recommendations are listed below. In all cases the organizational structure should show a clear chain-of-command, every individual should know his or her position and authority, and the chain-of-command must be flexible enough to handle multiple emergencies, such as a rescue and a spill response or two rescues with a fire and spill response.

Table 12-2. Personnel Involved in Emergency Response

Project Team Leader
- Directs emergency response operations.
- Serves as liaison with appropriate government officials.

Site Safety Officer
- Recommends that work be stopped if any operation threatens worker or public health or safety.
- Knows emergency procedures, evacuation routes, and the appropriate telephone numbers including: the ambulance, medical facility, poison control center, fire department, and police department.
- Notifies local public emergency officials.
- Provides for emergency medical care on site.

Command Post Supervisor
- Notifies emergency support personnel by telephone or radio in case rescue operations are required.
- Assists the Site Safety Officer in a rescue, if necessary.

Rescue Team
- An emergency rescue team stands by, partially dressed in protective gear, near the Exclusion Zone ready to rescue any workers whose health or safety is endangered.
- State emergency response personnel (varies among states).

Decontamination Station Officers
- Perform emergency decontamination.

24-Hour Medical Team
- Transportation and treatment of victims by ambulance personnel, personnel at local clinics or hospitals, and physicians.

Communication Personnel
- Local emergency service networks provide communication links for mutual aid.
- Civil Defense organizations and local radio and television stations provide information to the public during an emergency.

Environmental Scientists
- Predict the immediate and future movement of released hazardous substances through the geologic and hydrologic environment and air.
- Assess the effect of this movement on groundwater quality, surface water quality, and air quality.
- Determine the probable movement of released toxic gases.
- Estimate the expected concentration of gases in the community and the expected duration of exposure.
- Predict the exposure levels of people and the ecosystem to the materials.

Hazardous Chemicals Experts
- Provide immediate advice to those at the scene of a chemical-related emergency.

Firefighters
- Respond to fires that occur at a site; rescue victims.

Meteorologists
- Provide meteorological information needed by environmental scientists.

Public Safety Personnel
- The county sheriff, industrial security forces, the National Guard, and the police control site access, crowds, and traffic.

Public Evacuation Personnel
- Civil Defense organizations plan evacuations.
- The National Guard and other military, the Red Cross, the Salvation Army, and municipal transportation systems mobilize transit equipment and assist in evacuations.

On-Scene Coordinator
- Coordinates federal response activities.

Onsite Personnel

The Contingency Plan should identify all individuals and teams who will participate in emergency response and define their roles. All personnel, whether directly involved in emergency response or not, should know their own responsibilities in an emergency. They must also know the names of those in authority, and the extent of that authority.

Leader

In an emergency situation, one person must be able to assume total control and decision-making on site. This leader must:

- Be identified in the emergency response plan. This person may be, for example, the Project Team Leader, Site Safety Officer, or Field Team Leader.
- Be backed up by a specified alternate(s).
- Have the authority to resolve all disputes about health and safety requirements and precautions.
- Be authorized to seek and purchase supplies as necessary.
- Have control over activities of everyone entering the site, for example, contractors, fire departments, and police.
- Have the clear support of management.

Teams

Although individuals (e.g., the Site Safety Officer) may perform certain tasks in emergencies, in most cases teams provide greater efficiency and safety. Teams composed of onsite personnel may be created for specific emergency purposes, such as decontamination, rescue, and entry. Rescue teams can be used during a particularly dangerous operation, or at large sites with multiple work parties in the Exclusion Zone. Their sole function is to remain near hazardous work areas, partially dressed in protective gear, ready for full suiting and immediate rescue of any endangered worker. These teams should be capable of administering cardiopulmonary resuscitation (CPR) and emergency first aid. Other teams can be formed for responding to containment emergencies and fire-fighting until offsite assistance arrives.

Offsite Personnel

These may include individual experts such as meteorologists or toxicologists (see Table 12-2), and representatives or groups from local, state, and federal organizations offering rescue, response, or support (see Table 12-3 for a listing of typical organizations). As part of advance planning, site personnel should:

- Make arrangements with individual experts to provide guidance as needed.
- Make arrangements with the appropriate agencies (e.g., local fire department, state environmental agency, EPA regional office) for support.
- Alert these authorities to the types of emergencies that may arise.
- Determine their estimated response time and resources.
- Identify backup facilities.
- Provide training and information about hazards on site and special procedures for handling them.
- Establish a contact person and means of notification at each agency.

Table 12-3. Examples of Agencies and Groups Involved in Emergencies

AGENCY OR GROUP	RESCUE[a]	RESPONSE[b]	SUPPORT[c]
FEDERAL			
Army Corps of Engineers			•
Coast Guard[d]		•	•
Department of Defense[d]		•	•
Department of Transportation			•
Environmental Protection Agency (EPA)[d]		•	•
Federal Aviation Administration (FAA)			•
Federal Emergency Management Agency (FEMA)			•
National Institute for Occupational Safety and Health (NIOSH)			•
Occupational Safety and Health Administration (OSHA)			•
STATE			
Civil Defense			•
Department of Health			•
Department of Labor			•
Environmental Agency		•	•
Office of the Attorney General			•
State Police	•		•
LOCAL			
Ambulance and rescue services	•	•	•
Cleanup contractor	•	•	•
Disposal companies	•	•	
Fire department	•	•	•
Hospital			•
Police	•		•
Red Cross			•
Salvation Army			•
Transporters			•
Utility companies (electric, gas, water, phone)			•

[a] Rescue = extricating and/or providing on-the-spot emergency treatment to victims.
[b] Response = controlling and stabilizing hazardous conditions.
[c] Support = providing technical assistance, equipment, and/or resources.
[d] This agency may provide an On-Scene Coordinator (OSC), depending on the jurisdiction.

Federal Response Organizations

Site emergencies involving significant chemical releases should be coordinated with federal response organizations. The federal government has established a National Contingency Plan (NCP) to promote the coordination and direction of federal and state response systems, and to encourage the development of local government and private capabilities to handle chemical emergencies involving chemical releases.

To implement the NCP, a national organization was established, including a National Response Team (NRT), a network of Regional Response Teams (RRTs), a cadre of On-Scene Coordinators (OSCs), and a National Response Center (NRC). The NRC is the national terminal point for receipt of notification of significant chemical releases, and the OSCs are the interface between the onsite personnel and the federal response organizations. The OSC is the federal official responsible for ensuring that necessary response actions are taken to protect the public and the environment from the effects at a chemical release. Many federal agencies have specific technical expertise which is available to assist the OSC.

If a significant chemical release occurs at a hazardous waste site, the National Response Center in Washington, D.C., should be contacted (Telephone: 800-424-8802). The NRC will activate federal response under the National Contingency Plan.

Training

Since immediate, informed response is essential in an emergency, all site personnel and others entering the site (visitors, contractors, offsite emergency response groups, other agency representatives) must have some level of emergency training. Any training program should:

- Relate directly to site-specific, anticipated situations.
- Be brief and repeated often.
- Be realistic and practical.
- Provide an opportunity for special skills to be practiced regularly.
- Feature drills frequently (e.g., site-specific mock rescue operations).
- Ensure that training records are maintained in a training logbook.

Everyone entering the site must be made aware of the hazards and of hazardous actions which are forbidden or should be avoided (e.g., smoking). They must also know what to do in case of an emergency.

Visitors should be briefed on basic emergency procedures such as decontamination, emergency signals, and evacuation routes.

Personnel without defined emergency response roles (e.g., contractors, federal agency representatives) must still receive a level of training that includes at a minimum:

- Hazard recognition.
- Standard Operating Procedures.
- Signaling an emergency: the alarm used, how to summon help, what information to give and who to give it to.
- Evacuation routes and refuges.
- The person or station to report to when an alarm sounds.

Onsite emergency personnel, who have emergency roles in addition to their ordinary duties, must have a thorough understanding of emergency response. Training should be directly related to their specific roles and should include subjects such as:

- Emergency chain-of-command.
- Communication methods and signals.
- How to call for help.
- Emergency equipment and its use.
- Emergency evacuation while wearing protective equipment.
- Removing injured personnel from enclosed spaces.
- Offsite support and how to use it.

These personnel should obtain certification in first aid and CPR, and practice treatment techniques regularly, with an emphasis on:

- Recognizing and treating chemical and physical injuries.
- Recognizing and treating heat and cold stress.

Offsite emergency personnel such as local firefighters and ambulance crews often are first responders and run a risk of acute hazard exposure equal to that of any onsite worker. These personnel should be informed of ways to recognize and deal effectively with onsite hazards. Lack of information may inadvertently worsen an emergency by improper actions (e.g., spraying water on a water-reactive chemical and causing an explosion). Inadequate knowledge of the onsite emergency chain-of-command may cause confusion and delays. Site management should, at a minimum, provide offsite emergency personnel with information about:

- Site-specific hazards.
- Appropriate response techniques.
- Site emergency procedures.
- Decontamination procedures.

Emergency Recognition and Prevention

On a day-to-day basis, individual personnel should be constantly alert for indicators of potentially hazardous situations and for signs and symptoms in themselves and others that warn of hazardous conditions and exposures. Rapid recognition of dangerous situations can avert an emergency. Before daily work assignments, regular meetings should be held. Discussion should include:

- Tasks to be performed.
- Time constraints (e.g., rest breaks, air tank changes).
- Hazards that may be encountered, including their effects, how to recognize symptoms or monitor them, concentration limits, or other danger signals.
- Emergency procedures.

After daily work assignments, a debriefing session should be held to review work accomplished and problems observed.

Communications

In an emergency, crucial messages must be conveyed quickly and accurately. Site staff must be able to communicate information such as the location of injured personnel, orders to evacuate the site, and notice of blocked evacuation routes, even through noise and confusion. Outside support sources must be reached, help obtained, and measures for public notification ensured, if necessary. To do this, a separate set of internal emergency signals should be developed and rehearsed daily. External communication systems and procedures should be clear and accessible to all workers.

Internal Communications

Internal emergency communication systems are used to alert workers to danger, convey safety information, and maintain site control. Any effective system or combination may be employed. Radios or field telephones are often used when work teams are far from the Command Post. Alarms or short clear messages can be conveyed by audible signals, e.g., bullhorns, megaphones, sirens, bells, whistles, or visual signals such as colored flags, flares, lights, and hand or whole-body movements. The primary system must have a backup. For example, hand signals may be used as a backup if radio communications fail. All internal systems should be:

- Clearly understood by all personnel.
- Checked and practiced daily.
- Intrinsically safe (spark-free).

A special set of emergency signals should be set up. These should be:

- Different from ordinary signals.
- Brief and exact.
- Limited in number so that they are easily remembered.

Examples include: stop, evacuate, help, all clear. Any set of signals may be used to convey these messages as long as all personnel understand their meaning. See Table 12-4 for examples.

When designing and practicing communication systems, remember that:

- Background noise on site will interfere with talking and listening.
- Wearing personal protective equipment will impede hearing and limit vision (e.g., the ability to recognize hand and body signals).
- Inexperienced radio users may need practice in speaking clearly.

External Communications

Offsite sources must be contacted to get assistance or to inform officials about hazardous conditions that may affect public or environmental safety. The telephone is the most common mode of offsite communication; phone hook-ups are considered a necessity at all but the most remote sites.

- The National Response Center (NRC) (Telephone: 800-424-8802) should be contacted in the event of a significant chemical release. The NRC will contact the appropriate federal On-Scene Coordinator.
- All personnel must be familiar with the protocol (phone number or emergency code, contact person) for contacting public emergency aid teams such as fire departments, ambulance units, and hospitals.
- If there is no site telephone system, all personnel must know the location of the nearest public telephone. A supply of telephone change and the necessary phone numbers must be readily available.

Table 12-4. Sample Internal Emergency Communication Signals

DEVICES* AND SIGNALS	EXAMPLE
Radio (citizen's band or FM)	Established code words.
Noisemakers, including: Bell Compressed air horn Megaphone Siren Whistle	One long blast: Evacuate area by nearest emergency exit. Two short blasts: Localized problem (not dangerous to workers). Two long blasts: all clear.
Visual signal, including: Hand signals Whole body movements	Hand clutching throat: Out of air/can't breathe. Hands on top of head: Need assistance. Thumbs up: OK/I'm alright/I understand. Thumbs down: No/negative. Grip partner's wrist or both hands around partner's waist: Leave area immediately.

*All devices and equipment used in the Exclusion and Contamination Reduction Zones must be intrinsically safe and not capable of sparking.

Site Mapping

Detailed information about the site is essential for advance planning. For this purpose, a site map is a valuable tool. It serves as a graphic record of the locations and types of hazards, a reference source, and a method of documentation. This map can be a duplicate of the one developed for the Site Safety Plan (see Chapter 3), but it should focus on potential areas where emergencies may develop. Pins and colored flags can be used to mark changes in personnel deployment, hazard areas, and equipment locations. The map should highlight:

- Hazard areas, especially potential IDLH conditions.
- Site terrain: topography, buildings, barriers.
- Evacuation routes.
- Site accessibility by land, sea, and air.
- Work crew locations.
- Changes (e.g., work activities, vandalism, accidents).
- Offsite populations or environments at potential risk.

The map can be used for planning and training. It can serve as a basis for developing potential emergency scenarios and alternative response strategies.

When an emergency occurs, the problem areas should be pinpointed on the map. Pertinent information—such as weather and wind conditions, temperature, and forecast—should be added. The map can then be used to design the emergency plan, e.g., to define zones; determine evacuation routes; and identify emergency first-aid, decontamination, and Command Post stations. When using the map for such purposes, the accuracy of the data obtained and the potential for over- or underestimating a hazard should be considered.

Even if the emergency develops so fast that the map cannot be used for on-the-spot planning, prior familiarity with it will aid in making informed decisions.

Safe Distances and Refuges

Safe Distances

No single recommendation can be given for evacuation or safe distances because of the wide variety of hazardous substances and releases found at sites. For example, a "small" chlorine leak may call for an isolation distance of only 140 feet (43 meters), while a "large" leak may require an evacuation distance of 1 mile (1.6 kilometers) or more, depending on the wind direction [1].

Safe distances can only be determined at the time of an emergency, based on a combination of site- and incident-specific factors. However, planning and outlining potential emergency scenarios will help familiarize personnel with points to consider. Factors that influence safe distances include:

- The toxicological properties of the substance.
- The physical state of the substance.
- The quantity released.
- The rate of release.
- The method of release.
- The vapor pressure of the substance.
- Vapor density relative to air.
- Wind speed and direction.
- Atmospheric stability.
- The height of release.
- Air temperature and temperature change with altitude.
- Local topography (e.g., barriers may enhance or retard a cloud or plume, and attentuate a blast).

Public Evacuation

If an incident may threaten the health or safety of the surrounding community, the public will need to be informed and possibly evacuated from the area. Site management should plan for this in coordination with the appropriate local, state and federal groups, such as the Federal Emergency Management Agency, the Civil Defense, county sheriff, local radio and television stations, municipal transportation systems, National Guard, and police.

Refuges (Safety Stations)

Onsite refuges (safety stations) can be set up for localized emergencies that do not require site evacuation. These refuges should only be used for essential needs, such as short rest breaks, emergency response strategy meetings, or temporary relief during mild cases of muscle strain and heat stress. The refuge should be located in a relatively safe, but not necessarily "clean" area, e.g., along the upwind fence line in specially cleared places or on the periphery of the Exclusion Zone.[1] The refuge should never be used for activities such as eating, drinking, or air changes. Typical items located in a refuge area include:

- A sitting/resting area that should be shaded if possible.
- Water for decontamination.
- Wind indicator.
- Communication system with the Command Post.
- First-aid supplies, e.g., eyewash, stretcher, blanket.
- Special monitoring devices (e.g., extra detector tubes and personal monitors).
- Bolt cutters.
- Fire extinguishers.
- Hand tools.

Other refuges can be set up in the Support Zone, or in the case of site-wide evacuations, offsite at the safe exit destination. These will provide for emergency needs such as first aid for injured personnel, clean dry clothing and wash water for chemical exposure victims, and communications with the Command Post. In a sitewide evacuation, they can be used to house evacuation exit equipment, thereby reducing security problems. These refuges should be stocked with such items as:

- Decontamination supplies.
- Oxygen and/or air.
- Water.
- Special testing equipment (e.g., pH paper, cyanide paper).
- First-aid supplies.
- Communication system.

Site Security and Control

In an emergency, the Project Team Leader (or designated representative) must know who is on site and must be able to control the entry of personnel into the hazardous areas to prevent additional injury and exposure. Only necessary rescue and response personnel should be allowed into the Exclusion Zone.

One control technique is a checkpoint or series of checkpoints through which all personnel entering or exiting the

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[1] In an emergency, as in daily work activities, the site is divided into three areas: Exclusion (contaminated) Zone, Contamination Reduction Zone, and Support (clean) Zone (see Chapter 9, *Site Control*).

site must pass, e.g., a Support Zone checkpoint and an Exclusion Zone checkpoint. Identification or authorization must be presented to a Checkpoint Control Manager, who records each person's:

- Name (and affiliation if offsite personnel).
- Status (in or out).
- Time of entry.
- Anticipated exit time.
- Zones or areas to be entered.
- Team or "buddy."
- Task being performed.
- Location of task.
- Protective equipment worn; air time left.
- Rescue and response equipment used.

The emergency area Checkpoint Control Manager should inform the Project Team Leader if a person remains in the emergency area beyond his or her anticipated exit time.

Personal Locator Systems

In an emergency, it is vital for the Project Team Leader (or designee) and rescue personnel to rapidly determine where workers are located and who may be injured. A passive locator system (i.e., a written record of the location of all personnel on site at any time) could be used to help find personnel in an emergency. Any such system should be:

- Graphic (such as a drawing with a written key).
- Roughly drawn to scale, with the scale and visible landmarks included.
- Kept current.
- Easy to locate.
- Stored outside the Exclusion Zone.

A good passive locator system is a site map with flags or color-headed pins identifying each worker.

Active locator systems can also be used. These are worn or carried by individual personnel, and are activated by actions such as flipping a switch, a decrease in air supply, or a fall. They have the advantage of precisely locating individuals.

Evacuation Routes and Procedures

A severe emergency, such as a fire or explosion, may cut workers off from the normal exit near the Command Post. Therefore, alternate routes for evacuating victims and endangered personnel should be established in advance, marked, and kept clear. Routes should be directed (1) from the Exclusion Zone through an upwind Contamination Reduction Zone to the Support Zone, and (2) from the Support Zone to an offsite location in case conditions necessitate a general site evacuation. The following guidelines will help in establishing safe evacuation routes.

- Place the evacuation routes in the predominantly upwind direction of the Exclusion Zone. (At a very large site, or one with many obstacles, some exits may be placed in the downwind fenceline, normally an undesirable location. If this is done, workers must know that they are not "out" until they reach the designated safety area.)
- Run the evacuation routes through the Contamination Reduction Zone. Even if there is not enough time to process the evacuees through decontamination procedures, there should be a mechanism for accounting for all personnel.
- Consider the accessibility of potential routes. Take into account obstructions such as locked gates, trenches, pits, tanks, drums, or other barriers, and the extra time or equipment needed to maneuver around or through them.
- Develop two or more routes that lead to safe areas and that are separate or remote from each other. Multiple routes are necessary in case one is blocked by a fire, spill, or vapor cloud. These routes must not overlap because if a common point were obstructed by a fire or other emergency, all intersecting routes would be blocked.
- Mark routes "safe" or "not safe" on a daily basis according to wind direction and other factors.
- Mark evacuation routes with materials such as barricade tape, flagging, or traffic cones. Equally important, mark areas that do not offer safe escape or that should not be used in an emergency, such as low ground, which can fill with gases or vapors, or routes blocked by natural barriers, such as cliffs or streams.
- Consider the mobility constraints of personnel wearing protective clothing and equipment. They will have difficulty crossing even small streams and going up and down banks.

  Place ladders across any cut or excavation that is more than 3 feet (1 meter) deep. For long cuts, place ladders at least every 25 feet (7.5 meters), and for deep cuts, place plywood or planks on top of ladders.

  Provide ladders for rapid descent from areas or structures elevated more than 3 feet (1 meter).

  Use only ladders capable of supporting a 250-lb (114-kg) load.

  Secure ladders to prevent slipping.

  Place standard cleated ramps ("chickenboard") across ditches and other similar obstacles. Add a railing and toe boards if the board is narrow or steeply sloped.

  Check the toe and body clearance of ladders to make sure that personnel wearing protective clothing and SCBA can use them.

  Check the clearance of access ports, such as crawlspaces, hatches, manholes, and tunnels to make sure that personnel wearing a protective ensemble can get through. In any case, access ports should be at least 3 feet (1 meter) in diameter where possible. (Standard tank manways are smaller.)
- Make escape routes known to all who go on site.

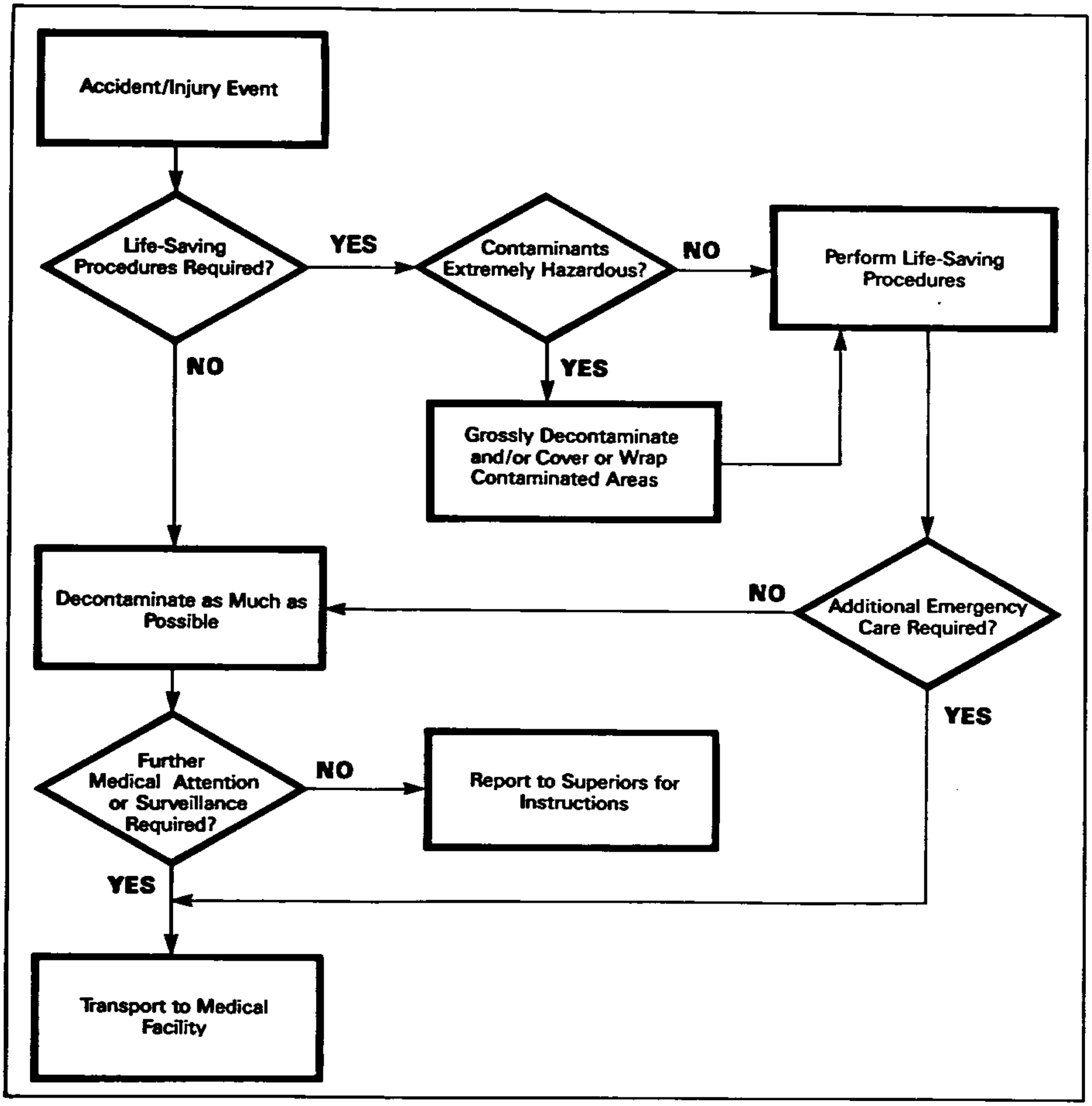

Figure 12-1. Decision Aid for Emergency Decontamination.

Decontamination

When planning for decontamination in medical emergencies, procedures should be developed for:

- Decontaminating the victim.
- Protecting medical personnel.
- Disposing of contaminated protective equipment and wash solutions.

These activities should be coordinated. The decision whether or not to decontaminate a victim is based on the type and severity of the illness or injury and the nature of the contaminant. For some emergency victims, immediate decontamination may be an essential part of life-saving first aid. For others, decontamination may aggravate the injury or delay life-saving treatment. If decontamination does not interfere with essential treatment, it should be performed. Figure 12-1 is a decision aid for emergency decontamination.

- If decontamination can be done:

Wash, rinse and/or cut off protective clothing and equipment.

- If decontamination cannot be done:

  Wrap the victim in blankets, plastic, or rubber to reduce contamination of other personnel.

  Alert emergency and offsite medical personnel to potential contamination; instruct them about specific decontamination procedures if necessary.

  Send along site personnel familiar with the incident.

See Chapter 9, *Decontamination*, for details on decontamination techniques and procedures.

Equipment

In an emergency, equipment will be necessary to rescue and treat victims, to protect response personnel, and to mitigate hazardous conditions on site (e.g., to contain chemicals or fight fires). Some regular equipment can double for emergency use. Because of its high cost, most heavy equipment (e.g., bulldozers, drum movers, pumps) employed in emergencies will also be used for regular work assignments. All equipment should be in working order, fueled, and available when an emergency occurs. Provide safe and unobstructed access for all firefighting and emergency equipment at all times. Consider adopting the following work procedures:

- Refuel all heavy equipment when there is still one-half to one-quarter of a tank of fuel left.
- Require all equipment repairs to take place at the time the problem is discovered.
- Separate two similar pieces of equipment (e.g., two front-loaders or a bulldozer and a front-loader); park each at a different spot on site and do not use them at the same time in a hazardous area unless absolutely necessary. (This will minimize the possibility of both pieces of equipment being damaged in the same explosion or fire.)

For personal protective equipment:

- Refill all empty self-contained breathing apparatus (SCBA) tanks and prepare them for emergencies immediately after normal use.
- Stock higher levels of protective equipment than required for anticipated hazards (e.g., a site where Level C equipment is normally used [see Table 8-6] should have Level A and B equipment available for emergencies).

Basic equipment that should be available at any site is listed in Table 12-5. Special equipment should be obtained depending on the specific types of emergencies that may occur at a particular site and the capabilities of backup offsite personnel. For example, if the nearest fire department is small and only carries one bucket of foaming solution because of its high cost and short shelf-life, a site may need to stock a large quantity of foam. When determining the type and quantity of special equipment, the following factors should be considered:

- The types of emergencies that may arise. For each emergency, consider a probable and a worst-case scenario.
- The types of hazards that site personnel may be exposed to and the appropriate containment, mitigative, and protective measures.
- The capabilities and estimated response times of offsite emergency personnel.
- The number of site personnel who could be victims during an emergency.
- The probable number of personnel available for response.

Table 12-5. Onsite Equipment and Supplies for Emergency Response

PERSONAL PROTECTION	MEDICAL	HAZARD MITIGATION
• Escape SCBA or SCBA, which can be brought to the victim to replace or supplement his or her SCBA • Personal protective equipment and clothing specialized for known site hazards	• Air splints • Antiseptics • Blankets • Decontamination solutions appropriate for onsite chemical hazards • Emergency eye wash • Emergency showers or wash stations • Ice • Reference books containing basic first-aid procedures and information on treatment of specific chemical injuries • Resuscitator • Safety harness • Stretchers • Water, in portable containers • Wire basket litter (Stokes litter) which can be used to carry a victim in bad weather and on a difficult terrain, allows easy decontamination of the victim, and is itself easy to decontaminate	• Fire-fighting equipment and supplies • Spill-containment equipment, such as absorbents and oil booms • Special hazardous-use tools such as remote pneumatic impact wrenches, nonsparking wrenches and picks • Containers to hold contaminated materials

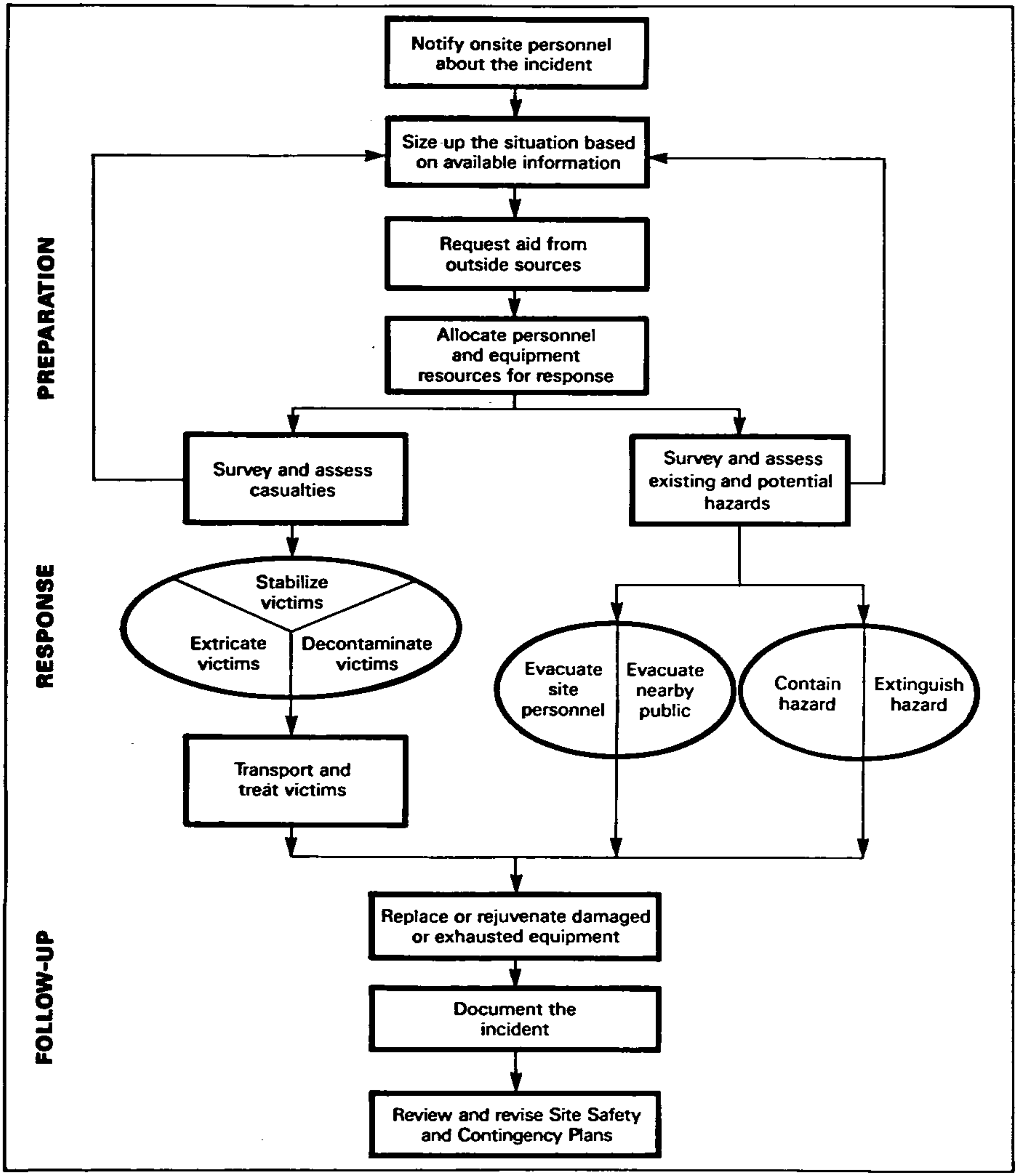

Figure 12-2. Emergency Response Operations.

Medical Treatment/First Aid

In emergencies, toxic exposures and hazardous situations that cause injuries and illnesses will vary from site to site. Medical treatment may range from bandaging of minor cuts and abrasions to life-saving techniques. In many cases, essential medical help may not be immediately available. For this reason, it is vital to train onsite emergency personnel in on-the-spot treatment techniques, to establish and maintain telephone contact with medical experts (e.g., toxicologists), and to establish liaisons with local hospitals and ambulance services. Guidelines for establishing an emergency medical program are detailed in Chapter 5. When designing this program, these essential points should be included:

- Train a cadre of personnel in emergency treatment such as first aid and CPR. Training should be thorough, frequently repeated, and geared to site-specific hazards.
- Establish liaison with local medical personnel, for example: 24-hour on-call physician, medical specialists, local hospitals, ambulance service, and poison control center. Inform and educate these personnel about site-specific hazards so that they can be optimally helpful if an emergency occurs. Develop procedures for contacting them; familiarize all onsite emergency personnel with these procedures.
- Set up onsite emergency first-aid stations; see that they are well supplied and restocked immediately after each emergency.

Emergency Response Procedures

Response operations usually follow a sequence that starts with the notification of trouble and continues through the preparation of equipment and personnel for the next emergency. This process is illustrated in Figure 12-2.

Notification

Alert personnel to the emergency. Sound a site alarm to:

- Notify personnel.
- Stop work activities if necessary.
- Lower background noise in order to speed communication.
- Begin emergency procedures.

Notify onsite emergency response personnel about the emergency and include essential information:

- What happened.
- Where it happened.
- Whom it happened to.
- When it happened.
- How it happened.
- The extent of damage.
- What aid is needed.

Size-Up

Available information about the incident and emergency response capabilities should be evaluated. The following information should be determined, to the extent possible:

- What happened:

  Type of incident.

  Cause of incident.

  Extent of chemical release and transport.

  Extent of damage to structures, equipment, and terrain.
- Casualties:

  Victims (number, location, and condition).

  Treatment required.

  Missing personnel.
- What could happen. Consider:

  Types of chemicals on site.

  Potential for fire, explosion, and release of hazardous substances.

  Location of all personnel on site relative to hazardous areas.

  Potential for danger to offsite population or environment.
- What can be done. Consider:

  Equipment and personnel resources needed for victim rescue and hazard mitigation.

  Number of uninjured personnel available for response.

  Resources available on site.

  Resources available from outside groups and agencies.

  Time for outside resources to reach the site.

  Hazards involved in rescue and response.

Rescue/Response Action

Based on the available information, the type of action required should be decided and the necessary steps implemented. Some actions may be done concurrently. No one should attempt emergency response or rescue until backup personnel and evacuation routes have been identified. Rescue/response actions may include:

- Enforce the buddy system: Allow no one to enter an Exclusion Zone or hazardous area without a partner. At all times, personnel in the Exclusion Zone should be in line-of-sight or communications contact with the Command Post Supervisor or designee.
- Survey casualties:

  Locate all victims and assess their condition.

  Determine resources needed for stabilization and transport.
- Assess existing and potential hazards to site personnel and to the offsite population. Determine:

  Whether and how to respond.

  The need for evacuation of site personnel and offsite population.

  The resources needed for evacuation and response.

- Allocate resources. Allocate onsite personnel and equipment to rescue and incident response operations.
- Request aid. Contact the required offsite personnel or facilities, such as the ambulance, fire department, and police.
- Control. Bring the hazardous situation under complete or temporary control; use measures to prevent the spread of the emergency.
- Extricate. Remove or assist victims from the area.
- Decontaminate. Use established procedures to decontaminate uninjured personnel in the Contamination Reduction Zone. If the emergency makes this area unsafe, establish a new decontamination area at an appropriate distance. Decontaminate victims before or after stabilization as their medical condition indicates (see Figure 12-1 for decision aid).
- Stabilize. Administer any medical procedures that are necessary before the victims can be moved. Stabilize or permanently fix the hazardous condition (e.g., repack; empty filled runoff dikes). Attend to what caused the emergency and anything (e.g., drums, tanks) damaged or endangered by the emergency.
- Transport. Take measures to minimize chemical contamination of the transport vehicle and ambulance and hospital personnel. Adequately protected rescuers should decontaminate the victims before transport. If this is not possible, cover the victims with adequate sheeting. Before transportation, determine the level of protection necessary for transport personnel. Provide them with disposable coveralls, disposable gloves, and supplied air, as necessary, for their protection. If appropriate, have response personnel accompany victims to the medical facility to advise on decontamination.
- Evacuate:

  Move site personnel to a safe distance upwind of the incident.

  Monitor the incident for significant changes. The hazards may diminish, permitting personnel to reenter the site, or increase and require public evacuation.

  Inform public safety personnel when there is a potential or actual need to evacuate the offsite population. Do *not* attempt large-scale public evacuation. This is the responsibility of government authorities (see Table 12-3).

Follow-Up

Before normal site activities are resumed, personnel must be fully prepared and equipped to handle another emergency.

- Notify appropriate government agencies as required. For example, OSHA must be notified if there have been any fatalities or five or more hospitalizations.
- Restock all equipment and supplies. Replace or repair damaged equipment. Clean and refuel equipment for future use.
- Review and revise all aspects of the Contingency Plan according to new site conditions and lessons learned from the emergency response. When reviewing the information, consider typical questions such as:

  Cause: What caused the emergency?

  Prevention: Was it preventable? If so, how?

  Procedures: Were inadequate or incorrect orders given or actions taken? Were these the result of bad judgment, wrong or insufficient information, or poor procedures? Can procedures or training be improved?

  Site profile: How does the incident affect the site profile? How are other site cleanup activities affected?

  Community: How is community safety affected?

  Liability: Who is liable for damage payments?

Documentation

The Project Team Leader should initiate the investigation and documentation of the incident. This is important in all cases, but especially so when the incident has resulted in personal injury, onsite property damage, or damage to the surrounding environment. Documentation may be used to help avert recurrences, as evidence in future legal action, for assessment of liability by insurance companies, and for review by government agencies. Methods of documenting can include a written transcript taken from tape recordings made during the emergency or a bound field book (not a looseleaf book) with notes. The document must be:

- Accurate: All information must be recorded objectively.
- Authentic: A chain-of-custody procedure should be used. Each person making an entry must date and sign the document. Keep the number of documentors to a minimum (to avoid confusion and because they may have to give testimony at hearings or in court). Nothing should be erased. If details change or revisions are needed, the person making the notation should mark a horizontal line through the old material and initial the change.
- Complete: At a minimum, the following should be included:

  Chronological history of the incident.

  Facts about the incident and when they became available.

  Title and names of personnel; composition of teams.

  Actions: decisions made and by whom; orders given: to whom, by whom, and when; and actions taken: who did what, when, where, and how.

  Types of samples and test results; air monitoring results.

  Possible exposures of site personnel.

  History of all injuries or illnesses during or as a result of the emergency.

References

1. U.S. Department of Transportation. 1984. DOT 1984 Emergency Response Guidebook. DOT P5800.3. U.S. Department of Transportation, Washington, DC.

Appendix A. List of Abbreviations and Acronyms

List of Abbreviations

cm^3	cubic centimeter
CO_2	carbon dioxide
dBA	decibels on A-weighted scale
ft	foot
g	gram
g-mole	gram-mole
hr	hour
l	liter
lb	pound
m^3	cubic meter
mg	milligram
ml	milliliter
mrem	milliroentgen equivalent in man
O_2	oxygen
psi	pounds per square inch
ppb	parts per billion
ppm	parts per million
ta	ambient air temperature
ta adj	adjusted ambient air temperature

List of Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
CAA	Clean Air Act
CBC	Complete blood count
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (also called Superfund)
CFR	Code of Federal Regulations
CGI	combustible gas indicator
CNS	central nervous system
CPR	cardiopulmonary resuscitation
CRC	Contamination Reduction Corridor
CRZ	Contamination Reduction Zone
EPA	U.S. Environmental Protection Agency
ESLI	end-of-service-life indicator
FEF	forced expiratory flow
FID	flame ionization detector
FRC	functional residual capacity
GC	gas chromatography
IDLH	immediately dangerous to life or health
IR	infrared
LEL	lower explosive limit
LFL	lower flammable limit
MEFR	maximal expiratory flow rate
MSHA	Mine Safety and Health Administration
MVV	maximal voluntary ventilation
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administratio
OVA	organic vapor analyzer
PAPR	powered air-purifying respirator
PCB	polychlorinated biphenyl
PDS	personnel decontamination station
PEL	permissible exposure limit
PID	photoionization detector
PPE	personal protective clothing and equipment
PVC	polyvinyl chloride
RBC	red blood count
REL	recommended exposure limit
RV	residual volume
SAR	supplied-air respirator
SCBA	self-contained breathing apparatus
SOP	Standard Operating Procedure
TLC	total lung capacity
TLV	threshold limit value
TLV-C	threshold limit value—ceiling
TLV-STEL	threshold limit value—short-term exposure limit
TWA	time-weighted average
UEL	upper explosive limit
UFL	upper flammable limit
USCG	U.S. Coast Guard
UV	ultraviolet

Appendix B. Generic Site Safety Plan

This appendix provides a generic plan based on a plan developed by the U.S. Coast Guard for responding to hazardous chemical releases.[1] This generic plan can be adapted for designing a Site Safety Plan for hazardous waste site cleanup operations. It is not all inclusive and should only be used as a guide, not a standard.

A. SITE DESCRIPTION

Date__________ Location__________

Hazards__________

Area affected__________

Surrounding population__________

Topography__________

Weather conditions__________

Additional information__________

B. ENTRY OBJECTIVES - The objective of the initial entry to the contaminated area is to (describes actions, tasks to be accomplished; i.e., identify contaminated soil; monitor conditions, etc.)

C. ONSITE ORGANIZATION AND COORDINATION - The following personnel are designated to carry out the stated job functions on site. (Note: One person may carry out more than one job function.)

PROJECT TEAM LEADER__________

SCIENTIFIC ADVISOR__________

SITE SAFETY OFFICER__________

PUBLIC INFORMATION OFFICER__________

SECURITY OFFICER__________

RECORDKEEPER__________

FINANCIAL OFFICER__________

FIELD TEAM LEADER__________

FIELD TEAM MEMBERS__________

---

[1] U.S. Coast Guard. Policy Guidance for Response to Hazardous Chemical Releases. USCG Pollution Response COMDTINST-M16465.30.

FEDERAL AGENCY REPS (i.e., EPA, NIOSH) ____________________

STATE AGENCY REPS ____________________

LOCAL AGENCY REPS ____________________

CONTRACTOR(S) ____________________

All personnel arriving or departing the site should log in and out with the Recordkeeper. All activities on site must be cleared through the Project Team Leader.

D. ONSITE CONTROL

(Name of individual or agency ____ has been designated to coordinate access control and security on site. A safe perimeter has been established at (distance or description of controlled area) ____________________

No unauthorized person should be within this area.

The onsite Command Post and staging area have been established at ____________________

The prevailing wind conditions are ____________. This location is upwind from the Exclusion Zone.

Control boundaries have been established, and the Exclusion Zone (the contaminated area), hotline, Contamination Reduction Zone, and Support Zone (clean area) have been identified and designated as follows: (describe boundaries and/or attach map of controlled area) ____________________

These boundaries are identified by: (marking of zones, i.e., red boundary tape - hotline; traffic cones - Support Zone; etc.) ____________________

E. HAZARD EVALUATION

The following substance(s) are known or suspected to be on site. The primary hazards of each are identified.

Substances Involved	Concentrations (If Known)	Primary Hazards
(chemical name)		(e.g., toxic on inhalation)

The following additional hazards are expected on site: (i.e., slippery ground, uneven terrain, etc.)

Hazardous substance information form(s) for the involved substance(s) have been completed and are attached.

F. PERSONAL PROTECTIVE EQUIPMENT

Based on evaluation of potential hazards, the following levels of personal protection have been designated for the applicable work areas or tasks:

Location	Job Function	Level of Protection
Exclusion Zone		A B C D Other
		A B C D Other
		A B C D Other
		A B C D Other
Contamination Reduction Zone		A B C D Other
		A B C D Other
		A B C D Other
		A B C D Other

Specific protective equipment for each level of protection is as follows:

Level A	Fully-encapsulating suit SCBA (disposable coveralls)	Level C	Splash gear (type) Full-face canister resp.
Level B	Splash gear (type) SCBA	Level D	

Other

The following protective clothing materials are required for the involved substances:

Substance	Material
(chemical name)	(material name, e.g., Viton)

If air-purifying respirators are authorized, (filtering medium) is the appropriate canister for use with the involved substances and concentrations. A competent individual has determined that all criteria for using this type of respiratory protection have been met.

NO CHANGES TO THE SPECIFIED LEVELS OF PROTECTION SHALL BE MADE WITHOUT THE APPROVAL OF THE SITE SAFETY OFFICER AND THE PROJECT TEAM LEADER.

G. ONSITE WORK PLANS

Work party(s) consisting of ____ persons will perform the following tasks:

Project Team Leader	(name)	(function)
Work Party #1		
Work Party #2		
Rescue Team (required for entries to IDLH environments)		
Decontamination Team		

The work party(s) were briefed on the contents of this plan at ______________.

H. COMMUNICATION PROCEDURES

Channel ____ has been designated as the radio frequency for personnel in the Exclusion Zone. All other onsite communications will use channel ____.

Personnel in the Exclusion Zone should remain in constant radio communication or within sight of the Project Team Leader. Any failure of radio communication requires an evaluation of whether personnel should leave the Exclusion Zone.

(Horn blast, siren, etc.) is the emergency signal to indicate that all personnel should leave the Exclusion Zone. In addition, a loud hailer is available if required.

The following standard hand signals will be used in case of failure of radio communications:

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

Telephone communication to the Command Post should be established as soon as practicable. The phone number is ____________________.

I. DECONTAMINATION PROCEDURES

Personnel and equipment leaving the Exclusion Zone shall be thoroughly decontaminated. The standard level _____ decontamination protocol shall be used with the following decontamination stations: (1) ______________
(2) ______________ (3) ______________ (4) ______________ (5) ______________
(6) ______________ (7) ______________ (8) ______________ (9) ______________
(10) ______________ Other ____

Emergency decontamination will include the following stations: ______________
____
____
____

The following decontamination equipment is required: ______________________
____
____
____

(Normally detergent and water) will be used as the decontamination solution.

J. SITE SAFETY AND HEALTH PLAN

1. (name) is the designated Site Safety Officer and is directly responsible to the Project Team Leader for safety recommendations on site.

2. Emergency Medical Care

__(names of qualified personnel)__ are the qualified EMTs on site. __(medical facility names)__, at __(address)__, phone ____________ is located _____ minutes from this location. __(name of person)__ was contacted at __(time)__ and briefed on the situation, the potential hazards, and the substances involved. A map of alternative routes to this facility is available at __(normally Command Post)__.

Local ambulance service is available from ____________ at phone ____________. Their response time is _____ minutes. Whenever possible, arrangements should be made for onsite standby.

First-aid equipment is available on site at the following locations:

First-aid kit ____________
Emergency eye wash ____________
Emergency shower ____________
__(other)__ ____________

Emergency medical information for substances present:

Substance	Exposure Symptoms	First-Aid Instructions

List of emergency phone numbers:

Agency/Facility	Phone #	Contact
Police		
Fire		
Hospital		
Airport		
Public Health Advisor		

3. Environmental Monitoring

The following environmental monitoring instruments shall be used on site (cross out if not applicable) at the specified intervals.

Combustible Gas Indicator - continuous/hourly/daily/other ________
O_2 Monitor - continuous/hourly/daily/other ________
Colorimetric Tubes - continuous/hourly/daily/other ________
__(type)__ ____________
____________ ____________
____________ ____________
HNU/OVA - continuous/hourly/daily/other ________
Other ____________ - continuous/hourly/daily/other ________
____________ - continuous/hourly/daily/other ________

4. Emergency Procedures (should be modified as required for incident)

The following standard emergency procedures will be used by onsite personnel. The Site Safety Officer shall be notified of any onsite emergencies and be responsible for ensuring that the appropriate procedures are followed.

Personnel Injury in the Exclusion Zone: Upon notification of an injury in the Exclusion Zone, the designated emergency signal ______________________ shall be sounded. All site personnel shall assemble at the decontamination line. The rescue team will enter the Exclusion Zone (if required) to remove the injured person to the hotline. The Site Safety Officer and Project Team Leader should evaluate the nature of the injury, and the affected person should be decontaminated to the extent possible prior to movement to the Support Zone. The onsite EMT shall initiate the appropriate first aid, and contact should be made for an ambulance and with the designated medical facility (if required). No persons shall reenter the Exclusion Zone until the cause of the injury or symptoms is determined.

Personnel Injury in the Support Zone: Upon notification of an injury in the Support Zone, the Project Team Leader and Site Safety Officer will assess the nature of the injury. If the cause of the injury or loss of the injured person does not affect the performance of site personnel, operations may continue, with the onsite EMT initiating the appropriate first aid and necessary follow-up as stated above. If the injury increases the risk to others, the designated emergency signal ______________________ shall be sounded and all site personnel shall move to the decontamination line for further instructions. Activities on site will stop until the added risk is removed or minimized.

Fire/Explosion: Upon notification of a fire or explosion on site, the designated emergency signal _________________________ shall be sounded and all site personnel assembled at the decontamination line. The fire department shall be alerted and all personnel moved to a safe distance from the involved area.

Personal Protective Equipment Failure: If any site worker experiences a failure or alteration of protective equipment that affects the protection factor, that person and his/her buddy shall immediately leave the Exclusion Zone. Reentry shall not be permitted until the equipment has been repaired or replaced.

Other Equipment Failure: If any other equipment on site fails to operate properly, the Project Team Leader and Site Safety Officer shall be notified and then determine the effect of this failure on continuing operations on site. If the failure affects the safety of personnel or prevents completion of the Work Plan tasks, all personnel shall leave the Exclusion Zone until the situation is evaluated and appropriate actions taken.

The following emergency escape routes are designated for use in those situations where egress from the Exclusion Zone cannot occur through the decontamination line: (describe alternate routes to leave area in emergencies)

In all situations, when an onsite emergency results in evacuation of the Exclusion Zone, personnel shall not reenter until:

1. The conditions resulting in the emergency have been corrected.
2. The hazards have been reassessed.
3. The Site Safety Plan has been reviewed.
4. Site personnel have been briefed on any changes in the Site Safety Plan.

5. Personal Monitoring

The following personal monitoring will be in effect on site:

Personal exposure sampling: (describe any personal sampling programs being carried out on site personnel. This would include use of sampling pumps, air monitors, etc.)

Medical monitoring: The expected air temperature will be (°F) . If it is determined that heat stress monitoring is required (mandatory if over 70°F) the following procedures shall be followed: (describe procedures in effect, i.e., monitoring body temperature, body weight, pulse rate)

All site personnel have read the above plan and are familiar with its provisions.

Site Safety Oficer	(name)	(signature)
Project Team Leader		
Other Site Personnel		

Appendix C. Sample Hazardous Substance Information Form

COMMON NAME:____________ CHEMICAL NAME:____________

I. PHYSICAL/CHEMICAL PROPERTIES

		SOURCE
Natural physical state: Gas____ Liquid____ Solid____ (at ambient temps of 20°C-25°C)		____________
Molecular weight	____________g/g-mole	____________
Density[a]	____________g/ml	____________
Specific gravity[a]	______@______°F/°C	____________
Solubility: water	______@______°F/°C	____________
Solubility[b]: ________	______@______°F/°C	____________
Boiling point	____________°F/°C	____________
Melting point	____________°F/°C	____________
Vapor pressure	______mmHg @______°F/°C	____________
Vapor density	______@______°F/°C	____________
Flash point (open cup_____; closed cup_____)	____________°F/°C	____________
Other: ____________	____________	____________

II. HAZARDOUS CHARACTERISTICS

A. TOXICOLOGICAL HAZARD	HAZARD?	CONCENTRATIONS (PEL, TLV, other)	SOURCE
Inhalation	Yes No	____________	____________
Ingestion	Yes No	____________	____________
Skin/eye absorption	Yes No	____________	____________
Skin/eye contact	Yes No	____________	____________
Carcinogenic	Yes No	____________	____________
Teratogenic	Yes No	____________	____________
Mutagenic	Yes No	____________	____________
Aquatic	Yes No	____________	____________
Other: ________	Yes No	____________	____________

B. TOXICOLOGICAL HAZARD	HAZARD?	CONCENTRATIONS	SOURCE
Combustibility	Yes No	____________	____________
Toxic byproduct(s):	Yes No		
____________		____________	____________
____________		____________	____________
Flammability	Yes No		
LFL		____________	____________
UFL		____________	____________
Explosivity	Yes No		
LEL		____________	____________
UEL		____________	____________

---

[a] Only one is necessary.

[b] For organic compounds, recovery of spilled material by solvent extraction may require solubility data.

C. REACTIVITY HAZARD	HAZARD?	CONCENTRATIONS	SOURCE
	Yes No		
Reactivities:			
____________		____________	____________
____________		____________	____________

D. CORROSIVITY HAZARD	HAZARD?	CONCENTRATIONS	SOURCE
ph ____________	Yes No		
Neutralizing agent:			
____________		____________	____________
____________		____________	____________

E. RADIOACTIVE HAZARD	HAZARD?	EXPOSURE RATE	SOURCE
Background	Yes No	____________	____________
Alpha particles	Yes No	____________	____________
Beta particles	Yes No	____________	____________
Gamma radiation	Yes No	____________	____________

III. DESCRIPTION OF INCIDENT:

Quantity involved ____________________

Release information ______________________________

____

Monitoring/sampling recommended ______________________________

____

IV. RECOMMENDED PROTECTION:

Worker ______________________________

____

Public ______________________________

____

V. RECOMMENDED SITE CONTROL:

Hotline ______________________________

____

Decontamination line ______________________________

____

Command Post location ______________________________

____

VI. REFERENCES FOR SOURCES:

____

____

____

____

____

____

____

____

SAMPLE HAZARDOUS SUBSTANCE INFORMATION FORM FILLED OUT FOR VINYL CHLORIDE

COMMON NAME: Vinyl Chloride CHEMICAL NAME: Chloroethene

I. PHYSICAL/CHEMICAL PROPERTIES

			SOURCE
Natural physical state: Gas ✓ Liquid ___ Solid ___ (at ambient temps of 20°C-25°C)			CHRIS
Molecular weight	62.5	g/g-mole	CHRIS
Density^{a}		g/ml	
Specific gravity^{a}	0.9121 @ 20	°F/[✓ °C]	CHEM DIC
Solubility: water	slightly @ —	°F/°C	CHEM DIC
Solubility^{b}: alcohol	soluble @	°F/°C	CHEM DIC
Boiling point	7.2	[✓ °F]/°C	CHRIS
Melting point	-244.8	[✓ °F]/°C	CHRIS
Vapor pressure	2,300 mmHg @ 20	°F/[✓ °C]	CHEM DIC
Vapor density	2.2 @ —	°F/°C	NFPA
Flash point (open cup ✓; closed cup ___)	-110	°F/[✓ °C]	CHRIS
Other: Polymerizes readily in air and water			OHMTADS

II. HAZARDOUS CHARACTERISTICS

A. TOXICOLOGICAL HAZARD	HAZARD?	CONCENTRATIONS (PEL, TLV, other)	SOURCE
Inhalation	[✓ Yes] No	PEL-TWA 1 ppm/TLV-TWA 5ppm	OSHA/ACGIH
Ingestion	Yes No		
Skin/eye absorption	[✓ Yes] No		SITTIG
Skin/eye contact	[✓ Yes] No	Skin burn from contact	OHMTADS
Carcinogenic	[✓ Yes] No	TLV 5ppm/PEL 1ppm	ACGIH/OSHA
Teratogenic	Yes No		
Mutagenic	Yes No		
Aquatic	Yes No		
Other: ___	Yes No		

B. TOXICOLOGICAL HAZARD	HAZARD?	CONCENTRATIONS	SOURCE
Combustibility	[✓ Yes] No		
Toxic byproduct(s):	[✓ Yes] No		
Hydrogen chloride			
Phosgene, carbon monoxide			
Flammability	[✓ Yes] No		
LFL		3.6	OHMTADS
UFL		33	OHMTADS
Explosivity	Yes No		
LEL			
UEL			

---

[a] Only one is necessary.

[b] For organic compounds, recovery of spilled material by solvent extraction may require solubility data.

C. REACTIVITY HAZARD	HAZARD?	CONCENTRATIONS	SOURCE
	[✓ Yes] No		
Reactivities: Polymerizes in air, sunlight or heat			CHRIS

D. CORROSIVITY HAZARD	HAZARD?	CONCENTRATIONS	SOURCE
ph Neutralizing agent:	Yes [✓ No]		

E. RADIOACTIVE HAZARD	HAZARD?	EXPOSURE RATE	SOURCE
Background	Yes [✓ No]		
Alpha particles	Yes [✓ No]		
Beta particles	Yes [✓ No]		
Gamma radiation	Yes [✓ No]		

III. DESCRIPTION OF INCIDENT:

Quantity involved 1,000 lbs

Release information Suspected Leaking Cylinder

Monitoring/sampling recommended

IV. RECOMMENDED PROTECTION:

Worker Level B protection. Protective clothing materials recommended: CPE or Viton

Public

V. RECOMMENDED SITE CONTROL:

Hotline

Decontamination line

Command Post location

VI. REFERENCES FOR SOURCES:

CHRIS – Chemical Hazards Response Information System Manual II
ACGIH – TLVs – Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment 1984-85
CHEM DIC – Condensed Chemical Dictionary, Tenth Edition, 1981
NFPA – Fire Protection Guide on Hazardous Materials, Seventh Ed., 1978
OHMTADS – Oil and Hazardous Materials Technical Assistance Data System, EPA 1984
SITTIG – Handbook of Toxic and Hazardous Chemicals, Marshall Sittig, 1981
OSHA – 29 CFR Part 1910.1017

Appendix D. Sample Decontamination Procedures for Three Typical Levels of Protection[a]

F.S.O.P. No. 7

Process: DECONTAMINATION PROCEDURES

INTRODUCTION

1.1 The objective of these procedures is to minimize the risk of exposure to hazardous substances. These procedures were derived from the U.S. Environmental Protection Agency, Office of Emergency and Remedial Response's (OERR), "Interim Standard Operating Safety Guides (revised Sep. 82)". This version of the guides is in a format that is more appropriate for use in the field.

1.2 Protective equipment must be worn by personnel when response activities involve known or suspected hazardous substances. The procedures for decontaminating personnel upon leaving the contaminated area are addressed for each of the EPA, OERR designated levels of protection. The procedures given are for the maximum and minimum amount of decontamination used for each level of protection.

1.3 The maximum decontamination procedures for all levels of protection consist of specific activities at nineteen stations. Each station emphasizes an important aspect of decontamination. When establishing a decontamination line, each aspect should be incorporated separately or combined with other aspects into a procedure with fewer steps (such as the Minimum Decontamination Procedures).

1.4 Decontamination lines are site specific since they are dependent upon the types of contamination and the type of work activities on site. A cooling station is sometimes necessary within the decontamination line during hot weather. It is usually a location in a shaded area in which the wind can help to cool personnel. In addition, site conditions may permit the use of cooling devices such as cool water hose, ice packs, cool towels, etc. When the decontamination line is no longer required, contaminated wash and rinse solutions and contaminated articles must be contained and disposed of as hazardous wastes in compliance with state and federal regulations.

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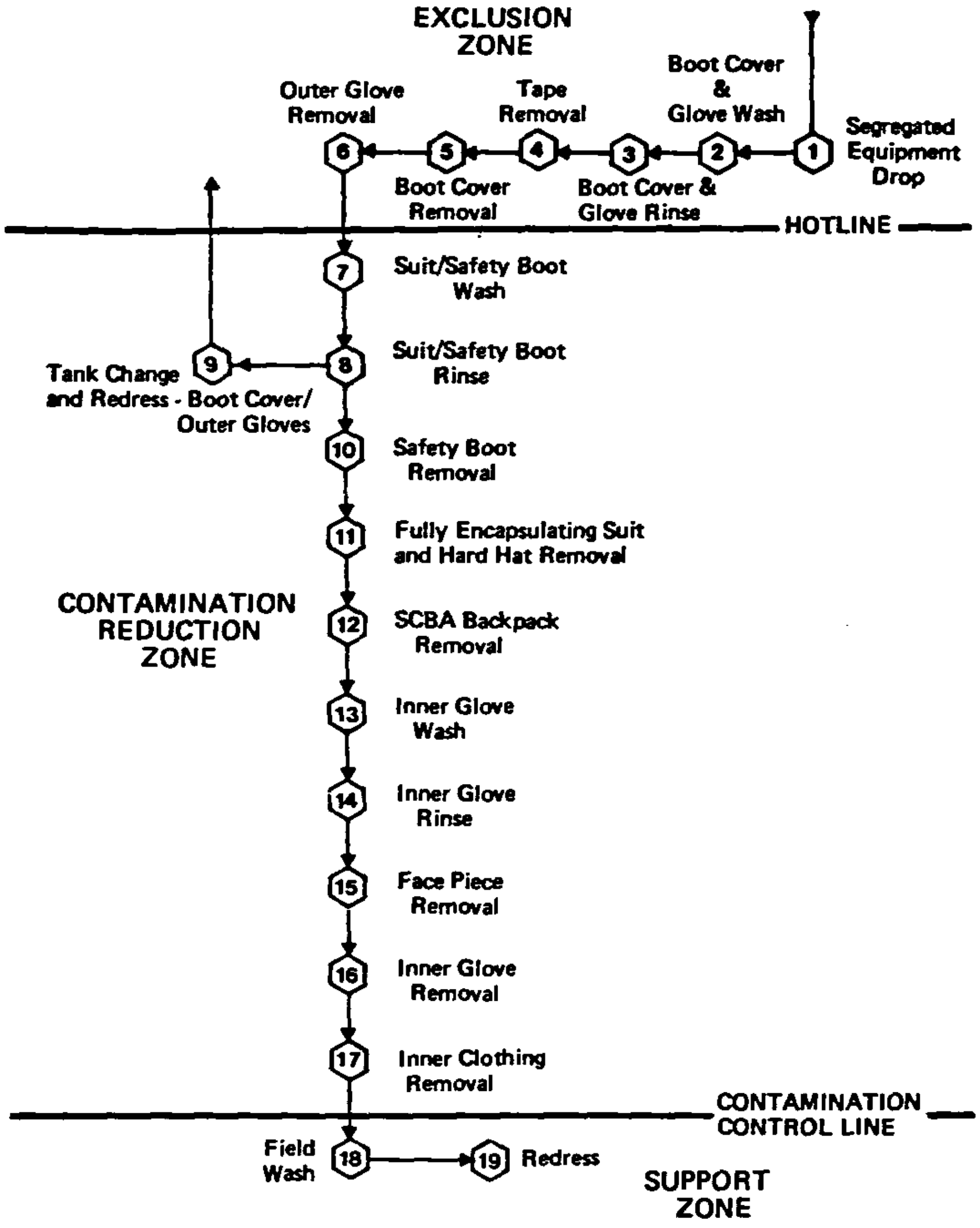
[a] **Source:** Excerpted from *Field Standard Operating Procedures for the Decontamination of Response Personnel (FSOP 7)*. EPA Office of Emergency and Remedial Response, Hazardous Response Support Division, Washington, DC. January 1985.

F.S.O.P. No. 7

PROCESS DECON PROCEDURES

MAXIMUM DECONTAMINATION LAYOUT

LEVEL A PROTECTION

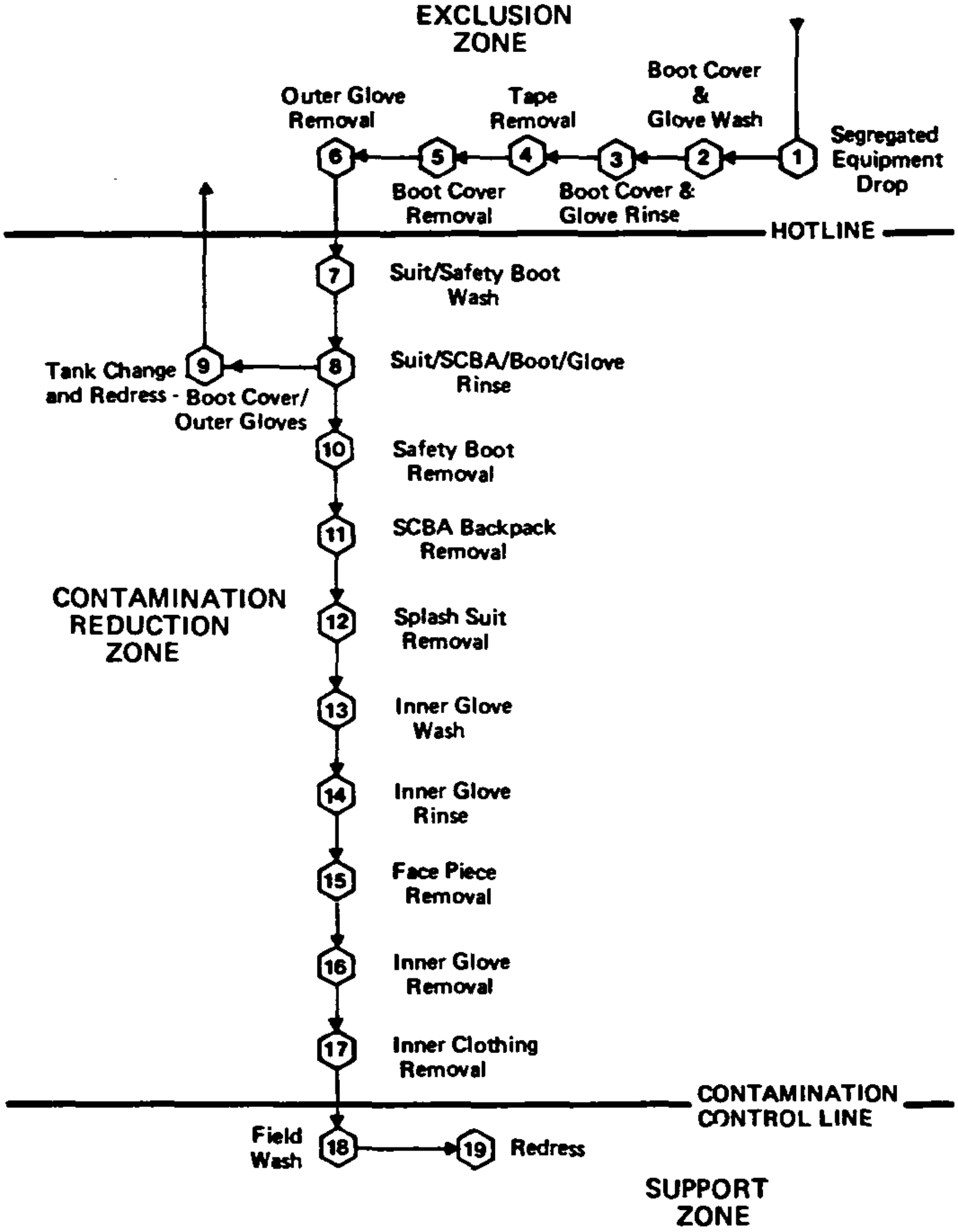


F.S.O.P. No. 7

PROCESS DECON PROCEDURES

MAXIMUM DECONTAMINATION LAYOUT

LEVEL B PROTECTION

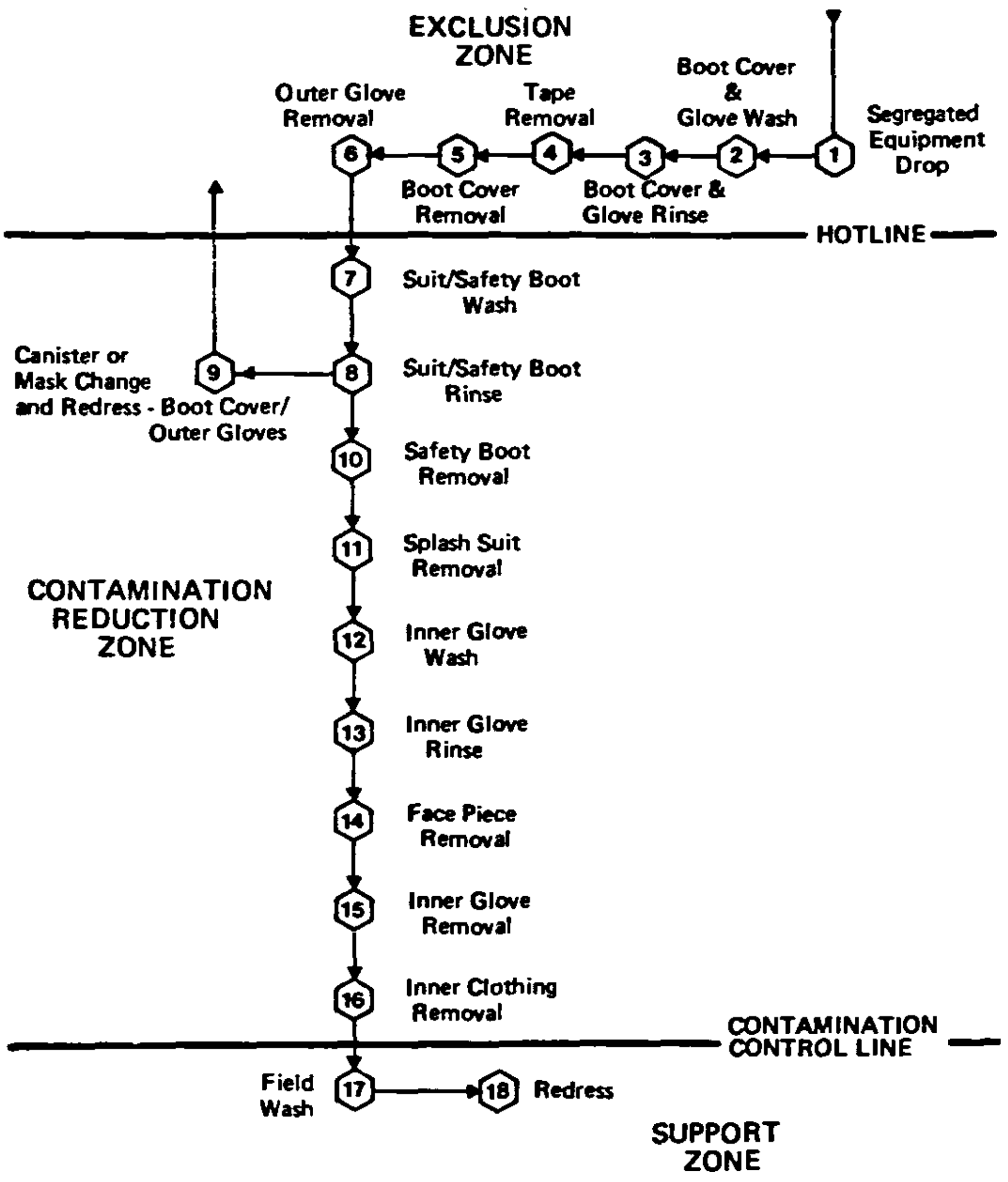


F.S.O.P. No. 7

PROCESS DECON PROCEDURES

MAXIMUM DECONTAMINATION LAYOUT

LEVEL C PROTECTION

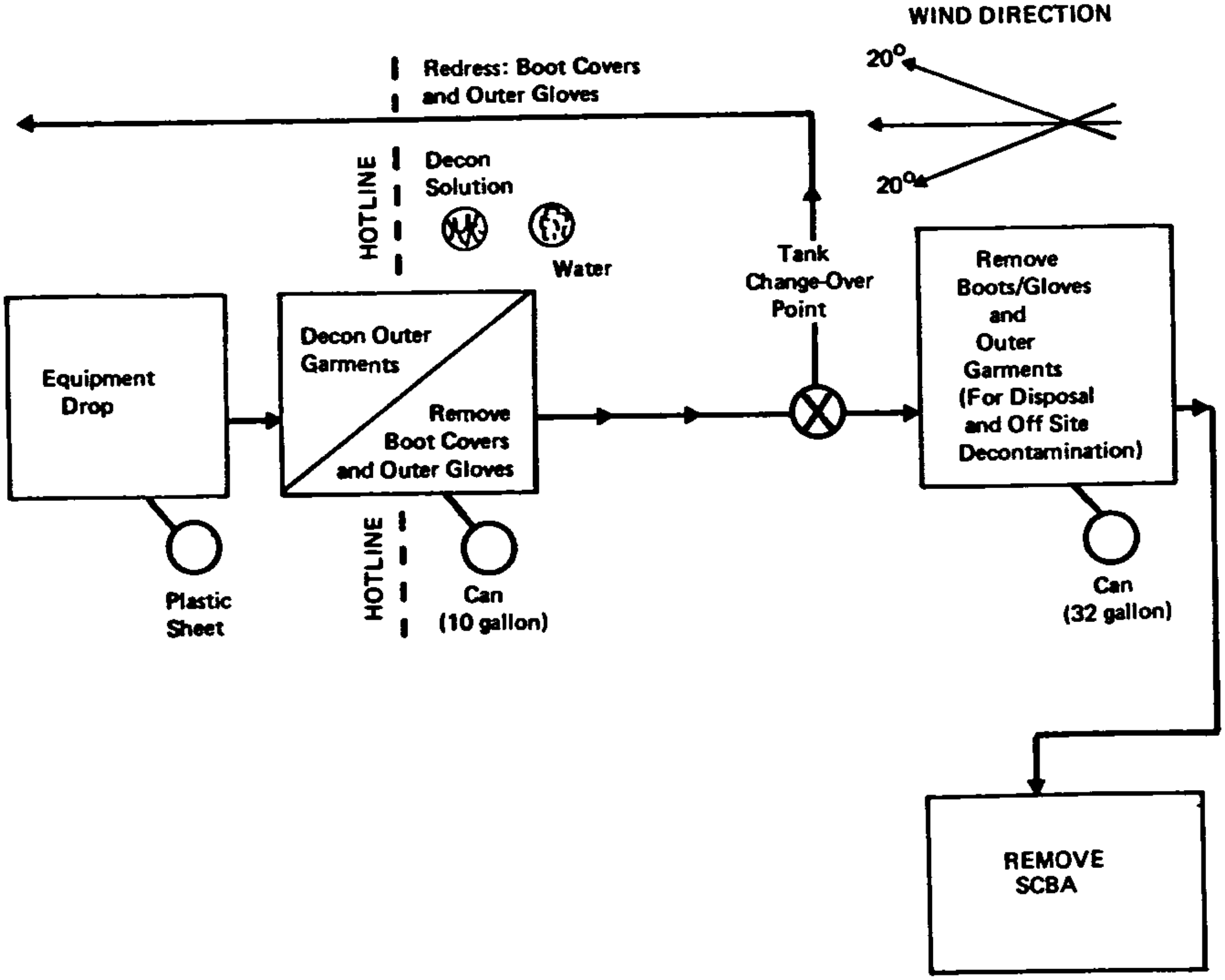


F.S.O.P. No. 7

PROCESS DECON PROCEDURES

MINIMUM DECONTAMINATION LAYOUT

LEVELS A & B PROTECTION

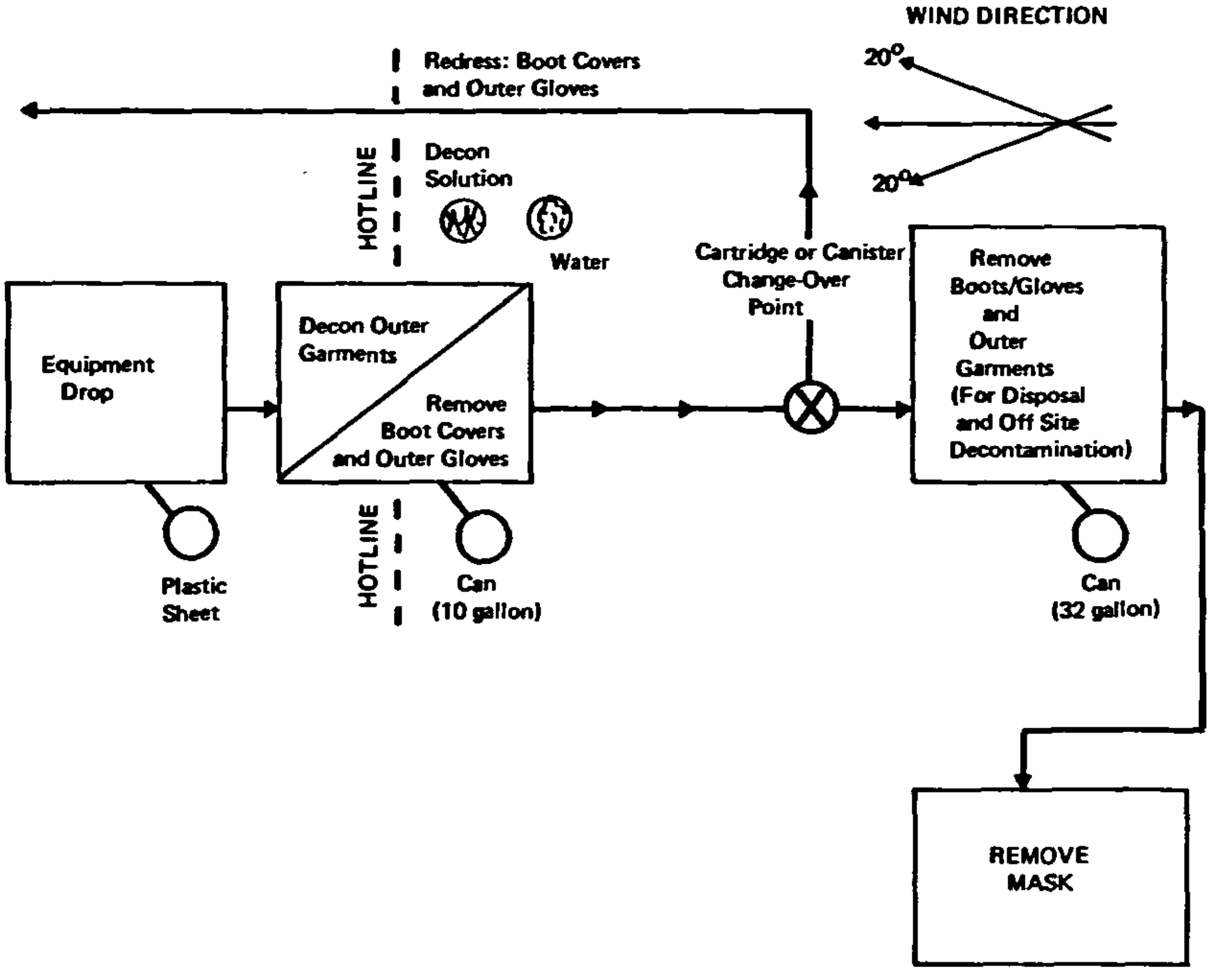


P.S.O.P. No. 7

PROCESS DECON PROCEDURES

MINIMUM DECONTAMINATION LAYOUT

LEVEL C PROTECTION



EQUIPMENT NEEDED TO PERFORM MAXIMUM DECONTAMINATION MEASURES FOR LEVELS A, B, AND C

Station 1:
a. Various Size Containers
b. Plastic Liners
c. Plastic Drop Cloths

Station 2:
a. Containers (20-30 Gallons)
b. Decon Solution or Detergent Water
c. 2-3 Long-Handled, Soft-Bristled Scrub Brushes

Station 3:
a. Containers (20-30 Gallons)
OR
High-Pressure Spray Unit
b. Water
c. 2-3 Long-Handled, Soft-Bristled Scrub Brushes

Station 4:
a. Containers (20-30 Gallons)
b. Plastic Liners

Station 5:
a. Containers (20-30 Gallons)
b. Plastic Liners
c. Bench or Stools

Station 6:
a. Containers (20-30 Gallons)
b. Plastic Liners

Station 7:
a. Containers (20-30 Gallons)
b. Decon Solution or Detergent Water
c. 2-3 Long-Handled, Soft-Bristled Scrub Brushes

Station 8:
a. Containers (20-30 Gallons)
OR
High-Pressure Spray Unit
b. Water
c. 2-3 Long-Handled, Soft-Bristled Scrub Brushes

Station 9:
a. Air Tanks or Face Masks and Cartridge Depending on Level
b. Tape
c. Boot Covers
d. Gloves

Station 10:
a. Containers (20-30 Gallons)
b. Plastic Liners
c. Bench or Stools
d. Boot Jack

Station 11:
a. Rack
b. Drop Cloths
c. Bench or Stools

Station 12:
a. Table

Station 13:
a. Basin or Bucket
b. Decon Solution
c. Small Table

Station 14:
a. Water
b. Basin or Bucket
c. Small Table

Station 15:
a. Containers (20-30 Gallons)
b. Plastic Liners

Station 16:
a. Containers (20-30 Gallons)
b. Plastic Liners

Station 17:
a. Containers (20-30 Gallons)
b. Plastic Liners

Station 18:
a. Water
b. Soap
c. Small Table
d. Basin or Bucket
e. Field Showers
f. Towels

Station 19:
a. Dressing Trailer is Needed in Inclement Weather
b. Tables
c. Chairs
d. Lockers
e. Cloths

EQUIPMENT NEEDED TO PERFORM MINIMUM DECONTAMINATION MEASURES FOR LEVELS A, B, AND C

Station 1:
a. Various Size Containers
b. Plastic Liners
c. Plastic Drop Cloths

Station 2:
a. Containers (20-30 Gallons)
b. Decon Solution
c. Rinse Water
d. 2-3 Long-Handled, Soft-Bristled Scrub Brushes

Station 3:
a. Containers (20-30 Gallons)
b. Plastic Liners
c. Bench or Stools

Station 4:
a. Air Tanks or Masks and Cartridges Depending Upon Level
b. Tape
c. Boot Covers
d. Gloves

Station 5:
a. Containers (20-30 Gallons)
b. Plastic Liners
c. Bench or Stools

Station 6:
a. Plastic Sheets
b. Basin or Bucket
c. Soap and Towels
d. Bench or Stools

Station 7:
a. Water
b. Soap
c. Tables
d. Wash Basin or Bucket

FSOP 7: MAXIMUM MEASURES FOR LEVEL A DECONTAMINATION

Station 1:	Segregated Equipment Drop	1. Deposit equipment used on site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. During hot weather operations, a cool down station may be set up within this area.
Station 2:	Boot Cover and Glove Wash	2. Scrub outer boot covers and gloves with decon solution or detergent/water.
Station 3:	Boot Cover and Glove Rinse	3. Rinse off decon solution from station 2 using copious amounts of water.
Station 4:	Tape Removal	4. Remove tape around boots and gloves and deposit in container with plastic liner.
Station 5:	Boot Cover Removal	5. Remove boot covers and deposit in container with plastic liner.
Station 6:	Outer Glove Removal	6. Remove outer gloves and deposit in container with plastic liner.
Station 7:	Suit and Boot Wash	7. Wash encapsulating suit and boots using scrub brush and decon solution or detergent/water. Repeat as many times as necessary.
Station 8:	Suit and Boot	8. Rinse off decon solution using water. Repeat as many times as necessary.
Station 9:	Tank Change	9. If an air tank change is desired, this is the last step in the decontamination procedure. Air tank is exchanged, new outer gloves and boot covers donned, and joints taped. Worker returns to duty.
Station 10:	Safety Boot Removal	10. Remove safety boots and deposit in container with plastic liner.
Station 11:	Fully Encapsulating Suit and Hard Hat Removal	11. Fully encapsulated suit is removed with assistance of a helper and laid out on a drop cloth or hung up. Hard hat is removed. Hot weather rest station maybe set up within this area for personnel returning to site.
Station 12:	SCBA Backpack Removal	12. While still wearing facepiece, remove backpack and place on table. Disconnect hose from regulator valve and proceed to next station.
Station 13:	Inner Glove Wash	13. Wash with decon solution that will not harm the skin. Repeat as often as necessary.
Station 14:	Inner Glove Rinse	14. Rinse with water. Repeat as many times as necessary.
Station 15:	Face Piece Removal	15. Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers.
Station 16:	Inner Glove Removal	16. Remove inner gloves and deposit in container with liner.

FSOP 7: MAXIMUM MEASURES FOR LEVEL A DECONTAMINATION

Station 17:	Inner Clothing Removal	17. Remove clothing and place in lined container. Do not wear inner clothing off-site since there is a possibility that small amounts of contaminants might have been transferred in removing the fully-encapsulating suit.
Station 18:	Field Wash	18. Shower if highly toxic, skin-corrosive or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Station 19:	Redress	19. Put on clean clothes.

FSOP 7: MINIMUM MEASURES FOR LEVEL A DECONTAMINATION

Station 1:	Equipment Drop	1. Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, cool down stations maybe set up within this area.
Station 2:	Outer Garment, Boots, and Gloves Wash and Rinse	2. Scrub outer boots, outer gloves and fully-encapsulating suit with decon solution or detergent and water. Rinse off using copious amounts of water.
Station 3:	Outer Boot and Glove Removal	3. Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Tank Change	4. If worker leaves Exclusion Zone to change air tank, this is the last step in the decontamination procedure. Worker's air tank is exchanged, new outer gloves and boot covers donned, joints taped, and worker returns to duty.
Station 5:	Boot, Gloves and Outer Garment Removal	5. Boots, fully-encapsulating suit, inner gloves removed and deposited in separate containers lined with plastic.
Station 6:	SCBA Removal	6. SCBA backpack and facepiece is removed (avoid touching face with fingers). SCBA deposited on plastic sheets.
Station 7:	Field Wash	7. Hands and face are thoroughly washed. Shower as soon as possible.

FSOP 7: MAXIMUM MEASURES FOR LEVEL B DECONTAMINATION

Station 1:	Segregated Equipment Drop	1. Deposit equipment used on site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, cooldown stations may be set up within this area.
Station 2:	Boot Cover and Glove Wash	2. Scrub outer boot covers and gloves with decon solution or detergent and water.
Station 3:	Boot Cover and Glove Rinse	3. Rinse off decon solution from station 2 using copious amounts of water.
Station 4:	Tape Removal	4. Remove tape around boots and gloves and deposit in container with plastic liner.
Station 5:	Boot Cover Removal	5. Remove boot covers and deposit in container with plastic liner.
Station 6:	Outer Glove removal	6. Remove outer gloves and deposit in container with plastic liner.
Station 7:	Suit and Safety Boot Wash	7. Wash chemical-resistant splash suit, SCBA, gloves and safety boots. Scrub with long-handle scrub brush and decon solution. Wrap SCBA regulator (if belt mounted type) with plastic to keep out water. Wash backpack assembly with sponges or cloths.
Station 8:	Suit, SCBA, Boot, and Glove Rinse	8. Rinse off decon solution using copious amounts of water.
Station 9:	Tank Change	9. If worker leaves exclusion zone to change air tank, this is the last step in the decontamination procedure. Worker's air tank is exchanged, new outer gloves and boot covers donned, and joints taped. Worker returns to duty.
Station 10:	Safety Boot Removal	10. Remove safety boots and deposit in container with plastic liner.
Station 11:	SCBA Backpack Removal	11. While still wearing facepiece, remove backpack and place on table. Disconnect hose from regulator valve.
Station 12:	Splash Suit Removal	12. With assistance of helper, remove splash suit. Deposit in container with plastic liner.
Station 13:	Inner Glove Wash	13. Wash inner gloves with decon solution.
Station 14:	Inner Glove Rinse	14. Rinse inner gloves with water.
Station 15:	Face Piece Removal	15. Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers.
Station 16:	Inner Glove Removal	16. Remove inner gloves and deposit in container with liner.

FSOP 7: MAXIMUM MEASURES FOR LEVEL B DECONTAMINATION

Station 17:	Inner Clothing Removal	17. Remove inner clothing. Place in container with liner. Do not wear inner clothing off-site since there is a possibility that small amounts of contaminants might have been transferred in removing the fully-encapsulating suit.
Station 18:	Field Wash	18. Shower if highly toxic, skin-corrosive or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Station 19:	Redress	19. Put on clean clothes.

FSOP 7: MINIMUM MEASURES FOR LEVEL B DECONTAMINATION

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

FSOP 7: MAXIMUM MEASURES FOR LEVEL C DECONTAMINATION

Station 1:	Segrated Equipment Drop	1. Deposit equipment used on site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, a cool down station may be set up within this area.
Station 2:	Boot Cover and Glove Wash	2. Scrub outer boot covers and gloves with decon solution or detergent and water.
Station 3:	Boot Cover and Glove Rinse	3. Rinse off decon solution from station 2 using copious amounts of water.
Station 4:	Tape Removal	4. Remove tape around boots and gloves and deposit in container with plastic liner.
Station 5:	Boot Cover Removal	5. Remove boot covers and deposit in containers with plastic liner.
Station 6:	Outer Glove Removal	6. Remove outer gloves and deposit in container with plastic liner.
Station 7:	Suit and Boot Wash	7. Wash splash suit, gloves, and safety boots. Scrub with long-handle scrub brush and decon solution.
Station 8:	Suit and Boot, and Glove Rinse	8. Rinse off decon solution using water. Repeat as many times as necessary.
Station 9:	Canister or Mask Change	9. If worker leaves exclusion zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot covers donned, and joints taped worker returns to duty.
Station 10:	Safety Boot Removal	10. Remove safety boots and deposit in container with plastic liner.
Station 11:	Splash Suit Removal	11. With assistance of helper, remove splash suit. Deposit in container with plastic liner.
Station 12:	Inner Glove Rinse	12. Wash inner gloves with decon solution.
Station 13:	Inner Glove Wash	13. Rinse inner gloves with water.
Station 14:	Face Piece Removal	14. Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers.
Station 15:	Inner Glove Removal	15. Remove inner gloves and deposit in lined container.

FSOP 7: MAXIMUM MEASURES FOR LEVEL C DECONTAMINATION

Station 16:	Inner Clothing Removal	16. Remove clothing soaked with perspiration and place in lined container. Do not wear inner clothing off-site since there is a possibility that small amounts of contaminants might have been transferred in removing the fully-encapsulating suit.
Station 17:	Field Wash	17. Shower if highly toxic, skin-corrosive or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Station 18:	Redress	18. Put on clean clothes.

FSOP 7: MINIMUM MEASURES FOR LEVEL C DECONTAMINATION

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

Appendix E. NIOSH, OSHA, and EPA Regional Offices and USCG District Offices

NIOSH Regional Offices

HHS Region I
Government Center
(JFK Federal Building)
Boston, MA 02203
Telephone: (617) 223-3848

HHS Region II
26 Federal Plaza, Room 3337
New York, NY 10278
Telephone: (212) 264-5747

HHS Region III
521-35 Market Street
P.O. Box 13716
Philadelphia, PA 19101
Telephone: (215) 596-6716

HHS Region IV
101 Marietta Tower, Suite 1007
Atlanta, GA 30323
Telephone: (404) 221-2396

HHS Region V
300 South Wacker Drive, 33rd Floor
Chicago, IL 60606
Telephone: (312) 886-3881

HHS Region VI
1200 Main Tower Building
Room 1835
Dallas, TX 75202
Telephone: (214) 767-3916

HHS Region VII
601 East 12th Street
Kansas City, MO 64106
Telephone: (816) 374-3491

HHS Region VIII
1185 Federal Building
1961 Stout Street
Denver, CO 80294
Telephone: (303) 844-6163 x17

HHS Region IX
50 United Nations Plaza
San Francisco, CA 94102
Telephone: (415) 556-3782

HHS Region X
2901 Third Avenue, M.S. 402
Seattle, WA 98121
Telephone: (206) 442-0530

OSHA Regional Offices

OSHA Region I
16-18 North Street
1 Dock Square Building, 4th Floor
Boston, MA 02109
Telephone: (617) 223-6710

OSHA Region II
One Astor Plaza, Room 3445
1515 Broadway
New York, NY 10036
Telephone: (212) 944-3432

OSHA Region III
Gateway Building, Suite 2100
3535 Market Street
Philadelphia, PA 19104
Telephone: (215) 596-1201

OSHA Region IV
1375 Peachtree Street, N.E.
Suite 587
Atlanta, GA 30367
Telephone: (404) 881-3573

OSHA Region V
230 South Dearborn Street
32nd Floor, Room 3244
Chicago, IL 60604
Telephone: (312) 353-2220

OSHA Region VI
525 Griffin Square, Room 602
Dallas, TX 75202
Telephone: (214) 767-4731

OSHA Region VII
911 Walnut Street, Room 406
Kansas City, MO 64106
Telephone: (816) 374-5861

OSHA Region VIII
Federal Building, Room 1554
1961 Stout Street
Denver, CO 80294
Telephone: (303) 837-3061

OSHA Region IX
450 Golden Gate Avenue
Box 36017
San Francisco, CA 94102
Telephone: (415) 556-7260

OSHA Region X
Federal Office Building, Room 6003
909 First Avenue
Seattle, WA 98174
Telephone: (206) 442-5930

EPA Regional Offices

EPA Region I
JFK Federal Building
Boston, MA 02203
Telephone: (617) 223-7210

EPA Region II
26 Federal Plaza
Room 900
New York, NY 10218
Telephone: (212) 264-2525

EPA Region III
841 Chestnut Street
Philadelphia, PA 19107
Telephone: (215) 597-9800

EPA Region IV
345 Cortland Street, N.E.
Atlanta, GA 30365
Telephone: (404) 881-4727

EPA Region V
230 S. Dearborne Street
Chicago, IL 60604
Telephone: (312) 353-2000

EPA Region VI
First International Building
1201 Elm Street
Dallas, TX 75270
Telephone: (214) 767-2600

EPA Region VII
726 Minnesota Avenue
Kansas City, KS 66101
Telephone: (913) 236-2800

EPA Region VIII
One Denver Place
999 18th Street, Suite 1300
Denver, CO 80202-2413
Telephone: (303) 293-1603

EPA Region IX
215 Fremont Street
San Francisco, CA 94105
Telephone: (415) 974-8153

EPA Region X
1200 6th Avenue
Seattle, WA 98101
Telephone: (206) 442-5810

USCG District Offices

Commander (mep)
First Coast Guard District
150 Causeway Street
Boston, MA 02114
Telephone: (617) 223-6915

Commander (meps)
Second Coast Guard District
1430 Olive Street
St. Louis, MO 63103
Telephone: (314) 425-4655

Commander (mer)
Third Coast Guard District
Governors Island
New York, NY 10004
Telephone: (212) 668-7152

Commander (mep)
Fifth Coast Guard District
Federal Building
431 Crawfort Street
Portsmouth, VA 23705
Telephone: (804) 398-6383

Commander (mep)
Seventh Coast Guard District
Federal Building
51 S.W. 1st Avenue
Miami, FL 33130
Telephone: (305) 350-5276

Commander (mep)
Eighth Coast Guard District
Hale Boggs Federal Building
500 Camp Street
New Orleans, LA 70130
Telephone: (504) 589-6296

Commander (mep)
Ninth Coast Guard District
1240 East 9th Street
Cleveland, OH 44199
Telephone: (216) 522-3918

Commander (mep)
Eleventh Coast Guard District
Union Bank Building
400 Oceangate
Long Beach, CA 90822
Telephone: (213) 590-2301

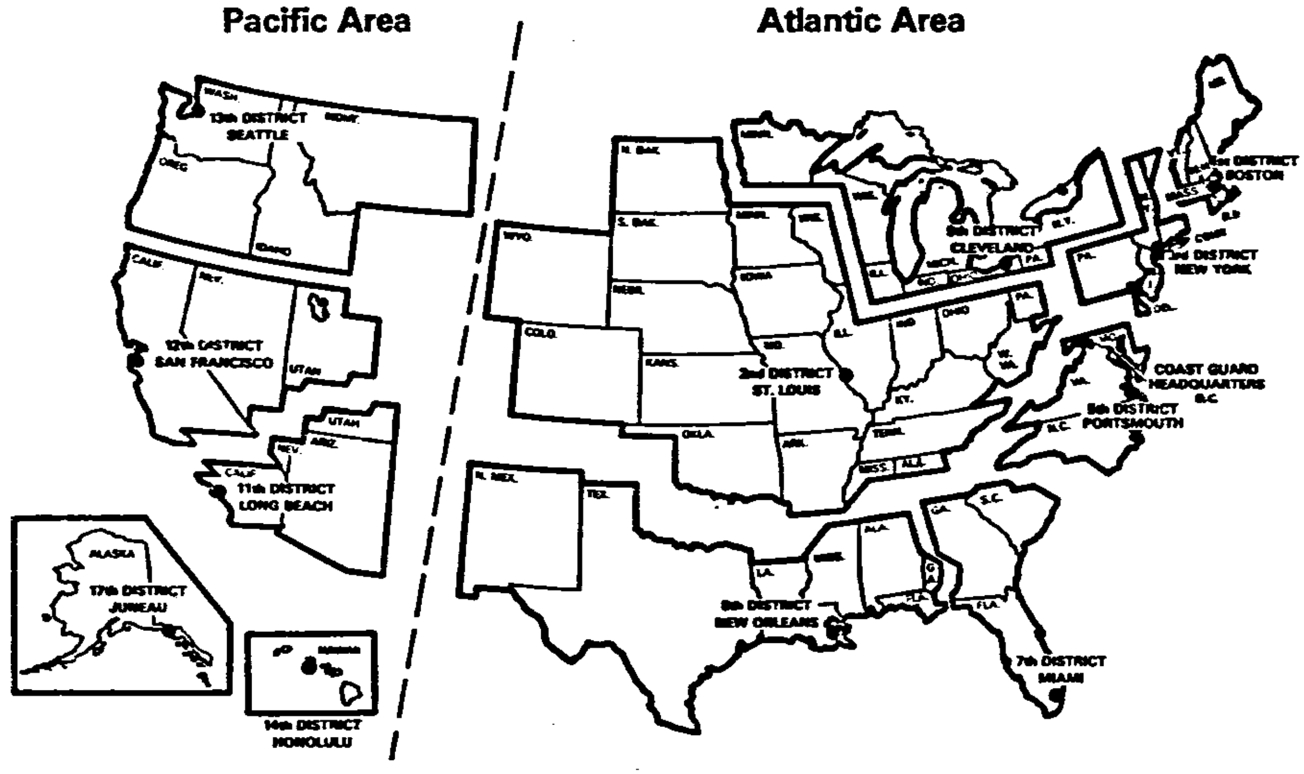
Commander (mepps)
Twelfth Coast Guard District
Building 51
Government Island
Alameda, CA 94501
Telephone: (415) 437-3465

Commander (mep)
Thirteenth Coast Guard District
Federal Building
915 Second Avenue
Seattle, WA 98174
Telephone: (206) 442-5850

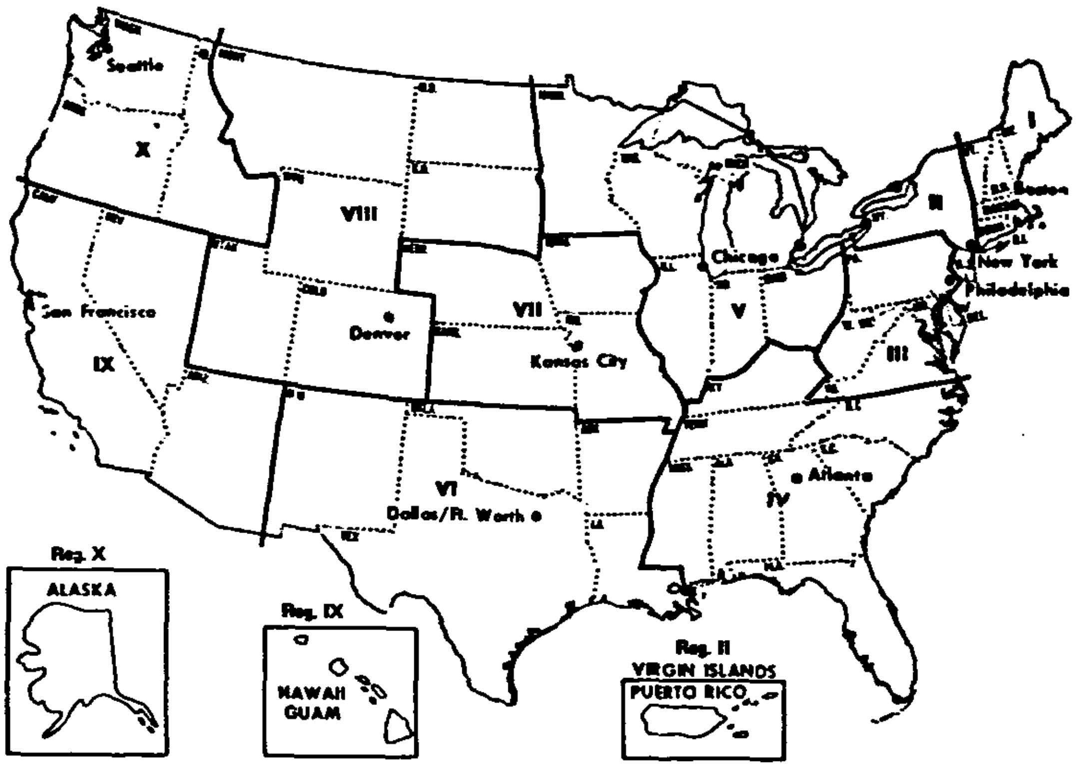
Commander (mep)
Fourteenth Coast Guard District
Prince Kalanianaole Federal Building
300 Ala Moana Boulevard, 9th Floor
Honolulu, HI 96850
Telephone: (808) 546-7510

Commander (mep)
Seventeenth Coast Guard District
P.O. Box 3-5000
Juneau, AK 99802
Telephone: (907) 586-7195

U.S. Coast Guard Districts



NIOSH, OSHA, AND EPA REGIONS



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Tighe&Bond

Former N.L. Industries
3241 Walden Avenue
Depew, New York

BCA Index# B9-0554-98-12
Site# C-915200

Community Air Monitoring Plan

September 2009

LETTER OF TRANSMITTAL

SECTION 1 INTRODUCTION

SECTION 2 COMMUNITY AIR MONITORING PLAN

APPENDIX A SAMPLING DATA LOG

APPENDIX B AIR SAMPLING SUMMARY

APPENDIX C EQUIPMENT SPECIFICATIONS

APPENDIX D ACTION LEVEL DOCUMENTATION

1.1 OVERVIEW

Environmental air monitoring and visual observation will be conducted during the remediation activities at the Former N.L. Industries Site, located at 3241 Walden Avenue, in Depew NY. The proposed program consists of two primary forms of environmental monitoring: Work Area Monitoring required by law for environmental remediation projects and intended to monitor the efficacy of project engineering controls; and voluntary Community Monitoring intended to gauge and document the impact (or lack thereof) of the project to the surrounding area.

This report provides requirements for the Contractor in preparing the Site Health and Safety (HASP) as well as implementing the Community Air Monitoring Plan (CAMP) Component of the HASP, as developed by the Engineer. The requirements shall apply to all work performed by the Contractor.

The following shall be submitted by the Contractor in advance of field work and shall become a major component of this Work Plan:

- Corporate health and safety program
- Site HASP
- Worker training certification and medical clearance
- Air monitoring logs
- Equipment decontamination plan
- Spill and discharge control plan

1.2 REGULATORY REQUIREMENTS

The Contractor’s work performed under this contract will help ensure compliance with applicable federal, state, and local safety and occupational health laws and regulations. This includes, but is not limited to, Occupational Health and Safety Administration (OSHA) standards, 29 Code of Federal Regulations (CFR) 1910.120, "Hazardous Waste Site Operations and Emergency Response" and 29 CFR 1926.65, "Hazardous Waste Site Operations and Emergency Response." Matters of interpretation of standards shall be submitted to the appropriate administrative agency for resolution before starting work. Where the requirements of the HASP, CAMP, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements shall apply.

1.3 SAFETY AND HEALTH PROGRAM

OSHA Standards 29 CFR 1910.120(b) and 29 CFR 1926.65(b) require contractors to develop and implement a written Health and Safety Program for workers involved in hazardous waste operations. The site-specific program requirements of the OSHA Standards shall be integrated into one site-specific document, the HASP. The HASP shall interface with the Contractor's overall Health and Safety Program. Any portions of the overall Health and Safety Program that are referenced in the HASP shall be included as appendices to the HASP. The Contractor is responsible for creating their own site specific HASP. An example of a HASP is provided as Appendix C within the SMP.

1.3.1 Site Health and Safety Plan Requirements

The HASP should cover work to be performed by the Contractor and all subcontractors. The Health and Safety Manager shall be responsible for the development, implementation and oversight of the HASP. The HASP should establish, in detail, the protocols necessary for the anticipation, recognition, evaluation, and control of hazards associated with each task performed. The HASP should address site-specific health and safety requirements and procedures based upon site-specific conditions. The level of detail provided within the HASP should be tailored to the type of work, complexity of operations to be performed, and hazards anticipated. Details about some activities may not be available when the initial HASP is prepared and submitted. Therefore, the HASP should address, in as much detail as possible, anticipated tasks, their related hazards, and anticipated control measures.

A copy of the written HASP will be maintained onsite. As work proceeds, the HASP shall be adapted to new situations and new conditions. Changes and modifications to the accepted HASP shall be made with the knowledge and concurrence of the Health and Safety Manager, the Site Superintendent, and the Engineer. Should any unforeseen hazard become evident during the performance of the work, the Site Health and Safety Officer shall bring such hazard to the attention of the Health and Safety Manager, the Site Superintendent, and the Engineer, both verbally and in writing, for resolution as soon as possible.

In the interim, necessary action shall be taken to re-establish and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public, and the environment. Disregard for the provisions of the accepted HASP shall be cause for stopping work until the matter has been rectified. Topics required by 29 CFR 1910.120(b) (4) and 29 CFR 1926.65 (b) (4) and those described in this section will be addressed in the HASP. Where the use of a specific topic is not applicable to the project, the HASP shall include a statement to justify its omission or reduced level of detail and establish that adequate consideration was given the topic. At a minimum, the following topics shall be addressed:

- health and safety organization
- site description and hazard evaluation
- health and safety risk or hazard analysis
- provisions for employee training
- use of personal protective equipment
- medical surveillance requirements
- air monitoring requirements (personnel and community)
- site control measures
- personnel and equipment decontamination procedures
- standard operating work practices
- confined space entry procedures
- emergency response procedures
- first aid procedures
- temperature extremes monitoring

The Health and Safety Manager establishes appropriate levels of protection for each work activity based on review of historical site information, existing data, an evaluation of the potential for exposure (inhalation, dermal, ingestion, and injection) during each task, past air monitoring results, and a continuing health and safety monitoring program. The Health and Safety Manager also establishes action levels for upgrade or downgrade in levels of PPE from the specified levels of protection. These action levels should be shown in the Contractor’s HASP. Protocols and the communication network for changing the level of protection should also be described in the HASP. The PPE reassessment protocol should address air monitoring results, potential for exposure, changes in site conditions, work phases, job tasks, weather, temperature extremes, individual medical considerations, etc.

The Health and Safety Manager prepares and implements an exposure monitoring/air sampling program to identify and quantify health and safety hazards and airborne levels of site, related substances in order to assure proper selection of engineering controls, work practices and personal protective equipment for affected site personnel. Available site information is reviewed and the exposure monitoring/air sampling program is expanded and/or revised for submittal as part of the HASP.

2.1 COMMUNITY AIR MONITORING PLAN OVERVIEW

In addition to air monitoring to protect site personnel, the New York State Department of Health (NYSDOH) requires the implementation of a Community Air Monitoring Plan (CAMP) for all ground intrusion activities, including contaminated soil excavation and handling.

The CAMP is not intended to establish safe working conditions for personnel onsite; it is meant to protect offsite receptors (including residences and businesses) from potential airborne releases and document the conditions to prevent potential claims of exposure. The contents of the CAMP are based on the type of intrusive work being performed onsite (i.e., excavation, loading, and transportation of soil). The CAMP includes, but is not limited to, the following activities:

2.2 SELECTION OF CAMP MONITORING LOCATIONS

Monitoring locations shall be positioned at three locations along the property boundary areas down wind and at one location within up wind of potential contaminant generating activities. The Engineer shall identify each monitoring location and the rationale for its placement within a sampling data log as presented in Appendix A. In addition, the Engineer shall include a contingency for moving the monitoring locations based on the prevailing wind direction during site activities. A portable weather station will be used to continuously record wind direction and velocity with time. Monitoring shall be performed at these locations.

2.3 ACTION AND RESPONSE LEVELS

The Air Sampling Summary included in Appendix B specifies the action and response levels for contaminants detected during monitoring. The appropriate response actions shall be taken to control contaminants before active remedial measures are allowed to resume.

2.4 DOCUMENTATION

The forms in Appendix A provide a method for recording all measurements collected during the plan's implementation. All records shall be made available to NYSDOH and NYSDEC upon request. At a minimum, a daily log shall be kept to document monitoring results, wind speed, direction, and weather conditions.

2.5 BACKGROUND SAMPLES

Background samples will be collected for contaminants prior to any excavation activity on the site. All monitoring data collected during the course of the project will be compared to the background samples and action levels. The action levels for each target compound will be adjusted as needed based upon the background and up-wind samples.

2.6 EXCAVATION PHASE MONITORING

During the excavation phase contaminants will be continuously monitored.

2.7 BACKFILLING/CONSTRUCTION PHASE MONITORING

During the backfilling phase, clean soil will be transferred on-site to fill and re-grade excavated areas. During this time, contaminants will be intermittently monitored at the discretion of the NYSDEC and NYSDOH officials.

2.8 SAMPLING FREQUENCY

Sampling for dust using the DataRAMs will be conducted throughout the project at three locations along the property line downwind of the site, and one location along the property line upwind of the site, according to the prevailing wind direction. The DataRAMs should be placed eqi-distant depending on the prevailing downwind direction.

When excavation begins, one high volume sampler will be placed up-wind and one will be placed down wind of the site, operating side by side with a DataRAM at each location. These high volume samples will be analyzed for lead at an outside laboratory. If it is determined that the levels monitored during the first week of excavation do not trigger action levels for lead, high volume lead monitoring will be discontinued.

To monitor VOCs, one Summa canister will be placed up wind and one will be placed downwind during the first week of excavation. These canisters will be analyzed for VOCs at an outside laboratory. If it is determined that the levels monitored during the first week of excavation do not trigger action levels for VOCs, VOC monitoring will be discontinued.

In the event that the prevailing wind direction changes during the course of a sample, the Engineer will relocate the monitoring equipment to a downwind location as soon as feasible. In order to achieve this, a portable weather station will be installed on-site to continuously record the wind direction and velocity.

2.9 SAMPLING EQUIPMENT/SET-UP/RESPONSE

2.9.1 Dust

Real-time air monitoring for PM-10 or Total Suspended Particulate (TSP) will be accomplished with direct reading DataRAM4 Particle Counters. Please see Appendix E for Sampling Equipment Specifications.

As dust monitoring will be conducted on a real-time basis, any exceedances of the National Ambient Air Quality Standards (NAAQS) of 150 ug/m3 over a 24-hr period or 450 ug/m3 over an 8-hr period will be immediately communicated to NYSDOH and

NYSDEC on-site employees. Engineering controls (i.e. water, salt, plastic, foam, etc.) will be used to keep dust levels at a minimum. Please see Appendix F for PM10 action level documentation.

2.9.2 Lead

Monitoring for lead will be conducted using a High Volume Sampler with a filter. Analysis of the samples will be conducted at a certified laboratory off-site. In the event that the lead levels detected in the samples exceed an average of 5 ug/m3 over a 24-hr period or 15 ug/m3 over an 8-hr period, the results will be immediately communicated to NYSDOH and NYSDEC on-site employees. Engineering controls (i.e. water, salt, plastic, foam, etc.) will be used to keep lead levels at a minimum. Please see Appendix F for lead action level documentation.

2.9.3 VOCs

Monitoring for Volatile Organic Compounds (VOCs) will be conducted using a Summa canister via Toxic Organic Method 15 (TO-15). Analysis of the samples will be conducted at a certified laboratory off-site.

Three VOCs are present at levels of concern including Benzene, Xylene and Trimethylbenzene. The Department of Health and Human Services Agency for Toxic Substance and Disease Registry (ASTDR) has developed minimum risk levels (MRLs) for Benzene (0.009 parts per million [ppm]) and Xylene (2.0 ppm). MRLs are screening levels that are not expected to cause adverse health effects to the general population. MRLs used in this study are based on 1 to 14 day exposures. Please see Appendix F for VOC action level documentation.

Trimethylbenzene does not have an established MRL. However, the MRLs for Xylene and Benzene are approximately 100 times lower than the OSHA worker levels. Based on the preceding information, we propose an action level of 0.25 ppm for Trimethylbenzene, which is the OSHA worker level of 25 ppm divided by 100.

In the event that the VOC levels detected in the samples exceed healthy levels, NYSDOH and NYSDEC will be immediately notified and engineering controls (i.e. water, salt, plastic, foam, etc.) will be used to keep VOC levels at a minimum.

Appendix A

Sampling Data Log

AIR SAMPLING RECORD

Tighe&Bond

Client:___________________________ Job #: ____

Date: ___________________________ Project Manager:________________________________

213 Court Street
Middletown, CT 06457
Attn: Brian Conte

J:\C\6254\CAMP\IAQ Sampling Form.doc

ID	Location	Time	Wind Direction & Speed	Equipment	Temp °F	Rh %	Lead ug/m^3	VOC's ppm	Dust ug/m3	Comments Other:_________

Appendix B

Air Sampling Summary

Parameter	Location	Frequency 8-hr	Equipment	Analysis	Action level	Corrective action
PM10 (dust)	1 Upwind 3 Downwind	Throughout project	DataRAM4	On-site	450 ug/m3 for 8-hours, 150 ug/m3 for 24-hours	Dust suppression with foam, water, salt, cover dirt piles in plastic
VOCs : Benzene Xylene Trimethylbenzene	1 Upwind 1 Downwind	During excavation	SUMMA cans	Laboratory	Benzene: 0.009 ppm Xylene: 2.0 ppm Trimethylbenzene: 0.25 ppm	Dust suppression with foam, water, salt, cover dirt piles in plastic
Lead	1 Upwind 1 Downwind	During excavation	High Volume Sampler	Laboratory	15 ug/m3 for 8 hours, 5 ug/m3 for 24 hours	Dust suppression with foam, water, salt, cover dirt piles in plastic
Lead	Workers*	Throughout project	Pumps	Laboratory	OSHA Levels	Personal Protective Equipment
VOCs	Workers*	Throughout project	PID	On-site	OSHA Levels	Personal Protective Equipment
PM-10 (dust)	Workers*	Throughout project	Particle Counter	On-site	OSHA Levels	Personal Protective Equipment

Appendix C

Equipment Specifications

Appendix D

Action Level Documentation

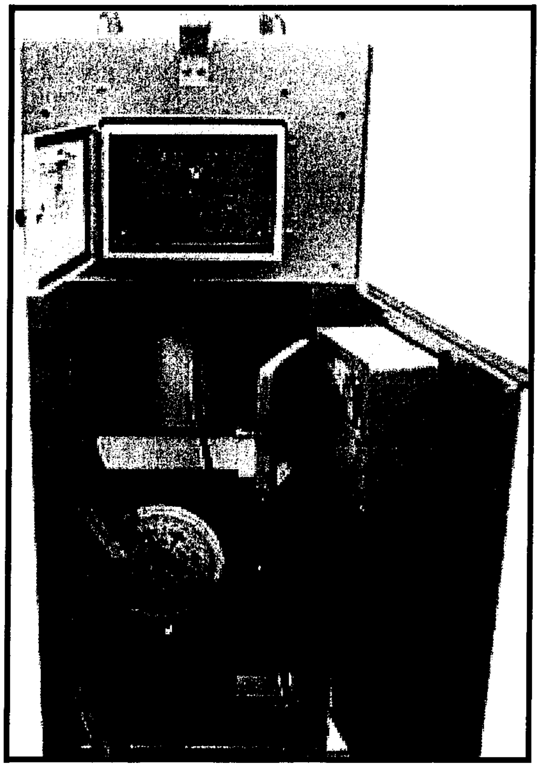
Appendix C

Equipment Specifications

Tisch Environmental, Inc.

TE-5170 Total Suspended Particulate MFC High Volume Air Sampler

OPERATIONS MANUAL



145 South Miami Avenue
Village of Cleves, Ohio 45002

Toll Free: (877) 263 -7610 (TSP AND-PM10)
Direct: (513) 467-9000
FAX: (513) 467-9009
Web Site: Tisch-Env.com
Email: sales@tisch-env.com

PREFACE

Tisch Environmental, Inc. is a third generation family owned business. The owners Wilbur J. Tisch and James P. Tisch have been involved in the High Volume Air Pollution field for the last 20 years. Started in March of 1998, they would like to welcome you to their company.

The intent of this manual is to instruct the user with unpacking, assembly, operating and calibration techniques. For information on air sampling principles, procedures and requirements please contact the local Environmental Protection Agency Office serving your area.

CONTENTS

INTRODUCTION

The High Volume Air Sampler is the recommended instrument for sampling large volumes of air for the collection of TSP (**T**otal **S**uspended **P**articulate). The physical design of the sampler is based on aerodynamic principles which result in the collection of particles of 100 microns (Stokes Equivalent Diameter) and less. The TE-5170 TSP MFC sampler consists of a TE-5001 Anodized Aluminum Shelter, TE-5005 Aluminum Blower Motor Assembly, TE-5004 8"x10" Stainless Steel Filter Holder with probe hole, TE-5009 Continuous flow/pressure recorder, TE-5007 7-Day Mechanical Timer, TE-300-310 Mass Flow Controller and TE-5012 Elapsed Time Indicator.

APPLICATIONS

- Ambient air monitoring to determine suspended particulate levels relative to air quality standards.
- Impact of a specific source on ambient levels of suspended particulates by incorporating a "wind direction-activation" modification which permits the sampler to operate only when conditions are such that a source-receptor relationship exists.
- Monitoring of enclosed environments for relatively high levels of particulate matter, particularly toxic materials.
- Monitoring of emissions from large diameter vents where physical conditions preclude the use of conventional stack-testing equipment.

UNPACKING

1. Shelter Box – 46" x 20" x 23" 75 lbs

TE-5170	Anodized Aluminum Shelter with mounted Flow Controller, Timer and TE-5009 Continuous Flow Recorder (or 8WT manometer).
TE-5005	Blower Motor Assembly with tubing
TE-5004	8" x 10" TSP Stainless Steel Filter Holder with probe hole
TE-5005-9	Filter Holder Gasket

Envelope with TE-106 box of charts, and literature.

2. Lid Box – 19" x 14" x 14" 9 lbs

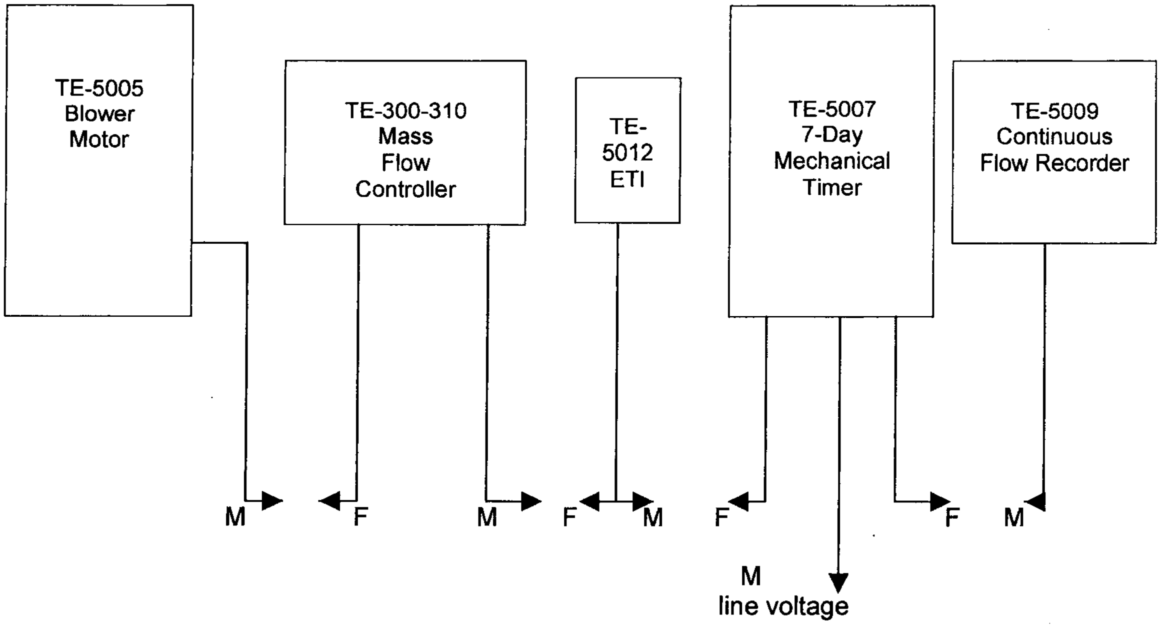
TE-5001-10 Gabled Roof

***** Save the shipping containers and packing material for future use.**

ASSEMBLY:

1. Open shelter box and remove Anodized Aluminum Shelter.
2. Enclosed in the 14" x 11" x 9" box on bottom of shelter is the TE-5005 Blower Motor Assembly. Enclosed in the 14" x 11" x 9" box inside of shelter is the TE-5004 Filter Holder with TE-5005-9 gasket. Remove from boxes.
3. Open lid box and remove 5001-10 Roof (for roof assembly see page 6).
4. If TE-5100 sampler has TE-5008 oil manometer, fill with red gauge oil.
5. Screw TE-5005 Blower Motor Assembly onto TE-5004 Filter Holder (tubing, power cord, and hole in filter holder collar to the right) make sure TE-5005-9 gasket is in place.
6. Lower Filter Holder and Blower Motor down through top support pan on shelter.
7. Take Flow Controller probe and insert into filter holder collar. Before tightening make sure probe slot is turned so air coming into filter holder goes through it. Connect tubing from pressure tap of blower motor to TE-5009 Flow Recorder or TE-5008 oil manometer.

ELECTRICAL HOOK-UP



The TE-5005 Blower Motor male cord set plugs into the TE-300-310 Mass Flow Controller Female cord set.

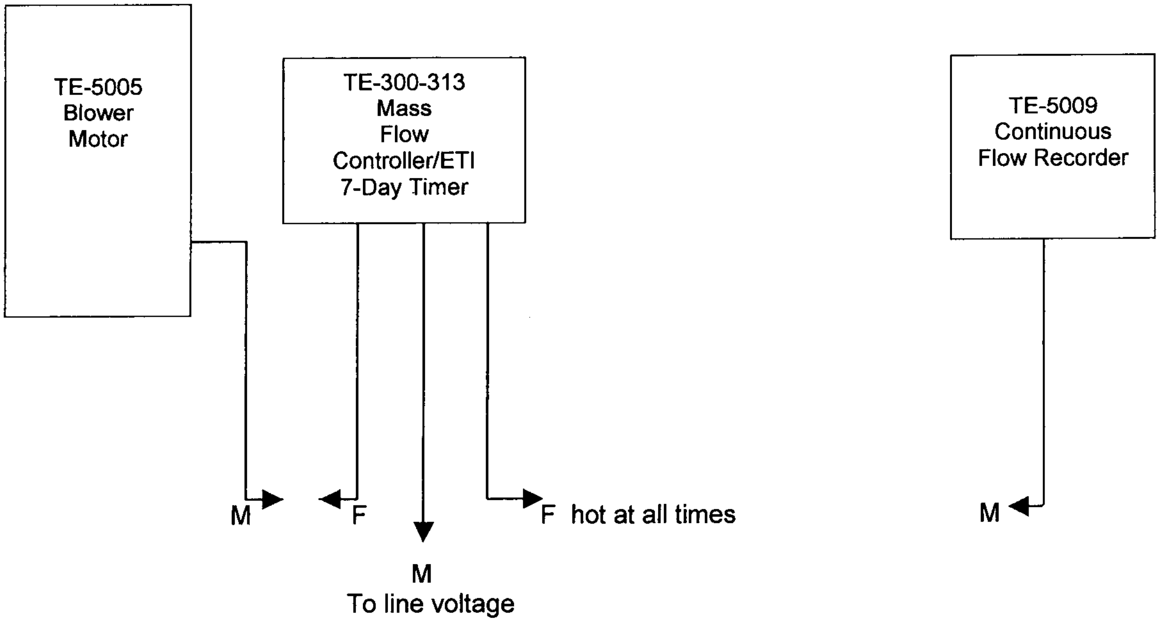
The Mass Flow Controller male cord set plugs into the TE-5012 Elapsed Time Indicator female side.

The male side of the ETI cord set plugs into the TE-5007 7-Day Mechanical Timer timed female cord set which is on the left side of timer.

The other female cord set on timer (on the right) is hot all the time and plugs into the TE-5009 Continuous Flow Recorder male cord set.

The male cord set of timer plugs into the line voltage.

ELECTRICAL HOOK-UP WITH TE-300-313



The TE-5005 Blower Motor male cord set plugs into the TE-300-313 Mass Flow Controller/ETI/Timer **Left** Female cord set (this is the timed cord set).

The Mass Flow Controller/ETI/Timer male cord set plugs into the line voltage.

The other female cord set on Mass Flow Controller/ETI/Timer (on the right) is hot all the time and plugs into the TE-5009 Continuous Flow Recorder male cord set.

GABLED ROOF ASSEMBLY

Lid parts bag contents (taped inside of lid):

5 pcs	10-24 x 1/2 pan head screws
5 pcs	10-24 stop nuts
1 pc	6-32 x 3/8 pan head screw
1 pc	6-32 hex nut
1 pc	20" chain with "S" hook
1 pc	TE-5001-10-9 roof back catch
1 pc	TE-5001-10-10 front catch
1 pc	TE-5001-10-11 rear lid hasp

1. Secure TE-5001-10-10 front catch to the shelter using 2 10-24 pan head screws with stop nuts.
2. Secure TE-5001-10-9 roof back catch to the back of shelter using 10-24 pan head screw with stop nut.
3. Secure TE-5001-10-11 rear lid hasp inside the lid with the slotted end angled up using 2 - 10-24 pan head screws with stop nuts.

   Note: These three items may need adjustment after the shelter lid is installed.

4. Remove 4 - 10-24 x 1/2 pan head screws from the nutserts in back of shelter.
5. Attach the lid to the shelter by placing the lid hinge plates on the **"OUTSIDE"** of the shelter top and tighten the 4 - 10-24 x 1/2 pan head screws into the nutserts.
6. Adjust the front catch to be sure that the lid slot lowers over it when closing the lid. The rear lid hasp should align with the roof back catch when the lid is open.
7. Attach the chain and "S" hook assembly to the side of the shelter with a 6-32 pan head screw and nut.
8. The lid can now be secured in an open or closed position with the "S" hook.

GENERAL CALIBRATION REQUIREMENTS

TE-5170 TSP MFC High Volume Air Sampler should be calibrated:

1. Upon installation
2. After any motor maintenance
3. Once every quarter (three months)
4. After 360 sampling hours

CALIBRATION KITS

The two types of calibration kits available for the TE-5170 TSP MFC High Volume Air Sampler are the TE-5025 and the TE-5028.

The TE-5025 utilizes five resistance plates to simulate various filter loading. The TE-5025 calibration kit includes: carrying case, 30" slack tube water manometer, adapter plate, 3' piece of tubing, TE-5025A orifice with flow calibration certificate, and 5 load plates (5, 7, 10, 13, 18).

The TE-5028 is the preferred method to calibrate the TE-5100 MFC TSP High Volume Air Sampler. It simulates change in the resistance by merely rotating the knob on the top of the calibrator. The infinite resolution lets the technician select the desired flow resistance. The TE-5028 calibration kit includes: carrying case, 30" slack tube water manometer, adapter plate, 3' piece of tubing, and TE-5028A orifice with flow calibration certificate.

Each TE-5025A and TE-5028A is individually calibrated on a primary standard positive displacement device (Rootsmeter) which is directly traceable to NIST.

** It is recommended that each calibrator should be re-calibrated annually for accuracy and reliability.

CALIBRATION PROCEDURE

The following is a step by step process of the calibration of a **TE-5170 Mass Flow Controlled Total Suspended Particulate High Volume Sampling Systems.** Following these steps are example calculations determining the calibration flow rates, and resulting slope and intercept for the sampler. These instructions pertain to the samplers which have air flow controlled by electronic mass flow controllers (MFC) in conjunction with a continuous flow recorder or a manometer. This calibration differs from that of a volumetric flow controlled sampler.

The Total Suspended Particulate samplers (TSP) are many times referred to as lead samplers as this is the primary duty given to these instruments in most cases. These instruments are suitable for capturing larger particulates such as heavy metals. Air monitoring studies that are concerned with smaller respirable particulate generally will call for the use of PM-10 particulate samplers which have a different calibration procedure. The TSP samplers have a very wide range of acceptable air flow operating limits, i.e., 1.10 to 1.70 m^3/min (39 to 60 CFM).

A mass flow controller will sense a decrease in air flow and increases the voltage to the blower which increases the blower speed in order to compensate. This is necessary when sampling with a PM-10 sampler due to the narrow acceptable air flow range of these types of instruments.

The attached example calibration worksheets can be used with either a **TE-5025 Fixed Orifice Calibrator** which uses resistance plates to vary air flow or a **TE-5028 Variable Orifice Calibrator** which uses an adjustable or variable orifice. The attached worksheet uses a fixed orifice. Either type of orifice is acceptable for calibrating high volume samplers and the calibration process does not change with either type.

Proceed with the following steps to begin the calibration:

Step one: Disconnect the sampler motor from the mass flow controller and connect the motor to a stable AC power source.

Step two: Mount the calibrator orifice and top loading adapter plate to the sampler. A sampling filter is generally not used during this procedure. Tighten the top loading adapter hold down nuts securely for this procedure to assure that no air leaks are present.

Step three: Allow the sampler motor to warm up to its normal operating temperature.

Step four: Conduct a leak test by covering the hole on top of the orifice and pressure tap on the orifice with your hands. Listen for a high-pitched squealing sound made by escaping air. If this sound is heard, a leak is present and the top loading adapter hold-down nuts need to be re-tightened.

Note: Avoid running the sampler for longer than 30 seconds at a time with the orifice blocked. This will reduce the chance of the motor overheating. Also, **never** try this leak test procedure with a manometer connected to the side tap on the calibration orifice or the blower motor. Liquid from the manometer could be drawn into the system and cause motor damage.

Step five: Connect one side of a water manometer to the pressure tap on the side of the orifice with a rubber vacuum tube. Leave the opposite side of the manometer open to the atmosphere.

Note: Both valves on the manometer have to be open for the liquid to flow freely also to read a manometer one side of the 'U' tube goes up the other goes down; add together this is the "H_2O

Step six: Insert the #18 resistance plate and gasket under the orifice **(TE-5025A)**, tighten the threaded collar securely, and record the manometer reading from the orifice and the continuous flow recorder reading (or manometer) from the sampler. A manometer must be held vertically to insure accurate readings. Tapping the backside of the continuous flow recorder will help to center the pen and give accurate readings. Repeat this procedure until the readings have been taken from all five resistance plates. If you are using a variable orifice **(TE-5028A)**, five flow rates are achieved in this step by adjusting the knob on the variable orifice to five different positions and taking five different readings.

Step seven: Record the ambient air temperature, the ambient barometric pressure, the sampler serial number, the orifice s/n, the orifice slope and intercept with date last certified, today's date, site location and the operator's initials.

Step eight: Disconnect the sampler motor from its power source and remove the orifice and top loading adapter plate. Re-connect the sampler motor to the electronic mass flow controller.

An example of a Lead (or TSP) Sampler Calibration Data Sheet has been attached with data filled in from a typical calibration. This includes the transfer standard orifice calibration relationship which was taken from the Orifice Calibration Worksheet that accompanies the calibrator orifice. Since this calibration is for a TSP sampler, the slope and intercept for this orifice uses **standard** flows rather than actual flows and is taken from the Qstandard section of the Orifice Calibration Worksheet. The Qactual flows are used when calibrating a PM-10 sampler.

The five orifice manometer readings taken during the calibration have been recorded in the column on the data worksheet titled Orifice "H_2O. The five continuous flow recorder readings taken during the calibration have been recorded under the column titled I chart (if using a manometer instead of a recorder the five manometer readings are recorded under the column titled FLOW (mano)).

The orifice manometer readings need to be converted to the standard air flows they represent using the following equation:

$$\mathbf{Qstd = 1/m[Sqrt((H_20)(Pa/760)(298/Ta))-b]}$$

where: Qstd = actual flow rate as indicated by the calibrator orifice, m^3/min
H_2O = orifice manometer reading during calibration, in. H_2O
Ta = ambient temperature during calibration, K (K = 273 + °C)
298 = standard temperature, a constant that never changes, K
Pa = ambient barometric pressure during calibration, mm Hg
760 = standard barometric pressure, a constant that never changes, mm Hg
m = *Qstandard slope of orifice* calibration relationship
b = *Qstandard intercept of orifice* calibration relationship

Once these standard flow rates have been determined for each of the five run points, they are recorded in the column titled Qstd, and are represented in cubic meters per minute.

The continuous flow recorder readings taken during the calibration need to be corrected to the current meteorological conditions using the following equation:

$$\mathbf{IC = I[Sqrt((Pa/760)(298/Ta))]}$$

where: IC = continuous flow recorder readings corrected to current Ta and Pa
I = continuous flow recorder readings during calibration
Pa = ambient barometric pressure during calibration, mm Hg.
760 = standard barometric pressure, a constant that never changes, mm Hg
Ta = ambient temperature during calibration, K (K = 273 + °C)
298 = standard temperature, a constant that never changes, K

If using a manometer instead of a continuous flow recorder:

FLOW (corrected) = [Sqrt("H_2O)(Pa/760)(298/Ta)]

Flow (corrected) = sampler manometer readings corrected to current Pa and Ta
"H_2O = sampler manometer reading during calibration
Pa = ambient barometric pressure during calibration, mm Hg
760 = standard barometric pressure, a constant that never changes, mm Hg
Ta = ambient temperature during calibration, K (K= 273 + Celsius)
298 = standard temperature, a constant that never changes, K

After each of the continuous flow recorder readings have been corrected, they are recorded in the column titled IC (corrected) (if using a manometer instead of a recorder use the column titled FLOW (corrected)).

Using Qstd and IC (or FLOW (corrected)) as the x and y axis respectively, a slope, intercept, and correlation coefficient can be calculated using the least squares regression method. The correlation coefficient should never be less than 0.990 after a five point calibration. A coefficient below .990 indicates a calibration that is not linear and the calibration should be performed again. If this occurs, it is most likely the result of an air leak during the calibration.

The equations for determining the slope (m) and intercept (b) are as follows:

$$m = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sum x^2 - \frac{(\sum x)^2}{n}} \quad ; \quad b = \bar{y} - m\bar{x}$$

where: n = number of observations
$\bar{y}$ = Σy/n
$\bar{x}$ = Σx/n
Σ = sum of

The equation for the coefficient of correlation (r) is as follows:

$$r = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sqrt{\left[\sum x^2 - \frac{(\sum x)^2}{n}\right]\left[\sum y^2 - \frac{(\sum y)^2}{n}\right]}}$$

where: n = number of observations
Σ = sum of

The acceptable operating flow range of a TSP sampler is 1.1 to 1.7 m^3/min (39 to 60 CFM). Looking at the worksheet column Qstd, the flow rates that are within this range can be identified along with the chart reading (I) that represents them. For instance if you wanted to set this sampler at 1.353 m^3/min (47.77 CFM) (Make sure the mass flow controller is plugged in and a filter is in place) you would turn the Flow Adjustment screw until the continuous flow recorder read 29 on the chart. If using a manometer instead of a continuous flow recorder and you wanted to set the sampler at 1.353 m^3/min (47.77 CFM) you would turn the Flow Adjustment screw until the manometer read 4.5 inches of H_2O. By making sure that the sampler is operating at a chart reading (or manometer reading) that is within the acceptable range, it can be assumed that valid TSP data is being collected.

Example Problems

The following example problems use data from the attached calibration worksheet.

After all the sampling site information, calibrator information, and meteorological information have been recorded on the worksheet, standard air flows need to be determined from the orifice manometer readings taken during the calibration using the following equation:

1. **Qstd = 1/m[Sqrt((H_20)(Pa/760)(298/Ta))-b]**

where: Qstd = actual flow rate as indicated by the calibrator orifice, m^3/min
H_2O = orifice manometer reading during calibration, "H_2O
Ta = ambient temperature during calibration, K (K = 273 + °C)
298 = standard temperature, a constant that never changes, K
Pa = ambient barometric pressure during calibration, mm Hg
760 = standard barometric pressure, a constant that never changes, mm Hg
m = *Qstandard slope of orifice* calibration relationship
b = *Qstandard intercept of orifice* calibration relationship.

Note that the ambient temperature is needed in degrees Kelvin to satisfy the Qstd equation. Also, the barometric pressure needs to be reported in millimeters of mercury. In our case the two following conversions may be needed:

2. **degrees Kelvin = [5/9 (degrees Fahrenheit - 32)] + 273**
3. **millimeters of mercury = 25.4(inches of H_2O/13.6)**

Inserting the numbers from the calibration worksheet run point number one we get:

4. Qstd = 1/2.01[Sqrt((11.5)(737/760)(298/294)) - (-.02003)]
5. Qstd = .4975[Sqrt((11.5)(.9697)(1.0136)) + .02003]
6. Qstd = .4975[Sqrt(11.296) + .02003]
7. Qstd = .4975[3.361 + .02003]
8. Qstd = .4975[3.381]
9. Qstd = 1.682

Throughout these example problems you may find that your answers vary some from those arrived at here. This is probably due to different calculators carrying numbers to different decimal points. The variations are usually slight and should not be a point of concern.

With the Qstd determined, the corrected chart reading (IC) for this run point needs to be calculated using the following equation:

10. **IC = I[Sqrt((Pa/760)(298/Ta))]**

where: IC = continuous flow recorder readings corrected to standard
I = continuous flow recorder readings during calibration
Pa = ambient barometric pressure during calibration, mm Hg.
760 = standard barometric pressure, mm Hg
Ta = ambient temperature during calibration, K (K = 273 + °C)
298 = standard temperature, K.

Inserting the data from run point one on the calibration worksheet we get:

11. IC = 46[Sqrt(737/760)(298/294)]

12. IC = 46[Sqrt(.983)]

13. IC = 46[.9914635]

14. IC = 45.61

If using a manometer instead of a continuous flow recorder:

FLOW (corrected) = [Sqrt("H_2O)(Pa/760)(298/Ta)]
FLOW (corrected) = sampler manometer readings corrected to current Pa and Ta
"H_2O = sampler manometer reading during calibration
Pa = ambient barometric pressure during calibration, mm Hg.
760 = standard barometric pressure, a constant that never changes, mm Hg
Ta = ambient temperature during calibration, K (K =273 + Celsius)
298 = standard temperature, a constant that never changes, K

Inserting the data from run point one from the calibration worksheet (two manometers) we get:

FLOW (corrected) = [Sqrt(6.9)(737/760)(298/294)]
FLOW (corrected) = Sqrt(6.7822)
FLOW (corrected) = 2.6

This procedure should be completed for all five run points. EPA guidelines state that at least three of the five Qstd flow rates during the calibration be within or nearly within the acceptable operating limits of 1.10 to 1.70 m^3/min (39 to 60 CFM). If this condition is not met, the instrument should be recalibrated.

Using Qstd as our x-axis, and IC (or FLOW (corrected)) as our y-axis, a slope, intercept, and correlation coefficient can be determined using the least squares regression method.

The equations for determining the slope (m) and intercept (b) are as follows:

15. $$m = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sum x^2 - \frac{(\sum x)^2}{n}} \quad ; \quad b = \bar{y} - m\bar{x}$$

where: n = number of observations
$\bar{y} = \Sigma y/n$; $\bar{x} = \Sigma x/n$

Σ = sum of.

The equation for the coefficient of correlation (r) is as follows:

16. $$r = \frac{\sum xy - \dfrac{(\sum x)(\sum y)}{n}}{\sqrt{\left[\sum x^2 - \dfrac{\left(\sum x\right)^2}{n}\right]\left[\sum y^2 - \dfrac{\left(\sum y\right)^2}{n}\right]}}$$

where: n = number of observations

Σ = sum of

Before these can be determined, some preliminary algebra is necessary. Σx, Σy, Σx^2, Σxy, $(\Sigma x)^2$, $(\Sigma y)^2$, n, $\bar{y}$, and $\bar{x}$ need to be determined.

17. $\Sigma x = 1.684 + 1.532 + 1.353 + 1.08 + .851 = 6.5$

18. $\Sigma y = 45.65 + 35.73 + 28.78 + 18.86 + 11.91 = 140.93$

19. $\Sigma x^2 = (1.684)^2 + (1.532)^2 + (1.353)^2 + (1.08)^2 + (.851)^2 = 8.904$

20. $\Sigma y^2 = (45.65)^2 + (35.73)^2 + (28.78)^2 + (18.86)^2 + (11.91)^2 = 4686.392$

21. $\Sigma xy = (1.684)(45.65) + (1.532)(35.73) + (1.353)(28.78) + (1.08)(18.86) + (.851)(11.91) = 201.057$

22. $n = 5$

23. $\bar{x} = \Sigma x/n = 1.3$

24. $\bar{y} = \Sigma y/n = 28.186$

25. $(\Sigma x)^2 = (6.5)^2 = 42.25$

26. $(\Sigma y)^2 = (140.93)^2 = 19861.264$

Inserting the numbers:

27. $$\text{slope} = \frac{201.057 - \dfrac{(6.5)(140.93)}{5}}{8.904 - \dfrac{42.25}{5}}$$

28. $$\text{slope} = \frac{201.057 - \dfrac{(916.045)}{5}}{8.904 - \dfrac{42.25}{5}}$$

29. $$\text{slope} = \frac{201.057 - 183.209}{8.904 - 8.45}$$

30. $$\text{slope} = \frac{17.848}{0.454}$$

31. slope = 39.31

32. intercept = 28.186 - (39.31)(1.3)

33. intercept = 28.186 - 51.103

34. intercept = - 22.917

35. correlation coeff. = $$\frac{201.057 - \frac{(6.5)(140.93)}{5}}{\sqrt{\left[8.904 - \frac{42.25}{5}\right]\left[4686.392 - \frac{19861.264}{5}\right]}}$$

36. correlation coeff. = $$\frac{201.057 - \frac{(916.045)}{5}}{\sqrt{[(8.904 - 8.45)]\ [(4686.392 - 3972.253)]}}$$

37. correlation coeff. = $$\frac{(201.057 - 183.209)}{\sqrt{[(8.904 - 8.45)][(4686.392 - 3972.253)]}}$$

38. correlation coeff. = $$\frac{17.848}{\sqrt{(0.454)(714.139)}}$$

39. correlation coeff. = $$\frac{17.848}{\sqrt{324.2191}}$$

40. correlation coeff. = $$\frac{17.848}{18.006}$$

41. correlation coeff. = .991

A calibration that has a correlation coefficient of less than .990 is not considered linear and should be re-calibrated. As you can see from both worksheets we have 3 Qstd numbers that are in the TSP range (1.1 - 1.7) and the correlation coeff. is > .990, thus a good calibration.

TISCH ENVIRONMENTAL, INC.
TE-5170 MFC SAMPLER CALIBRATION
(DICKSON RECORDER)

Site

Location: Cleves, Ohio
Sampler: TE-5170 MFC
Date: Jan. 01, 2003
Tech: Jim Tisch

Conditions

Sampler Elevation (Feet)	400
Sea Level Pressure (in HG)	29.43
Temperature (deg F)	70
Seasonal SL Press. (in HG)	29.43
Seasonal Temp (deg F)	70

Corrected Pressure (mm HG)	737
Temperature (deg K)	294
Corrected Seasonal (mm HG)	737
Seasonal Temp. (deg K)	294

Calibration Orifice

Make: Tisch-Env
Model: TE-5025A
Serial # 0005
Qstd Slope: 2.01000
Qstd Intercept: -0.02003
Date Certified: Original

Calibration

Plate or Test #	H2O (in)	Qstd (m3/min)	I (Chart)	IC (corrected)
1	11.50	1.684	46.0	45.65
2	9.50	1.532	36.0	35.73
3	7.40	1.353	29.0	28.78
4	4.70	1.080	19.0	18.86
5	2.90	0.851	12.0	11.91

Linear Regression

Slope = 39.2991
Intercept = -22.9067
Corr. coeff. = 0.9911

Calculations

Qstd = 1/m [Sqrt (H_20 (Pa/Pstd) (Tstd/Ta)) –b]
IC = I [Sqrt (Pa/Pstd) (Tstd/Ta)]

Qstd = standard flow rate
IC = corrected chart response
I = actual chart response
m = calibrator Qstd slope
b = calibrator Qstd intercept
Ta = actual temperature during calibration (deg K)
Pa = actual pressure during calibration (mm HG)
Tstd = 298 deg K
Pstd = 760 mm Hg

For subsequent calculation of sampler flow:

1/m ((I) [Sqrt (298/Tav) (Pav/760)] -b)

m = sampler slope
b = sampler intercept
Tav = daily average temperature
Pav = daily average pressure

TISCH ENVIRONMENTAL, INC.
TE-5170 MFC SAMPLER CALIBRATION
(2 MANOMETERS)

Site

Location: Cleves, Ohio	Date: Jan. 01, 2003
Sampler: TE-5170 MFC	Tech: Jim Tisch

Conditions

Sampler Elevation (Feet)	400	Corrected Pressure (mm HG)	737
Sea Level Pressure (in HG)	29.43	Temperature (deg K)	294
Temperature (deg F)	69	Corrected Seasonal (mm HG)	737
Seasonal SL Press. (in HG)	29.43	Seasonal Temp. (deg K)	294
Seasonal Temp (deg F)	69		

Calibration Orifice

Make: Tisch-Env	Qstd Slope: 2.01000
Model: TE-5025A	Qstd Intercept: -0.02003
Serial # 0005	Date Certified: Original

Calibration

Plate or Test #	H2O (in)	Qstd (m3/min)	FLOW (mano)	FLOW (corrected)
18	11.50	1.684	6.9	2.61
13	9.50	1.532	5.8	2.39
10	7.40	1.353	4.5	2.11
7	4.70	1.080	2.8	1.66
5	2.90	0.851	1.5	1.22

Linear Regression

Slope = 1.6646
Intercept = -0.1684
Corr. coeff. = 0.9987

Calculations

H20 (in) = manometer on orifice
Qstd = 1/m [Sqrt (H20 (Pa/Pstd) (Tstd/Ta)) –b]
FLOW (mano) = manometer on blower motor port
FLOW (mano) = [Sqrt (in H20) (Pa/Pstd) (tstd/Ta)]
Qstd = standard flow rate
FLOW (corrected) = corrected flow reading

m = calibrator Qstd slope
b = calibrator Qstd intercept
Ta = actual temperature during calibration (deg K)
Pa = actual pressure during calibration (mm HG)
Tstd = 298 deg K
Pstd = 760 mm Hg

For subsequent calculation of sampler flow:

1/m ((Sqrt (in H20) (Pav/Pstd) (Tstd/Tav)) -b) (in H20) = manometer on blower motor port

m = sampler slope
b = sampler intercept
Tav = daily average temperature
Pav = daily average pressure

TOTAL VOLUME

TE-5170 MFC TSP with TE-5009 Continuous Flow Recorder

To figure out the total volume of air that flowed through the sampler during your sampling run take a set-up reading (when you set the sampler up manually turn it on and take a continuous flow recorder reading; in our example it should be 29) and a pick-up reading (after the sample has been taken again manually turn sampler on and take a continuous recorder reading; for our example let's say it read 27). Take 29 + 27 = 56 56/2 = 28 so the continuous recorder reading you would use is 28. Put that into the formula (on bottom of worksheet):

1/m((I)[Sqrt(298/Tav)(Pav/760)]- b)

m = sampler slope
b = sampler intercept
I = average chart response
Tav = daily average temperature
Pav = daily average pressure
Sqrt = square root

Example:

m^3/min = 1/39.2991((28)[Sqrt(298/294)(737/760)]-(-22.9067))
m^3/min = .025 ((28)[Sqrt(1.01)(.97)] + 22.9067)
m^3/min = .025 ((28)[Sqrt(.98)] + 22.9067)
m^3/min = .025 ((28)[(.99)] + 22.9067)
m^3/min = .025 ((27.72) + 22.9067)
m^3/min = .025 (50.627)
m^3/min = 1.266
ft^3/min = 1.266 x 35.31 = 44.70
Total ft^3 = ft^3/min x 60 x hours that sampler ran

Let's say our sampler ran 23.3 hours (end ETI reading - start ETI reading)

** Make sure ETI is in hours otherwise convert to hours **

Total ft^3 = 44.70 x 60 x 23.3 = 62,490.6 ft^3
Total m^3 = 1.266 x 60 x 23.3 = 1769.87 m^3

TOTAL VOLUME

TE-5170 MFC TSP with TE-5008 Manometer

To figure out the total volume of air that flowed through the sampler during your sampling run take a set-up reading (when you set the sampler up manually turn it on and take a TE-5008 manometer reading; in our example it should be 4.5 inches of H_2O) and a pick-up reading (after the sample has been taken again manually turn sampler on and take a TE-5008 manometer reading; for our example let's say it read 4.3 inches of H_2O).

Take 4.5 + 4.3 = 8.8 8.8/2 = 4.4 so the 8WT manometer reading you would use is 4.4 . Put that into the formula (on bottom of worksheet):

1/m((Sqrt(in H_2O)(Pav/760)(298/Tav)) - b)

m = sampler slope
b = sampler intercept
in H_2O = average TE-5008 manometer reading
Tav = daily average temperature
Pav = daily average pressure
Sqrt = square root

Example:

m^3/min = 1/1.6718((Sqrt(4.4)(298/294)(737/760))-(-0.1808))
m^3/min = .598 ((Sqrt(4.4)(1.01)(.97)) + 0.1808)
m^3/min = .598 ((Sqrt(4.311)) + 0.1808)
m^3/min = .598 ((2.076) + 0.1808)
m^3/min = .598 (2.257)
m^3/min = 1.349
ft^3/min = 1.349 x 35.31 = 47.63
Total ft^3 = ft^3/min x 60 x hours that sampler ran

Let's say our sampler ran 23.3 hours (end ETI reading - start ETI reading)

** Make sure ETI is in hours otherwise convert to hours **

Total ft^3 = 47.63 x 60 x 23.3 = 66,586.74 ft^3
Total m^3 = 1.349 x 60 x 23.3 = 1885.90 m^3

SAMPLER OPERATION TE-5170 MFC TSP

1. After performing calibration procedure, remove filter holder frame by loosening the four wing nuts allowing the brass bolts and washers to swing down out of the way. Shift frame to one side and remove.
2. Carefully center a new filter, rougher side up, on the supporting screen. Properly align the filter on the screen so that when the frame is in position the gasket will form an airtight seal on the outer edges of the filter.
3. Secure the filter with the frame, brass bolts, and washers with sufficient pressure to avoid air leakage at the edges (make sure that the plastic washers are on top of the frame).
4. Wipe any dirt accumulation from around the filter holder with a clean cloth.
5. Close shelter lid carefully and secure with the "S" hook.
6. Make sure all cords are plugged into their appropriate receptacles and the rubber tubing between the blower motor pressure tap and the TE-5009 continuous flow recorder (or TE-5008 manometer) is connected (be careful not to pinch tubing when closing door).
7. Prepare TE-5009 continuous flow recorder as follows:
    a) Clean any excess ink and moisture on the inside of recorder by wiping with a clean cloth.
    b) Depress pen arm lifter to raise pen point and carefully insert a fresh chart.
    c) Carefully align the tab of the chart to the drive hub of the recorder and press gently with thumb to lower chart center onto hub. Make sure chart is placed under the chart guide clip and the time index clip so it will rotate freely without binding. Set time by rotating the drive hub clock-wise until the correct time on chart is aligned with time index pointer.
    d) Make sure the TE-160 pen point rests on the chart with sufficient pressure to make a visible trace.
8. Prepare the Timer as instructed on page 20.
9. Manually trip timer switch on to determine if sampler is operating properly and the recorder is inking correctly.
10. Manually trip timer switch off. If the timer is set correctly you are ready to sample.
11. At the end of the sampling period, remove the frame to expose the filter. Carefully remove the exposed filter from the supporting screen by holding it gently at the ends (not at the corners). Fold the filter lengthwise so that sample touches sample.
12. It is always a good idea to contact the lab you are dealing with to see how they may suggest you collect the filter and any other information that they may need.

To prepare the Timer:

TE-5007 7-Day Mechanical Timer

a) To set the "START" time, attach a (bright) "ON" tripper to the dial face on the desired "START" time. Tighten tripper screw securely.

b) To set the "STOP" time, attach a (dark) "OFF" tripper to the dial face on the desired "STOP" time. Tighten tripper screw securely.

c) To set current time and day, grasp dial and rotate **clockwise only** until correct time and day appear at time pointer.

TE-5006 6-Day Mechanical Timer

a) To set the "START" time, attach a (bright) "A" tripper to the dial face on the desired "START" time that is away from the current time. Tighten tripper screws with fingers only.

b) If you want to sample 24 hours put a (dark) "B" tripper 24 hours away from the "A" tripper. **Make sure** that the "A" (start) tripper is in front of the "B" (stop) tripper otherwise it will sample for 120 hours instead of 24 hours. Remember this is a six day timer so you will continue to sample every six days.

c) Set current time by turning dial **clockwise only** until correct military time is obtained.

MAINTENANCE

A regular maintenance schedule will allow a monitoring network to operate for longer periods of time without system failure. Our customers may find the adjustments in routine maintenance frequencies are necessary due to the operational demands on their sampler(s). We recommend that the following cleaning and maintenance activities be observed until a stable operating history of the sampler has been established.

TE-5170 MFC TSP Sampler

1. Make sure all gaskets (including motor cushion) are in good shape and that they seal properly.
2. The power cords should be checked for good connections and for cracks (replace if necessary).

   CAUTION: Do not allow power cord or outlets to be immersed in water!
3. Inspect the filter screen and remove any foreign deposits.
4. Inspect the filter holder frame gasket each sample period and make sure of airtight seal.
5. Check or replace motor brushes every 500 hours.
6. Make sure elapsed time indicator is working properly.
7. Make sure continuous flow recorder pen is still inking each time, tubing has no crimps or cracks, and that the door is sealed completely.

MOTOR BRUSH REPLACEMENT TE-5170 MFC TSP

(110v Brush part #TE-33384)
(220v Brush part #TE-33378)

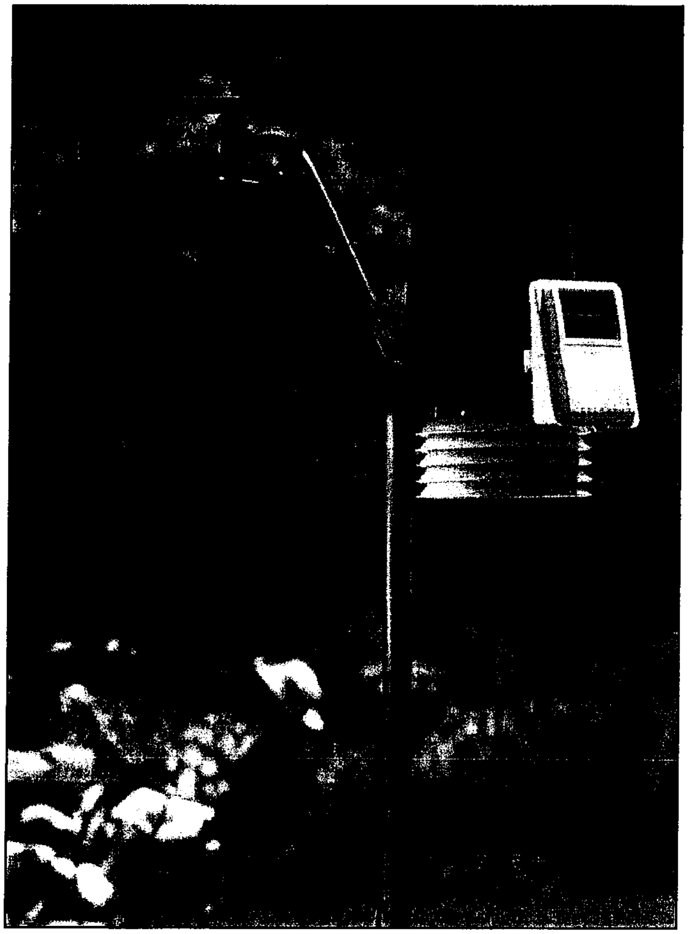
CAUTION: Unplug the unit from any line voltage sources before any servicing of blower motor assembly.

1. Remove the blower motor flange by removing the four bolts. This will expose the gasket and the TE-116311 motor.
2. Turn assembly on side, loosen the cord retainer and then push cord into housing and at the same time let motor slide out exposing the brushes.
3. Looking down at motor, there are 2 brushes, one on each side. Carefully pry the brass quick disconnect tabs (the tabs are pushed into end of brush) away from the expended brushes and toward the armature. Try to pry the tabs as far as you can without damaging the armature.
4. With a screwdriver loosen and remove brush holder clamps and release TE-33384 brushes. Carefully, pull quick disconnect tabs from expended brushes.
5. Carefully slide quick disconnect tabs into tab slot of new TE-33384 brush.
6. Push brush carbon against armature until brush housing falls into brush slot on motor.
7. Put brush holder clamps back onto brushes.
8. Make sure quick disconnect tabs are firmly seated into tab slot. Check field wires for good connections.
9. Assemble motor after brush replacement by placing housing over and down on the motor (at same time pull power cord out of housing), being careful not to pinch any motor wires beneath the motor spacer ring.
10. Secure power cord with the cord retainer cap.
11. Replace blower motor flange on top of motor making sure to center gasket.

****IMPORTANT**** To enhance motor life:

1. Change brushes before brush shunt touches armature.
2. Seat new brushes by applying 50% voltage for 10 to 15 minutes, the TE-5075 brush break in device allows for the 50% voltage.

Integrated Sensor Suite Installation Manual



For Vantage Pro2™ & Vantage Pro2 Plus™ Weather Stations

Davis Instruments, 3465 Diablo Avenue, Hayward, CA 94545 • 510-732-9229 • www.davisnet.com

Contents

FCC Part 15 Class B Registration Warning

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modification not expressly approved in writing by Davis Instruments may void the warranty and void the user's authority to operate this equipment.

FCC ID: IR2DWW6328
IC: 378810-6328

EC EMC Compliance

This product complies with the essential protection requirements of the EC EMC Directive 89/336/EC.

Integrated Sensor Suite Installation Manual

Rev. C, September 14, 2006
Document Part Number: 07395.249
For Vantage Pro2 Weather Stations # 6322, 6322C, 6323, 6327, 6327C, 6328

DAVIS
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Introduction

The Integrated Sensor Suite (ISS) collects outside weather data and sends the data to a Vantage Pro2 console or Weather Envoy. Wireless and cabled versions of the ISS are available, as well as standard and plus versions. The Wireless ISS is solar powered and sends data to the console via a low-power radio. The Cabled ISS sends data and receives power via the console cable.

The standard version of the ISS contains a rain collector, temperature sensor, humidity sensor and anemometer. In addition to the standard weather features, the ISS Plus adds a pre-installed solar radiation sensor and an ultra-violet (UV) radiation sensor. Temperature and humidity sensors are mounted in a passive radiation shield to minimize the impact of solar radiation on sensor readings. The anemometer measures wind speed and direction and can be installed adjacent to the ISS or apart from it. See "Locating the ISS and Anemometer" on page 15 for siting guidelines.

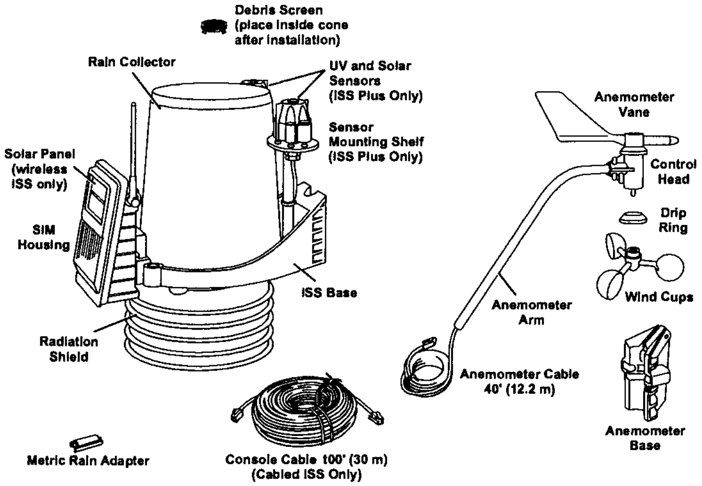
On an ISS Plus, the additional solar and UV sensors are mounted next to the rain collector cone. Solar and UV sensors are available separately to upgrade a standard ISS.

The Sensor Interface Module (SIM) contains the "brains" of the ISS and the radio transmitter. The SIM is located on the front of the radiation shield in the SIM box. The SIM collects outside weather data from the ISS sensors and then transmits the data to your Vantage Pro2 console or Weather Envoy.

Included Components and Hardware

The ISS comes with all the components and hardware shown in the following illustrations. If you purchased your ISS as part of a weather station package containing the Vantage Pro2 console, additional components may be included in the package that are not shown here.

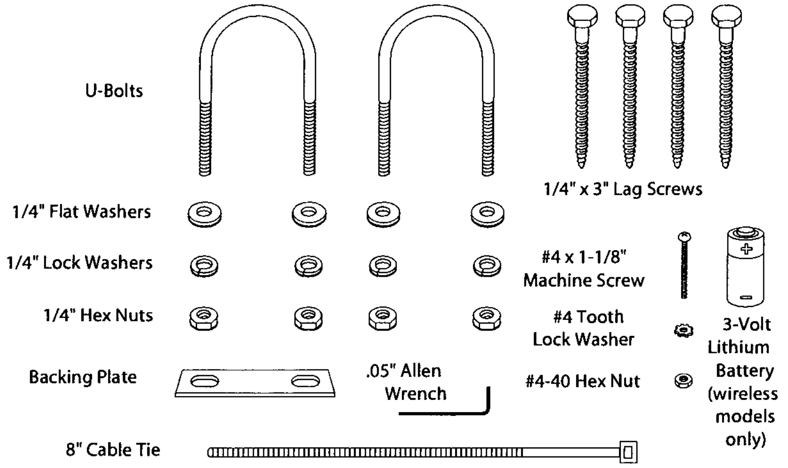
Components



Note: If the ISS is a Plus model and contains UV and solar sensors, do not touch the small white diffusers on top of the sensors. Oil from skin reduces their sensitivity. If you are concerned that you have touched the diffusers at any time during the installation, clean the UV diffuser using ethyl alcohol with a soft cloth. When cleaning the UV diffuser, DO NOT use rubbing or denatured alcohols because they can affect accuracy of the sensor readings. Ethyl alcohol can be procured through an industrial or laboratory supply store. Clean the solar diffuser with a soft damp cloth.

Hardware

The following hardware is included with the ISS and weather station assembly. Some of the hardware is optional based on how the ISS is assembled and installed. (See "Installing the ISS" on page 19 for more information.)



Note: If any of the hardware components are missing or not included, contact Customer Service toll free at 1-800-678-3669 about receiving replacement hardware or other components.

Tools for Setup

The following are additional tools required to set up and install the ISS:

- Small Phillips head screwdriver
- Scissors or wire-cutters
- Adjustable wrench or 7/16" wrench
- Compass or local area map
- Ballpoint pen or paper clip (or other small pointed object)
- Drill and 3/16" (5 mm) drill bit (if mounting on a vertical surface)

Preparing the ISS for Installation

Please follow the steps in the order they are presented. Each step builds on tasks completed in previous steps.

Note: Using a well-lit work table or work area to prepare the ISS for installation is recommended.

The steps to prepare the ISS for installation are:

- Assemble the anemometer.
- Check the factory-installed sensor cable connections to the SIM.
- Connect the anemometer sensor cable to the SIM.
- Apply power to the ISS and test communication with the console.
- Change the Transmitter ID for wireless communication, if necessary.

Assemble the Anemometer

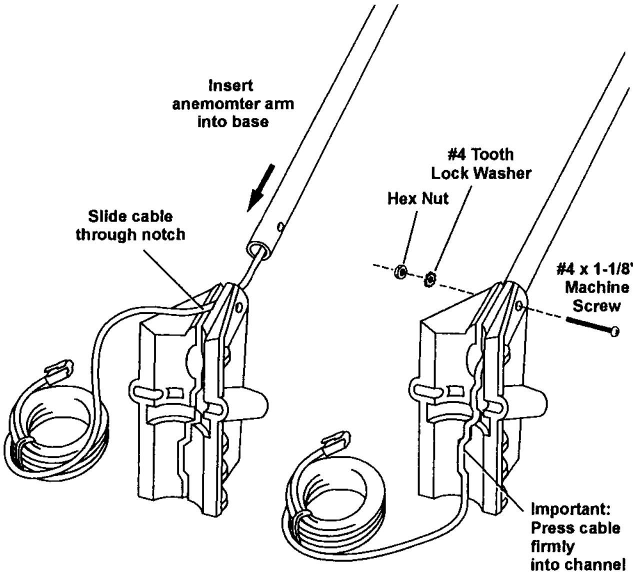
The anemometer measures wind direction and speed. The anemometer arm comes partially assembled with the wind vane attached. The anemometer arm requires assembly before it can be assembled with the rest of the ISS.

Please locate the following parts to prepare the anemometer:

- Anemometer arm (wind vane and cable already attached)
- Anemometer base
- Wind cups
- Drip ring
- Allen wrench (0.05")
- #4 machine screw, #4 tooth-lock washer, #4 hex nut

Attaching Anemometer Arm to Base

1. Insert the anemometer arm into the base, sliding the cable through the notch in the base as shown in illustration.
2. Be sure to line up the small hole in the arm with the holes in the base.
3. Insert the machine screw through the holes in the base and arm.



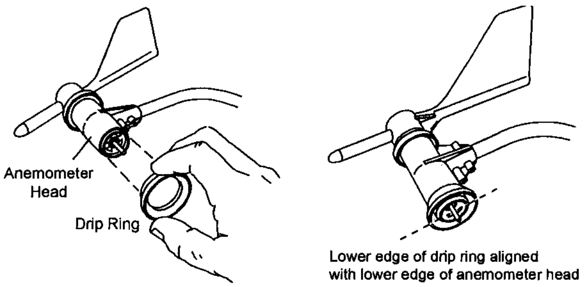
4. Slide the tooth-lock washer and hex nut onto the machine screw. Tighten the hex nut while holding the screw with a Phillips head screwdriver to prevent it from turning.
5. Press the sensor cable firmly and completely into the zig-zagging channel in the base, starting from the arm and progressing downward to the bottom of the base. Be sure to press the cable into the channel at the bottom of the groove.

Note: The pole can pinch or cause wear on the anemometer cable if the cable is not pressed completely into the channel at the bottom of the groove.

Attaching the Drip Ring and Wind Cups

The drip ring attaches to the bottom edge of the anemometer head. It assists in preventing ice from immobilizing the wind cups.

1. Place the black plastic drip ring on the bottom edge of the anemometer head. Gently push the drip ring onto the head until it clicks into place.
2. Make sure the lower edge of the drip ring is aligned with the lower edge of the anemometer head.

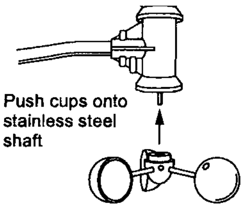


Attaching the Drip Ring

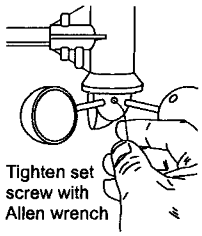
3. Push the wind cups up onto the anemometer's stainless steel shaft.
4. Slide the wind cups up the shaft as far as possible.
5. Use the Allen wrench provided to tighten the set screw on the side of the wind cups.

   The wind cups should drop slightly when you let go.
6. Spin the wind cups.

   If the wind cups spin freely, the anemometer is ready and can be set aside while you prepare the rest of the ISS for installation.



Attaching Wind Cups



Note: If the wind cups don't spin freely, take them off and repeat the wind cup installation process.

Check SIM Sensor Connections

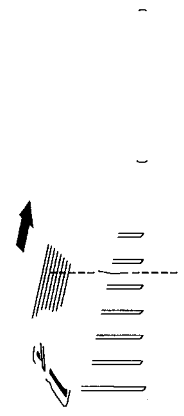
The SIM is located in the housing on the front of the ISS station. The SIM contains all the connections for the weather sensors of the ISS. Check the SIM to ensure that all sensors are connected properly.

Open the SIM Box

1. Locate the white box with the solar panel containing the SIM on the front of the ISS unit. The cabled model does not have a solar panel.
2. Locate the white tab at the bottom center of the SIM box cover.
3. Lift the tab away from the box while sliding the cover up.

   Look on the side of the SIM box. The box cover can be easily removed from the box when the alignment indicator on the cover is lined up with the alignment indicator on the box
4. Lift the cover off the box, being careful not to stress the solar panel cable.

   The SIM and sensor connectors are visible once the SIM cover has been removed.

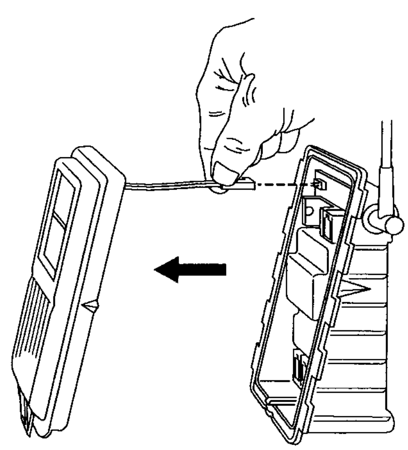


Note: See "SIM Board Display and Contents" on page 30 for information on locating the components and points of interest on the SIM board.

Optional: Disconnect the solar panel connection

The solar panel on the box cover is connected to the SIM by a wire. If the cover cannot be set aside while still connected to the SIM box safely, it should be disconnected from the SIM box. To disconnect the solar power connection:

1. Locate the brown connector for the solar power wire.
2. Pull the connector outward off the brown solar power tab. The solar panel is no longer connected to the SIM.
3. Set the SIM cover aside.

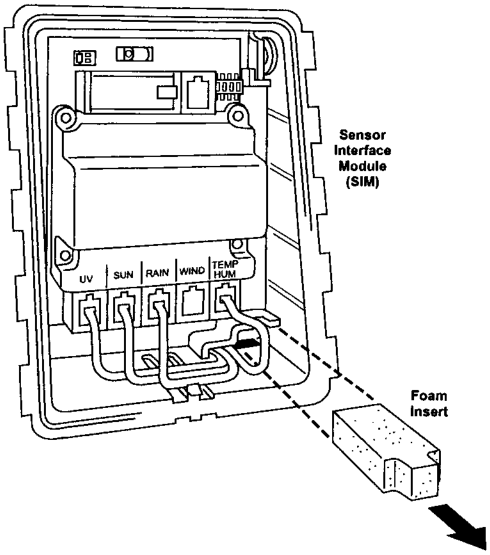


Check the Factory Installed Sensor Connections

1. Verify that the rain collector and temperature/humidity sensor cables are plugged into the receptacles labeled RAIN and TEMP/HUM on the SIM.
2. If the station includes UV and/or solar radiation sensors, verify that the sensor cables are plugged into the receptacles labeled UV and SUN on the SIM.

Connect the Anemometer Cable to the SIM

1. Unwind the coil of cable enough to work with the anemometer. Do not unwind the entire coil of anemometer cable at this time.
2. Pull the foam insert out of cable access port in between the cables and set the foam insert aside.
3. Insert the anemometer cable end into the cable access port from beneath the SIM box.
   Slide the cable through the cable access port with the connector lever down.
4. Firmly insert the end of the anemometer cable into the connector labeled WIND. The lever clicks into place.
5. Make sure that the cables lie flat on the bottom the cable access port.
6. Firmly insert the foam in between the cables and at the top of the cable access port, taking care to ensure that the foam seals the access port entirely, leaving no holes or gaps large enough for weather or insects.



Note: Only Plus models have UV and solar cables already attached

Note: If you are assembling a cabled station, wait to reinsert the foam until cable assembly is complete. See "Cabled ISS Assembly" on page 7.

Once the sensor connections have been checked and the anemometer cable has been inserted, a connection between the ISS and the Vantage Pro2 console must be made.

7. Read the following instructions that best apply to your ISS and Vantage Pro2 assembly:
   - See "Cabled ISS Assembly" on page 7 for assembling Vantage Pro2 weather stations that contain a cabled connection between the ISS and the console.
   - See "Wireless ISS Assembly" on page 9 for assembling Vantage Pro2 weather stations that use a wireless connection to transmit and receive data.

Cabled ISS Assembly

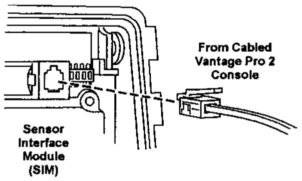
The Cabled ISS system contains a cable for connecting the ISS to a Vantage Pro2 cabled console. Once the anemometer has been installed and the sensors have been checked, a cabled connection between the ISS and the console can be established. Follow the steps below for powering the ISS and connecting to the console.

Applying Power

The 100' (30 m) console cable provides power to the ISS and is used to send data from the ISS to the console. The console cable can be extended up to 1000' (305 m) in length with extension cables purchased from Davis Instruments.

1. Locate the 100' console cable included with your system.
2. Pull the foam insert out of cable access port, if it has been reinserted, and set the foam aside.
3. Insert the console connector cable end into the cable access port from beneath the SIM box. Slide the cable through the cable access port with the connector tab down.
4. On the SIM, firmly insert one end of the 4-conductor cable into the modular connector located apart from the sensor connectors next to the battery insert. This connector is labeled CONSOLE.

   If you haven't powered up the console yet, refer to the installation instructions in the *Vantage Pro2 Console Manual* and apply power to the console.



5. On the back of your console, insert the other end of the console cable into the modular receptacle labeled "ISS".
6. Firmly insert the foam in between the cables and at the top of the cable access port, taking care to ensure that the foam seals the access port entirely, leaving no holes or gaps for weather or insects. See the graphic on page 6 for more information on inserting the foam insert.

   Plugging the console cable into the console powers the ISS and establishes communication between the ISS and the console. The ISS should immediately begin collecting weather data and start sending the data to the console.

Verifying Communication with the Console

Use these steps to verify reception of ISS data at the Cabled Vantage Pro2 console and to test the operation of the ISS sensors.

1. If the console is in Setup Mode, press and hold DONE until the Current Weather screen displays.

   Sensor readings from the ISS should display on the screen.
2. Near the center of the screen, look for the outside temperature.
3. Spin the wind cups to check wind speed, pressing WIND if necessary to alternate between speed and direction in the compass rose.
4. Turn the wind vane, and allow 5 seconds for the wind direction display to stabilize before moving it again.

Approximately one minute after power-up the outside relative humidity reading should be displayed on the console.

5. If the ISS contains a UV sensor and/or solar sensor, press 2ND and then press RAIN YR for current ultraviolet readings or press 2ND then press RAIN DAY for solar radiation readings.

   The UV reading displays in the center of the console. The solar reading displays in the bottom right corner of the console display. UV and solar readings should be zero or close to zero if the ISS is inside. Zero is a valid reading. Dashes(--) are displayed if no data comes from the sensors.

6. Current weather data displayed on the console confirms communication.

   Once the ISS has been powered and the console has successfully received accurate readings from all the sensors, prepare the ISS for installation. Continue on to "Preparing the ISS for Installation" on page 13 for more information.

   If the communication problems still exist between the cabled ISS and the console, see "Troubleshooting Cabled ISS Communication" below.

   To ease the installation process of ISS at a location, disconnect the console cable from the SIM. Remove the foam and slide the cable out through access port. Once a location for both the ISS and the console has been arranged, reinsert the cable through the access port, into the console connector, and reinsert the foam.

Troubleshooting Cabled ISS Communication

If the console is not receiving sensor readings from the ISS, please try the following troubleshooting procedures.

- Check the console to make sure it is being powered with the AC adapter supplied in the Vantage Pro2 packaged box or three C batteries.

Note: The supplied adapter is a five-volt positive center AC to DC adapter. Other adapters may not work if the voltage or adapter type is different.

- Make sure the cable is firmly plugged into the ISS connector on the console.
- Make sure that the console cable is firmly plugged into the correct connector on the SIM.
- Verify that all sensor cables are firmly plugged in.
- An LED indicator light on the SIM flashes each time the ISS transmits, which is about once every 2.5 seconds. If the LED remains dark, there is a problem with the ISS transmitter. Call Technical Support. See "Contacting Davis Instruments" on page 27.

See "SIM Board Display and Contents" on page 30 for information on locating the LED indicator light and the DIP switches.

Note: If the LED is flashing rapidly, call Technical Support. See "Contacting Davis Instruments" on page 27 for more information.

If the console is still not receiving readings, ensure that the console is in Setup Mode and reboot the console by disconnecting the AC power adapter from the console and removing the console batteries for at least 30 seconds. If the console is still not displaying sensor readings from the ISS, please contact Davis Technical Support.

Wireless ISS Assembly

The ISS has a wireless connection to a Vantage Pro2 wireless console. Once the anemometer has been installed and the sensors have been checked, the ISS must be powered and a wireless communication channel must be established between the ISS and the console. Follow the steps below for powering the ISS and establishing a connection to the console.

- Applying Power to a Wireless ISS
- Verifying Communications with the Console
- Verifying Data from the ISS Sensors
- Troubleshooting ISS Reception

Applying Power to a Wireless ISS

1. Insert the 3-volt lithium battery into the SIM.

   Once powered, the ISS immediately begins transmitting data to the console.

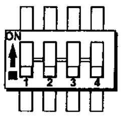
   Be sure to match the "+" sign on the battery with the "+" sign on the SIM. See "SIM Board Display and Contents" on page 30.

   The SIM stores energy from the solar panel for power at night. The battery is an alternative power source the SIM uses when it is depleted of energy.

Checking Transmitter ID

A Vantage Pro2 console can receive data from up to eight different wireless stations. The default Transmitter ID for the ISS and console is 1.

In most cases it will not be necessary to change the Transmitter ID. The console and ISS should begin communicating automatically when power is applied.



Settings for Transmitter ID 1:
DIP Switch 1 = OFF
DIP Switch 2 = OFF
DIP Switch 3 = OFF

Note: If it is necessary to change the Transmitter ID, remember to use the same ID for the ISS and console. See "SIM Board Display and Contents" on page 30 for locating the components and points of interest on the SIM board.

Verifying Communication with the Console

1. Power the console if it does not already have power. Refer to the *Vantage Pro2 Console Manual* and apply power the console.

   The console automatically enters Setup Mode when powered up.
2. If the console is not in Setup Mode, press and hold DONE then press the down arrow.

   The message RECEIVING FROM... and STATION NO. followed by the Transmitter IDs that the console detects displays on the console screen.
3. Look for the ISS Transmitter ID. The number 1 displays unless the Transmitter ID has been changed. If the console displays the ISS Transmitter ID, the ISS is detected.

Note: If the console does not display the number of the ISS Transmitter ID setting, see "Troubleshooting Wireless ISS Reception" on page 10 for more information. It can take several minutes for the console to acquire and display all the available Transmitter IDs.

4. Press and hold DONE to view ISS data once the ISS Transmitter ID displays.

Verifying Data from the ISS Sensors

Use these steps to verify reception of ISS data at the wireless Vantage Pro2 console and to test the operation of the ISS sensors.

1. Press and hold DONE until the Current Weather screen displays, if the console is in Setup Mode.
   Sensor readings from the ISS should display on the screen.
2. Near the center of the screen, look for the outside temperature.
3. Spin the wind cups to check wind speed, pressing WIND if necessary to alternate between speed and direction in the compass rose.
4. Turn the wind vane, and allow 5 seconds for the wind direction display to stabilize before moving it again.
   Approximately one minute after power-up the outside relative humidity reading should be displayed on the console.
5. If the ISS contains a UV sensor and/or solar sensor, press 2ND and then press RAIN YR for current ultraviolet readings or press 2ND then press RAIN DAY for solar radiation readings.
   The UV reading displays in the center of the console. The solar reading displays in the bottom right corner of the console display. UV and solar readings should be zero or close to zero if the ISS is inside. Zero is a valid reading — dashes are displayed if no data comes from the sensors.
6. Current weather data displayed on the console confirms successful communication.

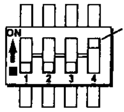
Once the ISS has been powered and the console has successfully received accurate readings from all the sensors, prepare the ISS for installation. Continue on to "Preparing the ISS for Installation" on page 13 for more information.

If the communication problems still exist between the wireless ISS and the console, see "Troubleshooting Wireless ISS Reception."

Troubleshooting Wireless ISS Reception

If the console isn't displaying data from the ISS, perform the following steps:

1. Verify that the console is powered and is not in Setup Mode.
2. Make sure that all ISS sensor cables are firmly connected to the SIM and the ISS battery is properly installed.
3. Walk around the room with the console, standing for a few moments in various locations, to see if you are picking up signals from the ISS. Look on the screen's lower right corner. An "X" toggles on and off when the console receives a transmission.
4. If you do not see the "X" slowly blinking, no matter where you stand with the console, put your ISS in Test Mode.
   - The DIP switch #4 on the SIM is the Test Mode switch. Switch it to the ON position, using a ball-point pen or paper clip.
   - An LED indicator light on the SIM flashes each time the ISS transmits, which is about once every 2.5 seconds.



Setting for Test Mode
DIP Switch #4 = ON

Note: If the LED is flashing rapidly, call Technical Support. See "Contacting Davis Instruments" on page 27 for more information.

See "SIM Board Display and Contents" on page 30 for information on locating the components and points of interest on the SIM board.

5. If the LED remains dark, there is a problem with the ISS transmitter. Call Technical Support. See "Contacting Davis Instruments" on page 27.
6. If the LED flashes repeatedly but your console isn't picking up a signal anywhere in the room, it could be related to one of the following causes:
    - You changed the ISS Transmitter ID at the ISS or console, but not at both.
    - Reception is being disrupted by frequency interference from outside sources. Interference has to be strong to prevent the console from receiving a signal while in the same room as the ISS. In high-interference environments, it may be preferable to install the Cabled Vantage Pro2.
    - There is a problem with the console.
7. If a problem with receiving the wireless transmission still exists, please contact Technical Support. See "Contacting Davis Instruments" on page 27.
8. When you are finished testing wireless transmission, set DIP switch # 4 to OFF to take the SIM out of Test Mode.

Note: If the SIM is left in Test Mode, the blinking LED will significantly reduce ISS battery life.

Optional: Changing ISS Transmitter ID

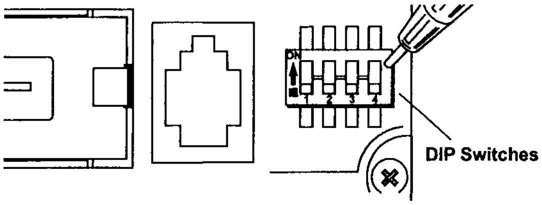
Each wireless transmitting station, including the Integrated Sensor Suite (ISS), uses one of eight selectable Transmitter IDs. DIP switches #1, 2 and 3 on the transmitter control the ID — or channel — the station transmits on. DIP switch #4 is used for transmission testing, not for Transmitter ID.

Note: The transmitter on the ISS and receiver on the console communicate with each other only when both are set to the same ID.

The default Transmitter ID is 1 for both the ISS and the Vantage Pro2 console, and should work fine for most situations. Change the Transmitter ID if any of the following issues are true:

- Another Davis Instruments wireless weather station operating nearby already uses Transmitter ID 1.
- Additional wireless transmitting stations have been purchased with the Vantage Pro2 or Vantage Pro2 Plus and one of the stations has been designated as Station No. 1 instead of the selected ISS.

    On the ISS, the Transmitter ID is set using the DIP switches located on the Sensor Interface Module (SIM). To access the SIM, open the SIM housing cover. See "Open the SIM Box" on page 5.



Transmitter ID DIP Switches in Top-right Corner of SIM

To change to another ID, use a ballpoint pen or paper clip to toggle DIP switches #1, 2, and 3. The settings for Transmitter IDs 1 - 8 are shown in the table on the next page.

Set the Vantage Pro2 console to the same ID as the transmitters, as described in the *Vantage Pro2 Console Manual.*

ID CODE	SWITCH 1	SWITCH 2	SWITCH 3
#1 (default)	off	off	off
#2	off	off	ON
#3	off	ON	off
#4	off	ON	ON
#5	ON	off	off
#6	ON	off	ON
#7	ON	ON	off
#8	ON	ON	ON

Using Multiple Transmitting Stations

This table shows the maximum number of each type of station that can be used with a single Vantage Pro2 console.

Station Type	Maximum Number
Integrated Sensor Suite (ISS)	1
Anemometer Transmitter Kit*	1
Leaf & Soil Moisture/Temperature Station	2**
Temperature Station	8
Temperature/Humidity Station	8

**Replaces the ISS anemometer.*

***Two are allowable only if both stations are only partially populated. For example, A network can either have both a Leaf Wetness/Temperature station and a Soil Moisture/Temperature station, or it can have one combined Leaf Wetness and Soil Moisture/Temperature station.*

Preparing the ISS for Installation

Once all the sensors have been connected and communication between the ISS and the console has been successfully established, continue to prepare the ISS unit for installation. The steps for preparing the ISS for installation are as follows.

- Close the SIM Box
- Prepare the Solar Panel
- Prepare the Rain Collector
- Site the ISS and Anemometer

Close the SIM Box

To close the SIM box and continue assembling the ISS:

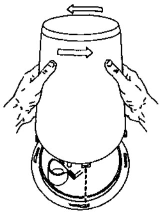
1. If the solar panel wire was disconnected during ISS assembly, reconnect the wire on the SIM box cover to the solar panel tab on the SIM board.

Note: See "SIM Board Display and Contents" on page 30 for information on locating the solar panel tab.

2. Look on the side of the SIM box. Match up the box cover alignment indicator with the alignment indicator on the SIM box and place the cover against the box.
3. Slide the cover down until it snaps securely in place.

Prepare the Rain Collector

The tipping bucket is secured at the factory to protect it from damage during shipping. To use the ISS properly, the bucket must be released. To release the bucket:

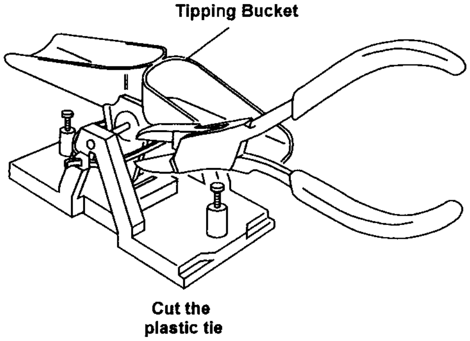


Twist to Open

1. Remove the rain collector cone from the ISS base by rotating the cone counter-clockwise. When the cone's latches line up with openings in the base, lift the cone off the ISS base.

   When new, the cone fits tightly in the base and may require extra pressure to remove. Steady the ISS base between your knees when removing the cone.
2. Carefully cut and remove the plastic tie (usually black in color) that holds the tipping bucket in place during shipping.
3. On your console screen, look for the DAILY RAIN display.

   If the console is cabled to the ISS, reconnect the cable and see if the console is receiving rain readings.

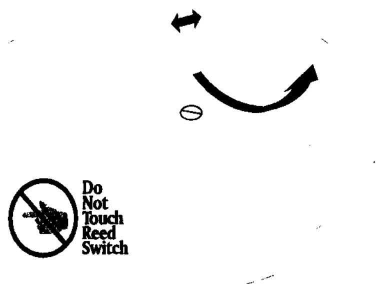


4. While watching the daily rain display, slowly tip the bucket until it drops to the opposite side. Each tip indicates 0.01" of rain and may take up to a minute to register at the console. If the bucket is tipped too quickly, the number on the console display may not change. Tip the bucket slowly when testing the rain collector.
5. Temporarily reinstall the rain collector cone until you are ready to mount the ISS outside. If you are installing the metric measurement adapter, do not reinstall the rain collector cone.

Optional: Insert the Metric Measurement Adapter

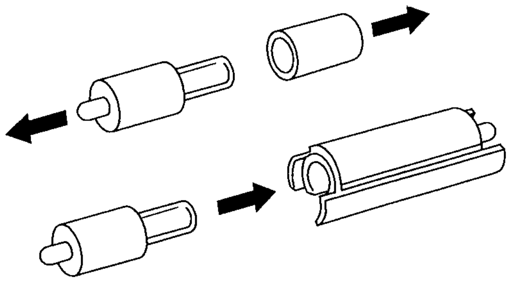
The rain collector tipping bucket mechanism contains a standard measurement weight magnet that takes measurements in 0.01". The ISS hardware kit contains a metric adapter that adjusts the weight of the tipping bucket mechanism so that it reports 0.2 mm metric measurements for every tip of the bucket. To install the metric adapter:

1. Find the metric adapter included in the hardware.
2. Locate the magnet between the arms of the bucket.
3. Open the arms slightly with one hand while pulling the magnet out with the other.



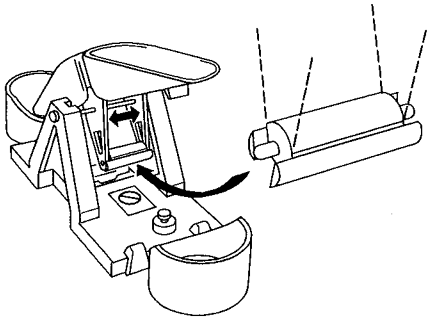
Open plastic tipping mechanism arms, pull out magnet

4. Separate an end cap from one end of the magnet.



Separate magnet from one end cap
Insert magnet with other end cap into metric measurement adapter

5. Slide the magnet, exposed end of magnet first, into the open slot of the metric adapter.
6. Insert the metric adapter and magnet between the arms of the bucket, with the solid side of the metric adapter facing up.



Open plastic arms to insert metric measurement adapter, with adapter in "V" position

Note: The above procedure converts the collector to 0.2 mm measurements. The console must be set accordingly. See the *Vantage Pro2 Console Manual* for more information.

Locating the ISS and Anemometer

For the weather station to perform at its best, use these guidelines to select the optimum mounting locations for the ISS and anemometer. Be sure to take into consideration ease of access for maintenance, sensor cable lengths and wireless transmission range when siting the station.

Note: When selecting a location for installing your ISS, especially on a rooftop, make sure it is a location far from power lines. Seek professional help if you uncertain about the safety of your installation.

General ISS Siting Guidelines

- Place the ISS away from sources of heat such as chimneys, heaters, air conditioners and exhaust vents.
- Place the ISS at least 100' (30 m) away from any asphalt or concrete roadway that readily absorbs and radiates heat in the sun. Avoid installations near fences or sides of buildings that receive a lot of sun during the day.
- Ideally, place the radiation shield of the ISS 5' (1.5 m) above the ground in the middle of gently sloping or flat, regularly mowed grassy or naturally landscaped area that drains well when it rains. For areas with average maximum yearly snow depths over 3' (0.9 m), mount the ISS 2' (0.6 m) above this depth.
- Never install the ISS where it will be directly sprayed by a sprinkler system because it will adversely affect the readings.
- Avoid installations near bodies of water such as swimming pools or ponds.
- Do not locate the ISS under tree canopies or near the side of buildings that create "rain shadows". For heavily forested areas, site the ISS in a clearing or meadow.
- Site the ISS in a location with good sun exposure throughout the day if the ISS is wireless or includes solar radiation or UV radiation sensors.

For *agricultural applications* (Important for evapotranspiration (ET) calculations):

- Install the ISS and anemometer as a single unit with the radiation shield 5' (1.5 m) above the ground and in the middle of the farm between similar crop types (i.e. two orchards, two vineyards or two row crops), if possible.
- Avoid areas exposed to extensive or frequent applications of agricultural chemicals (which can degrade the sensors).
- Avoid installation over bare soils. The ET formula works best when the ISS is installed over well-irrigated, regularly mowed grass.
- If the last three guidelines cannot be met, install the weather station at the edge of the primary crop of interest.

Anemometer Siting Guidelines

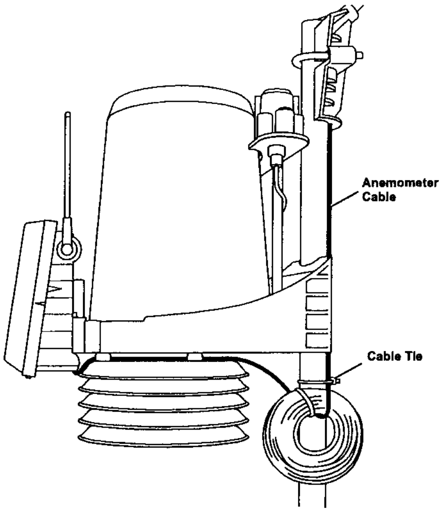
- For best results, place the anemometer at least 7' (2.1 m) above surrounding obstructions such as trees or buildings that obstruct wind flow.
- If mounting on a roof, mount the anemometer at least 7' (2.1 m) above the roof apex (when using a Mounting Tripod, install the anemometer at the very top of the pole).
- The standard for meteorological and aviation applications is to place the anemometer 33' (10 m) above the ground. Seek professional help for this type of installation.
- The standard for *agricultural applications* is to place the anemometer 6' (2 m) above the ground. This is important for evapotranspiration (ET) calculations.

Note: For roof mounting, and ease of installation, we recommend using the optional mounting Tripod (#7716). For other installations, use the Mounting Pole Kit (#7717).

Optional: Anemometer Cable Length Considerations

- All Vantage Pro2 stations include a 40' (12 m) cable to go between the ISS and the anemometer. This can be extended up to 540' (165 m) using optional extension cables purchased from Davis Instruments.
- If most of the anemometer cable length is unused, the coiled cable length can be stowed once the anemometer and ISS have been installed on a site. Attaching the anemometer cable to the mounting pole using the supplied cable tie is the recommended option.

  Keep the anemometer cable coiled if possible during the ISS and anemometer assembly so that it is easily stowed once installation is complete.



- The Cabled Vantage Pro2 includes a 100' (30 m) cable to go between the console and the ISS. This can be extended up to 1000' (300 m) using optional cables.

Optional: Wireless Transmission Considerations

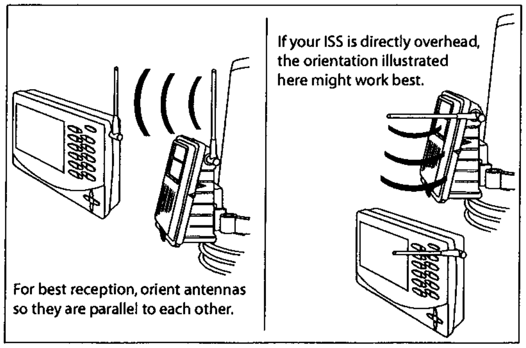
The range of the radio transmission depends on several factors. Try to position the transmitter and the receiver as close as possible for best results.

Typical maximum ranges include:

- Line of sight: 1000 feet (300 m).
- Under most conditions: 200 - 400 feet (60 - 120 m).

Other range and transmission considerations include:

- Range may be reduced by walls, ceilings, trees, foliage, a metal roof or other large metal structures or objects such as aluminum siding, metal ducts, and metal appliances, such as refrigerators, televisions, heaters, or air conditioners.
- Frequency interferers also reduce transmission distance. Cordless phones (900 Mhz) are a common example of frequency interference.
- Transmission between wireless units may be obscured by something unidentifiable, or by some obstacle that can't be worked around.
- For best results, orient the ISS antenna and the console antenna so that the orientation and angles of the antennas are parallel to each other.



For best reception, orient antennas so they are parallel to each other.

If your ISS is directly overhead, the orientation illustrated here might work best.

- If possible, align the pivot joints of both the ISS and the console antennas so that they are facing each other for maximum signal strength.
- Turn the gain on to improve reception of a weak signal. Refer to the *Vantage Pro2 Console Manual* for information on setting the console gain.
- For better reception over greater distances or for weaker signals, consider using a Wireless Repeater (#7626 or #7627) or Long-Range Wireless Repeater (#7653 or #7654) to strengthen the signal or increase the distance between your ISS and the console.

Testing Wireless Transmission at ISS Location

After a suitable place has been found for the wireless ISS, it is very important to test reception from the installation location before permanently mounting it there.

1. Set the ISS in the desired installation location.
2. Set the console in the desired location.
3. Press and hold TEMP and press HUM to display statistical and reception diagnostics on the console.
   - It's a good idea to test the console's reception anywhere that you might want to use or mount it now or in the future. Take your time. If you aren't picking up a strong signal where you intend to place your console, try rotating the antenna on the console and ISS or try moving the console and ISS to different positions.
   - Irregular terrain in the area may interfere with the signal. For example, if the ISS is mounted downhill from the console, the ground may block a large percentage of the transmitted signal.
4. Press and hold DONE to return to the normal screen when finished testing.

Note: See the Troubleshooting section of the *Vantage Pro2 Console Manual* for information on how to check wireless signal strength and for more information on troubleshooting reception problems.

Installing the ISS

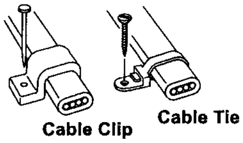
The anemometer and the main part of the ISS can be installed either together as a single unit on a pole, or apart from each other. The main part of the ISS includes the rain collector, the temperature and humidity sensors, the radiation shield, and the SIM housing. Use the U-bolts to install the ISS and anemometer together or separately on a pole. Use the lag screws to install them separately on a flat, vertical surface.

The anemometer comes with a 40' (12 m) cable for flexibility in configuring the system to monitor wind conditions. For example, the anemometer could be mounted at the highest point of a roof, and the ISS could be mounted on a fence closer to ground level.

General ISS Installation Guidelines

- Install the ISS as level as possible to ensure accurate rain measurements. Use a bubble level or carpenter's level to make sure the ISS is level.
- In the Northern Hemisphere, the solar panel should face south for maximum sun exposure.
- In the Southern Hemisphere, the solar panel should face north for maximum sun exposure. Either install the ISS and anemometer separately, each facing north, or mount them as a single unit with solar panel facing north and the wind vane re-oriented to the South. See "Appendix A: Re-orienting the Wind Vane" on page 28.

Optional: Guidelines for Securing Cables



- To prevent fraying or cutting of cables, secure them so they will not whip about in the wind.
- Secure cable to a metal pole using cable ties or by wrapping tape around both the cables and the pole.
- Place clips or ties approximately every 3' – 5' (1 – 1.6 m).
- Mounting clips, cable ties or additional hardware not included with your station can be easily obtained at a hardware or electronics store.

Note: Do not use metal staples or a staple gun to secure cables. Metal staples — especially when installed with a staple gun — have a tendency to cut the cables.

Orient the Wind Vane

The wind vane rotates 360° to display current and dominant wind directions on the compass rose of the console display. To obtain accurate readings, the vane must be *correctly oriented* when mounting the anemometer outside. By default, the wind vane reports the correct wind direction if the anemometer arm points true north.

To ensure correct orientation of the wind vane, do one of the following:

1. Mount the anemometer so that the arm points true north.
   The wind vane will be ready for use immediately.
2. If the anemometer is mounted so that it does not aim true north, remove the wind vane and re-attach it aiming toward the preferred direction. Refer to the instructions in "Appendix A: Re-orienting the Wind Vane" on page 28.

Installation Instructions

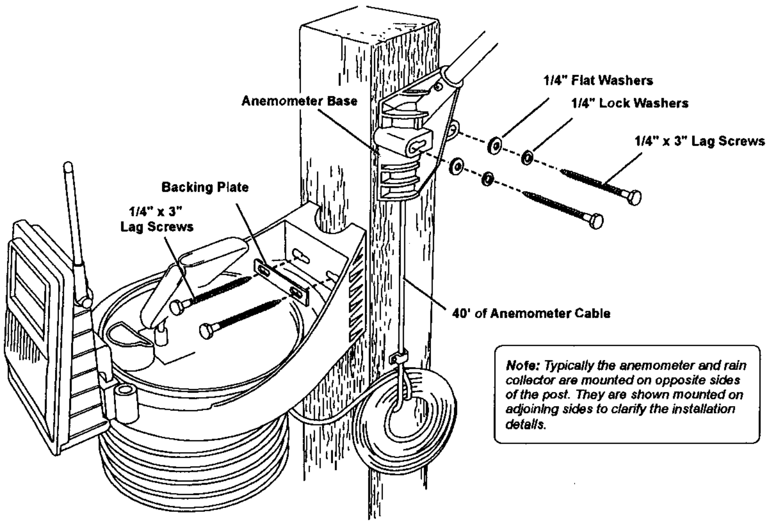
There are several ways to mount and install the ISS unit. The following are installation types that Davis Instruments recommends. Individual ISS locations and installations may vary.

- Installing the ISS on a flat surface
- Installing the Anemometer on a post or flat surface
- Installing the ISS on a pole

Note: All installations require that the rain collector cone be removed for assembly.

Installing the ISS on a Flat Surface

Refer to the following illustration to install the ISS on a post or flat, vertical surface.



***Note:** Typically the anemometer and rain collector are mounted on opposite sides of the post. They are shown mounted on adjoining sides to clarify the installation details.*

Option 1: Installing the ISS on a Post or Flat Surface

1. With a 3/16" (5 mm) drill bit, drill two holes approximately 2-1/8" (54 mm) apart. Use a carpenter's level to ensure the holes are level.
   Use the metal backing plate as a guide when marking the holes.
2. Remove the rain collector cone if it is installed on the ISS mounting base.
3. Insert the 1/4" x 3" lag screws through the metal backing plate and the holes in the mounting base into the post.
4. Tighten the lag screws using an adjustable wrench or 7/16" wrench.
5. Re-attach the rain collector cone. Set the cone back on the base so its latches slide downward into the latch openings on the base. Rotate cone clockwise.
6. Place the debris screen (shown in the illustration on page 1) inside the cone, "feet-down" over the funnel hole.

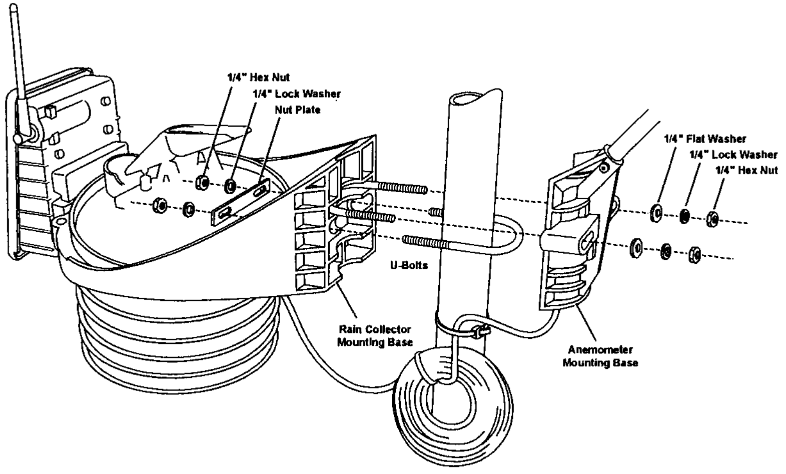
Option 2: Installing the Anemometer on a Post or Flat Surface

1. With a 3/16" (5 mm) drill bit, drill two holes approximately 2-1/8" (54 mm) apart. Use a carpenter's level to ensure the holes will be level.
2. Insert the 1/4" x 3" lag screws through the flat washers and the holes in the anemometer mounting base into the post.
3. Tighten the lag screws using an adjustable wrench or 7/16" wrench.
   If the anemometer arm is not pointing north, follow the instructions in "Appendix A: Re-orienting the Wind Vane" on page 28.

Installing the ISS on a Pole

When installing the ISS on a pole, the rain collector and radiation shield section of the ISS can be mounted as a single unit with the anemometer section, or the two sections can be mounted separately.

Refer to the following illustration when installing the ISS or anemometer on a pole.



Accessories for Pole Mounting

- Use the Mounting Tripod (#7716) for easy roof-mounting.
- Use the Mounting Pole Kit (#7717) to raise the installation height of the ISS by up to 37.5" (0.95 m).

General Guidelines for Installing on a Pole

- With the supplied U-bolts, the ISS can be mounted on a pole having an outside diameter ranging from 1-1/4" to 1-3/4" (32 – 44mm).
- Larger U-bolts (not supplied) can be used to mount to a pole with a maximum outside diameter of 2-1/2" (64mm).
- To mount on a smaller pole, obtain a U-bolt that fits the base openings but that has a shorter threaded section. If mounting the ISS on a smaller pole with the included U-bolts, the bolt interferes with the rain collector cone.

Guidelines for Installing the ISS on a Pole

- When mounting both sides together, remember that whichever side of the ISS is mounted first, the U-bolt from the opposite side must also be placed around the pole before tightening the U-bolts. (If it is not, there is no way to slide it in later.)
- In each side's mounting base, there is a groove to accommodate the other's U-bolt.
- Once the two sides of the ISS have been loosely mounted together on the pole, swivel the unit to the correct direction and then tighten the hex nuts. The desired height can also be achieved by sliding the ISS vertically.

Option 1: Installing ISS and Anemometer Together

Try to install the ISS so the anemometer arm is aiming north. If the arm doesn't point north, re-orient the wind vane. See "Appendix A: Re-orienting the Wind Vane" on page 28.

1. Place the U-bolt for the anemometer around the pole so that its round end fits in the top groove of the side of the rain collector side's plastic mounting base. The groove is right above two large holes.
2. While holding the mounting base of the rain collector against the pole, place the two ends of the remaining U-bolt around the pole and through the two holes in the base.
3. Slide the metal backing plate over the bolt ends as they stick out over the rain collector base. Secure the backing plate with a lock washer and hex nut on each of the bolt ends as shown previously.

Note: Do not tighten the hex nuts yet. Leave the hex nuts loose to swivel the ISS base on the pole.

4. The two ends of the anemometer's U-bolt should now be pointing away from the mounted rain collector side. Slide the anemometer's mounting base over the protruding bolt ends. Place a flat washer, a lock washer and a hex nut on each of the bolt ends as shown above. Do not tighten the nuts yet.
5. Raise the ISS unit to the desired height on the pole and swivel it so the anemometer arm is pointing north.
6. Using an adjustable wrench or 7/16" wrench, tighten all four hex nuts until the ISS is firmly fastened on the pole.
7. Re-attach the rain collector cone by setting the cone back on the base so its latches slide downward into the latch openings on the base, then rotate the cone clockwise.
8. Place the debris screen (shown in the illustration on page 1) inside the cone, "feet-down," over the funnel hole. When installing the ISS as a single unit, we recommend tucking the coil of anemometer cable between the rain collector cone and the ISS base.

Option 2: Installing ISS Only

1. While holding the mounting base against the pole, place the two ends of a U-bolt around the pole and through the two holes in the base.
2. Slide the metal backing plate over the bolt ends as they stick out toward the rain collector cone. Secure the backing plate with a washer, a lock washer, and a hex nut on each of the bolt ends. Do not tighten the nuts yet.

   For the wireless ISS, swivel the ISS base so the solar panel is facing south (in the Northern Hemisphere), or north (in the Southern Hemisphere).

3. Tighten the hex nuts using an adjustable wrench or 7/16" wrench.
4. Re-attach the rain collector cone.

   Set the cone back on the base so its latches slide downward into the latch openings on the base. Rotate the cone clockwise.
5. Place the debris screen (shown in the illustration on page 1) inside the cone, "feet-down," over the funnel hole.

Option 3: Installing Anemometer Only

1. While holding the mounting base against the pole, place a U-bolt around the pole and through the two holes in the base.
2. Place a flat washer, a lock washer and a hex nut on each of the bolt ends.
3. Swivel the anemometer until the arm is pointing north.

   If the anemometer arm is not pointing north, go to "Appendix A: Re-orienting the Wind Vane" on page 28 after tightening the hex nuts.
4. Using an adjustable wrench or 7/16" wrench, tighten the hex nuts.

Finishing the Installation

Level the Solar and UV Sensors

If you have a Vantage Pro2 Plus station that includes a solar or UV sensor, use the bubble level on the sensors as a guide to verify that the sensors are level.

Adjust the level by tightening or loosening the screws that hold the sensor onto the shelf.

Note: If you are installing the solar or UV sensors separately, see the Sensor Mounting Shelf installation manual and the Solar Radiation and UV Sensor Installation manuals for more information.

Clearing Data Collected During Testing and Installation

Now that the ISS is mounted outside, any data that was collected in the Vantage Pro2 console during testing and mounting can be cleared.

To clear all the collected data on the console:

1. Press WIND so that graph icon appears adjacent to the wind data on the display.
2. Press 2ND, then press and hold CLEAR for at least six seconds and until you see "CLEARING NOW" in the console ticker display.

Additional Mounting Options

Extending Wireless Transmission Range

Optional repeater stations can be used to extend the wireless transmission range.

- Wireless Repeater, AC-Powered (#7626)
- Wireless Repeater, Solar-Powered (#7627)
- Long-Range Wireless Repeater, AC-Powered (#7653)
- Long-Range Wireless Repeater, Solar-Powered (#7654)

Extending the Console Cable (Cabled ISS Only)

A Cabled ISS can be extended up to 1000' (300 m) away from the console by using Davis Instruments extension cables (#7876).

Relocating the Anemometer

Using Extension Cables:

Note: Not all cables are compatible with your Vantage Pro2 system. To be sure they will work, order Davis extension cables from your dealer or directly from Davis Instruments.

The Anemometer can be extended further than 40' from the ISS by using Davis Instruments extension cables (#7876).

Be aware that the maximum measurable wind speed reading decreases as the total length of cable from the anemometer to the ISS increases.

Note: If the cable length is greater than 540' (165m), the maximum measurable wind speed may be less than 100 MPH (161 km/h).

Using the Anemometer Transmitter Kit (Wireless ISS Only)

Use the Anemometer Transmitter Kit (#6332) to add an independent wireless transmitter to the anemometer. The kit allows the anemometer to function as a transmitter station sending wind data directly to the console, instead of transmitting via the ISS.

Remote Mounting the Solar and UV Sensors

The solar and UV sensors have a 3' (0.9 m) cable. If you wish to install these sensors away from the ISS, you can extend the length of the sensor cables up to 125' (38 m) with Davis Instruments extension cables (#7876).

Optional Wireless Stations

You may use our optional wireless sensor stations to collect weather measurements, without the inconvenience of routing cables.

- Wireless Temperature Station (#6372)
- Wireless Temperature/Humidity Station (#6382)
- Wireless Leaf & Soil Moisture/Temperature Station (#6345)

For more details, please visit our website or see the most recent *Davis Precision Weather Instruments* catalog.

Maintenance and Troubleshooting

Maintaining UV and Solar Radiation Sensors

If the ISS is a Plus model and contains UV and solar sensors, do not touch the small white diffusers on top of the sensors. Oil from skin reduces their sensitivity. If you are concerned that you have touched the diffusers at any time, clean the UV diffuser using ethyl alcohol with a soft cloth. When cleaning the UV diffuser, DO NOT use rubbing or denatured alcohols because they can affect accuracy of the sensor readings. Ethyl alcohol can be procured through an industrial or laboratory supply store. Clean the solar diffuser with a soft damp cloth.

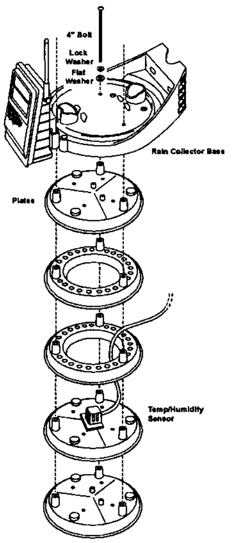
Due to the sensitivity of ultraviolet and solar radiation sensors it is common practice for manufacturers to recommend re-calibration after a period of time. Users demanding high accuracy typically recalibrate their sensors annually. Here at Davis Instruments, we have seen less than 2% drift per year on the readings from these sensors.

Contact Technical Support about returning your sensor for calibration. See "Contacting Davis Instruments" on page 27.

Cleaning the Radiation Shield

The outer plating of the radiation shield should be cleaned when there is excessive dirt and build-up on the plating. Use a damp cloth to clean the outer edge of each ring.

Note: Spraying down or using water excessively to clean the radiation shield can damage the sensitive sensors or alter the data and readings the ISS is transmitting.



Check the radiation shield for debris or insect nests at least once a year and clean when necessary. A buildup of material inside the shield reduces its effectiveness and may cause inaccurate temperature and humidity readings.

To thoroughly clean the radiation shield

1. Remove the rain collector cone.
2. Using a Phillips head screwdriver, loosen the three 4" (~100mm) bolts holding the radiation shield plates together.
3. Separate the plates as shown and remove all debris from inside the shield.
4. Reassemble the radiation shield plates and fasten them together using the bolts as shown in the illustration. Use a Phillips head screwdriver to tighten the bolts.

Cleaning the Rain Collector

To maintain accuracy, thoroughly clean the rain collector several times a year.

Note: Cleaning the rain collector and tipping buckets my cause false rain readings. Unplug the RAIN sensor from the SIM before cleaning so that no inaccurate readings are logged, or clear the weather data that was logged on the Vantage Pro2 console after cleaning is complete. See your *Vantage Pro2 Console Manual* for instructions on clearing weather data.

1. Separate the cone from the base by turning it counter-clockwise.
2. Use soapy water and a soft cloth to remove any debris from the cone, cone screen, and tipping bucket.
3. Use pipe cleaners to clear the funnel hole in the cone and drain screens in the base.
4. When all parts are clean, rinse with clear water.
5. Re-attach the cone and replace the debris screen.

Troubleshooting

If a Sensor Functions Intermittently

Carefully check all connections from the sensor to the ISS. See "Check SIM Sensor Connections" on page 4.

Loose connections account for a large portion of potential problems. Connections should be firmly seated in receptacles and plugged in straight. To check for a faulty connection, try jiggling the cable while looking at the display. If a reading displays intermittently on the console as the cable is jiggled, the connection is faulty. Try removing and then re-installing the cable to correct the faulty connection. If the sensor still functions intermittently contact Technical Support. See "Contacting Davis Instruments" on page 27.

Most Common Rain Collector Problem

If the rain collector seems to be under-reporting rainfall, remove the rain collector cone to clean the tipping bucket and clear out any debris. Make sure the cable tie around the tipping bucket has been cut and removed.

Most Common Anemometer Problems

"The anemometer head is tilted when I mount the anemometer."

With Allen wrench provided in the supplied hardware, loosen the screws holding the anemometer head on the arm. (The screws are on the bottom of the anemometer head, by the wind cups.) Turn the anemometer head so it is straight and then tighten the screws.

"The wind cups are spinning but my console displays 0 mph."

The signal from the wind cups may not be making it back to the display. Remove the cups from the anemometer (loosen the set screw). Put the cups back onto the shaft and adjust them up or down 1/16 – 1/8 inch (1.5 – 3 mm). Check your cables for visible nicks and cuts. Look for corrosion in the WIND connector on the SIM and on splices in the cable. If using an extension cable, remove it and test using only the anemometer cable. Contact Technical Support and ask for a wind test cable if the problem has not been resolved.

Note: If the anemometer is sending no data, the wind display indicates 0 speed and a North direction.

"The wind direction is stuck on north, or displays dashes."

It is likely that there is a short somewhere between the wind vane and the display. Check the cables for visible nicks and cuts. Look for corrosion in the "WIND" jack on the SIM and on splices in the cable (if any). If possible, remove any extensions and try it with the anemometer cable only. If none of these steps get the wind direction working, contact Technical Support and ask for a wind test cable.

"The wind cups don't spin or don't spin as fast as they should."

First check for and clear out any spider webs. Also, the anemometer may be located where wind is blocked by something, or there may be friction interfering with the cups' rotation. Remove the wind cups (loosen the set screw) and clear out any bugs or debris. Turn the shaft the cups rotate on. If it feels gritty or stiff, contact Davis Technical Support.

Note: Do not lubricate the shaft or bearings in any way. When replacing the cups, make sure they are not rubbing against any part of the anemometer head.

"Readings aren't what I expected them to be."

Comparing data from your ISS to measurements from TV, radio, newspapers, or a neighbor is NOT a valid method of verifying your readings. Readings can vary considerably over short distances. How you site the ISS and anemometer can also make a big difference. If you have questions, contact Technical Support.

Contacting Davis Instruments

If you have questions about the ISS or Vantage Pro2 system, or encounter problems installing or operating the weather station, please contact Davis Technical Support.

Note: Please do not return items to the factory for repair without prior authorization.

(510) 732-7814 – Technical Support phone, Monday – Friday, 7:00 a.m. – 5:30 p.m. Pacific Time.

(510) 670-0589 – Technical Support Fax.

support@davisnet.com – E-mail to Technical Support.

info@davisnet.com – General e-mail.

www.davisnet.com – Download manuals and specifications from the Support section. Watch for FAQs and other updates. Subscribe to the e-newsletter.

Appendices

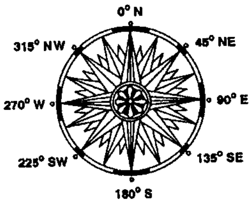
Appendix A: Re-orienting the Wind Vane

The Vantage Pro2 station is configured to register wind direction correctly if the anemometer points to true north. If the anemometer shaft cannot be mounted to point to true north, use the following instructions to correct the wind vane orientation.

- Do not rely on a compass unless it is properly calibrated. In North America there can be up to 15° variation between true north and a raw compass reading.
- Correct the wind direction readings by calibrating the wind direction in the Vantage Pro2 console. See the *Vantage Pro2 Console Manual* for information.
- To orient the wind vane accurately, look at the console display. Have another person watch the console display while orienting the wind vane.
- Also, re-orient the wind vane before the anemometer is installed if the direction in which the anemometer will be installed is already known.

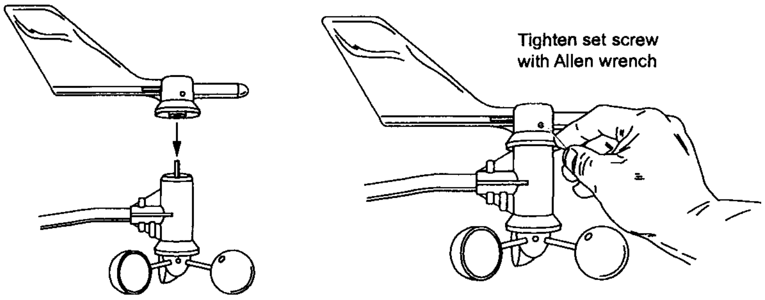
To re-orient the wind vane:

1. Loosen the wind vane set screw.
2. Pull the vane directly up and off the steel shaft on which it turns.
3. Press WIND on the console to display current wind direction in degrees.
4. Use a reliable map, properly calibrated compass or a landmark to determine which direction is true south.
5. Slowly turn the stainless-steel wind direction shaft with your fingers. Stop turning when the display reaches 180° obtained in step 3.



Wind Direction Chart

6. Allow the wind direction display approximately 5 seconds to stabilize after the shaft is turned. Turn the shaft, wait, and turn it again until 180° is displayed on the console.
7. Being careful to keep the stainless-steel shaft from turning, place the wind vane on top of shaft with the vane's nose pointing south.
8. Slide the wind vane down the shaft as far as it will go.
9. Use the Allen wrench provided to tighten the set screw on the side of the wind vane.
10. Test the anemometer by pointing the wind vane in any direction and making sure the console displays the correct wind direction. Remove and re-adjust the vane if it does not. Allow the wind direction display approximately 5 seconds to stabilize after turning the shaft.



Installing Wind Vane on Anemometer Shaft

11. Test the anemometer by pointing the wind vane in any direction and making sure the console displays the correct wind direction. Remove and re-adjust the vane if it does not. Allow the wind direction display approximately 5 seconds to stabilize after turning the shaft.

Appendix B: Specifications

Complete specifications for the ISS and other products are available in the Weather Support section of our website at www.davisnet.com.

Cabled ISS

Temperature range:	-40 to 150° Fahrenheit (-40 to 65° Celsius)
Power input:	Console Cable from Vantage Pro2 console Optional Vantage Pro2 AC power adapter

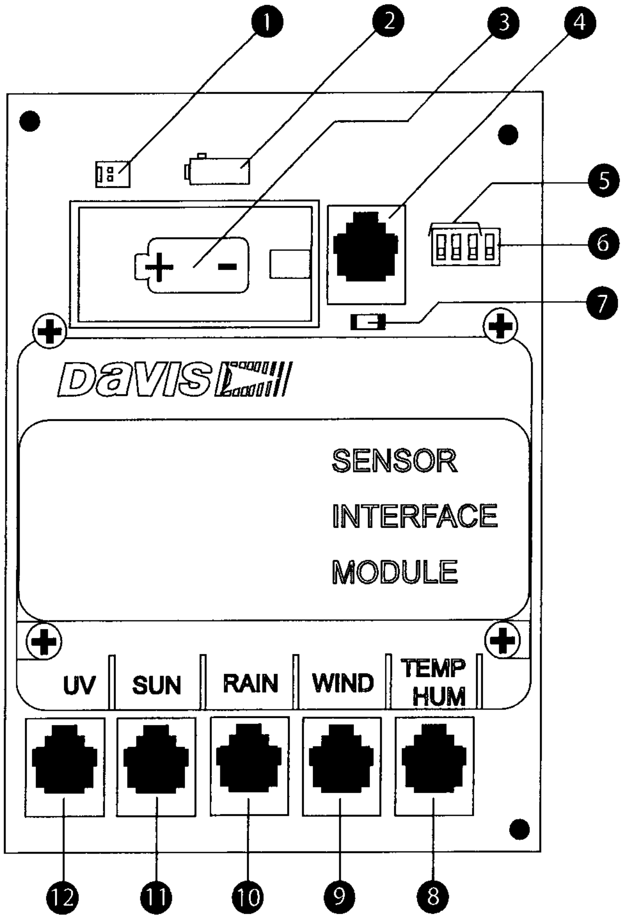
Wireless ISS

Temperature range:	-40 to 150° Fahrenheit (-40 to 65° Celsius)
Transmission frequency:	902 - 928 MHz FHSS for North America 868.0 -868.6 MHz FHSS for overseas versions: EU, UK, and OV
Transmitter ID codes:	8 user-selectable
License:	low power (less than 8 mW), no license required
Primary power:	Solar power – Davis solar charger
Backup power:	CR-123A 3-volt lithium battery (8 months without sunlight- greater than 2 years depending on solar charging)
Alternate power	AC power adapter

ISS Weather Variable Update Intervals (Transmitter ID Dependent)

Wind speed:	2.5 to 3 seconds
Wind direction:	2.5 to 3 seconds
Accumulated rainfall:	10 to 12 seconds
Rain rate:	10 to 12 seconds
Outside temperature:	10 to 12 seconds
Outside humidity:	50 seconds to 1 minute
Ultraviolet radiation:	50 seconds to 1 minute
Solar radiation:	50 seconds to 1 minute

SIM Board Display and Contents



① **Solar Power Tab**

② **AC Adapter Socket**

③ **Battery Socket**

④ **Cabled Connection**

⑤ **Transmitter ID DIP Switch**

⑥ **Test DIP Switch**

⑦ **Test LED**

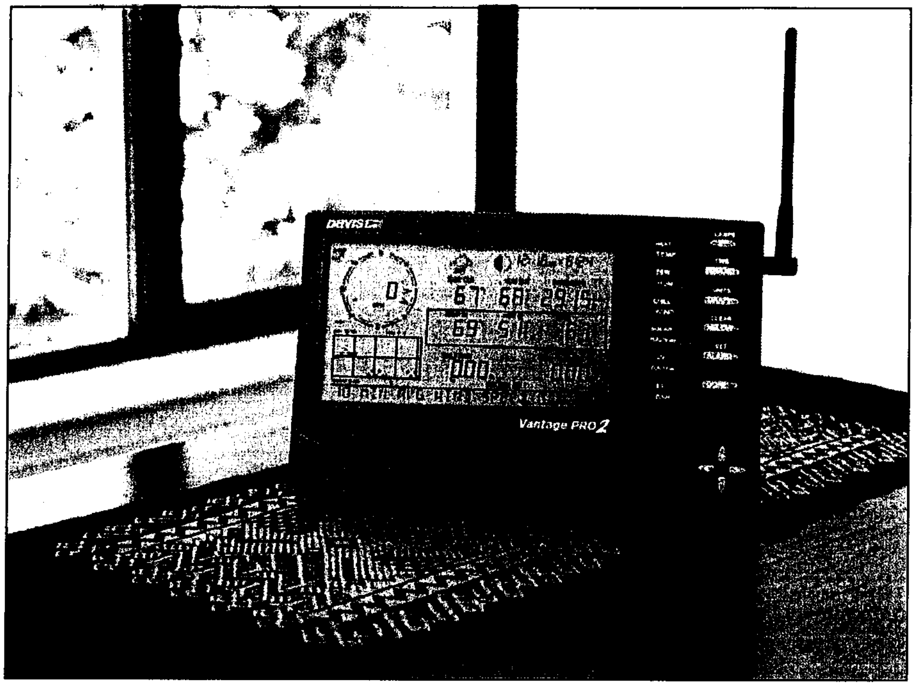
⑧ **Temperature/Humidity Sensor Connector**

⑨ **Wind Sensor Connector**

⑩ **Rain Sensor Connector**

⑪ **Solar Radiation Sensor Connector**

⑫ **UV Sensor Connector**

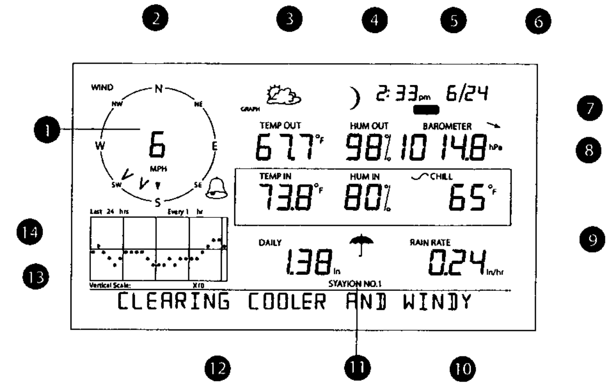


Vantage Pro2™ Console Manual

For Vantage Pro2™ & Vantage Pro2 Plus™ Weather Stations

Davis Instruments, 3465 Diablo Avenue, Hayward, CA 94545 • 510-732-9229 • www.davisnet.com

Vantage Pro2 Console Display Features



Display Features

1. Compass Rose
2. Graph & Hi/Low Mode Settings
3. Forecast Icons
4. Moon Phase Indicator
5. Time/Sunrise Time
6. Date/Sunset Date
7. 2ND Button Indicator
8. Barometric Trend Arrow
9. Graph Icon
10. Current Rain Icon
11. Station Number Indicator
12. Weather Ticker
13. Graph Field
14. Alarm Icon

FCC Part 15 Class B Registration Warning

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modification not expressly approved in writing by Davis Instruments may void the warranty and void the user's authority to operate this equipment.

FCC ID: IR2DWW6328

IC: 378810-6312

EC EMC Compliance

This product complies with the essential protection requirements of the EC EMC Directive 89/336/EC.

Vantage Pro 2 Console Manual

Document Part Number: 07395.234 Rev. G, September 21, 2006

For Vantage Pro2 Consoles # 6312 & 6312C

And Vantage Pro2 Weather Stations # 6152, 6152C, 6153, 6162, 6162C, 6163

Table of Contents

Chapter 1

Welcome to Vantage Pro2™

Welcome to your Vantage Pro2 Weather Station console. The console displays and records your station's weather data, provides graph and alarm functions, and interfaces to a computer using our optional WeatherLink software.

Vantage Pro2 stations are available in two basic versions: cabled and wireless. A cabled Vantage Pro2 station transmits outside sensor data from the Integrated Sensor Suite (ISS) to the console using a straight-through four-conductor cable. A wireless Vantage Pro2 station transmits outside sensor data from the ISS to the console via a low-power radio. Wireless stations can also collect data from optional Vantage Pro2 sensors. See "Optional Sensors" on page 2.

The *Vantage Pro2 Quick Reference Guide* included with your station provides an easy to use reference for most console functions.

Console Features

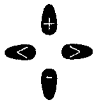
Keyboard & Display

The keyboard lets you view current and historical data, set and clear alarms, change station models, enter calibration numbers, set up and view graphs, select sensors, and read the forecast. The keyboard consists of 12 command keys located next to the screen display and four navigation keys located below the command keys.

A weather variable or console command is printed on each command key. Just press a key to select the variable or function printed on that key.

Each command key also has a secondary function which is printed above the key on the console case. To select the secondary function, press and release 2ND (on the front of the console, upper right corner) and then immediately press the key for that function.

Note: After pressing 2ND, the 2ND icon displays above the barometer reading on the screen for three seconds. All secondary key functions are enabled during this time. Keys resume normal operation after the icon disappears.



The up arrow, down arrow, left arrow, and right arrow navigation keys are used to select command options, adjust values, and to provide additional functions when used in combination with a command key.

Console Modes

The console operates in five basic modes: Setup, Current Weather, Highs and Lows, Alarm, and Graph. Each mode lets you access a different set of console functions or display a different aspect of your weather data.

Vantage Pro2 Options

Optional Sensors

Vantage Pro2 stations are extremely flexible. Use the following optional sensors and wireless stations to enhance the weather monitoring capabilities of your Vantage Pro2. See our website for complete details: www.davisnet.com.

Optional Sensor and Stations	Description
Wireless Weather Envoy (# 6316) Cabled Weather Envoy (# 6316C)	Performs much of the same functions as a Vantage Pro2 console, but without a display. Use an Envoy to interface your wireless station to a computer when you'd rather place the console in another location for viewing weather conditions
Anemometer Transmitter Kit (# 6332)	Provides more flexible anemometer placement for wireless stations.
Wireless Leaf & Soil Moisture/ Temperature Station (# 6345)	Measures and transmits leaf wetness, soil moisture and temperature data. Also for use with GLOBE.
Wireless Temperature Station (# 6372)	Measures and transmits temperature data.
Wireless Temperature/Humidity Station (# 6382)	Measures and transmits air temperature and humidity data.
Solar Radiation Sensor (# 6450)	Measures solar radiation. Required for calculating evapotranspiration (ET). Available for cabled and wireless stations. Requires Sensor Mounting Shelf (# 6673).
Ultraviolet (UV) Radiation Sensor (# 6490)	Measures UV radiation. Required for calculating the UV dose. Available for Cabled and Wireless stations. Requires Sensor Mounting Shelf (# 6673).

Note: Optional wireless stations can only be used with Wireless Vantage Pro2 Stations.

Optional WeatherLink® Software

The WeatherLink software and data logger connect your Vantage Pro2 station directly to a computer, providing enhanced weather monitoring capabilities, a continuous preserved data record, and powerful Internet features. The WeatherLink data logger fits neatly on the console and stores weather data even when the computer is turned off.

WeatherLink Option	Description
WeatherLink for Windows, USB connection (# 6150USB)	Includes WeatherLink software and USB data logger. Allows you to save and view your weather data on your PC.
WeatherLink for Windows, serial connection (# 6150SER)	Includes WeatherLink software and serial data logger. Allows you to save and view your weather data on your PC.

WeatherLink Option	Description
WeatherLink for Macintosh OS X, USB connection (# 6520)	Includes WeatherLink software and USB data logger. Allows you to save and view your weather data on your Mac.
WeatherLink for APRS, Windows version, with streaming data logger, serial connection (# 6540)	Includes WeatherLink software and streaming serial data logger. Allows real-time display of current weather conditions for use with APRS (Automatic Position Reporting System), for HAM radio users.
WeatherLink for Alarm Output, Windows version, with streaming data logger, serial connection (# 6544)	Includes WeatherLink software and streaming serial data logger. Gives you the ability to control external devices based on various combinations of weather trends and events.
WeatherLink for Emergency Response teams, Windows version, with streaming data logger, serial connection (# 6550)	Includes WeatherLink software and streaming serial data logger. Allows real-time display of current weather conditions for use by emergency response teams.
WeatherLink for Irrigation Control, Windows version, with streaming data logger, serial connection (# 6560)	Includes WeatherLink software and streaming serial data logger. Allows intelligent and efficient control of popular automated irrigation systems using weather data.

Optional Accessories

The following accessories are available from your dealer or may be ordered directly from Davis Instruments.

Sensor Mounting Shelf (# 6673)

Required for mounting the optional Solar Radiation and/or UV sensors. The mounting shelf attaches to the base of the rain collector on the ISS.

USB-to-Serial (DB-9) Cable (# 8434)

Allows the Serial version of WeatherLink (# 6510SER, 6540, 6550, 6560) to connect to a USB port on your computer.

Telephone Modem Adapter (# 6533)

Creates a dialup connection between the station and the computer.

Extension Cables (# 7876)

Allows you to place the Cabled Vantage Pro2 ISS further away from the console using the extension cable provided by Davis Instruments. Maximum cable length is 1000' feet (300 m).

- # 7876-040 Cable, 40' (12 m)
- # 7876-100 Cable, 100' (30 m)
- # 7876-200 Cable, 200' (61 m)

Davis Baseball Cap (# PR725)

100% cotton twill cap is two-toned with a washed khaki crown, dark blue brim, and embroidered Davis logo. Self-fabric closure with brass buckle. One size fits all.

Chapter 2

Installing the Console

The Vantage Pro2 console is designed to give extremely accurate readings. As with any precision instrument, use care in its assembly and handling. Although installing the console is relatively simple, following the steps outlined in this chapter and assembling the Vantage Pro2 correctly from the start will help ensure that you enjoy all of its features with a minimum of time and effort.

Powering the Console

Cabled Vantage Pro2 Stations

Cabled Vantage Pro2 consoles supply power to the Integrated Sensor Suite (ISS) through the console cable. Because of the added power consumption of the ISS, the cabled console requires an AC power adapter used as the main power supply. The console batteries provide backup power for up to four to six weeks.

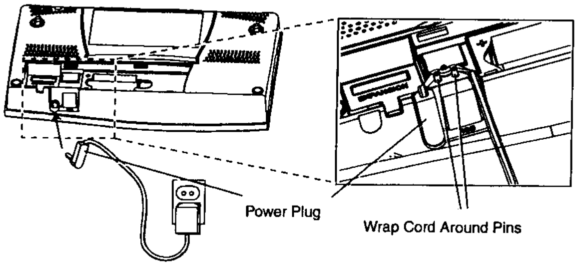
Wireless Vantage Pro2 Stations

Wireless Vantage Pro2 consoles do not require the use of an AC adapter. You may use the included adapter if you wish, but the three C-cell batteries should power a wireless console for up to nine months.

Note: When using an AC Power adapter, be sure to use the power adapter supplied with your Vantage Pro2 Console. Your console may be damaged by connecting the wrong power adapter. The console does not recharge the batteries. Because of this, and because NiCad batteries do not power the console as long as alkaline batteries, use alkaline batteries in the console.

Installing the AC Power Adapter

1. Remove the battery cover located on the back of the console by pressing down on the two latches at the top of the cover.
2. Find the power jack located on the bottom of the console case.

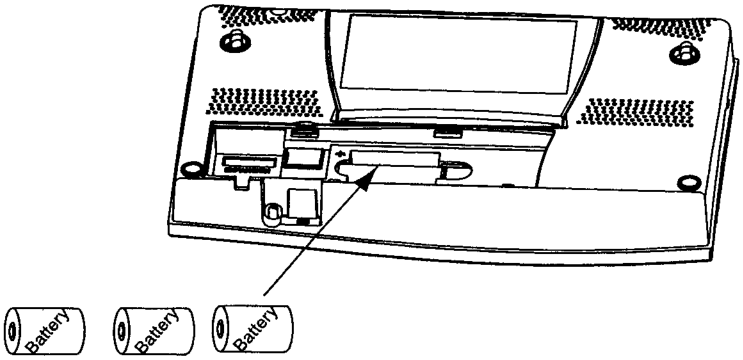


3. Insert the power adapter plug into the console power jack, then plug the other end of the adapter into an appropriate power outlet.
4. Check to make sure the console runs through a brief self-test procedure successfully. On power up, the console displays all the LCD segments and beeps twice. A message displays in the ticker banner at the bottom of the console, followed by the first screen that displays during Setup Mode. Press and hold DONE to skip the message and enter into Setup Mode.

   Setup Mode guides you through steps required to configure the station. See "Setup Mode" on page 9 for more information.

Installing Batteries

1. Remove the battery cover located on the back of the console by pressing down on the two latches at the top of the cover.

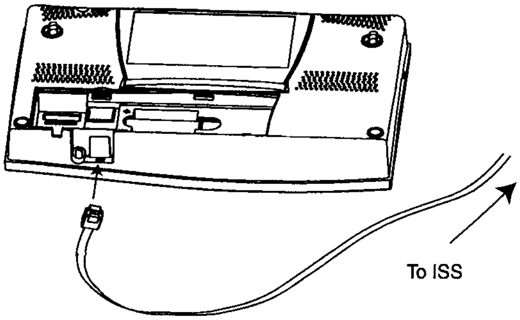


2. Insert three C batteries into the battery channel, negative (or flat) terminal first.
3. Replace the battery cover.

Connecting Cabled Stations

Cabled Vantage Pro2 stations come with 100 feet (30m) of cable. This cable is used for connecting the console to the ISS. Maximum cable length from ISS to the console using Davis Instruments cables is 1000 feet. To connect the console to the ISS:

1. Firmly insert the console end of the straight-through four-conductor wire into the console receptacle marked "ISS" until it clicks into place. Do not force the connector into the receptacle.



2. Ensure that the ISS cable is not twisted through the access port.

Note: The ISS must be assembled and connected to the console so that it is receiving power before the console connection can be tested.

Once the console and ISS are both powered up, cable connection should be tested and established.

Once the console is powered, it automatically enters Setup Mode. You can step through the Setup Mode options, or exit the Setup Mode to test the connection and sensor readings in Current Weather Mode. See “Setup Mode” on page 9 for Setup Mode options. See “Current Weather Mode” on page 18 for viewing and verifying current weather data coming from the cabled console.

To verify that the console is receiving data from the ISS through the console connection, see “Cabled ISS Assembly” in the Integrated Sensor Suite Installation Manual.

Console Location

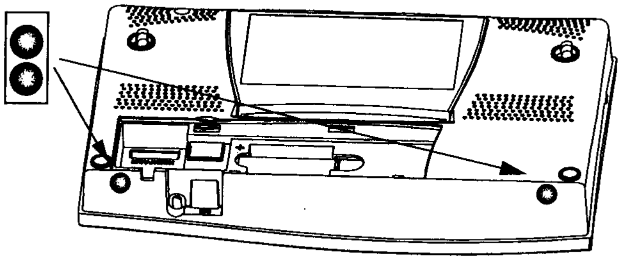
Place the console in a location where the keyboard is easily accessible and the display is easy to read. For more accurate readings, follow these suggestions.

- Avoid placing the console in direct sunlight. This may cause erroneous inside temperature and humidity readings and may damage the unit.
- Avoid placing the console near radiators or heating/air conditioning ducts.
- If you are mounting the console on a wall, choose an interior wall. Avoid exterior walls that tend to heat up or cool down depending on the weather.
- If you have a wireless console, be aware of possible interference from cordless phones or other devices. To prevent interference, maintain a distance of 10 feet between the Vantage Pro2 console and a cordless phone (handset and base).
- Avoid positioning a wireless console near large metallic appliances such as refrigerators, televisions, heaters, or air conditioners.
- The console antenna does not rotate in a complete circle. Avoid forcing the console antenna when rotating it.

Table & Shelf Placement

The console kickstand can be set to three different angles allowing five different display angles.

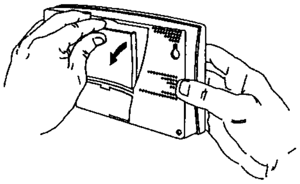
1. Install the two round rubber feet on the bottom of the console. The rubber feet help prevent damage to furniture and surfaces.

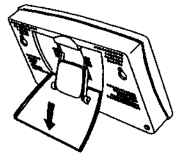


2. Lean the kickstand out by pulling on its top edge.

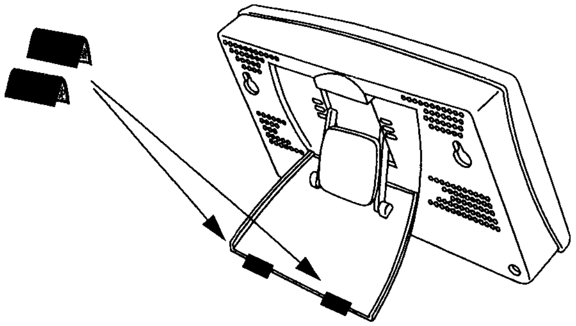
   You'll see the indentation for your finger at the top edge of the console.
3. Slide the catch to rest the kickstand in the appropriate angle.

   Choose low angles for display on a coffee table or other low area. Choose higher angles for display on a desk or shelf.





4. Install the two rubber channel feet on the kickstand.



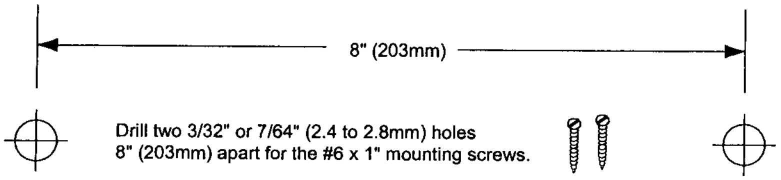
If necessary, pull up on the stand to close it. It will be a little tight, so it's okay to push hard enough to get it to slide.

Wall Mounting

The console mounts to the wall using two keyholes located on the back of the case.

To mount the console on a wall:

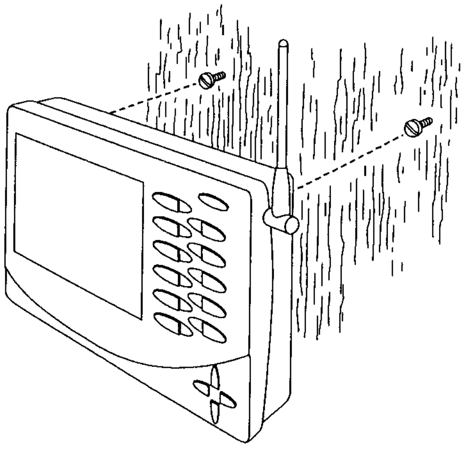
1. Use a ruler to mark two mounting hole positions on the wall 8 inches (203 mm) apart.



This is a representation for the mounting hole positions. This template is not true to size.

If installing a cabled Vantage Pro2 console with sensor cable running inside the wall, mount the console over an empty switch box.

2. Use a drill and a 3/32 or 7/64"(2.5 mm) drill bit to drill two pilot holes for the screws.
3. Using a screwdriver, drive the two #6 x 1" pan head self-threading screws into the wall. Leave at least 1/8" (3 mm) between the wall and the heads of the screws.
4. If the kickstand has been pulled out from the case, push it back into its upright and locked position.
5. Guide the two keyholes on the back of the console over the two screws.



Chapter 3

Using Your Weather Station

The console LCD screen and keyboard provide easy access to your weather information. The large LCD display shows current and past environmental conditions as well as a forecast of future conditions. The keyboard controls console functions for viewing current and historical weather information, setting and clearing alarms, changing stations types, viewing and/or changing station settings, setting up and viewing graphs, selecting sensors, getting the forecast, and so on.

Console Modes

The Vantage Pro2 console operates in five different modes:

Mode	Description
Setup	Use Setup Mode to enter the time, date, and other information required to calculate and display weather data.
Current Weather	Use Current Weather Mode to read the current weather information, change measurement units, and to set, clear or calibrate weather readings.
High/Low	High/Low Mode displays the daily, monthly or yearly high and low readings.
Alarm	Alarm Mode allows you to set, clear, and review alarm settings.
Graph	Graph Mode displays your weather data using over 100 different graphs.

Setup Mode

Setup Mode provides access to the station configuration settings that control how the station operates. Setup Mode consists of a series of screens for selecting console and weather station options. The screens that display in Setup Mode vary depending on the weather station type (cabled or wireless), or if the console has a WeatherLink connection already established. (See the *WeatherLink Getting Started Guide* for more information on connecting your console to your computer.)

Setup Mode Commands

Setup Mode displays when the console is first powered. This mode can be displayed at any time to change any of the console/weather station options. Use the following commands to enter, exit and navigate Setup Mode:

- Enter Setup Mode by pressing DONE and the down arrow (-) at the same time.

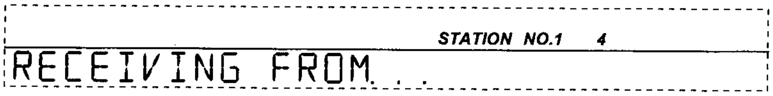
Note: The console automatically enters Setup Mode when first powered.

- Press DONE to move to the next screen in the Setup Mode.
- Press BAR to display the previous screen in the Setup Mode.
- Exit Setup Mode by pressing and holding DONE until the Current Weather screen displays.

Screen 1: Active Transmitters

Screen 1 displays the message "Receiving from..." and shows the transmitters being received by the console. In addition, an "X" blinks in the lower right-hand corner of the screen every time the console receives a data packet from a station. The rest of the LCD screen is blank.

If you have a cabled station, or if your wireless ISS uses the factory settings and you are receiving the signal, the screen displays "Receiving from station No. 1." Any optional stations that have been installed should also display.



STATION NO.1 4

RECEIVING FROM. . .

Screen 1: Active Transmitters

Note: An ISS or optional station must be powered for the console to recognize it. Refer to the *Integrated Sensor Suite Installation Manual* or optional station installation instructions for more information. It make take several minutes for the console to acquire and display a Transmitter ID.

1. Make a note of the station number(s) listed on the screen.
2. Press DONE to move to the next screen.

The console can receive signals from up to eight transmitters total, but there is a limit on the number of certain types of transmitters. The table below lists the maximum number of stations allowable for a receiver:

Station Type	Maximum Number
Integrated Sensor Suite (ISS)	1
Anemometer Transmitter Kit*	1
Leaf & Soil Moisture/Temperature Station	2**
Temperature Station	8
Temperature/Humidity Station	8

Maximum Number of Transmitters in a Network with One Receiver

**Replaces the ISS anemometer.*

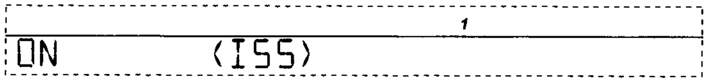
***Two are allowable only if both stations are only partially populated. For example, A network can either have both a Leaf Wetness/Temperature station and a Soil Moisture/Temperature station, or it can have one combined Leaf Wetness and Soil Moisture/Temperature station.*

Note: Listening to more than one transmitter may reduce battery life significantly.

Screen 2: Configuring Transmitter IDs — Wireless Only

(If you have a cabled station, press DONE and continue on to "Screen 4: Time & Date" on page 12.)

Setup screen 2 allows you to change the ISS transmitter ID and to add or remove optional transmitter stations. The default transmitter ID setting is "1" (ISS), which works fine for most installations.



1

ON (ISS)

Screen 2: Transmitter ID configuration

If you have a cabled station, or if you have a wireless station and are using the default transmitter ID setting, press DONE to move to the next screen.

Note: Typically, you can use the default transmitter ID setting of 1 unless you are installing one of the optional transmitter stations or a nearby neighbor has a Vantage Pro2 station that uses transmitter ID 1 for the ISS.

3. Press the right and left arrows to select the transmitter ID.

   When you select a transmitter ID, the ID number is displayed on the screen as well as the current configuration.
4. Press the up or down arrows to toggle console reception of signals from transmitters using that ID on and off.
5. Press GRAPH to change the type of station assigned to each transmitter number. Scroll through the station types - ISS, TEMP, HUM, TEMP HUM, WIND, RAIN, LEAF, SOIL, and LEAF/SOIL - until the correct type appears.
6. Press DONE to move to the next screen.

Note: This screen contains functionality for enabling repeaters. If the word "Repeater" displays in the right corner of the screen and you are not using repeaters as part of your network, see "Clearing Repeater ID" on page 52. If you are using repeaters as part of your network see "Wireless Repeater Configuration" (Appendix C) on page 51 for configuring repeaters on the console.

Screen 3: Retransmit — Wireless Only

Press DONE and go to "Screen 4: Time & Date" on page 12 if you have a cabled station.

The console can take data it receives from the ISS and transmit it to other Vantage Pro2 consoles using the retransmit feature. By toggling the feature on, the console becomes another transmitter that requires its own unique ID to transmit the data received from the ISS.

2

RETRANSMIT ON

Screen 3: Retransmit

1. Press the up or down arrow to turn the retransmit function on and off. The first available transmitter ID not used by the ISS or any optional sensor is automatically assigned. Data from the ISS is the only data that can be retransmitted by the console.

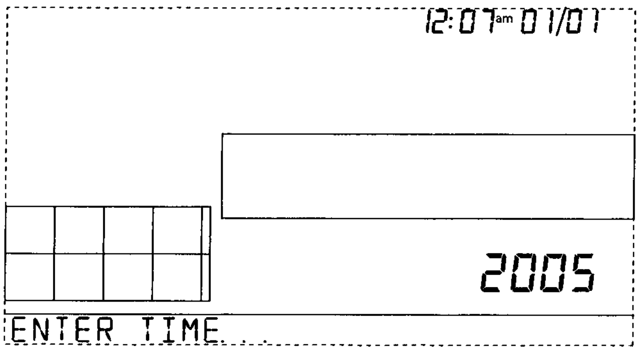
   When retransmit has already been enabled, pressing the right or left arrows changes the Transmitter ID used for retransmit.

2. Use the arrows to scroll through the list of available transmitter IDs and select the ID for your console.
3. Press DONE to move to the next screen.

Note: Make a note of the ID selected for retransmit. The console that receives the data from the console you have selected to retransmit should be configured to receive the transmitter ID you selected. See "Screen 2: Configuring Transmitter IDs — Wireless Only" on page 10 for more information.

Screen 4: Time & Date

The very first time you power-up the console, the time and date are set to 12:00AM January 1st, 2005. Be sure to enter the correct date and local time.



Screen 4: Time & Date

To change the time and date:

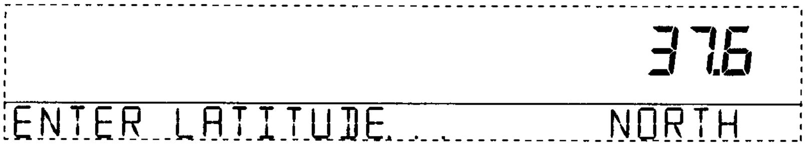
1. Press the right and left arrows to select the hour, minute, month, day or year. The selected time or date setting blinks on and off.
2. To change a setting, press the up and down arrows to adjust the value up or down.

   To choose a 12-hour or 24-hour clock, first select either the hour or minute setting, then press 2ND and immediately press UNITS. This toggles the clock setting between the two clock types.

   To choose between a MM/DD or DD.MM display for the date, first select either the day or month setting, then press 2ND and immediately press UNITS. This switches the console from one date display to the other.
3. Press DONE to move to the next screen.

Screen 5: Latitude

The console uses latitude along with longitude to determine your location, allowing it to adjust the forecast and calculate the times for sunset and sunrise.



37.6

ENTER LATITUDE... NORTH

Screen 5: Latitude

- Latitude measures distance north or south of the equator.
- Latitude is used with longitude to identify your position on earth.

If you do not know your latitude and longitude, there are several ways to find out. Many atlases and maps include latitude and longitude lines. You can also talk to the reference department of your local library, call your local airport, or search on the Internet.

Here are some on-line resources for finding your latitude and longitude:

http://www.geocode.com/eagle.html (North America only)

http://www.topozone.com/ (US only)

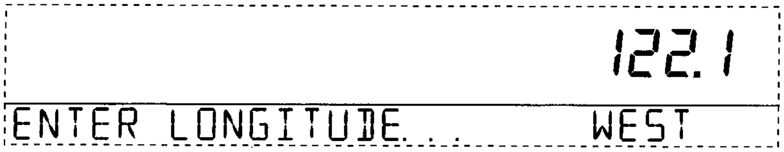
http://www.calle.com/world/ (outside US)

The more accurate you are, the better; however, a reasonable estimate will work, too.

1. Press the right and left arrows to move between fields.
2. Press the up and down arrows to change the settings up or down.
3. To select between SOUTH or NORTH, press 2ND and then UNITS.
4. Press DONE to move to the next screen.

Screen 6: Longitude

The console uses longitude along with latitude to determine your location, allowing it to adjust the forecast and calculate the times for sunset and sunrise. See Screen 5: Latitude for information on determining your logitude.



122.1

ENTER LONGITUDE... WEST

Screen 6: Longitude

- Longitude measures distance east or west of the Prime Meridian, an imaginary line running north and south through Greenwich, England.
- Longitude is used with latitude to identify your position on earth.

1. Press the right and left arrows to move between fields.
2. Press the up and down arrows to change the settings up or down.

3. To select the East or West Hemisphere, press 2ND, then UNITS.
4. Press DONE to move to the next screen.

Screen 7: Time Zone

The console is pre-programmed with a combination of US time zones and the names of major cities representing time zones around the world. You can also configure your time zone using the Universal Time Coordinate (UTC) offset.

(GMT-08.00) PACIFIC TIME

Screen 7: Time Zone

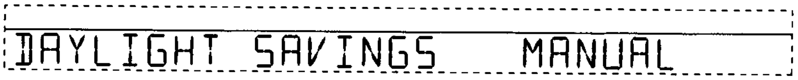
Note: UTC offset measures the difference between the time in any time zone and a standard time, set by convention as the time at the Royal Observatory in Greenwich, England. Hayward, California, the home of Davis Instruments, observes Pacific Standard Time. The UTC offset for Pacific Standard Time is -8:00, or eight hours behind Universal Time (UTC). When it's 7:00 pm (1900 hours) UTC, it's 19 - 8 = 1100 hours, or 11:00 am in Hayward in winter. When daylight savings time is observed, an hour is added to the offset time automatically. Use this function in correlation with Screen 8, Daylight Savings Settings.

1. Press the up and down arrows to cycle through time zones.
2. If your time zone is not shown, press 2ND then press the up and down arrows to set your UTC offset.
3. Press DONE to select the time zone or UTC offset shown on the screen and move to the next screen.

Screen 8: Daylight Savings Settings

In most of North America (except Saskatchewan, Arizona, Hawaii, and the Mexican State of Sonora); in Australia (except Western Australia, Northern Territory, and Queensland); and Europe use the AUTO Daylight Savings setting. The console is pre-programmed to use the correct starting and stopping dates for Daylight Savings Time in these areas, based on the time zone setting in screen 7.

Weather stations located outside North America, Europe, and Australia or in areas that do not observe daylight savings time should use the MANUAL setting.



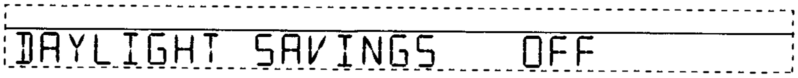
DAYLIGHT SAVINGS MANUAL

Screen 8: Daylight Savings Settings

1. Press the up and down arrows to choose Auto or Manual.
2. Press DONE to move to the next screen.

Screen 9: Daylight Savings Status

Use this screen to either verify the correct automatic Daylight Savings status or to set Daylight Savings manually.



DAYLIGHT SAVINGS OFF

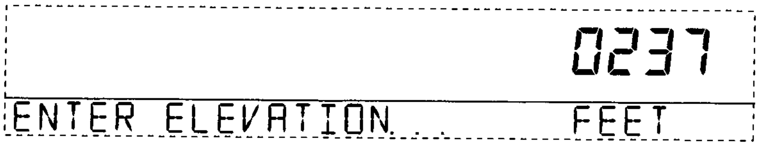
Screen 9: Daylight Savings Status

1. If Daylight Savings setting is MANUAL, press the up and down arrows to turn Daylight Savings Time on or off on the appropriate days of the year.

   If you have an AUTO Daylight Savings setting, the console displays the appropriate setting based on the current time and date.
2. Press DONE to move to the next screen.

Screen 10: Elevation

Meteorologists standardize barometric pressure data to sea level so that surface readings are comparable, whether they're taken on a mountainside or by the ocean. To make this same standardization and ensure consistent readings, enter your elevation in this screen.



0237

ENTER ELEVATION... FEET

Screen 10: Elevation

Note: If you do not know your elevation, there are several ways to find out. Many atlases and almanacs include elevation for cities and towns. You can also check with the reference department of your local library. The more accurate you are, the better; but a reasonable estimate works too.

1. Press the left and right arrows to move from one numeral in the elevation to another.
2. Press the up and down arrows to adjust a numeral up or down.
3. To switch between feet and meters, press 2ND then press UNITS.
4. If you are below sea level, like in Death Valley or Palm Springs, first enter the elevation as a positive number. Then, select the "0" immediately to the left of the leftmost non-zero digit (the second zero from the left in 0026, for example, or the first zero from the left in 0207) and press the up and down arrows to switch from a positive to negative elevation.

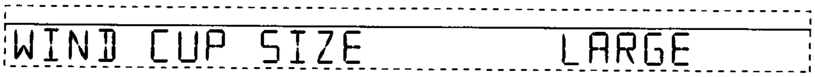
Note: You can only set the elevation to negative after you have entered a non-zero digit and when the zero in the position immediately to the left of the left-most non-zero digit has been selected.

5. Press DONE to move to the next screen.

Screen 11: Wind Cup Size

Vantage Pro2 stations come standard with large wind cups. Switch this setting to small only if you have separately purchased and installed small wind cups.

Note: Large wind cups are more sensitive to low wind speeds and are the best choice for most users. Small wind cups are less sensitive at low wind speeds but can measure much higher wind speeds. Install small wind cups if you wish to measure winds over 150 m.p.h. (242 km/h), (Category 5 Hurricane). Maximum speed sensitivity decreases with the age of the wind cups.



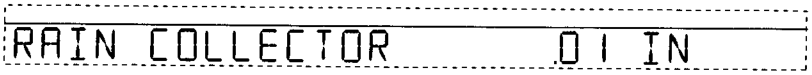
WIND CUP SIZE LARGE

Screen 11: Wind Cup Size

1. Press the up and down arrows to switch between large and small wind cups.
2. Press DONE to move to the next screen.

Screen 12: Rain Collector

The tipping bucket in the Vantage Pro2 rain collector has been calibrated at the factory to measure 0.01" of rain with each tip. The ISS comes equipped with a metric adapter that, once installed, takes 0.2 mm readings for every tip of the bucket. Determine which measurement you want your rain collector to take and configure your console and rain collector accordingly.



RAIN COLLECTOR .01 IN

Screen 12: Rain Collector Settings

To configure your console for inch measurements:

1. Press the up and down arrows to display the .01" setting.
2. Press DONE to use the selected setting and move to the next screen.

To configure your console for 0.2 mm measurements:

1. Press the up and down arrows to display the 0.2 mm setting.
2. Press DONE to use the selected setting and move to the next screen.

Note: See the *Integrated Sensor Suite Installation Manual* for instructions on installing the metric rain adapter. The 0.1mm setting does not provide correct rain measurements with either the standard measurement or the metric adapter installed in the rain bucket and should not be used. If necessary, the console can be configured to calculate the 0.01" measurements and convert these to metric measurements, rounding to the nearest 0.1 mm or can be configured to calculate the 0.2 mm measurements and convert them to the U.S. standard, rounding to the nearest .01".

To Display Rain in Metric Units on the Console

Even if you configure your console to display metric rain data in screen 12 of the Setup Mode, you have to configure your Current Weather Mode to display the same readings. To display metric rain readings in the Current Weather Mode, once you have completed or exited the Setup Mode:

1. Press RAINYR to display the current rain rate. RAIN

Selecting Metric units for one rain variable also sets all the other rain variables to Metric units.

2. Press and release 2ND and press UNITS once.

   The units used to display rain data toggle between inches and millimeters each time you repeat this key sequence.

2ND UNITS GRAPH

To Display Rain in Metric Units in WeatherLink

Refer to the *WeatherLink Online Help* for instructions to set the rain collector to 0.2 mm and to select millimeters as the unit for rain.

Screen 13: Rain Season

Because rainy seasons begin and end at different times in different parts of the world, you must specify the month you wish your yearly rain data to begin. January 1st is the default. The date the rain season begins affects yearly rain rate highs and lows.

RAIN SEASON BEGINS JAN 1.

Screen 13: Rain Season

1. Press the up and down arrows to select the month for the start of the rainy season.
2. Press DONE to move to the next screen.

Note: This setting determines when the yearly rain total is reset to zero. Davis Instruments recommends a January rain season setting (the default), unless you reside in the west coast of the United States, the Mediterranean coast, experience dry winters in the Southern Hemisphere. If so, change the rain season setting to July 1st. If you are performing hydrology studies in any of these climates in the Northern Hemisphere, change the rain season setting to October 1st.

Screen 14: Serial Baud Rate

The Baud Rate screen displays only if the console detects that a WeatherLink data logger installed on the console.

The console uses a serial or USB port to communicate with a computer. If you are connecting the console directly to your computer, leave the setting at 19200, the highest rate for the port. If you're using a modem, use the highest setting your modem can handle. The console must be equipped with a WeatherLink data logger to communicate with a computer or modem.

SERIAL BAUD RATE 19200

Screen 14: Baud Rate

Note: The baud rate setting on your console must match the serial port setting in the software on your computer. If you are using WeatherLink for Vantage Pro2, refer to WeatherLink help for instructions on setting the serial port baud rate on your computer.

1. Press the up and down arrows to select the baud rate.

   Your Vantage Pro2 console supports baud rates of 1200, 2400, 4800, 9600, 14400, and 19200.
2. You have completed the console setup. To exit Setup Mode, press and hold DONE until the current weather screen appears.

Clear All Command

After you have completed the above setup procedures and have exited the Setup Mode, please use the Clear All command before putting your weather station into service.

The Clear All command clears all stored high and low weather data including monthly and yearly highs and lows and clears the alarm settings. The command is recommended to properly clear and initialize the console's data logging function.

1. Press WIND on the console.
2. Press 2ND, then press and hold CLEAR for at least six seconds.
3. Release CLEAR when you see "CLEARING NOW" displayed at the bottom of the console's screen.

Current Weather Mode

In the Current Weather Mode you can display the current data readings from your station, select units of measure, and calibrate, set, or clear weather variables. You can see up to ten weather variables on the screen at the same time, as well as the time and date, the moon and forecast icons, a forecast or special message from your station, and a graph of the currently selected variable. A few variables are always visible on the console screen while most variables share their location with one or more variables. You can select any variable not currently on the screen to display it.

Selecting Weather Variables

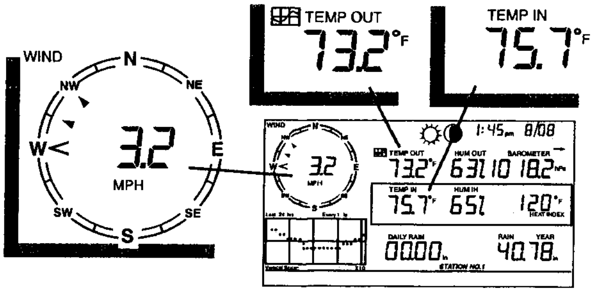
Select a weather variable to display its data on the screen if it isn't already visible or to graph the data available for that variable.

Weather variables are selected via the console command keys:

- If the variable is printed on a key, just press the key to select the variable.
- If the variable is printed on the console housing, first press and release 2ND, then quickly press the key below the variable to select it.

Note: After pressing 2ND, the 2ND icon displays on the screen for three seconds. Command key secondary functions are enabled during this time. The keys return to normal operation after the icon disappears.

- Select a variable and press GRAPH to graph the variable in the Current Weather Mode screen. The console places a graph icon on the screen next to the selected variable or value you want to view to indicate the currently selected variable.
- You can also select any variable currently displayed on the LCD screen using the navigation keys. Push up (+) to move up the screen. Press down (-) to move down the screen. Push left (<) to move left and push right (>) to move right.



Selecting Units of Measure

Most weather variables may be displayed in at least two different measurement units, including US and metric systems, although some variables feature more possibilities. Barometric pressure, for example, may be displayed in millibars, millimeters, inches, or hectoPascals. Note that you can set each variable's units independently, and at any time, as you like.

To change units:

1. Select the weather variable. See "Selecting Weather Variables" on page 18.
2. Press and release 2ND then press UNITS. The selected variable's units change. Repeat steps 1 and 2 until the desired units appear.

For example, to change the barometric pressure units, first select barometric pressure by pressing BAR. Next, press and release 2ND, then press UNITS. Repeating these steps cycles through the units available for barometric pressure: millibars, millimeters, inches, and hectoPascals.

Displaying Units:
Barometric Pressure Units: millibars (mb), millimeters (mm) and inches (in)

Wind Speed and Direction

WIND

1. Press WIND to select wind speed.
2. Wind speed may be displayed in miles per hour (m.p.h.), kilometers per hour (km/h), meters per second (m/s), and knots (knots). The 10 minute average wind speed will be displayed in the ticker.

   A solid arrow within the compass rose indicates the current wind direction. Arrow caps indicate up to six different 10-minute dominant wind directions to provide a history of the dominant wind directions for the past hour.
3. Press WIND a second time to display the wind direction in degrees instead of the wind speed.

Note: When displayed in degrees, Due North displays as 360° for consoles with firmware dated May 2005 or later. Previous releases marked Due North at 0°.

Each additional WIND key press toggles the display between wind speed and wind direction in degrees.

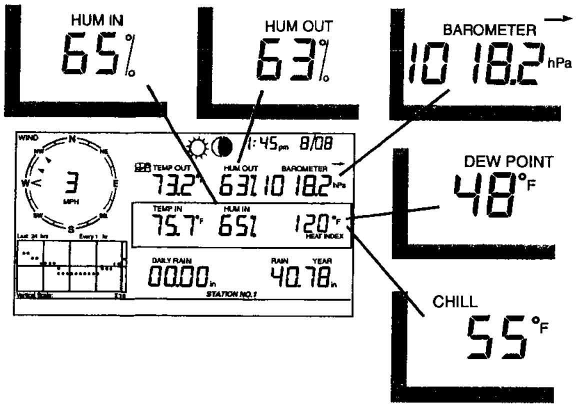
Outside and Inside Temperature

1. Press TEMP to select outside temperature.

   Temperature may be displayed in degrees Fahrenheit (°F) or Celsius (°C). Temperatures can also be displayed in degrees or in tenths of a degree.

   TEMP
2. Press TEMP again to select inside temperature.

   Each consecutive press of TEMP displays temperature readings for any optional temperature, temperature/humidity, soil temperature, soil moisture stations also connected to your console. The order of the optional sensors readings display depends on your station configuration. Temperatures for temperature stations display, with soil temperature and moisture stations displaying consecutively.



Humidity, Pressure, Dew Point & Wind Chill

Humidity

DEW HUM

Press HUM to select outside humidity. Pressing HUM a second time selects inside humidity. Humidity is displayed in percent relative humidity.

Each consecutive press of HUM displays humidity readings for any optional humidity, leaf wetness, and leaf temperature stations also connected to your console. The order of the optional sensors readings display depends on your station configuration. Humidity readings for humidity stations display, with leaf wetness and leaf temperature readings displaying consecutively.

Wind Chill

2ND CHILL WIND

Press 2ND then press CHILL to select Wind Chill. Wind Chill is displayed in either Fahrenheit (°F) or Celsius (°C) in whole degrees.

The console uses the ten-minute average wind speed to calculate wind chill.

Dew Point

2ND DEW HUM

Press 2ND then press DEW to select Dew Point. Dew Point is displayed in either Fahrenheit (°F) or Celsius (°C) in whole degrees.

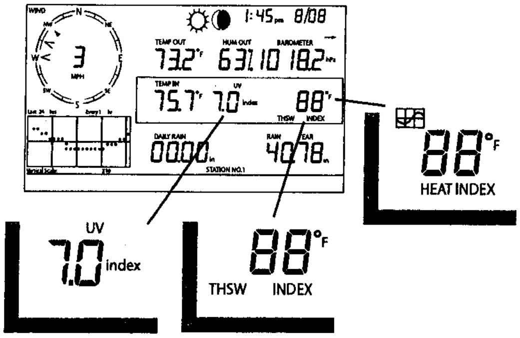
Barometric Pressure

BAR

Press BAR to select barometric pressure. Barometric pressure may be displayed in inches (in), millimeters (mm), millibars (mb) or hectoPascals (hPa).

Pressure Trend

The pressure trend arrow indicates the current barometric trend, measured over the last three hours. The pressure trend is updated every 15 minutes. The pressure trend requires three hours of data in order to be calculated so it won't display right away on a new station. The pressure trend is indicated on the console screen, as long as the required data is available.



UV, Heat, and THSW Index

UV (Ultraviolet Radiation)

2ND UV RAIN

Press 2ND and UV to display the current UV index. The current UV index is the amount of ultraviolet radiation the sensor is currently reading.

Press 2ND and UV again to display the accumulated UV index for the day. The accumulated UV index is the total ultraviolet radiation that the sensor has read throughout the day. The accumulated UV index for the day is reset to zero every night.

Note: Requires a UV sensor. See "Optional Sensors" on page 2.

Heat Index

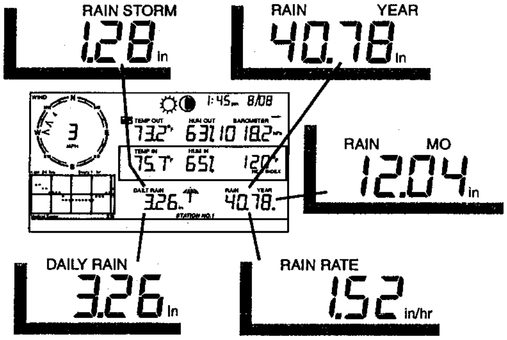
2ND HEAT TEMP

Press 2ND then press HEAT to display the Heat Index.

THSW Index

After you have selected the Heat Index, press 2ND then press HEAT again to select the Temperature Humidity Sun Wind (THSW) Index. The THSW Index is only available on stations equipped with a solar radiation sensor.

The Heat Index and the THSW Index display in the same place on the screen and are displayed in degrees Fahrenheit (°F) or Celsius (°C).



Daily Rain, Rain Storm, Rain Year, Rain Month, & Rain Rate

Rain Rate

UV RAIN

Press RAINYR to display the current rain rate. Rain Rate may be displayed as either inches per hour (in/hr.) or millimeters per hour (mm/hr.). Rain Rate will show zero and the umbrella icon does not appear until two tips of the rain bucket within a 15–minute period.

Month–to–date precipitation

Press RAINYR again to select the month–to–date precipitation record. Monthly rain displays the precipitation accumulated since the calendar month began. Month–to–date precipitation is displayed in inches or millimeters (mm).

Year–to–date precipitation

Press RAINYR a third time to display the year–to–date precipitation record. Yearly rain displays the precipitation accumulated since the 1st of the month you've chosen as the beginning of your rain season in Setup Mode (See "Screen 13: Rain Season" on page 17). Year–to–date precipitation is displayed in inches (in) or millimeters (mm).

Daily Rain

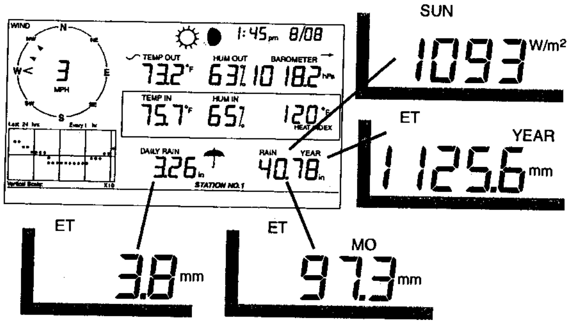
Press RAINDAY to display the rain accumulated since 12 midnight. Any rain accumulated in the last 24 hours displays in the ticker at the bottom of the screen.

RAIN DAY

Rain Storm

Rain Storm displays the rain total of the last rain event. It takes two tips of the rain bucket to begin a storm event and 24 hours without rain to end a storm event.

Press RAINDAY to toggle between the daily rain total and the Rain Storm total. Rain accumulation may be displayed as either millimeters (mm) or inches (in).



Solar Radiation, Current ET, ET Month & ET Year

Solar Radiation

Press and release 2ND then press SOLAR to display the current solar radiation reading. Solar radiation is displayed as Watts per square meter (W/m^2).

2ND SOLAR RAIN DAY

Current Evapotranspiration (ET)

Press and release 2ND then press ET to display the current evapotranspiration reading.

2ND ET BAR

Monthly Evapotranspiration (ET)

Press 2ND then press ET, then repeat the key sequence to display Monthly ET.

Yearly Evapotranspiration (ET)

Press 2ND then press ET, then repeat this key sequence two more times to display the ET reading since January 1st of the current year.

Note: A solar radiation sensor is required to take readings listed above. See "Optional Sensors" on page 2.

Lamps

LAMPS 2ND

Press 2ND then press LAMPS to turn on the backlight for the screen display. Press 2ND then LAMPS again to turn the backlight off.

Use the backlight when the LCD is not clearly visible. When the console is battery operated, the backlight remains on as long as keys are pressed or a ticker tape message is scrolling across the screen. It automatically turns off about ten seconds from the last key press. When battery power is low, the backlight does not light.

Note: When the console receives power from the AC adapter, the backlight remains on until it is toggled off. Leaving the backlight on raises the inside temperature reading and lowers the inside humidity reading.

Displaying the Forecast

Your console generates a weather forecast based on the barometric reading & trend, wind speed & direction, rainfall, temperature, humidity, latitude & longitude, and time of year. Included in the forecast is a prediction of the sky condition (sunny, cloudy, etc.) and changes in precipitation, temperature, wind direction or wind speed.

FORECAST

Press FORECAST to display the forecast. The forecast ticker message at the bottom of the screen predicts the weather up to 48 hours in advance. The forecast is updated once an hour, on the hour. Predictions are made for cloud cover, temperature trends, the likelihood of precipitation, timing, severity and windy conditions.

Forecast Icons

The forecast icons show the predicted weather for the next 12 hours. If rain and/or snow is possible but not necessarily likely, the partly cloudy icon along with the rain or snow icon displays. When both the rain and snow icons display together, a chance of rain, freezing rain, sleet and/or snow is likely.

Mostly Clear

Partly Cloudy

Mostly Cloudy

Rain

Snow

Displaying Time & Date or Sunrise & Sunset

Your console shows the sunrise and sunset time in the same place on the screen used by the current time and date.

Press 2ND and then press TIME to toggle the screen between the current time and date or the sunrise and sunset times for the current day.

Note: See "Screen 4: Time & Date" on page 12 to change the console time and date or to select a 12- or 24-hour clock.

Calibrating, Setting, and Clearing Variables

To fine-tune your station, you can calibrate most of the weather variables. For example, if your outside temperature seems consistently too high or too low, you can enter an offset to correct the deviation.

Calibrating Temperature And Humidity

You can calibrate inside & outside temperature, inside & outside humidity, as well as any extra temperature/humidity sensor readings you have transmitting to your Vantage Pro2.

1. Select a variable to be calibrated. See "Selecting Weather Variables" on page 18.
2. Press and release 2ND, then press and hold SET.

   2ND SET ALARM

   After a moment, the variable you've selected begins to blink. Keep holding SET until the Calibration Offset message displays in the ticker.

   The ticker displays the current calibration offset.
3. Press the up or down arrows to add or subtract from the temperature offset value.

   Inside and outside temperature are calibrated in 0.1° F or 0.1° C increments, up to a maximum offset of +12.7 (°F or °C) and a minimum offset of -12.8 (°F or °C). The variable will change value and the ticker will show the offset you've entered.
4. Press DONE to exit calibration.

Calibrate Wind Direction Reading

You can use this procedure to correct the anemometer reading. This is useful if the anemometer does not point north in your installation.

1. Check the current direction of the wind vane on the anemometer. Compare it to the wind direction reading on the console. If the wind vane is pointing south, for instance, the wind direction reading on the screen should be 180°.
   - If the wind direction reading is greater than 180°, subtract 180 from the reading and subtract the amount of the offset from the wind direction reading.
   - If the wind direction reading is less than 180°, subtract the reading from 180 and add the amount of the offset to the wind direction reading.
2. Press WIND as necessary to display the wind direction in degrees.
3. Press and release 2ND, then press and hold SET.
4. The wind direction variable will begin to blink.

5. Continue holding the key until the CAL message appears in the ticker.

Note: The ticker displays the current wind direction calibration value.

6. Press the arrows to select digits in the anemometer's current reading.
7. Press the up and down arrows to add/subtract from the anemometer reading.
8. Repeat steps 4 and 5 until you have entered the offset value from Step 1.
9. Press DONE to exit calibration.

Calibrating Barometric Pressure

Before calibrating the barometric pressure, be sure the station is set to the correct elevation. See "Screen 10: Elevation" on page 15 for more information.

1. Press BAR to select barometric pressure.
2. Press and release 2ND, then press and hold SET.

   The pressure variable blinks.
3. Continue holding the key until the ticker reads "set barometer . . . ".
4. Press the right and left arrows to select digits in the variable.
5. Press up and down arrows to add to or subtract from the digit's value.
6. Press DONE to exit calibration.

Setting Weather Variables

You can set values for the following weather variables:

- **Daily Rain**—Sets the daily rain total. Monthly and yearly rain totals are updated.
- **Monthly Rain**—Sets the current months total rain. Does not affect yearly rain total.
- **Yearly Rain**—Sets the current year's rain total.
- **Daily ET (Evapotranspiration)**—Sets the daily ET total. Monthly and yearly ET totals are updated.
- **Monthly ET**—Sets the current month's ET. Does not affect yearly total.
- **Yearly ET**—Sets the current year's total ET.

To set a weather variable's value:

1. Select the variable you wish to change.
2. Press and release 2ND, then press and hold SET. The variable blinks.
3. Keep holding SET until all digits are lit and only one digit is blinking.
4. Press the right or left arrows to select digits in the value.
5. Press the up and down arrows to add to or subtract from the selected digit.
6. When you are finished, press DONE to exit.

Clearing Weather Variables

The following weather variables can be cleared:

- **Barometer**—Clears any pressure offset used to calibrate the station, and the elevation entry.
- **Wind**—Clears the wind direction calibration.
- **Daily rain**—Clearing the daily rain value is reflected in the daily rain total, the last 15 minutes of rain, the last three hours of rain sent to the forecast algorithm, the umbrella icon, and the monthly and yearly rain totals. Clear the daily rain total if the station accidentally recorded rain when the ISS was installed.
- **Monthly rain**—Clears the monthly rain total. Does not affect the yearly rain total.
- **Yearly rain**—Clears the yearly rain total.
- **Daily ET**—Clears daily ET and subtracts the old daily ET total from the monthly and yearly ET totals.
- **Monthly ET**—Clears the current monthly ET total. Does not affect the yearly ET total.
- **Yearly ET**—Clears the current yearly ET total.

To clear a single weather variable:

1. Select the weather variable.

   See "Selecting Weather Variables" on page 18.
2. Press and release 2ND, then press and hold CLEAR.

   The variable you've chosen blinks. Keep holding the key until the value changes to zero or, in the case of the barometer, the raw barometer value. Clearing the barometer value also clears the elevation setting.

Clear All Command

This command clears all stored high and low weather data including monthly and yearly highs and lows and clears alarm settings all at once.

1. Press WIND on the console.
2. Press 2ND then press and hold CLEAR for at least six seconds.
3. Release CLEAR when "CLEARING NOW" displays at the bottom of the console's screen.

Highs and Lows Mode

The Vantage Pro2 records highs and lows for many weather conditions over three different periods: days, months, and years. Except for Yearly Rainfall, all high and low registers are cleared automatically at the end of each period.

For example, daily highs are cleared at midnight, monthly highs are cleared at month–end midnight, yearly highs are cleared at year–end midnight. You may enter the month that you would like the Yearly Rainfall accumulation to clear. The Yearly Rainfall clears on the first day of the month you chosen. The Yearly High Rain rate clears using the same setting.

The following table lists the high and low modes for all the weather variables:

Weather Variable	High	Low	Day, Time & Date	Month	Year	Additional Information
Outside Temperature	Yes	Yes	Yes	Yes	Yes	
Inside Temperature	Yes	Yes	Yes	Yes	Yes*	
Outside Humidity	Yes	Yes	Yes	Yes	Yes*	
Inside Humidity	Yes	Yes	Yes	Yes	Yes*	
Barometer	Yes	Yes	Yes	Yes	Yes*	
Heat Index	Yes		Yes	Yes	Yes*	
Temp/Hum/Wind/Sun (THSW) Index	Yes		Yes	Yes	Yes*	requires solar radiation sensor
Wind Chill		Yes	Yes	Yes	Yes*	
Wind Speed	Yes		Yes	Yes	Yes	Includes direction
Rainfall Rate	Yes		Yes	Yes	Yes	
Daily Rain			Total	Total	Total	
UV Index	Yes		Yes	Yes**	Yes*	requires UV sensor
Solar Radiation	Yes		Yes	Yes**	Yes*	requires solar radiation sensor
Dew Point	Yes	Yes	Yes	Yes	Yes*	
Evapotranspiration			Total	Total	Total	requires solar radiation sensor
Soil Moisture	Yes	Yes	Yes	Yes**	Yes*	requires soil moisture sensor
Leaf Wetness	Yes	Yes	Yes	No	Yes*	requires leaf wetness sensor

* Only stores the yearly high for the current year.
** Only stores monthly high for the current month.

Weather Data Highs and Lows

Viewing Highs and Lows

1. Press HI/LOW to enter the Highs and Lows mode.

   The DAY and HIGHS icons light up and the station displays the highs for all visible fields.

2. Press the up and down arrows to scroll between Day Highs, Day Lows, Month Highs, Month Lows, Year Highs and Year Lows.

   The HIGH or LOW icon, as well the DAY, MONTH or YEAR icon lights to display which High/Low screen you've selected.

3. Press the left and right arrows to scroll back and forth through the last 24 values.

   Pressing the left arrow displays the previous day's highs. Each time you press the left arrow, the date moves back another day. The 24 dots in the graph field also represent each of the last 24 days, months, or years; the right-most dot is the present. As you move backward and forward the flashing dot changes to show what value you're looking at.

4. Use the console keys to select a different weather variable.

   The console's time displays time of the selected variable's high or low.

5. Press DONE to exit the Highs and Lows mode. The console screen switches to the Current Weather mode.

Alarm Mode

The Vantage Pro2 features more than 30 alarms that can be programmed to sound whenever a reading exceeds or drops below a set value. With the exception of barometric pressure and time, all alarms sound when a reading reaches the alarm threshold. For example, if the high outside temperature alarm is set at 65° F, the alarm sounds when the temperature rises to 65.0° F.

When an alarm condition exists, the audible alarm sounds, the alarm icon blinks repeatedly, and an alarm description appears in the ticker at the bottom of the screen. The alarm sounds for a maximum of two minutes if the console is battery-powered, but the icon continues to blink and the message stays in the ticker until you clear the alarm or the condition clears. If you're using the AC adapter, the alarm will continue sounding as long as the condition exists.

The alarm will sound again for each new alarm. If more than one alarm is active, the description for each active alarm cycles onto the screen every four seconds. A "+" symbol appears at the end of the alarm text if more than one alarm is tripped.

Low alarms work the same way. For example, if the wind chill threshold is set for 30°F, the alarm condition begins when the wind chill drops to 30° and will continue until the wind chill rises above 30°.

Four Special Alarms

ET (Evapotranspiration)

ET is updated only once an hour, on the hour. If during a given hour the ET Value exceeds the alarm threshold, the ET alarm sounds at the end of that hour. This is true for daily, monthly, and yearly ET alarms. You must have the optional Solar Radiation Sensor to use this alarm. See "Evapotranspiration (ET)" on page 46. for a description of this variable.

Barometric Pressure

The Vantage Pro2 allows you to set two barometric pressure alarms: a "rise" alarm and a "fall" alarm. You may select any rate of change per three hours between 0.00 and 0.25 inches (6.35 mm) Hg, (8.5 mb, hPa); the alarm will sound if the rate of change (in either direction) exceeds the threshold you set. This alarm is updated every 15 minutes.

Time

The time alarm is a standard "alarm clock" alarm. It sounds for one minute at the set time. Make sure you choose AM or PM, if you're in 12-hour mode.

UV Dose

The UV dose alarm sounds when the accumulated UV dose has exceeded the dose you set. The UV dose alarm does not arm unless the initial UV dose for the day has been reset. Once the UV dose alarm value is set, clear the accumulated UV dose. See "Clearing Weather Variables" on page 27.

Setting Alarms

1. Press ALARM to enter the Alarm Mode to view or set the high alarm thresholds. The screen displays the current high alarm thresholds. The ALARM and HIGHS icons also appear.
2. Press the right and left arrows to select one of the variables displayed on the screen or use the console keys to select any weather variable. Also, press HI/LOW to display the toggle between the high and low alarm threshold settings.
3. Press 2ND then press ALARM to activate the currently selected weather variable.
4. Press the right and left arrows to select digits in the threshold value.
5. Press the up and down arrows to change the digit's value up and down.
6. Press DONE to finish changing the alarm setting.
7. Repeat steps 3 through 6 to change additional alarm settings.
8. Press DONE to exit Alarm Mode.

Setting the Time Alarm

1. Press ALARM to enter alarm mode.

   The ALARM and HIGHS icons appear.
2. Press 2ND, then press TIME, then press 2ND again, and then press ALARM.

   The time field begins blinking.
3. Press the left and right arrows to select hours, minutes, or AM/PM.
4. Press up and down arrows to change the digit's value up and down.
5. Press DONE to exit Alarm Mode.

Clearing Alarm Settings

1. Press ALARM to enter alarm mode.

   The ALARM and HIGHS icons appear.

2. Select the alarm setting you wish to clear.
3. Press 2ND, then press and hold CLEAR until the setting changes to all dashes.

   You have cleared the alarm setting.
4. Press DONE to exit Alarm Mode.

Silencing Alarms

1. Press DONE to silence an alarm when it sounds.

Vantage Pro2 Station Alarms

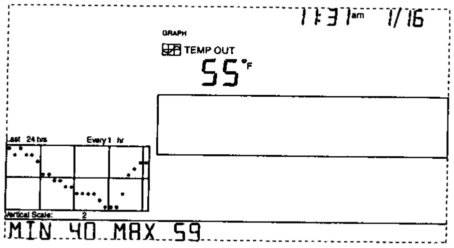
Variable	Alarms
Barometric Pressure Trend	Storm Warning - uses trend value rising rate Storm Clearing - uses trend value falling rate
Evapotranspiration	ET Alarm - uses total ET for the day
Humidity, Inside	High and Low
Humidity, Outside	High and Low
Dew Point	High and Low
Leaf Wetness	High and Low
Rain	Flash Flood Alarm - uses current 15 minute rainfall total 24 Hour Rain Alarm - uses current 24 hour rainfall total
Storm	Storm Alarm - uses current storm rainfall total
Rain Rate	High
Soil Moisture	High and Low
Solar Radiation	High
Inside Temperature	High and Low
Outside Temperature	High and Low
Extra Temperature	High and Low
Heat Index Temperature	High
THSW Index Temperature	High
Wind Chill Temperature	Low
UV Radiation Index	High
UV Radiation MED	High - uses the current total if variable has been reset
Wind Speed	High
Time & Date	Yes - the alarm sounds for 1 minute.

Graph Mode

The Vantage Pro2 console includes a powerful Graph Mode that allows you to view over 100 graphs of different kinds right on the screen, all without connecting to a personal computer.

Viewing Graphs

Although the graphs available may vary for each weather variable, you display the graphs in the same way.



1. Select a variable to graph.

   Only the date, graph, graph icon, and selected variable are visible. The rest of the screen is blank.

2. Press GRAPH to enter Graph Mode.

   Values for the each of the last 24 hours are displayed in the graph, each hour represented by a dot. The dot at right end of the graph is the value for the current hour. You'll notice that the dot is blinking.

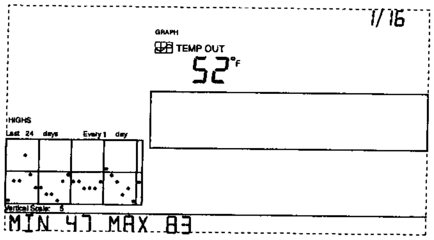
3. Press the left arrow and the second dot from the right starts to blink.

   The screen displays the new dot's value. The time display shows what hour of the last 24 is being viewed.

4. Press the left and right arrows to view the variable's values for each of the last 24 hours. The console also displays the maximum and minimum temperatures recorded in the last 24 hours.

5. Press the up and down arrows to shift the graph's time span.

   If you press the down arrow, the graph shifts from the last 24 hours to the last 24 days. Now each dot represents the high recorded on the day shown in the date field. To see the lows recorded in the last 24 days, press HI/LOW. Press the left and right arrows to move between days.



By pressing the down arrow again, the graph shifts to show the highs of the last 24 months. As before, use the right and left arrows to move between months. Press HI/LOW to shift between the highs and lows.

By pressing the down arrow again, the graph shifts one more time to show the highs of the last 24 years. Press HI/LOW to shift between highs and lows.

The console beeps when you've reached the first or last possible value or time span for the graph. Since the console only graphs data collected by the station, the graphs can only show data collected since the station was first installed.

View graphs of all other variables the same way.

1. Select the variable you want to view.
2. Press GRAPH.
3. Use the left and right arrows to select different variables.
4. Press the up arrow to shorten the time range.
5. Press the down arrow to lengthen the time range.
6. Press HI/LOW to shift between highs and lows.
7. Press DONE to exit.

Vantage Pro2 Console Graphs

Weather Variable	Available Graphs*							
	Current	1 Min	10 Min	15 Min	Hourly	Daily	Monthly	Yearly
Barometric Pressure	C			C	C	H, L	H, L	
Evapotranspiration (ET)**	T				T	T	T	T
Humidity, Inside	C				C	H, L	H, L	
Humidity, Outside	C				C	H, L	H, L	
Dew Point	C				C	H, L	H, L	
Leaf Wetness***	C				C	H, L		
Rain	T			T	T	T	T	T
Storm****								
Rain Rate	H	H			H	H	H	H
Soil Moisture	C				C	H, L		
Solar Radiation**	A				A	H		
Inside Temperature	C				C	H, L	H, L	
Outside Temperature	C				C	H, L	H, L	H, L
Heat Index Temperature	C				C	H	H	
Temp/Hum/Sun/Wind (THSW) Index**	C				C	H	H	
Wind Chill Temperature	L				L	L	L	
UV Radiation Index*****	A				A	H	C	
UV Radiation MED (Minimal Erythermal Dose)*****	T				T	T		
Wind Speed	A		A		A, H	H	H	H
Direction of High Wind Speed	Y					Y	Y	Y
Dominant Wind Direction	A				A	A	A	

* A = Average, H = Highs, L = Lows, T =Totals, Y = Yes, C = Current reading at the end of each period

** Requires solar radiation sensor, *****Requires UV sensor

*** Requires Wireless Leaf & Soil Moisture Temperature station

**** Graphs the last 24 storm events and doesn't follow the same graph conventions as other variables.

Chapter 4

Troubleshooting and Maintenance

Vantage Pro2 Troubleshooting Guide

While your Vantage Pro2 weather station is designed to provide years of trouble-free operation, occasional problems may arise. If you are having a problem with your station, please consult this troubleshooting guide before calling Davis technical support. You may be able to quickly solve the problem yourself. Please see “Contacting Davis Technical Support” on page 53.

Note: Refer to the ISS Installation Manual for additional troubleshooting information.

TABLE 4-1: TROUBLESHOOTING GUIDE

	Problem	Solution
Display	Display is blank	Unit is not receiving power. Check the power adapter connections and/or replace batteries.
	Display shows dashes in place of weather data	• ISS not plugged in (cabled station). See ISS manual. • Sensors not transmitting (wireless station). See ISS (or other transmitter) manual. • Console not receiving (wireless station) - See “Troubleshooting Reception Problems” on page 35. • A reading has exceeded the limits indicated in the specifications table. • Calibration numbers may be causing readings to exceed display limits. Check calibration number and adjust if necessary.
	Console is sluggish or does not work at low temperatures	The console and display may not work below 32° F (0° C). Use an External Temperature sensor in low-temperature locations or install the console indoors.
	Display “locks up”	Reset the console by removing AC and battery power then restoring power. If this occurs frequently in an AC-powered console, plug the AC power-adapter into a surge suppressor.
Humidity	Inside humidity seems too high or too low	Make sure the console is not near a humidifier or de-humidifier. Check calibration number and adjust if necessary. If inside humidity is low, and inside temperature is too high, see “inside temp” below. Also make sure the console backlight is not on.
Wind Speed	Wind speed reading seems too high or too low.	For low readings, remove wind cups and check for friction sources. Check the anemometer location. Is it sheltered from the wind? See ISS manual for additional wind speed troubleshooting information.
	Wind speed reads 0 either all the time or intermittently	The problem may be with the anemometer. Test anemometer by spinning wind cups. Check fields one-b and two-b on diagnostic screen and call technical support.
Dew	Dew Point reading seems too high or too low	Check calibration numbers for temperature. Dew point depends on temperature and outside humidity. Make sure they're working.

TABLE 4-1: TROUBLESHOOTING GUIDE

	Problem	Solution
Temperature	Outside temperature sensor reading seems too high	Check calibration number and adjust if necessary. ISS or temp sensor may need to be relocated. See ISS or other transmitter manual.
	Inside temperature sensor reading seems too high	Move the console out of direct sunlight. Make sure that the console or sensor is not in contact with an exterior wall that heats up in sunlight or when outside temperature rises. Make sure the console or sensor is not near a heater or other internal heat source (lamps, appliances, etc.). Also make sure the console backlight is not on. Check calibration number and adjust if necessary.
	Outside temperature seems too low	Check calibration number and adjust if necessary. Sprinklers may be hitting the ISS radiation shield. Relocate. See ISS manual.
	Inside temperature sensor reading seems too low	Make sure the console or other temperature sensor is not in contact with an exterior wall that cools down when outside temperature drops. Make sure the console or other temperature sensor is not near an air conditioning vent. Check calibration number and adjust if necessary.
Wind Direction	Wind direction reading is dashed out	• Wireless model - check reception. See Reception Problems below. • Cabled model - cable may be faulty. If these steps do not reveal the problem, the anemometer may be faulty. Call technical support for return authorization.
	Wind direction always says north	Usually an ISS problem, especially if outside temperature is dashed out as well. See the ISS manual for troubleshooting information
Chill	Wind chill reading seems too high or too low	Check calibration numbers for temperature. Wind chill depends on temperature and wind speed. Make sure they're working.
Heat	Heat Index reading seems too high or too low	Check calibration numbers for temperature. The heat index depends on temperature and outside humidity. Make sure the sensors are working.
Rain	No rain readings	Make sure cable-tie is removed from rain collector. See the ISS manual.
UVSolar	Readings are too high	Can be caused by high thin cirrus clouds.
Time	Incorrect times for sunrise and sunset	Check your latitude, longitude, time zone, and daylight savings time settings. Sunrise and sunset times are calculated from the console using all of these settings.

Troubleshooting Reception Problems

While we have tested the Wireless Vantage Pro2 radio extensively, each site and each installation presents its own issues and challenges. Obstructions, particularly metallic ones, often cut down your station's reception distance. Be sure to test reception between the console and ISS, in the locations you intend to install them, before permanently mounting your ISS or other transmitter(s).

The console's reception status displays at the lower right corner of the screen.

- An "X" flashes for every data packet received by the console.
- An "R" displays when the console is trying to re-establish a lost connection. The console tries for 10 minutes to re-establish a connection before going into L Mode.When no data packets have been received for 10 minutes, the console dashes-out any missing sensor readings.
- An "L" displays when the signal is lost. The console stays in this mode for 15 minutes until returned to "R" mode. Enter and exit Setup Mode to force the console into "R" mode, making the console manually exit "L" mode.

Check Console Reception

Enter Setup mode by pressing and holding DONE, then pressing the down arrow at the same time. Wait a few minutes while the console lists all the stations transmitting within range (See "Screen 1: Active Transmitters" on page 10 for more information). If the console does not detect your transmitter, check the following:

- Adjust the console and ISS antennas so that they are in line of sight with each other.
- Reduce the distance between the ISS and the console.
- If the console is directly beneath the ISS, the antennas should be horizontal.
- Try distancing your console from your ISS, at least 10 feet apart.

Refer to the *ISS Installation Manual* or other station manual for instructions on how to check the station for potential transmission problems.

Console Diagnostic Mode

In addition to logging weather data, the console continuously monitors the station's radio reception. You may find this information very helpful, especially when you are choosing locations for your console and ISS.

The Console Diagnostics Mode consists of two screens, the Statistical Diagnostic Screen and the Reception Diagnostic Screen. The Statistical Diagnostic screen applies for both cabled and wireless weather stations. The Reception Diagnostic screen applies only to wireless weather stations and is not accessible to a cabled weather station.

Note: Radio transmission data used by the diagnostic screens clears each day at midnight.

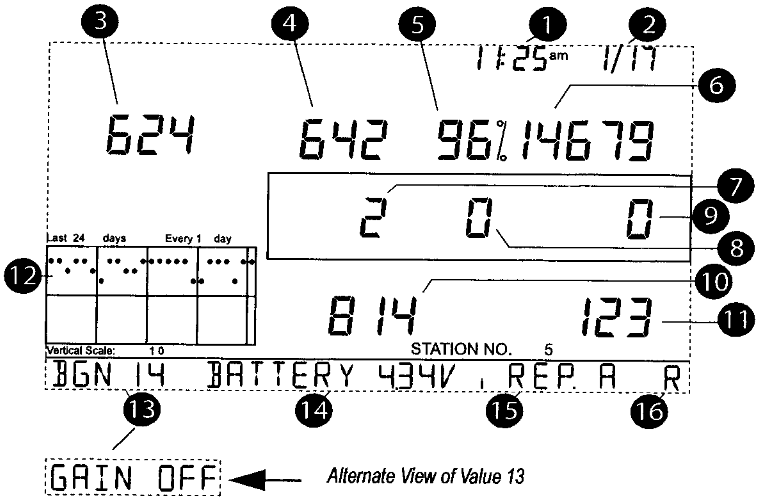
Diagnostic Screen Commands

- Press and hold TEMP, then press HUM to display the Statistical Diagnostic screen.
- Press DONE to exit the diagnostic screen.
- Press the right arrow to display signal statistics for the next installed transmitter ID.

- Press 2ND and then press CHILL to toggle between the Statistical and Reception Diagnostic screens.
- A degree (°) sign displays in right corner of value 1 of the Reception Diagnostic screen (screen 2) to differentiate which screen is currently displayed.

Screen 1: Statistical Diagnostic Screen

The Statistical Diagnostic displays information about how data is being received from the weather station to the console. The information that is displayed in this screen includes:



Screen 1: Statistical Diagnostics Screen

Note: All values with a * mark the value as being for Davis Instruments Internal use. All values with a ‡ mark values that are the same on both the Statistical and Reception Diagnostic screens.

1. Time of day or number of times the anemometer reed switch was seen closed*. The reed switch closes once each revolution of the anemometer wind cups. Press WIND to toggle between these two values.
2. Date or the number of times the anemometer reed switch was seen open*. Press WIND to toggle between these two values.

Note: The time and date displays can be toggled in both statistical and reception diagnostic screens.

3. Number of packets containing CRC errors received. The system runs a CRC check on data packets. Any data packets that don't pass this check are considered to contain errors and are discarded. These are considered bad packets.

4. The total number of bad data packets including missed packets and CRC errors. Missed packets are describes as when a data packet is expected, but is not recognized as a data packet by the console.
5. Percentage of good packets received.
6. Total number of good packets received.
7. Number of times the console resynchronized with the transmitter. The console will attempt to resynchronize with the station after 20 consecutive bad packets.
8. Maximum number of bad packets in a row without resynchronization.
9. Current streak of consecutive bad packets. The counter increments when the console is synchronized but the packet is bad. This value is reset to zero when a good packet is received.
10. Longest streak of consecutive good packets received.
11. Current streak of consecutive good packets received.
12. Graph of the daily percentage of good data packets received over the last 24 days.
13. Background noise level. This refers to the undesirable signal level the console hears while it is in the process of acquiring a signal from a station. The range displayed is from 5 to 60. When the noise level is high, try to move the console closer to the station to get a stronger signal. Small background noise level does not always guarantee good reception. The signal strength between the station and the console needs to be stronger than the background noise level in order for the console to receive clearly. If there are reception problems while a small background noise level is still being displayed, make sure the console is within reasonable range of the station.

    If the console currently has acquired all the station signals it is set to receive, the background noise level displayed is the last noise level measurement taken before acquisition finished.

Note: Receiver Gain Status is an alternate view that is displayed for consoles with firmware versions of May 2005 or earlier. For consoles in which background noise level displays, the receiver gain is automatically adjusted to obtain the best sensitivity and does not need to be controlled manually.

Alternate View: Receiver Gain Status. Some versions of the console display receiver gain status and not background noise level. The Receiver Gain setting provides control over the receiver sensitivity. Press HI/LOW to toggle Gain on and off. If you're having trouble with reception, try changing the Gain. Note that Gain can adversely affect performance depending upon conditions. If you are having reception problems, you should try both settings. Gain should generally not be turned on when signal strength is above 30. See Value 4 on page 40 for more information on signal strength.

14. Current console battery voltage. Ignore this value if using the AC Adapter only to power the console.
15. Repeater ID currently communicating with the console. If a repeater or group of repeaters is used to relay station information to the console, the Repeater ID displayed is the repeater that the console is set to receive. If the console is not listening to repeaters, this section remains blank. Please see Application Note 25 available on the Davis Instruments Support web page for more information on using repeaters.

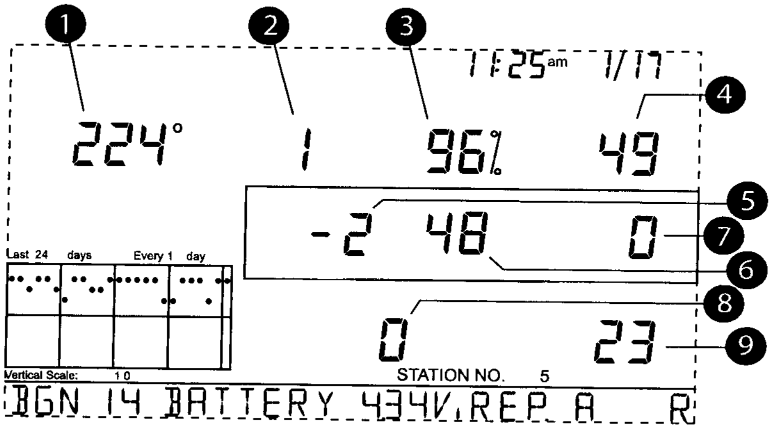
Note: The Repeater ID does not display in the ticker banner in firmware versions earlier than May 2005. If you want your console to support repeater communication, upgrade your console to the most recent console firmware version.

16. The console's reception status. See "Troubleshooting Reception Problems" on page 35 for information on the status types.

Screen 2: Reception Diagnostic Screen

The Reception Diagnostic screen displays information pertinent to the console's wireless reception. To view this screen from the Statistical Diagnostic screen, press 2ND and then press CHILL. The degree sign displaying in the upper left corner next to value 1 verifies that the Reception Diagnostic screen is currently displayed.

The information that is displayed in this screen includes:



Screen 2: Reception Diagnostics Screen

1. 8-bit timer value of next reception.*
2. Radio frequency error of the last packet received successfully. In normal operation, this value is +1, -1, or 0. This value affects the value of #5 on the next page.
3. Percentage of good data packets.‡

4. Signal strength of the last packet received. The values displayed in this field should generally be between 20 and 60. If a packet is not received successfully, the signal strength field is dashed out (--).
5. Current frequency correction factor. Shows the Automatic Frequency Control setting.
6. Frequency index of the next packet to be received.*
7. Current number of consecutive bad packets.‡
8. The number of times that the Phase Lock Loop did not lock.*
9. Current streak of consecutive good packets received.‡

Console Firmware Versions

In some cases, the problem may be that your console firmware doesn't support what you are trying to do. Use this command to determine the firmware revision level in your console. You can find more information on Vantage Pro2 console firmware versions and changes in the Weather Software Support section of our website. - for information.

Press and hold DONE then press the up arrow at the same time to display the console firmware version in the ticker at the bottom of the screen.

Console Maintenance

Changing Batteries

Use this procedure to change console batteries without losing any stored weather data or console configuration settings.

1. Plug in the AC adapter or, if the AC adapter is not present, enter Setup Mode by pressing DONE and then the down arrow.

   Entering Setup Mode makes sure the station isn't writing any data to memory when power is removed.
2. Remove the battery cover located on the back of the console by pressing down on the two latches at the top of the cover.
3. Place the console face down on a flat, firm surface.
4. Insert a fingertip between the two exposed batteries then press the middle battery down toward the notch (toward the "hidden" battery). This will relieve tension on the first battery and allow you to remove it.
5. Remove the old batteries and install the new batteries.
6. Replace the battery cover and remove the AC power adapter, if used.

One Year Limited Warranty

For details on our warranty policy, please refer to the *Maintenance, Service, and Repair Information* brochure included with your station.

Appendix A
Weather Data

Refer to this appendix to learn more about the weather variables that are measured, displayed, and logged by your Vantage Pro2 Station. Some weather variables require optional sensors. See “Optional Sensors” starting on page 2.

Wind

The anemometer measures wind speed and direction, and is part of the Integrated Sensor Suite (ISS). The console calculates a 10-minute average wind speed and 10-minute dominant wind direction. The 10-minute average wind speed is displayed in the console ticker whenever wind has been selected on the console. The last six 10-minute dominant wind directions are included in the compass rose wind display.

Temperature

The ISS houses the outside temperature sensor in a vented and shielded enclosure that minimizes the solar radiation induced temperature error. The console houses the inside temperature sensor. Additional temperature sensors are available for wireless stations and can measure up to eight locations.

Apparent Temperatures

Vantage Pro2 calculates three apparent temperature readings: Wind Chill, Heat Index, and the Temperature/Humidity/Sun/Wind (THSW) Index. Apparent temperatures use additional weather data to calculate what a human body perceives the temperature to be in those conditions.

Wind chill

Wind chill takes into account how the speed of the wind affects our perception of the air temperature. Our bodies warm the surrounding air molecules by transferring heat from the skin. If there’s no air movement, this insulating layer of warm air molecules stays next to the body and offers some protection from cooler air molecules. However, wind sweeps that warm air surrounding the body away. The faster the wind blows, the faster heat is carried away and the colder you feel. Wind has a warming effect at higher temperatures.

Note: The Wind chill is not calculated above 92° F (33° C) for console with firmware version May 2005 or later, or 78° F (26° C) for earlier firmware versions.

Heat Index

The Heat Index uses temperature and the relative humidity to determine how hot the air actually “feels.” When humidity is low, the apparent temperature will be lower than the air temperature, since perspiration evaporates rapidly to cool the body. However, when humidity is high (*i.e.*, the air is more saturated with water vapor) the apparent temperature “feels” higher than the actual air temperature, because perspiration evaporates more slowly.

Note: In console firmware versions May 2005 or later, Heat Index is equal to the air temperature at or below 0° F (-18° C). For console firmware versions earlier than May 2005, Heat Index is equal to the air temperature at or below 57° F (14° C), because the heat index is less significant at lower temperatures. Heat Index values about 135° F (57° C) are approximate.

Temperature/Humidity/Sun/Wind (THSW) Index

The THSW Index uses humidity and temperature like for the Head Index, but also includes the heating effects of sunshine and the cooling effects of wind (like wind chill) to calculate an apparent temperature of what it "feels" like out in the sun. The THSW Index requires a solar radiation sensor.

Humidity

Humidity itself simply refers to the amount of water vapor in the air. However, the total amount of water vapor that the air can contain varies with air temperature and pressure. Relative humidity takes into account these factors and offers a humidity reading which reflects the amount of water vapor in the air as a percentage of the amount the air is capable of holding. Relative humidity, therefore, is not actually a measure of the amount of water vapor in the air, but a ratio of the air's water vapor content to its capacity. When we use the term humidity in the manual and on the screen, we mean relative humidity.

It is important to realize that relative humidity changes with temperature, pressure, and water vapor content. A parcel of air with a capacity for 10 g of water vapor which contains 4 g of water vapor, the relative humidity would be 40%. Adding 2 g more water vapor (for a total of 6 g) would change the humidity to 60%. If that same parcel of air is then warmed so that it has a capacity for 20 g of water vapor, the relative humidity drops to 30% even though water vapor content does not change.

Relative humidity is an important factor in determining the amount of evaporation from plants and wet surfaces since warm air with low humidity has a large capacity to absorb extra water vapor.

Dew Point

Dew point is the temperature to which air must be cooled for saturation (100% relative humidity) to occur, providing there is no change in water vapor content. The dew point is an important measurement used to predict the formation of dew, frost, and fog. If dew point and temperature are close together in the late afternoon when the air begins to turn colder, fog is likely during the night. Dew point is also a good indicator of the air's actual water vapor content, unlike relative humidity, which takes the air's temperature into account. High dew point indicates high water vapor content; low dew point indicates low water vapor content. In addition a high dew point indicates a better chance of rain, severe thunderstorms, and tornados.

You can also use dew point to predict the minimum overnight temperature. Provided no new fronts are expected overnight and the afternoon relative humidity is greater than or equal to 50%, the afternoon's dew point gives you an idea of what minimum temperature to expect overnight, since the air can never get colder than the dew point.

Rain

Vantage Pro2 incorporates a tipping-bucket rain collector in the ISS that measures 0.01" for each tip of the bucket. A metric adapter can be installed to measure 0.2 mm for each tip of the bucket.Your station logs rain data in the same units it is measured in and converts the logged totals into the selected display units (inches or millimeters) at the time it is displayed. Converting at display time reduces possible compounded rounding errors over time.

Four separate variables track rain totals: "rain storm," "daily rain," "monthly rain," and "yearly rain." Rain rate calculations are based on the interval of time between each bucket tip, which is each 0.01" rainfall increment or .2 mm.

Barometric Pressure

The weight of the air that makes up our atmosphere exerts a pressure on the surface of the earth. This pressure is known as atmospheric pressure. Generally, the more air above an area, the higher the atmospheric pressure, this means that atmospheric pressure changes with altitude. For example, atmospheric pressure is greater at sea level than on a mountaintop. To compensate for this difference and facilitate comparison between locations with different altitudes, atmospheric pressure is generally adjusted to the equivalent sea level pressure. This adjusted pressure is known as barometric pressure. In reality, the Vantage Pro2 measures atmospheric pressure. When you enter your location's altitude in Setup Mode, the Vantage Pro2 stores the necessary offset value to consistently translate atmospheric pressure into barometric pressure.

Barometric pressure also changes with local weather conditions, making barometric pressure an extremely important and useful weather forecasting tool. High pressure zones are generally associated with fair weather while low pressure zones are generally associated with poor weather. For forecasting purposes, however, the absolute barometric pressure value is generally less important than the change in barometric pressure. In general, rising pressure indicates improving weather conditions while falling pressure indicates deteriorating weather conditions.

Solar Radiation

What we call "current solar radiation" is technically known as Global Solar Radiation, a measure of the intensity of the sun's radiation reaching a horizontal surface. This irradiance includes both the direct component from the sun and the reflected component from the rest of the sky. The solar radiation reading gives a measure of the amount of solar radiation hitting the solar radiation sensor at any given time, expressed in Watts/sq. meter (W/m^2). Solar radiation requires the solar radiation sensor.

UV (Ultra Violet) Radiation

Energy from the sun reaches the earth as visible, infrared, and ultraviolet (UV) rays. Exposure to UV rays can cause numerous health problems, such as sunburn, skin cancer, skin aging, cataracts, and can suppress the immune system. The Vantage Pro2 helps analyze the changing levels of UV radiation and can advise of situations where exposure is particularly unacceptable. UV radiation requires the UV radiation sensor. The Vantage Pro2 displays UV readings in two scales: MEDs and UV Index.

Note: Your station's UV readings do not take into account UV reflected off snow, sand, or water, which can significantly increase your exposure. Nor do your UV readings take into account the dangers of prolonged UV exposure. The readings do not suggest that any amount of exposure is safe or healthful. Do not use the Vantage Pro2 to determine the amount of UV radiation to which you expose yourself. Scientific evidence suggests that UV exposure should be avoided and that even low UV doses can be harmful.

UV MEDs

MED (Minimum Erythemal Dose) is defined as the amount of sunlight exposure necessary to induce a barely perceptible redness of the skin within 24 hours after sun exposure. In other words, exposure to 1 MED will result in a reddening of the skin. Because different skin types burn at different rates, 1 MED for persons with very dark skin is different from 1 MED for persons with very light skin.

Both the U.S. Environmental Protection Agency (EPA) and Environment Canada have developed skin type categories correlating characteristics of skin with rates of sunburn.

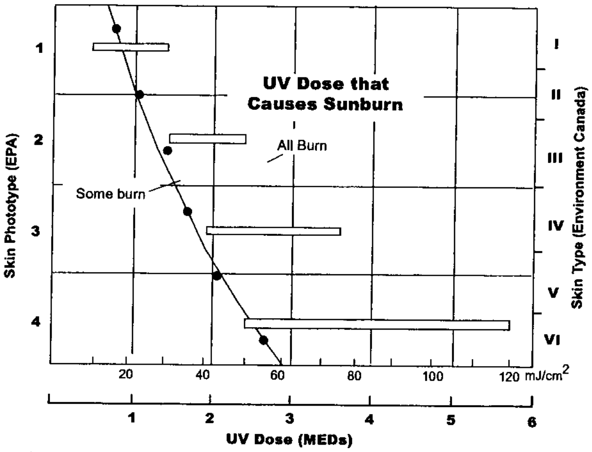
TABLE A-1: EPA SKIN PHOTOTYPES

Skin Phototype	Skin color	Tanning & Sunburn history
1 - Never tans, always burns	Pale or milky white; alabaster	Develops red sunburn; painful swelling, skin peels
2 - Sometimes tans, usually burns	Very light brown; sometimes freckles	Usually burns, pinkish or red coloring appears; can gradually develop light brown tan
3 - Usually tans, sometimes burns	Light tan; brown, or olive; distinctly pigmented	Rarely burns; shows moderately rapid tanning response
4 - Always tans; rarely burns	Brown, dark brown, or black	Rarely burns; shows very rapid tanning response

Table A-2: ENVIRONMENT CANADA SKIN TYPES AND REACTION TO THE SUN[a]

Skin Type	Skin Color	History of Tanning & Sunburning
I	White	Always burns easily, never tans
II	White	Always burns easily, tans minimally
III	Light Brown	Burns moderately, tans gradually
IV	Moderate Brown	Burns minimally, tans well
V	Dark Brown	Burns rarely, tans profusely
VI	Black	Never burns, deep pigmentation

[a] *Developed by T. B. Fitzpatrick of the Harvard Medical School. More about the Fitzpatrick Skin Types is available in: Fitzpatrick TB. Editorial: the validity and practicality of sun-reactive skin types I through VI. Arch Dermatol 1988; 124:869-871*



UV Dose and Sunburn - Use this plot to estimate the MED dose leading to sunburn. A person with Type II (Environment Canada) skin type might choose 0.75 MED as the maximum for the day; in contrast, a person with Type V (Environment Canada) Skin Type might consider 2.5 MEDs a reasonable dose for the day. NOTE: the Vantage Pro2 assumes a Fitzpatrick (Environment Canada) Skin Type of II.

UV Index

Vantage Pro2 can also display UV Index, an intensity measurement first defined by Environment Canada and since been adopted by the World Meteorological Organization. UV Index assigns a number between 0 and 16 to the current UV intensity. The US EPA categorizes the Index values as shown in table A-3. The lower the number, the lower the danger of sunburn. The Index value published by the U.S. National Weather Service is a forecast of the next day's noontime UV intensity. The index values displayed by the Vantage Pro2 are real-time measurements.

TABLE A-3: UV INDEX

Index Values	Exposure Category
0 - 2	Low
3 - 4	Moderate
5 - 6	High
7 - 9	Very High
10+	Extreme

Evapotranspiration (ET)

Evapotranspiration (ET) is a measurement of the amount of water vapor returned to the air in a given area. It combines the amount of water vapor returned through evaporation (from wet surfaces) with the amount of water vapor returned through transpiration (exhaling of moisture through plant stomata) to arrive at a total. Effectively, ET is the opposite of rainfall, and it is expressed in the same units of measure (inches, millimeters).

The Vantage Pro2 uses air temperature, relative humidity, average wind speed, and solar radiation data to estimate ET, which is calculated once an hour on the hour. ET requires the optional solar radiation sensor.

Leaf Wetness

Leaf wetness (see "Optional Sensors" on page 2) provides an indication of whether the surface of foliage in the area is wet or dry by indicating how wet the surface of the sensor is. The leaf wetness reading ranges from 0 (dry) to 15. Leaf wetness requires an optional Leaf & Soil Moisture/Temperature Station and is only available for Wireless Vantage Pro2 Stations.

Soil Moisture

Soil Moisture, as the name suggests, is a measure of the moisture content of the soil. Soil moisture is measured on a scale of 0 to 200 centibars, and can help choose times to water crops. The soil moisture sensor measures the vacuum created in the soil by the lack of moisture. A high soil moisture reading indicates dryer soil; a lower soil moisture reading means wetter soil. Soil Moisture requires an optional Leaf & Soil Moisture/Temperature Station or Soil Moisture Station and is only available for Wireless Vantage Pro2 Stations.

Time

A built-in clock and calendar track the time and date. The console automatically adjusts for daylight savings time in most of North America, Europe and Australia (and allows manual adjustment elsewhere) and for leap years.

Appendix B
Specifications

See complete specifications for your Vantage Pro2 Station at our website: www.davisnet.com.

Console Specifications

Console Operating Temperature	+14° to +140°F (-10° to +60°C)
Display Temperature	+32° to +140°F (0° to +60°C)
Non-operating Temperature	-5° to +158°F (-20° to +70°C)
Console Current Draw	Wireless: 0.9 mA average, 30 mA peak, (add 80 mA for display lamps, add 0.125 mA for each transmitter station received by console) at 4 to 6 VDC Cabled: 10 mA (average), 15 mA (peak) (+80 mA for illuminated display) at 4 to 6 VDC
Power Adapter	5 VDC, 200 mA
Battery Backup	3 C-cells
Battery Life (no AC power)	Wireless: up to 9 months; (Cabled: 1 month (approximately)
Connectors	Modular RJ-11
Housing Material	UV-resistant ABS plastic
Console Display Type	LCD Transflective
Display Backlight	LEDs
Dimensions:	
Console (with antenna)	10.375" x 6.125" x 1.5" (264 mm x 156 mm x 38 mm)
Console (no antenna)	9.625" x 6.125" x 1.5" (244 mm x 156 mm x 38 mm)
Display	5.94" x 3.375" (151 mm x 86 mm)
Weight (with batteries)	1.88 lbs. (.85 kg)

Wireless Communication Specifications

Transmit/Receive Frequency	US Models: 902 - 928 MHz Overseas Models:868.0 -868.6 MHz
ID Codes Available	8
Output Power	902 - 928 MHz FHSS: FCC-certified low power, less than 8 mW, no license required 868.0 -868.6 MHz: CE-certified, less than 8 mW, no license required
Range	
Line of Sight	up to 1000 feet (120 m)
Through Walls	200 to 400 feet (75 to 150 m)

Console Data Display Specifications

Historical Data	Includes the past 24 values listed unless otherwise noted; all can be cleared and all totals reset.
Daily Data	Includes the earliest time of occurrence of highs and lows; period begins/ends at 12:00 am.
Monthly Data	Period begins/ends at 12:00 am on the first of every month.
Yearly Data	Period begins/ends at 12:00 am on January 1st unless otherwise noted.
Current Data	Current data appears in the right most column in the console graph and represents the latest value within the last period of the graph; totals can be set or reset.
Graph Time Interval	1 min., 10 min., 15 min., 1 hour, 1 day, 1 month, 1 year (user-selectable, availability depends upon variable selected).
Graph Time Span	24 Intervals + Current Interval (see Graph Intervals to determine time span).
Graph Variable Span (Vertical Scale)	Automatic (varies depending upon data range); maximum and minimum value in range appear in ticker.
Alarm Indication	Alarms sound for 2 minutes (time alarm is 2 minute) if operating on battery power. Alarm message displays in ticker as long as threshold is met or exceeded. Alarms can be silenced, but not cleared, by pressing DONE.
Update Interval	Varies with sensor - see individual sensor specs. Also varies with transmitter ID code - 1 = shortest, 8 = longest.
Forecast:	
Variables Used	Barometric reading & trend, wind speed & direction, rainfall, temperature, humidity, latitude & longitude, time of year.
Update Interval	1 hour
Display Format	Icons on top center of display; detailed message in ticker at bottom.
Variables Predicted	Sky condition, precipitation, temperature changes, wind direction and speed changes.

Weather Data Specifications

Note: These specifications include optional sensors that may not be installed in your Vantage Pro2 Station.

Weather Data Specifications

Variable	Required Sensors	Resolution	Range	Nominal Accuracy (+/-)
Barometric Pressure[*]	Included in Console	0.01" Hg; 0.1 mm; 0.1 hPa; 0.1 mb	26" to 32" Hg; 660 to 810 mm; 880 to 1080 hPa; 880 to 1080 mb[**]	0.03" Hg; 0.8 mm Hg; 1.0 hPa; 1.0 mb
Barometric Trend (3 hour)		Change Rates Rapidly: ≥.06" H; 1.5 mm Hg; 2 hPa; 2 mb Slowly: ≥.02" H; 0.5 mm Hg; 0.7 hPa; 0.7 mb	5 Arrow Positions: Rising Rapidly Rising Slowly Steady Falling Slowly Falling Rapidly	
Evapotranspiration (ET)	ISS or Temp/Hum Station & Solar Radiation sensor	0.01"; 0.25 mm	Daily to 99.99"; 999.9 mm Monthly & Yearly to 199.99"; 1999.9mm	greater of 5% or 0.01"; 0.25 mm
Inside Humidity	Included in Console	1%	10 to 90%	5% RH
Outside Humidity	ISS or Temp/Hum Station	1%	0 to 100%	3% RH; 4% above 90%
Extra Humidity	ISS or Temp/Hum Station	1%	0 to 100%	3% RH; 4% above 90%
Dew Point (overall)	ISS or Temp/Hum Station	1°F; 1°C	-105° to +130°F; -76° to +54°C	3°F; 1.5°C
Leaf Wetness	Leaf & Soil Station	1	0 to 15	0.5
Soil Moisture	Leaf & Soil Station or Soil Moisture Station	1 cb	0 to 200 cb	
Daily & Storm Rainfall	Rain Collector	0.01"; 0.25mm	to 99.99"; 999.9 mm	greater of 4% or 1 tip,
Monthly & Yearly Rainfall		0.01"; 0.25mm (1mm at totals over 2000 mm)	to 199.99"; 19,999 mm	greater of 4% or 1 tip
Rain Rate		0.01"; 0.25 mm	to 100"/hr.; 1999.9 mm/hr.	greater of 5% or 0.04"/hr.; 1 mm/hr.

[*] Barometric pressure readings are standardized to sea level. Elevation Range: -1500' to +15,300'; -460 to + 4670 m. Note: The console screen limits display of lower elevation to -999' when using feet as elevation unit.

[**] This is the reduced value after standardizing to sea level.

Weather Data Specifications

Variable	Required Sensors	Resolution	Range	Nominal Accuracy (+/-)
Solar Radiation	Solar sensor	1 W/m^2	0 to 1800 W/m^2	5% of full scale
Inside Temperature	Included in Console	0.1°F; 0.1°C	+32° to +140°F; 0 to +60°C	1°F; 0.5°C
Outside Temperature***	ISS, Temp Station or Temp Hum Station	0.1°F; 0.1°C	-40° to +150°F; -40° to +65°C	1°F; 0.5°C
Extra Temperature	ISS, Temp Station, Temp Hum Station, Leaf Soil Station or Soil Station	1°F; 1°C	-40° to +150°F -40° to +65°C	1°F (0.5°C)
Heat Index	ISS or Temp/Hum Station	1°F; 1°C	-40° to +135°F; -40° to +57° C	3°F (1.5°C)
Temp-Hum-Sun-Wind index (THSW)	ISS & Solar Radiation	1°F; 1°C	-90° to +135°F; -68° to +64° C	4°F (2°C)
Time	Included in Console	1 min	24 hours	8 sec/Mon.
Date		1 day	month/day	8 sec/Mon.
UV Index	UV Radiation	0.1 Index	0 to 16	5% of full scale
UV Dose		0.1 MED < 20, 1 MED > 20	0 to 199 MEDs	5%
Wind Direction	Anemometer	1°	0 to 360°	7°
Compass Rose		22.5°	16 compass pts	0.3 compass pt
Wind Speed (large cups)		1 mph; 1 kt; 0.5 m/s; 1 km/h	2 to 150 mph; 2 to 130 kts 3 to 241 km/h, 1 to 68 m/s	greater of 2 mph/kts; 1 m/s; 3 km/h or 5%
Wind Speed (small cups)		1 mph; 1 kt; 0.5 m/s; 1 km/h	3 to 175 mph; 3 to 150 kts 1.5 to 79 m/s 5 to 282 km/h	greater of 3mph; 3 kts; 1 m/s; 5km/h or 5%
Wind Chill	ISS	1°F; 1°C	-120° to +130°F -84° to +54°C	2°F;1°C

***Outside temperature accuracy is based on the temperature sensor itself and not on the sensor and the passive shielding together. The solar radiation induced error for standard ration shield: +4°F (2°C) at solar noon; for fan aspirated radiation shield: +0.6°F (0.3°C) at solar noon (insolation = 1040 W/m^2, avg. wind speed ≤ 2 mph (1 m/s), reference: RM Young Model 43408 Fan-Aspirated Radiation Shield).

Appendix C

Wireless Repeater Configuration

A Vantage Pro2 Wireless Repeater (#7626, #7627) or Long-Range Wireless Repeater (#7653, #7654) increase transmission distances or improve transmission quality between a station and a console. A repeater receives information transmitted from a Vantage Pro2 station and retransmits it to a console. Depending on transmission distance, one repeater or several repeaters can be used to collect and retransmit weather data.

All consoles communicating with repeaters must be set up with the correct Transmitter ID and Repeater ID before the console can correctly receive station information.

Note: Not all consoles have the capability for repeater support. If your console has firmware dated earlier than May 2005, it does not have the capability to receive Vantage Pro2 wireless repeaters. To check your console's firmware, press the DONE and up arrow (+) keys. The firmware revision date displays in the ticker tape section of the console. If the console firmware version is older than May 2005, a Vantage Pro2 Updater can be used to update the console. Contact Technical Support about acquiring an Updater for your console. See "Contacting Davis Technical Support" on page 53 for more information.

To set Repeater ID on the console:

1. Press DONE and the down arrow (-) to enter Setup Mode.
2. If Setup Mode has previously been completed, press DONE to display Screen 2: Configuring Transmitter IDs.
3. See "Screen 2: Configuring Transmitter IDs — Wireless Only" on page 10 for more information on configuring Transmitter IDs.

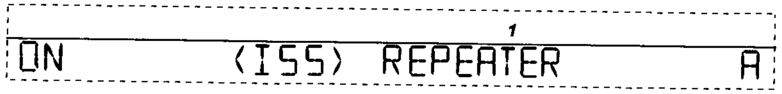
Note: The way the Repeater ID information is accessed depends on the firmware version available on the console. If the firmware is dated May 2005, the Repeater ID is accessed by pressing WIND. If the firmware is dated October 2005, the Repeater ID is accessed by pressing 2ND and WIND. Follow the instructions below based on your console's firmware.

4. For consoles with May 2005 firmware, press WIND to turn the repeater function on and to select a Repeater ID. Pressing WIND sets the console to receive the signal from a repeater instead of directly from a station. The first Repeater ID displayed is repeater A.

   For consoles with November 2005 firmware or later, press 2ND and then press WIND to enter Repeater Setup Mode and to select a Repeater ID. Pressing 2ND and WIND sets the console to receive the signal from a repeater instead of directly from a station. Once the console is in the repeater setup mode, subsequent pressing of WIND continue to cycle through the all the repeater IDs.
5. Press WIND repeatedly to cycle through all eight repeater IDs possible or to clear the repeater ID in the right hand corner. When no repeater ID is

shown, the console is configured to listen directly to a station and not to a repeater.

In the example below, the console is set up to receive an ISS station on transmitter ID 1 from repeater A.



1

ON (ISS) REPEATER A

6. For each station using a repeater, select the station and turn on the repeater function and select the correct repeater ID.
7. Press DONE to continue to the other screens in the Setup Mode, or press and hold DONE to return to the Current Weather Mode.

Note: In console with the October 2005 version of firmware, the only way to exit Repeater Setup mode is to press DONE to continue to the next setup screen.

Verifying Setup

To verify that you have successfully set up your console to receive a repeater in the console's Current Weather Mode:

1. View the transmitter information displaying at the bottom of the console screen.

   If the transmitter ID being repeated is displayed and an "X" flashes in the bottom right corner of the ticker tape, the transmitter is being repeated and received by the console successfully.

   The repeater's information also displays at the bottom of the console's diagnostics screens.

Clearing Repeater ID

If a repeater ID is being displayed in Screen 2 and you are not using a repeater with the selected station, you must turn off the repeater function to receive station information successfully.

In Setup Screen 2:

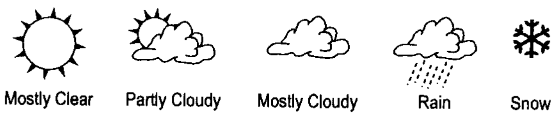
For consoles with May 2005 firmware, press WIND repeatedly so that the console cycles through the list of repeater IDs (Repeaters A-H) until the section where the repeater ID was displayed is blank. Press DONE to continue to the next screen or press and hold DONE to return to the Current Weather Mode.

For consoles with October 2005 firmware, press 2ND and then press WIND repeatedly so that the console cycles through the list of repeater IDs (Repeaters A-H) until the section where the repeater ID was displayed is blank. Press DONE to continue to the next screen or press and hold DONE to return to the Current Weather Mode.

Vantage Pro2 Console Icons

Console icons indicate weather conditions and special functions.

Forecast



Indicates the weather forecast for the next 12 hours.

Moon Phase

Shows the current moon phase. Sequence shown for Northern Hemisphere. Reverse sequence for the Southern Hemisphere.

Alarm Bell

Flashes when an alarm is triggered. Also indicates when the console is in Alarm Mode.

Graph

Appears next to the currently selected weather variable. Also indicates the graphed variable on most screens.

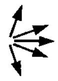
Second Function

Appears when you press 2ND key. Indicates that console key secondary functions are enabled.

Rain

Appears when the console is currently detecting rain.

Barometric Pressure Trend



Arrows show direction of pressure change for last three hours.

Contacting Davis Technical Support

If you have any questions, or encounter problems installing or operating your Vantage Pro 2 weather station, please contact Davis Technical Support. We'll be glad to help.

(510) 732-7814 — Monday - Friday, 7:00 a.m. - 5:30 p.m. Pacific Time. We are unable to accept collect calls.

(510) 670-0589 — Technical Support Fax.

support@davisnet.com — E-mail to Technical Support.

info@davisnet.com — General e-mail.

www.davisnet.com — Davis Instruments web site.

See the Weather Support section for copies of user manuals, product specifications, application notes, and information on software updates. Watch for FAQs and other updates.

Appendix D

Action Level Documentation

ATSDR Department of Health and Human Services
Agency for Toxic Substances & Disease Registry

Home › MRLs

Minimal Risk Levels (MRLs) for Hazardous Substances

Minimal Risk Levels (MRLs)
for
Hazardous Substances

Print MRL List, 43 KB

- Narrative
- MRL List

Narrative

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [42 U.S.C. 9604 et seq.], as amended by the Superfund Amendments and Reauthorization Act (SARA) [Pub. L. 99 499], requires that the Agency for Toxic Substances and Disease Registry (ATSDR) develop jointly with the U.S. Environmental Protection Agency (EPA), in order of priority, a list of hazardous substances most commonly found at facilities on the CERCLA National Priorities List (NPL) (42 U.S.C. 9604(i)(2)); prepare toxicological profiles for each substance included on the priority list of hazardous substances, and to ascertain significant human exposure levels (SHELs) for hazardous substances in the environment, and the associated acute, subacute, and chronic health effects (42 U.S.C. 9604(i)(3)); and assure the initiation of a research program to fill identified data needs associated with the substances (42 U.S.C. 9604(i)(5)).

The ATSDR Minimal Risk Levels (MRLs) were developed as an initial response to the mandate. Following discussions with scientists within the Department of Health and Human Services (HHS) and the EPA, ATSDR chose to adopt a practice similar to that of the EPA's Reference Dose (RfD) and Reference Concentration (RfC) for deriving substance specific health guidance levels for non neoplastic endpoints. An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure. These substance specific estimates, which are intended to serve as screening levels, are used by ATSDR health assessors and other responders to identify contaminants and potential health effects that may be of concern at hazardous waste sites. **It is important to note that MRLs are not intended to define clean up or action levels for ATSDR or other Agencies.**

The toxicological profiles include an examination, summary, and interpretation of available toxicological information and epidemiologic evaluations of a hazardous substance. During the development of toxicological profiles, MRLs are derived when ATSDR determines that reliable and sufficient data exist to identify the target organ(s) of effect or the most sensitive health effect(s) for a specific duration for a given route of exposure to the substance. MRLs are based on noncancer health effects only and are not based on a consideration of cancer effects. Inhalation MRLs are exposure concentrations expressed in units of parts per million (ppm) for gases and volatiles, or milligrams per cubic meter (mg/m3) for particles. Oral MRLs are expressed as daily human doses in units of milligrams per kilogram per day (mg/kg/day). Radiation MRLs are expressed as external exposures in units of millisieverts.

ATSDR uses the no observed adverse effect level/uncertainty factor (NOAEL/UF) approach to derive MRLs for hazardous substances. They are set below levels that, based on current information, might cause adverse health effects in the people most sensitive to such substance-induced effects. MRLs are derived for acute (1-14 days), intermediate (>14-364 days), and chronic (365 days and longer) exposure durations, and for the oral and inhalation routes of exposure. Currently MRLs for the dermal route of exposure are not derived because ATSDR has not yet identified a method suitable for this route of exposure. MRLs are generally based on the most sensitive substance-induced end point considered to be of relevance to humans. ATSDR does not use serious health effects (such as irreparable damage to the liver or kidneys, or birth defects) as a basis for establishing MRLs. Exposure to a level above the MRL does not mean that adverse health effects will occur.

MRLs are intended to serve as a screening tool to help public health professionals decide where to look more closely. They may also be viewed as a mechanism to identify those hazardous waste sites that are not expected to cause adverse health effects. Most MRLs contain some degree of uncertainty because of the lack of precise toxicological information on the people who might be most sensitive (e.g., infants, elderly, and nutritionally or immunologically compromised) to effects of hazardous substances. ATSDR uses a conservative (i.e., protective) approach to address these uncertainties consistent with the public health principle of prevention. Although human data are preferred, MRLs often must be based on animal studies because relevant human studies are lacking. In the absence of evidence to the contrary, ATSDR assumes that humans are more sensitive than animals to the effects of hazardous substances that certain persons may be particularly sensitive. Thus the resulting MRL may be as much as a hundredfold below levels shown to be nontoxic in laboratory animals.

When adequate information is available, physiologically based pharmacokinetic (PBPK) modeling and benchmark dose (BMD) modeling have also been used as an adjunct to the NOAEL/UF approach in deriving MRLs.

Proposed MRLs undergo a rigorous review process. They are reviewed by the Health Effects/MRL Workgroup within the Division of

Toxicology and Environmental Medicine; an expert panel of external peer reviewers; the agency wide MRL Workgroup, with participation from other federal agencies, including EPA; and are submitted for public comment through the toxicological profile public comment period. Each MRL is subject to change as new information becomes available concomitant with updating the toxicological profile of the substance. MRLs in the most recent toxicological profiles supersede previously published levels. To date, 130 inhalation MRLs, 219 oral MRLs and 8 external radiation MRLs have been derived. A listing of the current published MRLs by route and duration of exposure is provided as follows.

ATSDR Contact Person for MRLs:

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MRL List

ATSDR Minimal Risk Levels (MRLs)
December 2006

Name	Route	Duration	MRL	Factors	Endpoint	Draft/Final	Cover Date	CAS Number
ACENAPHTHENE	Oral	Int.	0.6 mg/kg/day	300	Hepatic	Final	08/95	000083-32-9
ACETONE	Inh.	Acute	26 ppm	9	Neurol.	Final	05/94	000067-64-1
		Int.	13 ppm	100	Neurol.			
		Chr.	13 ppm	100	Neurol.			
	Oral	Int.	2 mg/kg/day	100	Hemato.			
ACROLEIN	Inh.	Acute	0.003 ppm	100	Resp.	Draft	09/05	000107-02-8
		Int.	0.00004 ppm	300	Resp.			
	Oral	Int.	0.008 mg/kg/day	100	Gastro.			
ACRYLONITRILE	Inh.	Acute	0.1 ppm	10	Neurol.	Final	12/90	000107-13-1
	Oral	Acute	0.1 mg/kg/day	100	Develop.			
		Int.	0.01 mg/kg/day	1000	Repro.			
		Chr.	0.04 mg/kg/day	100	Hemato.			
ALDRIN	Oral	Acute	0.002 mg/kg/day	1000	Develop.	Final	09/02	000309-00-2
		Chr.	0.00003 mg/kg/day	1000	Hepatic			
ALUMINUM	Oral	Int.	1.0 mg/kg/day	30	Neurol.	Draft	09/06	007429-90-5
		Chr.	1.0 mg/kg/day	90	Neurol.			
AMERICIUM	Rad.	Acute	4 mSv/yr	3	Develop.	Final	10/04	007440-35-9
		Chr.	1 mSv/yr	3	Other			
								007664-

AMMONIA	Inh.	Acute	1.7 ppm	30	Resp.	Final	10/04	41-7
		Chr.	0.1 ppm	30	Resp.			
ANTHRACENE	Oral	Int.	10 mg/kg/day	100	Hepatic	Final	08/95	000120-12-7
ARSENIC	Oral	Acute*	0.005 mg/kg/day	10	Gastro.	Draft	09/05	007440-38-2
*provisional		Chr.	0.0003 mg/kg/day	3	Dermal			
ATRAZINE	Oral	Acute	0.01 mg/kg/day	100	Body Wt.	Final	09/03	001912-24-9
		Int.	0.003 mg/kg/day	300	Repro.			
BARIUM, SOLUBLE SALTS	Oral	Int.	0.7 mg/kg/day	100	Renal	Draft	09/05	007440-39-3
		Chr.	0.6 mg/kg/day	100	Renal			
BENZENE	Inh.	Acute	0.009 ppm	300	Immuno.	Draft	09/05	000071-43-2
		Int.	0.006 ppm	300	Immuno.			
		Chr.	0.003 ppm	10	Immuno.			
BERYLLIUM	Oral	Chr.	0.002 mg/kg/day	300	Gastro.	Final	09/02	007440-41-7
BIS(CHLOROMETHYL) ETHER	Inh.	Int.	0.0003 ppm	100	Resp.	Final	12/89	000542-88-1
BIS(2 CHLOROETHYL) ETHER	Inh.	Int.	0.02 ppm	1000	Body Wt.	Final	12/89	000111-44-4
BORON	Oral	Int.	0.01 mg/kg/day	1000	Develop.	Final	07/92	007440-42-8
BROMODICHLOROMETHANE	Oral	Acute	0.04 mg/kg/day	1000	Hepatic	Final	12/89	000075-27-4
		Chr.	0.02 mg/kg/day	1000	Renal			
BROMOFORM	Oral	Acute	0.7 mg/kg/day	100	Hepatic	Final	09/05	000075-25-2
		Int.	0.2 mg/kg/day	300	Hepatic			
		Chr.	0.02 mg/kg/day	3000	Hepatic			
BROMOMETHANE	Inh.	Acute	0.05 ppm	100	Neurol.	Final	09/92	000074-83-9
		Int.	0.05 ppm	100	Neurol.			
		Chr.	0.005 ppm	100	Neurol.			
	Oral	Int.	0.003 mg/kg/day	100	Gastro.			
CADMIUM	Oral	Chr.	0.0002 mg/kg/day	10	Renal	Final	07/99	007440-43-9
CARBON DISULFIDE	Inh.	Chr.	0.3 ppm	30	Neurol.	Final	08/96	000075-15-0
	Oral	Acute	0.01 mg/kg/day	300	Hepatic			

CARBON TETRACHLORIDE	Inh.	Int.	0.03 ppm	30	Hepatic	Final	09/05	000056-23-5
		Chr.	0.03 ppm	30	Hepatic			
	Oral	Acute	0.02 mg/kg/day	300	Hepatic			
		Int.	0.007 mg/kg/day	100	Hepatic			
CESIUM	Rad.	Acute	4 mSv	3	Develop.	Final	10/04	007440-46-2
		Chr.	1 mSv/yr	3	Other			
CHLORDANE	Inh.	Int.	0.0002 mg/m3	100	Hepatic	Final	05/94	000057-74-9
		Chr.	0.00002 mg/m3	1000	Hepatic			
	Oral	Acute	0.001 mg/kg/day	1000	Develop.			
		Int.	0.0006 mg/kg/day	100	Hepatic			
		Chr.	0.0006 mg/kg/day	100	Hepatic			
CHLORDECONE	Oral	Acute	0.01 mg/kg/day	100	Neurol.	Final	08/95	000143-50-0
		Int.	0.0005 mg/kg/day	100	Renal			
		Chr.	0.0005 mg/kg/day	100	Renal			
CHLORFENVINPHOS	Oral	Acute	0.002 mg/kg/day	1000	Neurol.	Final	09/97	000470-90-6
		Int.	0.002 mg/kg/day	1000	Immuno.			
		Chr.	0.0007 mg/kg/day	1000	Neurol.			
CHLORINE DIOXIDE	Inh.	Int.	0.001 ppm	300	Resp.	Final	10/04	010049-04-4
CHLORITE	Oral	Int.	0.1 mg/kg/day	30	Neurol.	Final	10/04	007758-19-2
CHLOROBENZENE	Oral	Int.	0.4 mg/kg/day	100	Hepatic	Final	12/90	000108-90-7
CHLORODIBROMOMETHANE	Oral	Acute	0.1 mg/kg/day	300	Hepatic	Final	09/05	000124-48-1
		Chr.	0.09 mg/kg/day	300	Hepatic			
CHLOROETHANE	Inh.	Acute	15 ppm	100	Develop.	Final	12/98	000075-00-3
CHLOROFORM	Inh.	Acute	0.1 ppm	30	Hepatic	Final	09/97	000067-66-3
		Int.	0.05 ppm	300	Hepatic			
		Chr.	0.02 ppm	100	Hepatic			
	Oral	Acute	0.3 mg/kg/day	100	Hepatic			
		Int.	0.1 mg/kg/day	100	Hepatic			
		Chr.	0.01 mg/kg/day	1000	Hepatic			

CHLOROMETHANE	Inh.	Acute	0.5 ppm	100	Neurol.	Final	12/98	000074-87-3
		Int.	0.2 ppm	300	Hepatic			
		Chr.	0.05 ppm	1000	Neurol.			
CHLORPYRIFOS	Oral	Acute	0.003 mg/kg/day	10	Neurol.	Final	09/97	002921-88-2
		Int.	0.003 mg/kg/day	10	Neurol.			
		Chr.	0.001 mg/kg/day	100	Neurol.			
CHROMIUM(VI), AEROSOL MISTS	Inh.	Int.	0.000005 mg/m3	100	Resp.	Final	09/00	007738-94-5
CHROMIUM(VI), PARTICULATES	Inh.	Int.	0.001 mg/m3	30	Resp.	Final	09/00	018540-29-9
COBALT	Inh.	Chr.	0.0001 mg/m3	10	Resp.	Final	10/04	007440-48-4
	Oral	Int.	0.01 mg/kg/day	100	Hemato.			
	Rad.	Acute	4 mSv	3	Develop.			
		Chr.	1 mSv/yr	3	Other			
COPPER	Oral	Acute	0.01 mg/kg/day	3	Gastro.	Final	10/04	007440-50-8
		Int.	0.01 mg/kg/day	3	Gastro.			
CRESOLS	Oral	Int.	0.1 mg/kg/day	100	Resp.	Draft	09/06	001319-77-3
CYANIDE, SODIUM	Oral	Int.	0.05 mg/kg/day	100	Repro.	Final	07/06	000143-33-9
CYCLOTETRAMETHYLENE TETRANITRAMINE (HMX)	Oral	Acute	0.1 mg/kg/day	1000	Neurol.	Final	09/97	002691-41-0
		Int.	0.05 mg/kg/day	1000	Hepatic			
CYCLOTRIMETHYLENETRINITRAMINE (RDX)	Oral	Acute	0.06 mg/kg/day	100	Neurol.	Final	06/95	000121-82-4
		Int.	0.03 mg/kg/day	300	Repro.			
CYHALOTHRIN	Oral	Acute	0.01 mg/kg/day	100	Gastro.	Final	09/03	068085-85-8
		Int.	0.01 mg/kg/day	100	Gastro.			
CYPERMETHRIN	Oral	Acute	0.02 mg/kg/day	100	Neurol.	Final	09/03	052315-07-8
DDT, P,P'-	Oral	Acute	0.0005 mg/kg/day	1000	Develop.	Final	09/02	000050-29-3
		Int.	0.0005 mg/kg/day	100	Hepatic			
DI(2-ETHYLHEXYL)PHTHALATE	Oral	Int.	0.1 mg/kg/day	100	Repro.	Final	09/02	000117-81-7
		Chr.	0.06 mg/kg/day	100	Repro.			

DI-N-BUTYL PHTHALATE	Oral	Acute	0.5 mg/kg/day	100	Develop.	Final	09/01	000084-74-2
DI-N-OCTYL PHTHALATE	Oral	Acute	3 mg/kg/day	300	Hepatic	Final	09/97	000117-84-0
		Int.	0.4 mg/kg/day	100	Hepatic			
DIAZINON	Inh.	Int.	0.01 mg/m3	30	Neurol.	Draft	09/06	000333-41-5
	Oral	Acute	0.006 mg/kg/day	100	Neurol.			
		Int.	0.002 mg/kg/day	100	Neurol.			
		Chr.	0.0007 mg/kg/day	100	Neurol.			
DICHLOROBENZENE, 1,2-	Oral	Acute	0.7 mg/kg/day	100	Hepatic	Final	07/06	000095-50-1
		Int.	0.6 mg/kg/day	100	Hepatic			
		Chr.	0.3 mg/kg/day	100	Renal			
DICHLOROBENZENE, 1,3-	Oral	Acute	0.4 mg/kg/day	100	Hepatic	Final	07/06	000541-73-1
		Int.	0.02 mg/kg/day	100	Endocr.			
DICHLOROBENZENE, 1,4-	Inh.	Acute	2 ppm	10	Ocular	Final	07/06	000106-46-7
		Int.	0.2 ppm	100	Hepatic			
		Chr.	0.01 ppm	30	Resp.			
	Oral	Int.	0.07 mg/kg/day	100	Hepatic			
		Chr.	0.07 mg/kg/day	100	Hepatic			
DICHLORVOS	Inh.	Acute	0.002 ppm	100	Neurol.	Final	09/97	000062-73-7
		Int.	0.0003 ppm	100	Neurol.			
		Chr.	0.00006 ppm	100	Neurol.			
	Oral	Acute	0.004 mg/kg/day	1000	Neurol.			
		Int.	0.003 mg/kg/day	10	Neurol.			
		Chr.	0.0005 mg/kg/day	100	Neurol.			
DIELDRIN	Oral	Int.	0.0001 mg/kg/day	100	Neurol.	Final	09/02	000060-57-1
		Chr.	0.00005 mg/kg/day	100	Hepatic			
DIETHYL PHTHALATE	Oral	Acute	7 mg/kg/day	300	Repro.	Final	06/95	000084-66-2
		Int.	6 mg/kg/day	300	Hepatic			
DIISOPROPYL METHYLPHOSPHONATE	Oral	Int.	0.8 mg/kg/day	100	Hemato.	Final	10/98	001445-75-6
(DIMP)		Chr.	0.6	100	Hemato.			

			mg/kg/day					
DISULFOTON	Inh.	Acute	0.006 mg/m3	30	Neurol.	Final	08/95	000298-04-4
		Int.	0.0002 mg/m3	30	Neurol.			
	Oral	Acute	0.001 mg/kg/day	100	Neurol.			
		Int.	0.00009 mg/kg/day	100	Develop.			
		Chr.	0.00006 mg/kg/day	1000	Neurol.			
ENDOSULFAN	Oral	Int.	0.005 mg/kg/day	100	Immuno.	Final	09/00	000115-29-7
		Chr.	0.002 mg/kg/day	100	Hepatic			
ENDRIN	Oral	Int.	0.002 mg/kg/day	100	Neurol.	Final	08/96	000072-20-8
		Chr.	0.0003 mg/kg/day	100	Neurol.			
ETHION	Oral	Acute	0.002 mg/kg/day	30	Neurol.	Final	09/00	000563-12-2
		Int.	0.002 mg/kg/day	30	Neurol.			
		Chr.	0.0004 mg/kg/day	150	Neurol.			
ETHYLBENZENE	Inh.	Int.	1.0 ppm	100	Develop.	Final	07/99	000100-41-4
ETHYLENE GLYCOL	Inh.	Acute	0.5 ppm	100	Renal	Final	09/97	000107-21-1
	Oral	Acute	2.0 mg/kg/day	100	Develop.			
		Chr.	2.0 mg/kg/day	100	Renal			
ETHYLENE OXIDE	Inh.	Int.	0.09 ppm	100	Renal	Final	12/90	000075-21-8
FLUORANTHENE	Oral	Int.	0.4 mg/kg/day	300	Hepatic	Final	08/95	000206-44-0
FLUORENE	Oral	Int.	0.4 mg/kg/day	300	Hepatic	Final	08/95	000086-73-7
FLUORIDE, SODIUM	Oral	Chr.	0.05 mg/kg/day	3	Musculo.	Final	09/03	007681-49-4
FLUORINE	Inh.	Acute	0.01 ppm	10	Resp.	Final	09/03	007782-41-4
FORMALDEHYDE	Inh.	Acute	0.04 ppm	9	Resp.	Final	07/99	000050-00-0
		Int.	0.03 ppm	30	Resp.			
		Chr.	0.008 ppm	30	Resp.			
	Oral	Int.	0.3 mg/kg/day	100	Gastro.			
		Chr.	0.2 mg/kg/day	100	Gastro.			
			0.02					068476-

FUEL OIL NO.2	Inh.	Acute	mg/m3	1000	Neurol.	Final	06/95	30-2
GUTHION	Inh.	Acute	0.02 mg/m3	30	Neurol.	Draft	09/06	000086-50-0
		Int.	0.01 mg/m3	30	Neurol.			
		Chr.	0.01 mg/m3	30	Neurol.			
	Oral	Acute	0.01 mg/kg/day	100	Neurol.			
		Int.	0.003 mg/kg/day	100	Neurol.			
		Chr.	0.003 mg/kg/day	100	Neurol.			
HEPTACHLOR	Oral	Int.	0.0001 mg/kg/day	300	Immuno.	Draft	09/05	000076-44-8
HEXACHLOROBENZENE	Oral	Acute	0.008 mg/kg/day	300	Develop.	Final	09/02	000118-74-1
		Int.	0.0001 mg/kg/day	90	Repro.			
		Chr.	0.00005 mg/kg/day	300	Develop.			
HEXACHLOROBUTADIENE	Oral	Int.	0.0002 mg/kg/day	1000	Renal	Final	05/94	000087-68-3
HEXACHLOROCYCLOHEXANE, ALPHA-	Oral	Chr.	0.008 mg/kg/day	100	Hepatic	Final	09/05	000319-84-6
HEXACHLOROCYCLOHEXANE, BETA-	Oral	Acute	0.05 mg/kg/day	100	Neurol.	Final	09/05	000319-85-7
		Int.	0.0006 mg/kg/day	300	Hepatic			
HEXACHLOROCYCLOHEXANE, GAMMA-	Oral	Acute	0.003 mg/kg/day	300	Develop.	Final	09/05	000058-89-9
		Int.	0.00001 mg/kg/day	1000	Immuno.			
HEXACHLOROCYCLOPENTADIENE	Inh.	Int.	0.01 ppm	30	Resp.	Final	07/99	000077-47-4
		Chr.	0.0002 ppm	90	Resp.			
	Oral	Int.	0.1 mg/kg/day	100	Renal			
HEXACHLOROETHANE	Inh.	Acute	6 ppm	30	Neurol.	Final	09/97	000067-72-1
		Int.	6 ppm	30	Neurol.			
	Oral	Acute	1 mg/kg/day	100	Hepatic			
		Int.	0.01 mg/kg/day	100	Hepatic			
HEXAMETHYLENE DIISOCYANATE	Inh.	Int.	0.00003 ppm	30	Resp.	Final	10/98	000822-06-0
		Chr.	0.00001 ppm	90	Resp.			
HEXANE, N-	Inh.	Chr.	0.6 ppm	100	Neurol.	Final	07/99	000110-54-3
								000302-

HYDRAZINE	Inh.	Int.	0.004 ppm	300	Hepatic	Final	09/97	01-2
HYDROGEN FLUORIDE	Inh.	Acute	0.02 ppm	30	Resp.	Final	09/03	007664-39-3
HYDROGEN SULFIDE	Inh.	Acute	0.07 ppm	27	Resp.	Final	07/06	007783-06-4
		Int.	0.02 ppm	30	Resp.			
IODIDE	Oral	Acute	0.01 mg/kg/day	1	Endocr.	Final	10/04	007553-56-2
		Chr.	0.01 mg/kg/day	1	Endocr.			
IONIZING RADIATION, N.O.S.	Rad.	Acute	4 mSv	3	Neurol.	Final	09/99	HZ1800-45-T
		Chr.	1 mSv/yr	3	Other			
ISOPHORONE	Oral	Int.	3 mg/kg/day	100	Other	Final	12/89	000078-59-1
		Chr.	0.2 mg/kg/day	1000	Hepatic			
JP-4	Inh.	Int.	9 mg/m3	300	Hepatic	Final	06/95	050815-00-4
JP-5/JP-8	Inh.	Int.	3 mg/m3	300	Hepatic	Final	10/98	HZ0600-26-T
JP-7	Inh.	Chr.	0.3 mg/m3	300	Hepatic	Final	06/95	HZ0600-22-T
KEROSENE	Inh.	Int.	0.01 mg/m3	1000	Hepatic	Final	06/95	008008-20-6
MALATHION	Inh.	Acute	0.2 mg/m3	100	Neurol.	Final	09/03	000121-75-5
		Int.	0.02 mg/m3	1000	Resp.			
	Oral	Int.	0.02 mg/kg/day	10	Neurol.			
		Chr.	0.02 mg/kg/day	100	Neurol.			
MANGANESE	Inh.	Chr.	0.00004 mg/m3	500	Neurol.	Final	09/00	007439-96-5
MERCURIC CHLORIDE	Oral	Acute	0.007 mg/kg/day	100	Renal	Final	03/99	007487-94-7
		Int.	0.002 mg/kg/day	100	Renal			
MERCURY	Inh.	Chr.	0.0002 mg/m3	30	Neurol.	Final	03/99	007439-97-6
METHOXYCHLOR	Oral	Int.	0.005 mg/kg/day	1000	Repro.	Draft	09/00	000072-43-5
METHYL PARATHION	Oral	Int.	0.0007 mg/kg/day	300	Neurol.	Final	09/01	000298-00-0
		Chr.	0.0003 mg/kg/day	100	Hemato.			
METHYL-T-BUTYL ETHER	Inh.	Acute	2 ppm	100	Neurol.	Final	08/96	001634-

								04-4
		Int.	0.7 ppm	100	Neurol.			
		Chr.	0.7 ppm	100	Renal			
	Oral	Acute	0.4 mg/kg/day	100	Neurol.			
		Int.	0.3 mg/kg/day	300	Hepatic			
METHYLENE CHLORIDE	Inh.	Acute	0.6 ppm	100	Neurol.	Final	09/00	000075-09-2
		Int.	0.3 ppm	90	Hepatic			
		Chr.	0.3 ppm	30	Hepatic			
	Oral	Acute	0.2 mg/kg/day	100	Neurol.			
		Chr.	0.06 mg/kg/day	100	Hepatic			
METHYLMERCURY	Oral	Chr.	0.0003 mg/kg/day	4	Develop.	Final	03/99	022967-92-6
MIREX	Oral	Chr.	0.0008 mg/kg/day	100	Hepatic	Final	08/95	002385-85-5
N-NITROSODI-N-PROPYLAMINE	Oral	Acute	0.095 mg/kg/day	100	Hepatic	Final	12/89	000621-64-7
NAPHTHALENE	Inh.	Chr.	0.0007 ppm	300	Resp.	Final	09/05	000091-20-3
	Oral	Acute	0.6 mg/kg/day	90	Neurol.			
		Int.	0.6 mg/kg/day	90	Neurol.			
NICKEL	Inh.	Int.	0.0002 mg/m3	30	Resp.	Final	09/05	007440-02-0
		Chr.	0.00009 mg/m3	30	Resp.			
PENTACHLOROPHENOL	Oral	Acute	0.005 mg/kg/day	1000	Develop.	Final	09/01	000087-86-5
		Int.	0.001 mg/kg/day	1000	Repro.			
		Chr.	0.001 mg/kg/day	1000	Endocr.			
PERCHLORATES	Oral	Chr.	0.0007 mg/kg/day	10	Endocr.	Draft	09/05	007778-74-7
PERMETHRIN	Oral	Acute	0.3 mg/kg/day	100	Neurol.	Final	09/03	052645-53-1
		Int.	0.2 mg/kg/day	100	Neurol.			
PHENOL	Inh.	Acute	0.02 ppm	30	Resp.	Draft	09/06	000108-95-2
	Oral	Acute	0.6 mg/kg/day	100	Body Wt.			
PHOSPHORUS, WHITE	Inh.	Acute	0.02 mg/m3	30	Resp.	Final	09/97	007723-14-0
	Oral	Int.	0.0002 mg/kg/day	100	Repro.			

POLYBROMINATED BIPHENYLS (PBBs)	Oral	Acute	0.01 mg/kg/day	100	Endocr.	Final	10/04	036355-01-8
POLYBROMINATED DIPHENYL ETHERS (PBDEs), LOWER BROMINATED	Inh	Int.	0.006 mg/m3	90	Endocr.	Final	10/04	032534-81-9
	Oral	Acute	0.03 mg/kg/day	30	Endocr.			032536-52-0
		Int.	0.007 mg/kg/day	300	Hepatic			
PBDE, DECABROMINATED	Oral	Int.	10 mg/kg/day	100	Develop.	Final	10/04	001163-19-5
POLYCHLORINATED BIPHENYLS (PCBs) (Aroclor 1254)	Oral	Int.	0.03 ug/kg/day	300	Neurol.	Final	11/00	011097-69-1
		Chr.	0.02 ug/kg/day	300	Immuno.			
PROPYLENE GLYCOL DINITRATE	Inh.	Acute	0.003 ppm	10	Neurol.	Final	06/95	006423-43-4
		Int.	0.00004 ppm	1000	Hemato.			
		Chr.	0.00004 ppm	1000	Hemato.			
PROPYLENE GLYCOL	Inh.	Int.	0.009 ppm	1000	Resp.	Final	09/97	000057-55-6
REFRACTORY CERAMIC FIBERS	Inh.	Chr.	0.03 fibers/cc	30	Resp.	Final	10/04	HZ0900-26-T
SELENIUM	Oral	Chr.	0.005 mg/kg/day	3	Dermal	Final	09/03	007782-49-2
STRONTIUM	Oral	Int.	2 mg/kg/day	30	Musculo.	Final	10/04	007440-24-6
STYRENE	Inh.	Chr.	0.06 ppm	100	Neurol.	Final	09/92	000100-42-5
	Oral	Int.	0.2 mg/kg/day	1000	Hepatic			
SULFUR DIOXIDE	Inh.	Acute	0.01 ppm	9	Resp.	Final	12/98	007446-09-5
SULFUR MUSTARD	Inh.	Acute	0.0007 mg/m3	30	Ocular	Final	09/03	000505-60-2
		Int.	0.00002 mg/m3	30	Ocular			
	Oral	Acute	0.5 µg/kg/day	1000	Develop.			
		Int.	0.07 µg/kg/day	300	Gastro.			
TETRACHLOROETHYLENE	Inh.	Acute	0.2 ppm	10	Neurol.	Final	09/97	000127-18-4
		Chr.	0.04 ppm	100	Neurol.			
	Oral	Acute	0.05 mg/kg/day	100	Develop.			
TIN, INORGANIC	Oral	Int.	0.3 mg/kg/day	100	Hemato.	Final	09/05	007440-31-5
TIN, DIBUTYL-	Oral	Int.	0.005 mg/kg/day	1000	Immunol.	Final	09/05	000683-18-1

TIN, TRIBUTYL-	Oral	Int.	0.0003 mg/kg/day	100	Immunol.	Final	09/05	000056-36-9
		Chr.	0.0003 mg/kg/day	100	Immunol.			
TITANIUM TETRACHLORIDE	Inh.	Int.	0.01 mg/m3	90	Resp.	Final	09/97	007550-45-0
		Chr.	0.0001 mg/m3	90	Resp.			
TOLUENE	Inh.	Acute	1 ppm	10	Neurol.	Final	09/00	000108-88-3
		Chr.	0.08 ppm	100	Neurol.			
	Oral	Acute	0.8 mg/kg/day	300	Neurol.			
		Int.	0.02 mg/kg/day	300	Neurol.			
TOXAPHENE	Oral	Acute	0.005 mg/kg/day	1000	Hepatic	Final	08/96	008001-35-2
		Int.	0.001 mg/kg/day	300	Hepatic			
TRICHLOROETHYLENE	Inh.	Acute	2 ppm	30	Neurol.	Final	09/97	000079-01-6
		Int.	0.1 ppm	300	Neurol.			
	Oral	Acute	0.2 mg/kg/day	300	Develop.			
URANIUM, HIGHLY SOLUBLE SALTS	Inh.	Int.	0.0004 mg/m3	90	Renal	Final	09/99	HZ1800-90-T
		Chr.	0.0003 mg/m3	30	Renal			
	Oral	Int.	0.002 mg/kg/day	30	Renal			
URANIUM, INSOLUBLE COMPOUNDS	Inh.	Int.	0.008 mg/m3	30	Renal	Final	09/99	HZ1800-92-T
VANADIUM	Inh.	Acute	0.0002 mg/m3	100	Resp.	Final	07/92	007440-62-2
	Oral	Int.	0.003 mg/kg/day	100	Renal			
VINYL ACETATE	Inh.	Int.	0.01 ppm	100	Resp.	Final	07/92	000108-05-4
VINYL CHLORIDE	Inh.	Acute	0.5 ppm	30	Develop.	Final	07/06	000075-01-4
		Int.	0.03 ppm	30	Hepatic			
	Oral	Chr.	0.003 mg/kg/day	30	Hepatic			
XYLENES, MIXED	Inh.	Acute	2 ppm	30	Neurol.	Draft	09/05	001330-20-7
		Int.	0.6 ppm	90	Neurol.			
		Chr.	0.05 ppm	300	Neurol.			
	Oral	Acute	1 mg/kg/day	100	Neurol.			
		Int.	1 mg/kg/day	300	Neurol.			
		Chr.	0.6 mg/kg/day	300	Neurol.			

ZINC	Oral	Int.	0.3 mg/kg/day	3	Hemato.	Final	09/05	007440-66-6
		Chr.	0.3 mg/kg/day	3	Hemato.			
1-METHYLNAPHTHALENE	Oral	Chr.	0.07 mg/kg/day	1000	Resp.	Final	09/05	000090-12-0
2-METHYLNAPHTHALENE	Oral	Chr.	0.04 mg/kg/day	100	Resp.	Final	09/05	000091-57-6
1,1-DICHLOROETHENE	Inh.	Int.	0.02 ppm	100	Hepatic	Final	05/94	000075-35-4
	Oral	Chr.	0.009 mg/kg/day	1000	Hepatic			
1,1-DIMETHYLHYDRAZINE	Inh.	Int.	0.0002 ppm	300	Hepatic	Final	09/97	000057-14-7
1,1,1-TRICHLOROETHANE	Inh.	Acute	2 ppm	100	Neurol.	Final	07/06	000071-55-6
		Int.	0.7 ppm	100	Neurol.			
	Oral	Int.	20 mg/kg/day	100	Body Wt.			
1,1,2-TRICHLOROETHANE	Oral	Acute	0.3 mg/kg/day	100	Neurol.	Final	12/89	000079-00-5
		Int.	0.04 mg/kg/day	100	Hepatic			
1,1,2,2-TETRACHLOROETHANE	Oral	Int.	0.5 mg/kg/day	100	Hepatic	Draft	09/06	000079-34-5
1,2-DIBROMO-3-CHLOROPROPANE	Inh.	Int.	0.0002 ppm	100	Repro.	Final	09/92	000096-12-8
	Oral	Int.	0.002 mg/kg/day	1000	Repro.			
1,2-DICHLOROETHANE	Inh.	Chr.	0.6 ppm	90	Hepatic	Final	09/01	000107-06-2
	Oral	Int.	0.2 mg/kg/day	300	Renal			
1,2-DICHLOROETHENE, CIS-	Oral	Acute	1 mg/kg/day	100	Hemato.	Final	08/96	000156-59-2
		Int.	0.3 mg/kg/day	100	Hemato.			
1,2-DICHLOROETHENE, TRANS-	Inh.	Acute	0.2 ppm	1000	Hepatic	Final	08/96	000156-60-5
		Int.	0.2 ppm	1000	Hepatic			
	Oral	Int.	0.2 mg/kg/day	100	Hepatic			
1,2-DICHLOROPROPANE	Inh.	Acute	0.05 ppm	1000	Resp.	Final	12/89	000078-87-5
		Int.	0.007 ppm	1000	Resp.			
	Oral	Acute	0.1 mg/kg/day	1000	Neurol.			
		Int.	0.07 mg/kg/day	1000	Hemato.			
		Chr.	0.09 mg/kg/day	1000	Hepatic			
			0.0008					000540-

1,2-DIMETHYLHYDRAZINE	Oral	Int.	mg/kg/day	1000	Hepatic	Final	09/97	73-8
1,2,3-TRICHLOROPROPANE	Inh.	Acute	0.0003 ppm	100	Resp.	Final	09/92	000096-18-4
	Oral	Int.	0.06 mg/kg/day	100	Hepatic			
1,3-DICHLOROPROPENE	Inh.	Int.	0.008 ppm	30	Resp.	Draft	09/06	000542-75-6
		Chr.	0.007 ppm	30	Resp.			
	Oral	Int.	0.04 mg/kg/day	100	Gastro.			
		Chr.	0.03 mg/kg/day	100	Gastro.			
1,3-DINITROBENZENE	Oral	Acute	0.008 mg/kg/day	100	Repro.	Final	06/95	000099-65-0
		Int.	0.0005 mg/kg/day	1000	Hemato.			
1,4-DIOXANE	Inh.	Acute	2 ppm	30	Ocular	Final	07/06	000123-91-1
		Int.	1 ppm	30	Hepatic			
		Chr.	1 ppm	30	Hepatic			
	Oral	Acute	4 mg/kg/day	100	Resp.			
		Int.	0.6 mg/kg/day	100	Hepatic			
		Chr.	0.1 mg/kg/day	100	Hepatic			
2-BUTOXYETHANOL	Inh.	Acute	6 ppm	9	Hemato.	Final	10/98	000111-76-2
		Int.	3 ppm	9	Hemato.			
		Chr.	0.2 ppm	3	Hemato.			
	Oral	Acute	0.4 mg/kg/day	90	Hemato.			
		Int.	0.07 mg/kg/day	1000	Hepatic			
2,3-DICHLOROPROPENE	Inh.	Acute	0.002 ppm	90	Resp.	Draft	09/06	000078-88-6
2,3,4,7,8-PENTACHLORODIBENZOFURAN	Oral	Acute	0.001 ug/kg/day	3000	Immuno.	Final	05/94	057117-31-4
		Int.	0.00003 ug/kg/day	3000	Hepatic			
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	Oral	Acute	0.0002 ug/kg/day	21	Immuno.	Final	12/98	001746-01-6
		Int.	0.00002 ug/kg/day	30	Lymphor.			
		Chr.	0.000001 ug/kg/day	90	Develop.			
2,4-DICHLOROPHENOL	Oral	Int.	0.003 mg/kg/day	100	Immuno.	Final	07/99	000120-83-2
2,4-DINITROPHENOL	Oral	Acute	0.01 mg/kg/day	100	Body Wt.	Final	08/95	000051-28-5
2,4-DINITROTOLUENE	Oral	Acute	0.05 mg/kg/day	100	Neurol.	Final	12/98	000121-14-2
		Chr.	0.002 mg/kg/day	100	Hemato.			

2,4,6-TRINITROTOLUENE	Oral	Int.	0.0005 mg/kg/day	1000	Hepatic	Final	06/95	000118-96-7
2,6-DINITROTOLUENE	Oral	Int.	0.004 mg/kg/day	1000	Hemato.	Final	12/98	000606-20-2
4-CHLOROPHENOL	Oral	Acute	0.01 mg/kg/day	100	Hepatic	Final	07/99	000106-48-9
4,4'-METHYLENEBIS(2-CHLOROANILINE)	Oral	Chr.	0.003 mg/kg/day	3000	Hepatic	Final	05/94	000101-14-4
4,4'-METHYLENEDIANILINE	Oral	Acute	0.2 mg/kg/day	300	Hepatic	Final	10/98	000101-77-9
		Int.	0.08 mg/kg/day	100	Hepatic			
4,6-DINITRO-O-CRESOL	Oral	Acute	0.004 mg/kg/day	100	Neurol.	Final	08/95	000534-52-1
		Int.	0.004 mg/kg/day	100	Neurol.			

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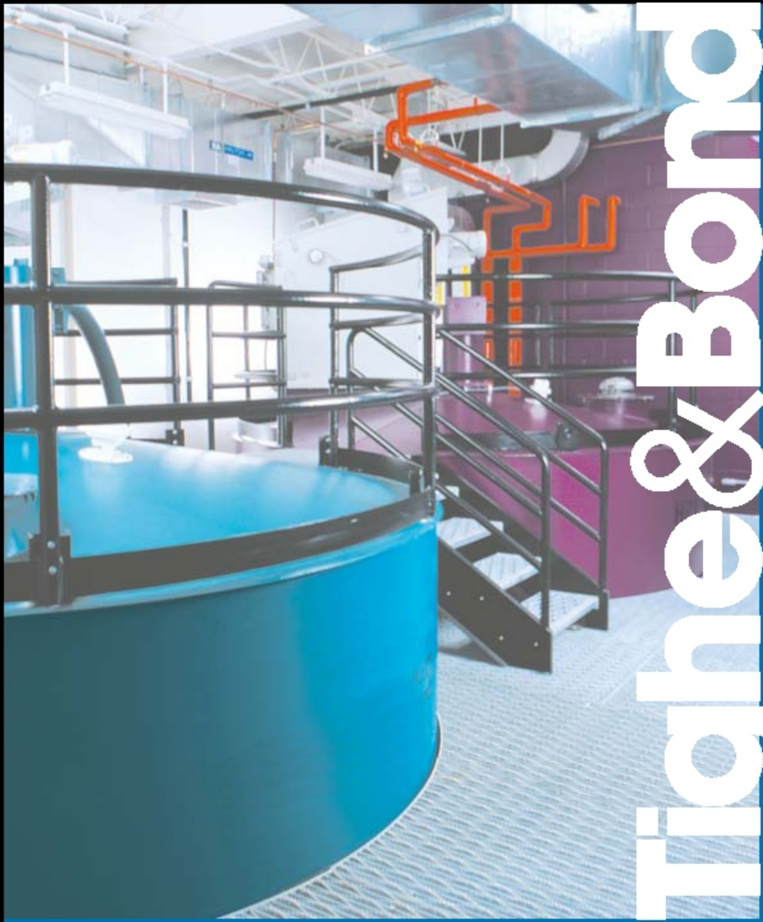

APPENDIX D

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GROUNDWATER INVESTIGATION REPORT

FORMER N.L. INDUSTRIES SITE
3241 WALDEN AVENUE
DEPEW, NEW YORK

Prepared For:
Cascades, Inc.

JUNE 2009
REF. NO. 630660 (2)
This report is printed on recycled paper.

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1.0 INTRODUCTION

This Groundwater Investigation Report presents the results of the 2009 groundwater investigation at the former N.L. Industries Site, located at 3241 Walden Avenue in Depew, New York (Site). This report has been prepared by Conestoga-Rovers & Associates (CRA) on behalf of Cascades inc. (Cascades) in accordance with CRA's Proposal for Professional Services dated February 3, 2009. Metro Waste Paper Recovery Inc. (Metro), a subsidiary of Cascades and a member of Norampac Inc., currently occupies the Site.

The scope of the Groundwater Investigation was as follows:

- Advance six boreholes on Site;
- Complete all six boreholes as monitoring wells;
- Develop all newly installed groundwater monitoring wells and existing monitoring well MW99-1;
- Measure groundwater elevations to determine groundwater flow and direction;
- Complete one round of groundwater sampling, using low-flow sampling techniques, to characterize groundwater impact through laboratory analysis; and
- Survey groundwater monitoring wells for location and elevation.

Monitoring well MW99-1 was destroyed and could not be sampled.

This report is organized into the following sections:

1) Section 1.0 – Introduction: The introduction presents an overview of the investigation and CRA's scope of work.
2) Section 2.0 – Site Description, History, and Current Use: Descriptions of the Site location, physical condition, and current use are presented in Section 2.0.
3) Section 3.0 – Prior Environmental Investigations: Prior environmental investigations are discussed in Section 3.0.
4) Section 4.0 – Groundwater Investigation Activities: A summary of the field work conducted during the investigation is presented in Section 4.0.
5) Section 5.0 – Investigative Results: The results of the investigation are presented in Section 5.0, including a characterization of Site soils and groundwater conditions, and a presentation and discussion of the groundwater analytical data.

6) <u>Section 6.0 - Conclusions</u>: The investigative conclusions are presented in Section 6.0.

7) <u>Section 7.0 - Signature Page:</u> This report is submitted by CRA Infrastructure & Engineering, Inc.

2.0 SITE DESCRIPTION, HISTORY, AND CURRENT USE

The Site is located at 3241 Walden Avenue in Depew, New York. The Site location and Site layout are shown on Figures 1 and 2, respectively. The legal description of the property is Part of Lot 68, Township 11, Range 7 of the Holland Land Company's Survey in the Village of Depew, Town of Cheektowaga, County of Erie. The Site comprises approximately 7.5 acres and is bounded on the north by Walden Avenue and a mix of residential and commercial sites, on the east and west by commercial/industrial properties, and on the south by railway tracks, and a concrete mixing plant further to the south.

The Site includes one main building, located at the east side of the property. The building area is approximately 63,400 square feet (ft^2) [5,890 square metres (m^2)]. A rail siding is adjacent to the south side of the building. A paved truck loading/unloading yard and trailer parking area are situated to the west of the building. The paved trucking yard acts as a cap for historically impacted soil underneath. The central and western portions of the Site are undeveloped.

The Site was developed for industrial use beginning in 1892. Past on-Site activities included brass foundry operations, smelting operations, lead processing, and Babbitt processing. Babbitt is formed from an alloy of various metals, including lead, copper, and antimony. Brass is an alloy of copper and zinc. Waste produced from Site operations, including the dredged material from the former settling lagoon and waste foundry sands, was reportedly spread throughout the Site.

A former lagoon and marsh area is located at the south side of the central undeveloped area. The former lagoon and marsh area were covered with hydroseeded-topsoil in 1999, and then surrounded by a chain link fence. The entire central undeveloped portion of the Site was covered with an asphalt parking lot to eliminate potential direct human exposure with metals-impacted fill. The western portion of the Site was covered with imported fill, including construction debris (i.e., brick and large concrete fragments).

Metro Site operations occur on the east side of the property. Since 1974, the Site has been used for paper fibre recycling by various companies.

3.0 PRIOR ENVIRONMENTAL INVESTIGATIONS

CRA reviewed the Remedial Action Plan (RAP), prepared by Tighe & Bond in December 2006. Tighe & Bond was retained by Norampac to prepare the RAP as a voluntary action in accordance with the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program. Tighe & Bond managed and served as lead engineer for the remediation project. The remediation strategy for the Site involved excavating lead-impacted soil from the western portion of the Site and consolidating it in the central portion. An asphalt parking lot was constructed, as a cap, on top of the consolidated and compacted material. To the west of the Site building, the truck loading/unloading yard and trailer parking area were paved to act as a cover cap for impacted soil underneath. Under the remediation strategy, the rail siding adjacent to the south of the building will be capped with geotextile fabric and crusher run or clear stone. Groundwater was not addressed in the RAP, as the criteria used to evaluate exceedances were developed for potable groundwater. Groundwater exceedances were deemed to be minor compared to drinking water standards. Groundwater at the Site was reported not to be a source of potable water, because the area is supplied by a public water system. The Site is a non-National Priorities List (NPL) site.

The RAP indicates that the Site is located in a commercial/industrial area and lies on a relatively flat parcel of land. The RAP reported that the Site is underlain by native overburden consisting of silt loam, silty clay, and bedrock. Tighe & Bond also indicated that fill material was encountered across the Site, ranging in depths from 2.9 to 11 feet below ground surface (ft bgs) (0.9 to 3.5 m bgs). The fill material consisted of various soils, including sand, gravel, and silty sand, in addition to metal waste.

Previous investigations conducted by NUS Corporation in the late 1980s, on behalf of the USEPA, identified the presence of elevated concentrations of polycyclic aromatic hydrocarbons (PAHs) and metals in surficial soils. The results of the investigation are presented in "Site Inspection Report, N.L. Industries/Buffalo Plant, Depew, New York", NUS Corporation, July 29, 1988.

Tighe & Bond completed subsurface investigations at the Site since 1998. Tighe & Bond investigations are summarized in:

- Limited Phase 1 Environmental Site Assessment, Former N.L. Industries Site, 3241 Walden Avenue, Depew, New York, dated June 11, 1999;
- Draft Limited Phase 2 Environmental Site Assessment, 3241 Walden Avenue, Depew, New York, dated February 10, 1999;

- Draft Limited Phase 2 Environmental Site Assessment, Former Oil Tanks Area, 3241 Walden Avenue, Depew, New York, dated February 10, 1999;
- Draft Additional Phase 2 Environmental Site Assessment, 3241 Walden Avenue, Depew, New York, dated May 18, 1999; and
- Draft Off-Site Surficial Soil Investigation, 3241 Walden Avenue, Depew, New York, dated July 26, 1999.

Off-Site surficial soil impacts were investigated by XCG Consultants Ltd. (XCG), under the oversight of New York State Department of Environmental Conservation (NYSDEC) and New York State Department of Health (NYSDOH). The results are presented in a document entitled "Health consultation – four metals in soil on off-Site residential properties, Former NL Industries Site, Depew, Erie County, New York", dated June 8, 2004.

A remedial investigation/feasibility study (RI/FS) was completed by XCG Consultants Ltd. (XCG) and presented in a report entitled "Remedial Investigation/Feasibility Study, Former NL Industries Site, 3241 Walden Avenue, Depew, New York", dated December 21, 2004.

Previous investigations, conducted by NUS Corporation, Tighe & Bond, and XCG, have identified the presence of hydrocarbon odors in the fill, and concentrations of polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and metals in soils at the Site at levels greater than the Technical and Administrative Guidance Memorandum (TAGM 4046) Cleanup Objectives or Eastern USA/New York State Background Values.

Monitoring wells sampled during previous investigations included five historic wells installed by an unknown party: one installed within fill material of the former lagoon, three monitoring wells installed in the central undeveloped area, and one monitoring well installed in the trucking yard. In 1999, Tighe & Bond installed three monitoring wells – one in the parking lot, and two in the western undeveloped area. Seven of the eight monitoring wells were abandoned because of remediation activities consisting of excavation activities in the west undeveloped area, and due to consolidation and cap activities in the central undeveloped area. Previous investigations, also conducted by Tighe & Bond, identified the presence of metals, PAHs, and bromide in groundwater samples from the Site at concentrations greater than Technical and Operational Guidance Series (TOGS) 1.1.1 Standards or Guidance Values.

4.0 GROUNDWATER INVESTIGATION ACTIVITIES

The primary objective of the groundwater investigation was to monitor groundwater conditions at the Site. The investigation was focused on the area adjacent to the central undeveloped area on Site.

Summaries of the field activities are presented in the following subsections. CRA completed field activities, including soil borings, groundwater monitoring well installations, and groundwater sampling, in March and April 2009.

4.1 SOIL BORING INSTALLATION

A total of six soil borings were advanced during this investigation to characterize groundwater. The soil boring locations are as follows:

i) Five boreholes were advanced adjacent to the central undeveloped area on Site (MW-101, MW-102, MW-103, MW-104, MW-105).

ii) One borehole was advanced within the impacted fill material (MW-106F). At the request of NYSDEC, MW-106F was installed only within the impacted fill material for the purpose of assessing the presence of perched soil water.

CRA contracted SJB Drilling Services, Inc., a New York state licensed well driller, to install the boreholes. Five soil borings were advanced into the first saturated zone, to a maximum depth of 27.3 ft bgs. All boreholes/monitoring wells were advanced using a rotary drill rig equipped with 11-centimetre (4.25-inch) internal diameter hollow stem augers (HSA). Continuous overburden soil samples were collected in 0.6-metre (2-foot) intervals using a 50-millimetre (2-inch) outside diameter split-spoon sampler. Soil samples were logged by a CRA technician, and included detailed geologic conditions encountered, soil classification, stratigraphy, relative moisture content, and photoionization detector (PID) headspace readings (for undifferentiated VOCs). Stratigraphic logs are presented in Appendix A. Soil cuttings generated during the installation activities were stored in 55-gallon DOT-approved drums, sampled for waste characterization, labeled, and staged at the Site for disposal at a later date.

As directed by Cascades, collected soil samples were not submitted for laboratory analyses.

4.2 GROUNDWATER MONITORING WELL INSTALLATION

Following completion of the boreholes, each location was converted to a new groundwater monitoring well (identified as MW-101, MW-102, MW-103, MW-104, MW-105, and MW-106F). Note that installation of monitoring well MW-102 was completed after the others due to the presence of overhead power lines in the only accessible location south of the capped area. New York State Electric & Gas (NYSEG) sent a representative to the Site to approve the clearance and grounding procedures.

Five of the six monitoring wells were constructed of a 3-m (10-ft) section of 1.5-inch, No. 10, pre-packed, manufactured slotted well screen, followed by 50-mm (2-inch) diameter Schedule 40 polyvinyl chloride (PVC) riser pipe. Due to the shallower depth of monitoring well MW-106F, which was installed into impacted fill material, it was constructed of a 1.5-m (5 ft) section of 1.5-inch, No. 10, pre-packed, manufactured slotted well screen, followed by 50-mm (2-inch) diameter Schedule 40 PVC riser pipe. Suitably graded sand pack was installed around the well screen, to a depth of approximately 2 feet above the top of the pre-packed screen. Above the well screen and sand pack, the void around the monitoring wells was filled with 2 feet of bentonite hole plug, and sealed to the surface with a cement/bentonite grout mixture. An 8-inch steel protective flushmount casing was installed to protect each well.

All of the monitoring wells installed during the groundwater investigation were drilled to a depth of 25 to 27 ft bgs, with the exception of MW-106F, which was drilled to a depth of 11 ft bgs.

Drilling equipment that came into contact with the soil was thoroughly decontaminated using a clean, hot water, high-pressure, low volume washer before each use. Water used in the decontamination process was contained inside two 55-gallon steel drums.

Groundwater monitoring well locations are shown on Figure 2. Table 1 presents the installation details of each of the six monitoring wells, including installed depths, screened length and intervals, and surveyed elevations. Well diagrams and construction details are provided on the stratigraphic logs presented in Appendix A.

4.3 GROUNDWATER SAMPLING

Samples were collected into laboratory-supplied sample containers specific to the matrix and analytical parameters. All samples scheduled for laboratory analyses were submitted to TestAmerica Inc. (TestAmerica, formerly Severn Trent Laboratories) in

North Canton, Ohio, under standard chain of custody (COC) procedures. From the time of collection to the time of submission to the laboratory, each sample was stored in a cooler to maintain a maximum sample temperature of less than 4°C.

CRA developed the monitoring wells two weeks after installation, to ensure that groundwater samples collected were representative of the groundwater in the formation in the vicinity of the well. CRA removed a minimum of three well volumes of groundwater from each well, and measured groundwater pH, temperature, conductivity, and turbidity to verify stabilization of the water within the well. Stabilization of groundwater was achieved when each of the field parameters was within 10 percent of the average over three consecutive readings, or in the case of pH, a minimum of three consecutive readings were within 1 standard unit of the average. In addition, as metals are a contaminant of concern at the Site, efforts were made to develop the wells with a resulting turbidity of less than 50 Nephelometric turbidity units (NTUs).

If, after three well volumes were removed, the field parameters had not stabilized according to the above criteria, additional well volumes (up to five well volumes) were removed. If the well purged dry, the well was allowed to recover overnight and sampled the following day.

Monitoring wells were allowed to recover a minimum of 24 hours following development, prior to completing sampling activities. CRA used low-flow field sampling procedures. All wells were sampled within 24 hours of completing the purging activities.

CRA collected one round of groundwater samples from the six new on-Site wells in April 2009. Existing on-Site monitoring well MW99-1 has been destroyed and could not be sampled. The flushmount casing of MW99-1 was destroyed, and the well was filled with dirt, debris, and gravel. The groundwater samples were submitted for Target Compound List (TCL) VOCs, semi-volatile organic compounds (SVOCs), and Target Analyte List (TAL) metals. For quality control purposes and to aid in the data validation process, CRA submitted one duplicate groundwater sample. A summary of groundwater sampling information, including wells sampled, water levels, purging information, field parameter measurements, and laboratory analysis, is presented in Table 2. Well development and purging records are presented in Appendix B.

One composite soil sample was collected from the drummed auger cuttings and submitted for Toxicity Characteristic Leaching Procedure (TCLP) analysis. TCLP testing was conducted for VOC, SVOC, and metals analyses on the soil to determine disposal requirements.

5.0 INVESTIGATIVE RESULTS

5.1 SOIL CONDITIONS

The fill encountered at the Site ranged in thickness from 2 ft (0.6 m) to 6 ft (1.8 m), with the thickest fill encountered around and within the central undeveloped area at MW-101, MW-102, MW-104, and MW-106F. The fill consisted of silt and gravel, fine to coarse-grained sand, and clay. Cinders and brick fragments were also encountered in the fill.

The native soils underlying the fill generally consist of clay and silt, trace gravel, and bedrock. The top of bedrock was observed only in MW-103, occurring at a depth of 27.3 ft bgs.

5.2 GROUNDWATER CONDITIONS

Based on the groundwater level measurements collected by CRA on April 14, 2009, it appears that groundwater flow occurs in a generally northerly direction. Water level measurements collected from MW-106F were not used in the determination of groundwater flow, as MW-106F was screened at the bottom of the fill adjacent to the central undeveloped area. Groundwater present in MW-106F was representative of a layer of perched groundwater, present above the native clay material. Groundwater contours generated for the round of measurements are presented on Figure 3.

5.3 GROUNDWATER ANALYTICAL RESULTS

The groundwater data resulting from the field activities were reviewed for quality assurance. The following subsections present a discussion of the analytical results. Laboratory analytical reports for groundwater samples are contained electronically in Appendix C. Data Validation reports are provided in Appendix D.

A summary of the compounds detected and exceedances of groundwater criteria in the groundwater samples is presented in Table 3. Analytical results were compared to the standards listed in NYSDEC 6 NYCRR Part 703.5 New York State Water Quality Standards (Standards). Where no standard was given, guidance values per NYSDEC Division of Technical and Operational Guidance Series (TOGS) 1.1.1 "Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations" (June 1998) were used. Exceedances are shown on Figure 4.

5.3.1 VOLATILE/SEMI-VOLATILE ORGANIC COMPOUNDS

The only VOC that was detected above Standards or Guidance Values was in the perched groundwater sample from MW-106F. Acetone was detected at a concentration of 71 µg/L, which exceeded the TOGS Guidance Value of 50 µg/L. Acetone was not detected in any laboratory QA/QC samples, including the method blank. However, acetone is a common laboratory contaminant. No other VOCs were detected in groundwater samples at concentrations greater than water quality standards or guidance values.

No exceedances of SVOCs were observed in the groundwater samples.

5.3.2 METALS

Total metals were analyzed in groundwater samples from all six monitoring wells (MW-101, MW-102, MW-103, MW-104, MW-105, and MW-106F). Concentrations of magnesium and sodium were detected in all wells at concentrations greater than their respective TOGS guidance values and groundwater quality standards of 35,000 µg/L and 20,000 µg/L, respectively. Concentrations of iron were detected at concentrations greater than the groundwater quality standard of 300 µg/L in samples from all wells except MW-104. Antimony was detected above the groundwater quality standard of 3.0 µg/L in the samples from MW-106F and MW-101. Manganese was also detected at a concentration greater than the groundwater quality standard of 300 µg/L in the sample from MW-105. The following table presents a summary of groundwater metal concentrations that were greater than water quality standards or guidance values.

Parameter	*Water Quality Standards (µg/L)*	*Guidance Values (µg/L)*	*Location(s)*	*Concentration Range (µg/L)*
Antimony	3	--	MW-101 and MW-106F	5.7 - 34.9
Iron	300	--	MW-101, MW-102, MW-103, MW-105, and MW-106F	541 - 19,000
Magnesium	--	35,000	All	46,000 - 108,000
Manganese	300	--	MW-105	478
Sodium	20,000	--	All	30,200 - 100,000

6.0 CONCLUSIONS

The following conclusions have been drawn from the groundwater investigation performed at the Site.

The central undeveloped area contains lead-impacted soil that was excavated from the western portion of the Site. Six monitoring wells were installed adjacent to the central undeveloped area. The existing on-Site monitoring well MW99-1 was destroyed and could not be sampled. Groundwater samples collected from the monitoring wells contained concentrations of acetone, antimony, iron, magnesium, manganese, and sodium that were greater than groundwater quality standards or TOGS guidance values. Lead was present in groundwater samples at concentrations less than the groundwater quality standard of 25 µg/L.

The one exceedance of acetone may have been the result of laboratory contamination, although acetone was not detected in any laboratory QA/QC samples. The concentration of antimony in the groundwater sample from MW-101 was likely due to historical Site activities. Iron, magnesium, manganese, and sodium are common elements contained in soils and are also typically present in groundwater.

Depew, New York is served by a public water supply system. The area surrounding the Site is a well-developed urbanized area with no reported water supply wells; therefore, exposure to contaminants in shallow groundwater is not expected.

7.0 SIGNATURE PAGE

All of Which is Respectfully Submitted,
CRA INFRASTRUCTURE & ENGINEERING, INC.

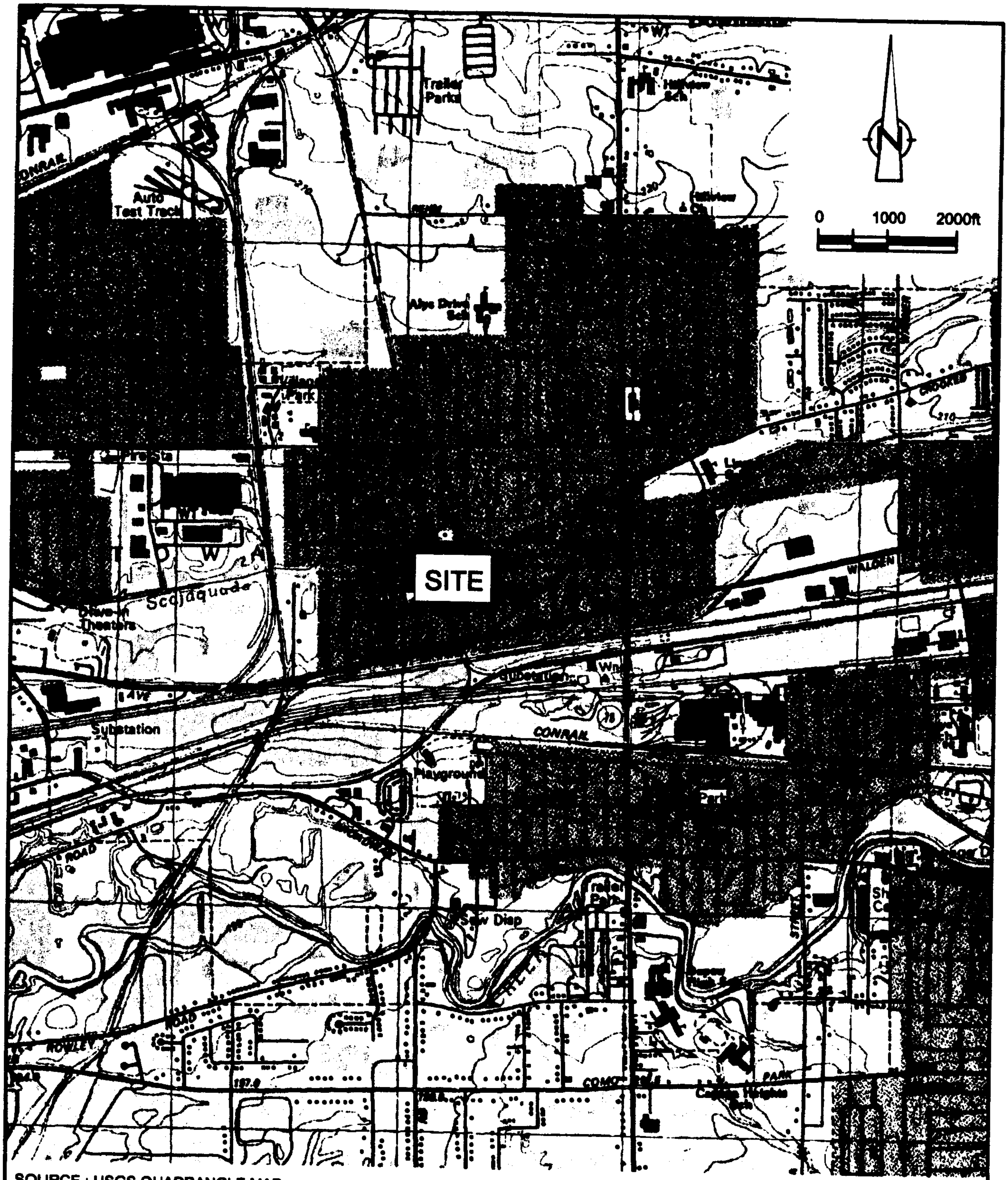
Robert G. Adams

Robert G. Adams, P.E.
New York State License Number 064918

6/1/09
Date

ROBERT G. ADAMS
064918

FIGURES

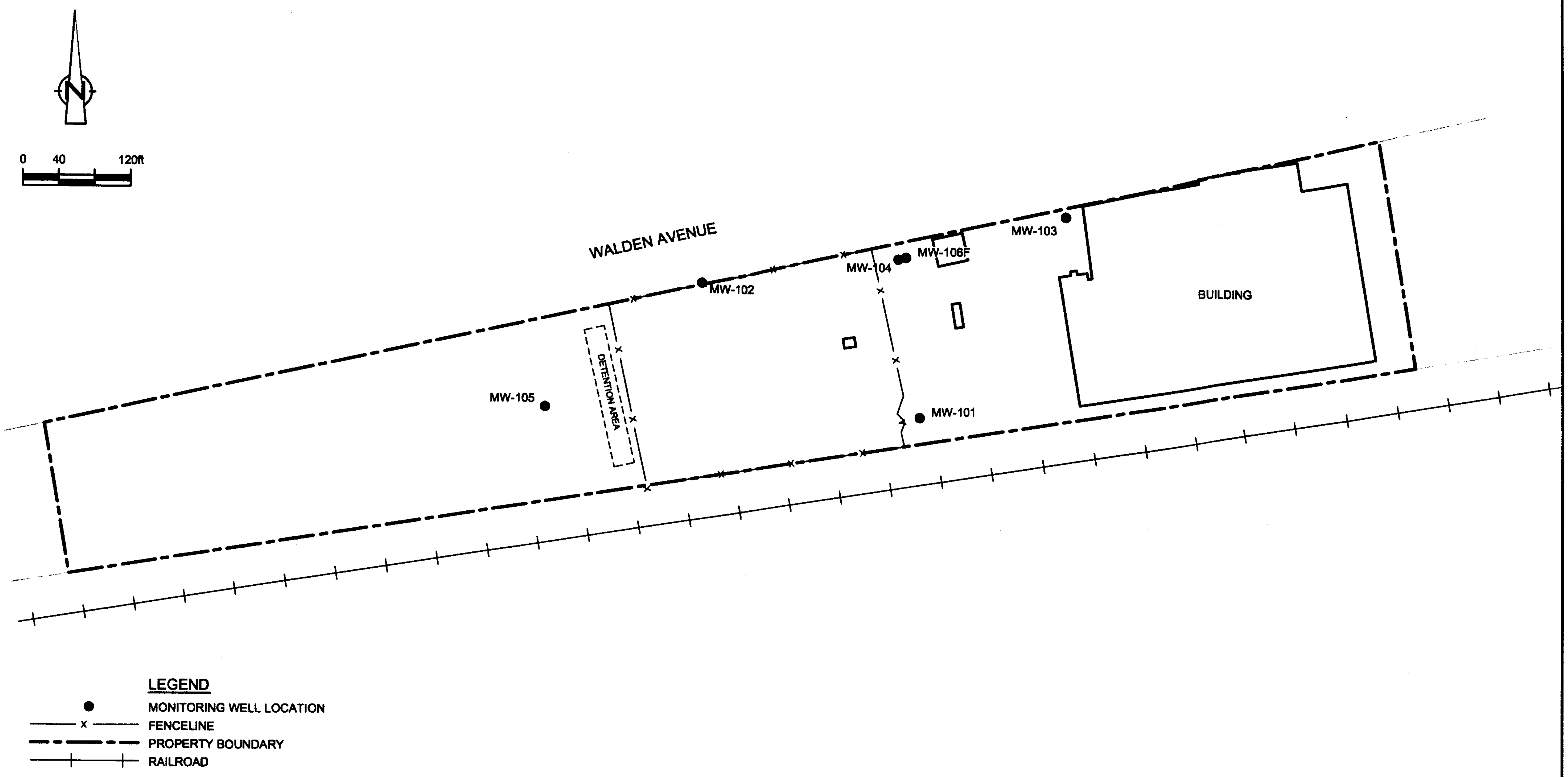


SOURCE : USGS QUADRANGLE MAP:
LANCASTER, NEW YORK

figure 1

SITE LOCATION MAP
FORMER N.L. INDUSTRIES SITE REMEDIATION
3241 WALDEN AVENUE
Depew, New York

630660-00(002)GN-WA001 APR 27/2009

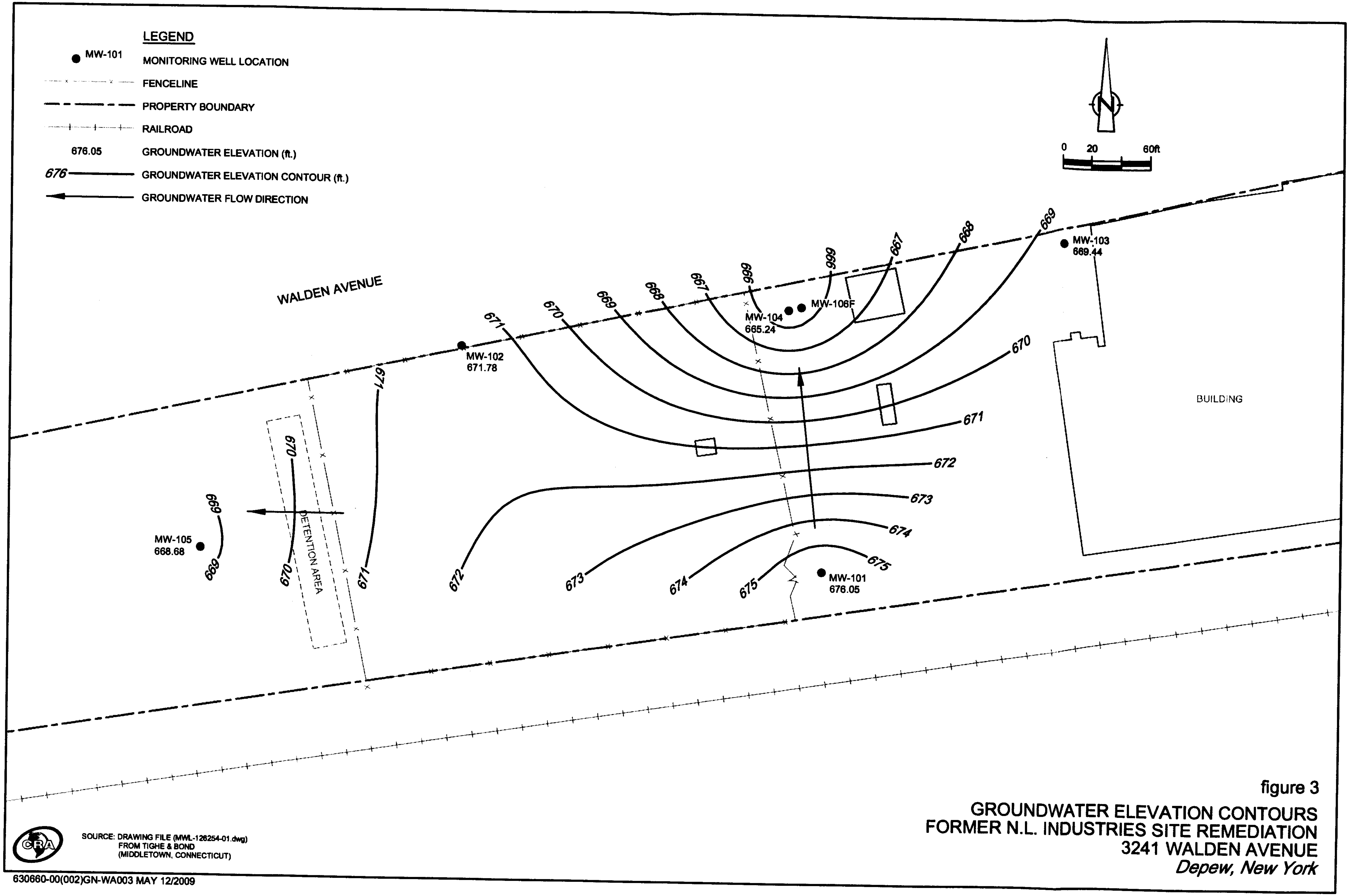


SOURCE: DRAWING FILE (MWL-126254-01.dwg)
FROM TIGHE & BOND
(MIDDLETOWN, CONNECTICUT)

figure 2

SITE LAYOUT
FORMER N.L. INDUSTRIES SITE REMEDIATION
3241 WALDEN AVENUE
Depew, New Yourk

630660-00(002)GN-WA002 APR 27/2009

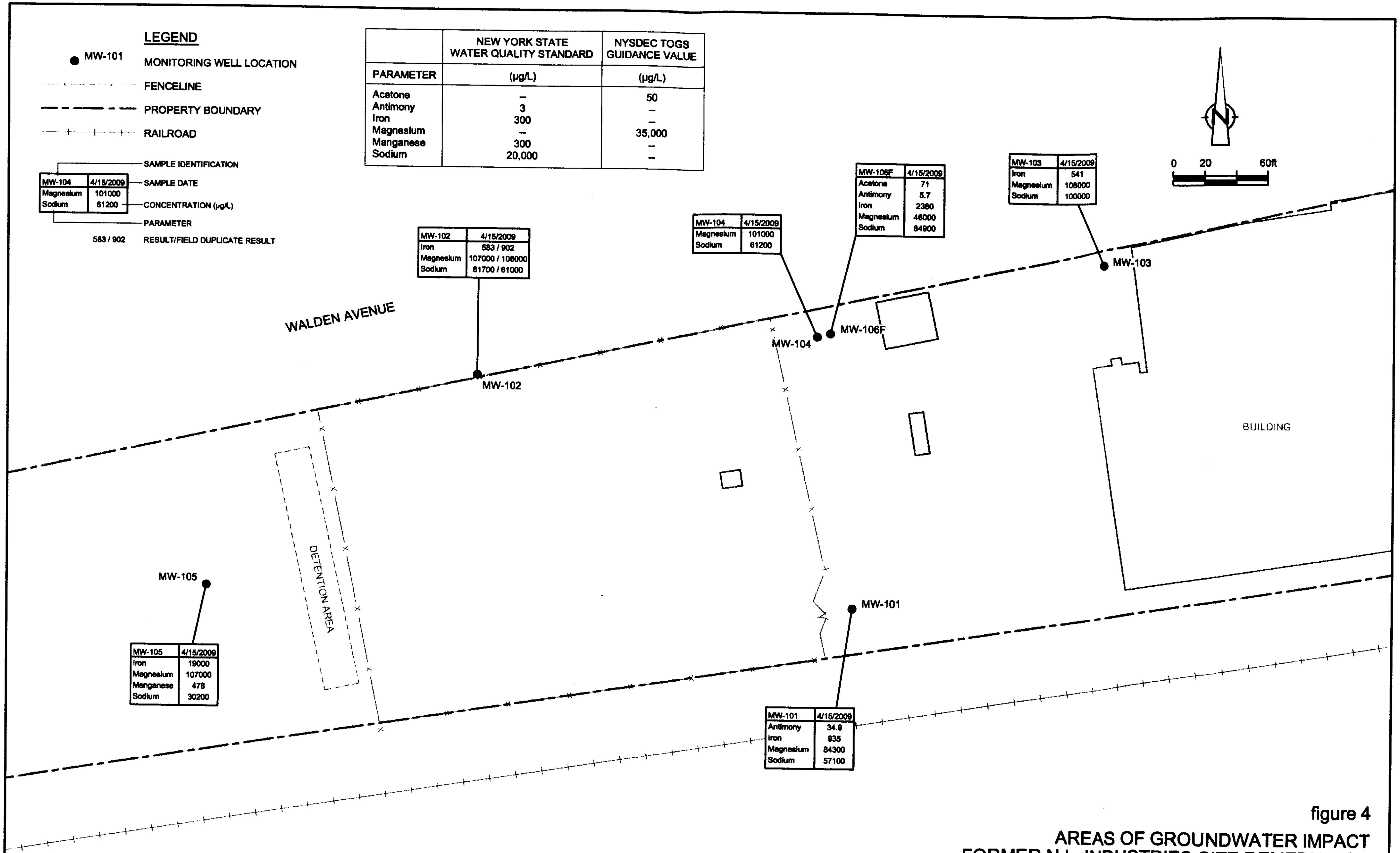


SOURCE: DRAWING FILE (MWL-126254-01.dwg)
FROM TIGHE & BOND
(MIDDLETOWN, CONNECTICUT)

figure 3

GROUNDWATER ELEVATION CONTOURS
FORMER N.L. INDUSTRIES SITE REMEDIATION
3241 WALDEN AVENUE
Depew, New York

630660-00(002)GN-WA003 MAY 12/2009



	NEW YORK STATE WATER QUALITY STANDARD	NYSDEC TOGS GUIDANCE VALUE
PARAMETER	(µg/L)	(µg/L)
Acetone	–	50
Antimony	3	–
Iron	300	–
Magnesium	–	35,000
Manganese	300	–
Sodium	20,000	–

MW-104	4/15/2009
Magnesium	101000
Sodium	61200

MW-102	4/15/2009
Iron	583 / 902
Magnesium	107000 / 106000
Sodium	61700 / 61000

MW-104	4/15/2009
Magnesium	101000
Sodium	61200

MW-106F	4/15/2009
Acetone	71
Antimony	5.7
Iron	2380
Magnesium	46000
Sodium	84900

MW-103	4/15/2009
Iron	541
Magnesium	108000
Sodium	100000

MW-105	4/15/2009
Iron	19000
Magnesium	107000
Manganese	478
Sodium	30200

MW-101	4/15/2009
Antimony	34.9
Iron	935
Magnesium	84300
Sodium	57100

SOURCE: DRAWING FILE (MWL-126254-01.dwg)
FROM TIGHE & BOND
(MIDDLETOWN, CONNECTICUT)

figure 4

AREAS OF GROUNDWATER IMPACT
FORMER N.L. INDUSTRIES SITE REMEDIATION
3241 WALDEN AVENUE
Depew, New York

630660-00(002)GN-WA004 MAY 13/2009

TABLES

TABLE 1

SUMMARY OF MONITORING WELL DETAILS
3241 WALDEN AVE.
CASCADES, INC.
DEPEW, NEW YORK

Well ID	*Date of Installation*	*Depth of Installation (ft bgs)*	*Top of Riser Elevation (ft above AMSL)*	*Bottom of Well Elevation (ft above AMSL)*	*Screen Length (ft)*	*Screened Interval (ft bgs)*
MW-101	23-Mar-2009	27.3	678.03	652.93	10	661.03 - 651.03
MW-102	27-Mar-2009	25.2	675.67	651.07	10	660.56 - 650.56
MW-103	23-Mar-2009	27	677.56	650.86	10	660.57 - 650.57
MW-104	24-Mar-2009	27.1	677.06	650.56	10	660.06 - 650.06
MW-105	25-Mar-2009	26	675.48	651.18	10	659.41 - 649.41
MW-106F	25-Mar-2009	11	677.43	667.13	5	671.38 - 666.38

Notes:

ft bgs	feet below ground surface
AMSL	above mean sea level

TABLE 2

SUMMARY OF GROUNDWATER SAMPLE COLLECTION AND ANALYSIS DETAILS
3241 WALDEN AVE.
CASCADES, INC.
DEPEW, NEW YORK

Well ID	*Sample Management Date*	*Depth to Water (ft below top of riser)*	*Water Elevation (ft above AMSL)*	*Sampling Method*	*Approximate Volume Purged (L)*	*pH*	*Turbidity (NTU)*	*Temperature (C)*	*Conductivity (mS/cm)*	*DO (mg/L)*	*Analysis/Parameters*			
											TCL VOCs	*TCL SVOCs*	*Total TAL Metals*	
MW-101	04/14/09	2.91	675.12	Low Flow	2.00	7.10	45.80	10.50	1.24	16.62	X	X	X	
MW-102	04/14/09	3.46	672.21	Low Flow	2.50	6.45	0.00	10.20	1.43	0.53	X	X	X	Duplicate
MW-103	04/14/09	4.88	672.68	Low Flow	2.00	6.54	60.80	11.00	1.91	3.32	X	X	X	
MW-104	04/14/09	5.62	671.44	Low Flow	2.00	6.77	0.00	12.20	1.41	4.43	X	X	X	
MW-105	04/14/09	6.61	668.87	Low Flow	2.00	7.19	84.90	9.70	0.81	3.84	X	X	X	
MW-106F	04/14/09	8.53	668.90	Low Flow	–	–	–	–	–	-	X	X	X	

Notes:

MW106F stability parameters were not measured, due to extremely low well volume.

TABLE 3

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
3241 WALDEN AVE.
CASCADES INC.
DEPEW, NEW YORK

Location ID:			MW-101	MW-102	MW-102	MW-103	MW-104	MW-105	MW-106F
Sample Name:			WG-630660-041509-JJW-006	WG-630660-041509-JJW-001	WG-630660-041509-JJW-002	WG-630660-041509-JJW-005	WG-630660-041509-JJW-003	WG-630660-041509-JJW-007	WG-630660-041509-JJW-004
Sample Date:			4/15/2009	4/15/2009	4/15/2009 Duplicate	4/15/2009	4/15/2009	4/15/2009	4/15/2009
	New York State Water Quality								
Parameters	*Standards* *a*	*Guidance Values* *b*							
Volatile Organic Compounds									
1,1,1-Trichloroethane	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,1,2,2-Tetrachloroethane	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,1,2-Trichloroethane	1	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethane	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethene	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromo-3-chloropropane (DBCP)	0.04	NC	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
1,2-Dibromoethane (Ethylene Dibromide)	0.0006	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichlorobenzene	3	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloroethane	0.6	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloropropane	1	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,3-Dichlorobenzene	3	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,4-Dichlorobenzene	3	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
2-Butanone (Methyl Ethyl Ketone)	NC	50	0.75 J	10 U	10 U	10 U	10 U	1.2 J	0.67 J
2-Hexanone	NC	50	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	NC	NC	10 U	10 UJ	10 U	10 UJ	10 U	10 U	10 U
Acetone	NC	50	1.1 J	10 U	10 U	10 U	10 U	3.8 J	71[b]
Benzene	1	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.79 J	1.0 U
Bromodichloromethane	NC	50	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.46 J
Bromoform	NC	50	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Bromomethane (Methyl Bromide)	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Carbon disulfide	60	60	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Carbon tetrachloride	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Chlorobenzene	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Chloroethane	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform (Trichloromethane)	7	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.1
Chloromethane (Methyl Chloride)	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
cis-1,2-Dichloroethene	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
cis-1,3-Dichloropropene	NC	NC	1.0 UJ	1.0 U	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ
Cyclohexane	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Dibromochloromethane	NC	50	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Dichlorodifluoromethane (CFC-12)	5	NC	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ
Ethylbenzene	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Isopropylbenzene	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methyl acetate	NC	NC	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Methyl cyclohexane	NC	NC	1.0 U	1.0 UJ	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methyl Tert Butyl Ether	NC	10	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylene chloride	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Styrene	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Tetrachloroethene	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Toluene	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.3	1.0 U
trans-1,2-Dichloroethene	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
trans-1,3-Dichloropropene	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Trichloroethene	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Trichlorofluoromethane (CFC-11)	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Trifluorotrichloroethane (Freon 113)	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl chloride	2	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Xylene (total)	NC	NC	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.73 J	2.0 U
Semi-Volatile Organic Compounds									
2,2'-oxybis(1-Chloropropane) (bis(2-chloroisopropyl) ether)	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
2,4,5-Trichlorophenol	NC	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2,4,6-Trichlorophenol	NC	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2,4-Dichlorophenol	5	NC	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
2,4-Dimethylphenol	NC	50	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
2,4-Dinitrophenol	NC	10	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2,4-Dinitrotoluene	5	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2,6-Dinitrotoluene	5	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Chloronaphthalene	NC	10	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
2-Chlorophenol	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
2-Methylnaphthalene	NC	NC	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
2-Methylphenol	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
2-Nitroaniline	5	NC	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
2-Nitrophenol	NC	NC	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
3,3'-Dichlorobenzidine	5	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
3-Nitroaniline	5	NC	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
4,6-Dinitro-2-methylphenol	NC	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
4-Bromophenyl phenyl ether	NC	NC	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
4-Chloro-3-methylphenol	NC	NC	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
4-Chloroaniline	5	NC	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
4-Chlorophenyl phenyl ether	NC	NC	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
4-Methylphenol	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
4-Nitroaniline	5	NC	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
4-Nitrophenol	NC	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Acenaphthene	NC	20	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U

TABLE 3

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
3241 WALDEN AVE.
CASCADES INC.
DEPEW, NEW YORK

Parameters	*New York State Water Quality Standards* *a*	*New York State Water Quality Guidance Values* *b*	*Location ID:* *MW-101*	*MW-102*	*MW-102*	*MW-103*	*MW-104*	*MW-105*	*MW-106F*
		Sample Name:	*WG-630660-041509-JJW-006*	*WG-630660-041509-JJW-001*	*WG-630660-041509-JJW-002*	*WG-630660-041509-JJW-005*	*WG-630660-041509-JJW-003*	*WG-630660-041509-JJW-007*	*WG-630660-041509-JJW-004*
		Sample Date:	*4/15/2009*	*4/15/2009*	*4/15/2009* *Duplicate*	*4/15/2009*	*4/15/2009*	*4/15/2009*	*4/15/2009*
Semi-Volatile Organic Compounds (cont'd)									
Acenaphthylene	NC	NC	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Acetophenone	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.5
Anthracene	NC	50	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Atrazine	7.5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Benzaldehyde	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Benzo(a)anthracene	NC	0.002	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Benzo(a)pyrene	NC	NC	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Benzo(b)fluoranthene	NC	0.002	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Benzo(g,h,i)perylene	NC	NC	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Benzo(k)fluoranthene	NC	0.002	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Biphenyl	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
bis(2-Chloroethoxy)methane	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
bis(2-Chloroethyl)ether	1	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
bis(2-Ethylhexyl)phthalate	5	NC	2.0 U	2.0 U	5.7 U	6.0 U	2.0 U	2.0 U	2.0 U
Butyl benzylphthalate	NC	50	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Caprolactam	NC	NC	130	5.0 U	5.0 U	5.0 U	18	5.0 U	5.0 U
Carbazole	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Chrysene	NC	0.002	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Dibenz(a,h)anthracene	NC	NC	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Dibenzofuran	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Diethyl phthalate	NC	50	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Dimethyl phthalate	NC	50	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Di-n-butylphthalate	50	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Di-n-octyl phthalate	NC	50	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Fluoranthene	NC	50	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.21 U	0.25
Fluorene	NC	50	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Hexachlorobenzene	0.04	NC	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Hexachlorobutadiene	0.5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Hexachlorocyclopentadiene	5	NC	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Hexachloroethane	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Indeno(1,2,3-cd)pyrene	NC	0.002	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Isophorone	NC	50	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.5	1.0 U
Naphthalene	NC	10	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Nitrobenzene	0.4	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
N-Nitrosodi-n-propylamine	NC	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
N-Nitrosodiphenylamine	NC	50	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Pentachlorophenol	1	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Phenanthrene	NC	50	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.23
Phenol	1	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Pyrene	NC	50	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Metals									
Aluminum	NC	NC	849	479	747	304	119 J	13100	3200
Antimony	3	NC	34.9^{a}	0.21 J	0.26 J	0.28 J	0.22 J	0.45 J	5.7^{a}
Arsenic	25	NC	3.1 J	0.94 J	1.1 J	1.8 J	8.2	4.0 J	1.9 J
Barium	1000	NC	156 J	69.5 J	70.7 J	90.8 J	42.6 J	172 J	114 J
Beryllium	NC	3	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	0.58 J	5.0 U
Cadmium	5	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Calcium	NC	NC	67200	85200	84200	109000	58100	252000	84900
Chromium	50	NC	2.0 J	1.2 J	1.9 J	10.0 U	10.0 U	23.6	11.0
Cobalt	NC	NC	1.3 J	0.76 J	0.85 J	0.46 J	0.20 J	6.0 J	0.60 J
Copper	200	NC	44.8	4.5 J	6.1 J	25.0 U	25.0 U	21.8 J	25.1
Iron	300	NC	935^{a}	583^{a}	902^{a}	541^{a}	251	19000^{a}	2380^{a}
Lead	25	NC	10.9	2.4	3.6	0.37 J	0.66 J	14.9	18.2
Magnesium	NC	35000	84300^{b}	107000^{b}	106000^{b}	108000^{b}	101000^{b}	107000^{b}	46000^{b}
Manganese	300	NC	173	110	110	49.7	18.8	478^{a}	58.9
Mercury	0.7	NC	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.17 J	0.20 U
Nickel	100	NC	3.5 J	1.1 J	1.7 J	1.2 J	0.49 J	20.0 J	2.5 J
Potassium	NC	NC	12500	3100 J	3110 J	3780 J	2440 J	13600	7110
Selenium	10	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	1.9 J
Silver	50	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Sodium	20000	NC	57100^{a}	61700^{a}	61000^{a}	100000^{a}	61200^{a}	30200^{a}	84900^{a}
Thallium	NC	0.5	0.26 J	1.0 U	1.0 U	1.0 U	1.0 U	0.18 J	1.0 U
Vanadium	NC	NC	2.4 J	0.79 J	1.3 J	0.56 J	50.0 U	23.6 J	3.4 J
Zinc	NC	2000	45.0 U	20.0 U	20.0 U	20.0 U	20.0 U	63.8 U	36.0 U

Notes:

All concentrations are expressed in units of micrograms per litre (µg/L), unless otherwise noted.
51 - Concentration was greater than applicable criteria.
U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
J - The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample
-- - Not available.
NC - No criteria.
a - New York State Department of Environmental Conservation (NYSDEC) 6 NYCRR Part 703.5 New York State Water Quality Standards.
b - NYSDEC Division of Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (June 1998).

APPENDICES

A

APPENDIX A

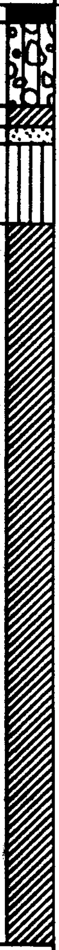
STRATIGRAPHIC LOGS

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

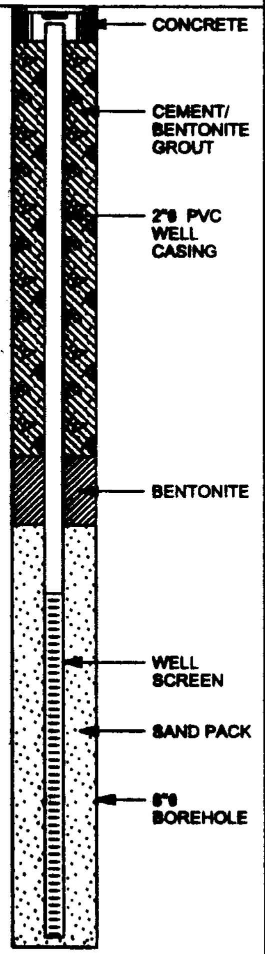
Page 1 of 1

PROJECT NAME: Cascades - Depew	**HOLE DESIGNATION:** MW-101
PROJECT NUMBER: 630660	**DATE COMPLETED:** 23 March 2009
CLIENT: Cascades Inc.	**DRILLING METHOD:** 4.25" HSA
LOCATION: Depew, New York	**FIELD PERSONNEL:** J. Williams

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. ft Site Datum
	TOP OF CASING GROUND SURFACE	678.03 678.03
	ASPHALT	677.53
	GM-SILT and GRAVEL, some sand, fine grained sand, angular gravel, black, dry (FILL)	
2		
	CL-CLAY, little silt, stiff, low plasticity, brown, dry (FILL)	675.13 674.53
4	SP-SAND, little gravel, fine grained sand, angular gravel, red/black, moist to wet (FILL)	674.03
6	ML-SILT, some sand and cinders, fine grained sand, black, moist to wet (FILL)	671.73
	CL-CLAY, little silt, stiff, low plasticity, red/brown, dry to moist	
8		
10		
12		
14		
16	- trace angular gravel, becoming soft, medium plasticity, brown, moist below 15.5 ft BGS	
	- some silt, little subrounded gravel, moist to wet below 16 ft BGS	
18		
20		
22	- spoon refusal-rock, auger from 21.6 to 27.3 ft BGS	
	- very soft, high plasticity below 22 ft BGS	
24		
	- some angular gravel and medium to coarse sand, wet below 24.7 ft BGS	
26	- dry to moist below 26 ft BGS	
	END OF BOREHOLE @ 27.3ft BGS	650.73
28		
	Spoon Refusal @ 27.3 ft BGS	
30		
32		
34		
36		



Monitoring Well



WELL DETAILS

Screened Interval:
661.03 to 651.03ft Site Datum
17.00 to 27.00ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 10
Material: PVC
Seal:
665.03 to 663.03ft Site Datum
13.00 to 15.00ft BGS
Material: BENTONITE
Sand Pack:
663.03 to 650.73ft Site Datum
15.00 to 27.30ft BGS
Material: #1 SAND

SAMPLE				
NUMBER	INTERVAL	REC (ft)	'N' VALUE	PID (ppm)
SS1	☒	1.0	30	0
SS2	☒	2.0	15	0
SS3	☒	2.0	3	0
SS4	☒	2.0	35	0
SS5	☒	2.0	28	0
SS6	☒	2.0	24	0
SS7	☒	2.0	59	0
SS8	☒	2.0	13	0
SS9	☒	2.0	16	0
SS10	☒	2.0	25	0
SS11	☒	1.5	>50	
SS12	☒	2.0	11	
SS13	☒	2.0	17	
SS14	☒	1.5	>100	

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

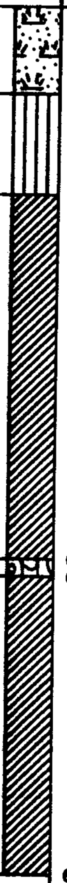
Page 1 of 1

PROJECT NAME: Cascades - Depew
PROJECT NUMBER: 630660
CLIENT: Cascades Inc.
LOCATION: Depew, New York

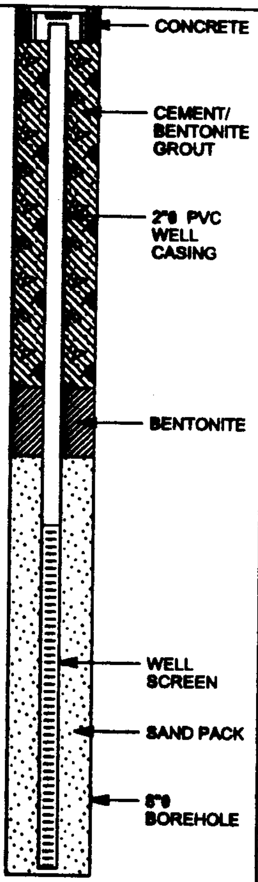
HOLE DESIGNATION: MW-102
DATE COMPLETED: 27 March 2009
DRILLING METHOD: 4.25" HSA
FIELD PERSONNEL: J. Williams

STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. ft Site Datum
TOP OF CASING	675.67
GROUND SURFACE	675.56
ML-SILT, some clay, little rounded gravel, firm, dark brown, moist (TOPSOIL)	
ML-SILT, little clay and gravel, firm, dark brown to black, moist (FILL) - wet below 4.5 ft BGS	673.06
CL-CLAY, little silt, stiff, brown, moist - red/brown, dry to moist below 6.8 ft BGS - little subrounded to subangular gravel below 8.2 ft BGS - brown below 13 ft BGS	670.16
GM-SILT and GRAVEL, some medium to coarse grained sand, brown, wet	659.56
CL-CLAY, little angular to rounded gravel, soft, high plasticity, brown, very moist - some gravel, moist to wet below 22 ft BGS - firm, dense, moist below 24 ft BGS - rock fragments between 25 and 25.2 ft BGS	659.06
END OF BOREHOLE @ 25.2ft BGS	650.36

DEPTH ft BGS: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36



Monitoring Well



WELL DETAILS
Screened Interval:
660.56 to 650.56ft Site Datum
15.00 to 25.00ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 10
Material: PVC
Seal:
664.56 to 662.56ft Site Datum
11.00 to 13.00ft BGS
Material: BENTONITE
Sand Pack:
662.56 to 650.36ft Site Datum
13.00 to 25.20ft BGS
Material: #1 SAND

SAMPLE				
NUMBER	INTERVAL	REC (ft)	'N' VALUE	PID (ppm)
SS1	☒	1.5	12	0
SS2	☒	1.0	9	0
SS3	☒	1.5	3	0
SS4	☒	1.5	29	0
SS5	☒	2.0	26	0
SS6	☒	1.7	19	0
SS7	☒	2.0	25	0
SS8	☒	2.0	10	0
SS9	☒	2.0	13	0
SS10	☒	2.0	10	0
SS11	☒	0.0	12	
SS12	☒	1.5	25	0
SS13	☒		>50	

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

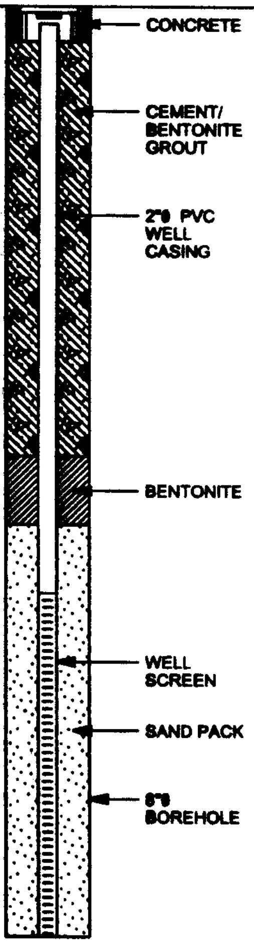
Page 1 of 1

PROJECT NAME: Cascades - Depew
PROJECT NUMBER: 630660
CLIENT: Cascades Inc.
LOCATION: Depew, New York

HOLE DESIGNATION: MW-103
DATE COMPLETED: 23 March 2009
DRILLING METHOD: 4.25" HSA
FIELD PERSONNEL: J. Williams

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. ft Site Datum
	GROUND SURFACE	677.57
	TOP OF CASING	677.56
	ASPHALT	677.07
	ML-SILT, little gravel, black, moist (FILL)	676.57
2	FILL-yellow brick fragments	675.37
	CL-CLAY, little silt, stiff, low plasticity, brown, moist	
4		
6	- red-brown, dry to moist below 6 ft BGS	
8		
	- little subrounded gravel, medium plasticity, moist below 9.2 ft BGS	
10	ML-SILT, little subrounded gravel, trace clay, medium soft, brown, moist	667.37
12		
14	- trace fine sand, soft, gray-brown below 14.3 ft BGS	
16		
18		
20	- bedrock fragment @ 20.5 ft BGS	
22		
24		
26	- some angular gravel and coarse sand, moist to wet below 26.7 ft BGS	650.57
28	END OF BOREHOLE @ 27.0ft BGS	
	Spoon Refusal @ 27 ft BGS	
30	Top of bedrock	
32		
34		
36		

Monitoring Well



WELL DETAILS
Screened interval:
660.57 to 650.57ft Site Datum
17.00 to 27.00ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 10
Material: PVC
Seal:
664.57 to 662.57ft Site Datum
13.00 to 15.00ft BGS
Material: BENTONITE
Sand Pack:
662.57 to 650.57ft Site Datum
15.00 to 27.00ft BGS
Material: #1 SAND

SAMPLE				
NUMBER	INTERVAL	REC (ft)	'N' VALUE	PID (ppm)
SS1	☒	0.8	7	0
SS2	☒	1.0	14	0
SS3	☒	2.0	24	0
SS4	☒	2.0	36	0
SS5	☒	2.0	17	0
SS6	☒	2.0	37	0
SS7	☒	1.7	17	0
SS8	☒	2.0	9	0
SS9	☒	2.0	14	
SS10	☒	0.0	10	0
SS11	☒	0.8	15	0
SS12	☒	2.0	21	0
SS13	☒	1.0	15	0
SS14	☒	1.0	>50	0

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

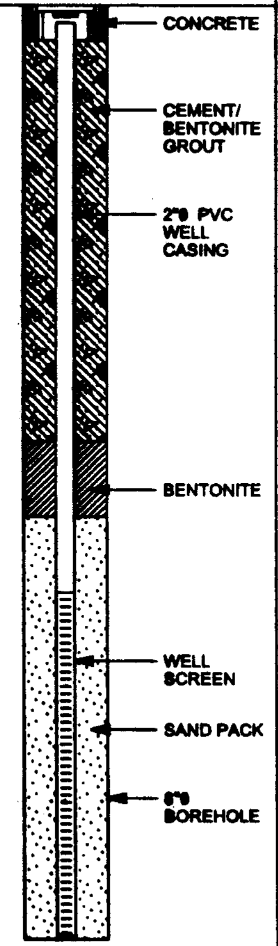
Page 1 of 1

PROJECT NAME: Cascades - Depew	**HOLE DESIGNATION:** MW-104
PROJECT NUMBER: 630660	**DATE COMPLETED:** 24 March 2009
CLIENT: Cascades Inc.	**DRILLING METHOD:** 4.25" HSA
LOCATION: Depew, New York	**FIELD PERSONNEL:** J. Williams

DEPTH ft BGS: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36

STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. ft Site Datum
TOP OF CASING	677.06
GROUND SURFACE	677.06
ASPHALT	676.56
GM-SILT and GRAVEL, some red brick fragments, firm, angular gravel, brown and black, moist (FILL) - some medium to coarse sand and cinders below 2.3 ft BGS - wet between 2.5 and 2.7 ft BGS - soft, brown below 4 ft BGS	670.76
SM-SAND, some silt, medium grained, brown, wet	670.56 670.06
ML-SILT, some clay, firm, brown, moist	669.06
SM-SAND, some silt, medium grained, brown, wet	
CL-CLAY, little silt, stiff, low plasticity, red/brown, moist - brown, dry to moist below 11.4 ft BGS - little subrounded to subangular gravel, gray/brown, moist below 14.3 ft BGS - medium plasticity below 15.4 ft BGS - high plasticity, moist to wet below 20 ft BGS - rock fragments, gray, dry below 26.6 ft BGS	650.46
END OF BOREHOLE @ 26.6ft BGS	

Monitoring Well



WELL DETAILS

Screened Interval:
660.06 to 650.06ft Site Datum
17.00 to 27.00ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 10
Material: PVC
Seal:
664.46 to 662.26ft Site Datum
12.60 to 14.80ft BGS
Material: BENTONITE
Sand Pack:
662.26 to 649.96ft Site Datum
14.80 to 27.10ft BGS
Material: #1 SAND

SAMPLE

NUMBER	INTERVAL	REC (ft)	'N' VALUE	PID (ppm)
SS1	☒	1.5	6	0
SS2	☒	1.2	5	0
SS3	☒	1.5	7	0
SS4	☒	1.3	6	0
SS5	☒	2.0	21	0
SS6	☒	2.0	16	0
SS7	☒	2.0	33	0
SS8	☒	2.0	18	0
SS9	☒	2.0	23	0
SS10	☒	1.0	19	0
SS11	☒	2.0	12	0
SS12	☒	2.0	16	0
SS13	☒	1.7	12	0
SS14	☒	0.7	>50	0

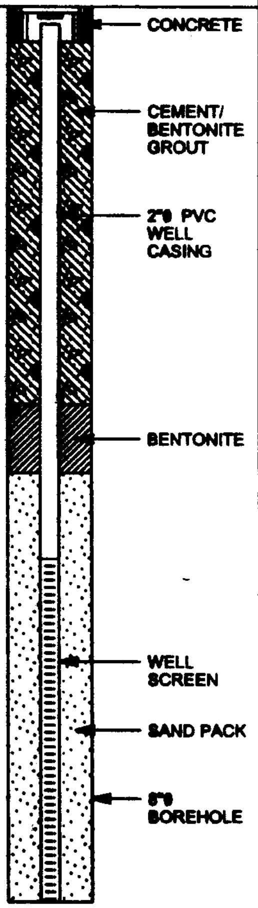
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

Page 1 of 1

PROJECT NAME: Cascades - Depew	HOLE DESIGNATION: MW-105
PROJECT NUMBER: 630660	DATE COMPLETED: 25 March 2009
CLIENT: Cascades Inc.	DRILLING METHOD: 4.25" HSA
LOCATION: Depew, New York	FIELD PERSONNEL: J. Williams

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. ft Site Datum
	TOP OF CASING	675.48
	GROUND SURFACE	675.41
0	ML-SILT, trace sand and clay, fine grained sand, brown, moist (TOPSOIL)	
2.5	ML-SILT, trace clay, stiff, red/brown, moist	672.91
4	- brown, dry to moist below 4 ft BGS	
9	- little subangular to subrounded gravel below 9 ft BGS	
10.5	- low plasticity, moist below 10.5 ft BGS	
12	- trace gravel, medium soft, medium plasticity below 12 ft BGS	
17.2	- becoming moist to wet below 17.2 ft BGS	
19.8	- SM-SAND and SILT layer, some clay, soft, brown, wet between 19.8 and 20.4 ft BGS	
20.4	- rock fragments below 20.4 ft BGS	
22	GM-SILT and GRAVEL, some sand, dense, fine grained sand, angular gravel, gray to brown, dry	653.41
26	END OF BOREHOLE @ 26.0ft BGS	649.41



WELL DETAILS
Screened Interval:
659.41 to 649.41ft Site Datum
16.00 to 26.00ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 10
Material: PVC
Seal:
663.91 to 661.91ft Site Datum
11.50 to 13.50ft BGS
Material: BENTONITE
Sand Pack:
661.91 to 649.41ft Site Datum
13.50 to 26.00ft BGS
Material: #1 SAND

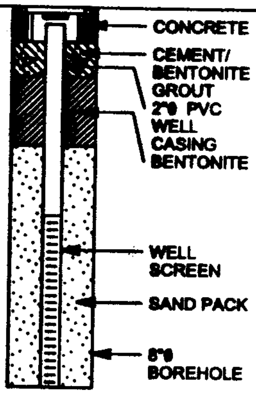
SAMPLE NUMBER	INTERVAL	REC (ft)	'N' VALUE	PID (ppm)
SS1		0.2	7	0
SS2		1.5	12	0
SS3		2.0	25	0
SS4		2.0	34	0
SS5		2.0	28	0
SS6		2.0	25	0
SS7		2.0	32	0
SS8		2.0	14	0
SS9		2.0	25	0
SS10		2.0	7	0
SS11		1.0	>50	0
SS12		1.2	>50	0
SS13		2.0	>50	0

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: Cascades - Depew
PROJECT NUMBER: 630660
CLIENT: Cascades Inc.
LOCATION: Depew, New York

HOLE DESIGNATION: MW-106F
DATE COMPLETED: 25 March 2009
DRILLING METHOD: 4.25" HSA
FIELD PERSONNEL: J. Williams

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. ft Site Datum	Monitoring Well	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (ft)	SAMPLE 'N' VALUE
	TOP OF CASING	677.43					
	GROUND SURFACE	677.38					
2 4 6 8 10	Not Sampled (Refer to MW-104 for stratigraphy)						
12 14 16 18 20 22 24 26 28 30 32 34 36	END OF BOREHOLE @ 11.0ft BGS	666.38	**WELL DETAILS** Screened Interval: 671.38 to 666.38ft Site Datum 6.00 to 11.00ft BGS Length: 5ft Diameter: 2in Slot Size: 10 Material: PVC Seal: 675.38 to 673.38ft Site Datum 2.00 to 4.00ft BGS Material: BENTONITE Sand Pack: 673.38 to 666.38ft Site Datum 4.00 to 11.00ft BGS Material: #1 SAND				

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

APPENDIX B

WELL DEVELOPMENT AND PURGING RECORDS

MW-103 Development

Date 4/14/09
Time 1220
W/L 8.12
Depth 26.7

Method - bailer (surge),
Peristaltic Pump (purge)

Volume 26.7 - 8.1 = 18.6 x 0.16 = 3 gal./vol.

Vol.	pH	Cond	Turb	DO	Temp	W/Q
3	6.36	2.82	122	12.08	11.7	cloudy gray
6	6.56	1.94	53.9	12.44	11.5	clear
9	6.82	1.85	16.7	12.40	11.9	cloudy gray
12	6.95	1.83	-5.0	12.55	11.9	same
15	6.85	1.82	-5.0	12.22	11.9	same

MW-101 Development

Date 4/14/09
Time 1330
W/L 1.98
depth 25.1

Method - bailer (surge)
peristaltic (purge)

Volume 25.1 - 1.98 = 23.12 x 0.16 = 3.7 gal/vol.

Vol.	pH	Cond.	Turb.	DO	Temp	W/Q
4	7.16	0.977	>999	8.07	11.0	muddy brown
8	7.01	1.05	>999	12.75	11.5	same
12						
16						
20						

* - Dry after 9.5 gallons, let recharge.
- purged add. 2 gallons to dry.
- purged add. 1 gallon to dry.

MW - 15 Development

Date 4/14/09 Method bailer (surge)
Time 1529 peristaltic (purge)
W/L 6.80
depth 24.3

Volume 24.3 - 6.8 = 17.5 x 0.16 = 2.8 gal/vol.

Vol.	pH	Cond.	Turb.	DO	Temp.	W/Q
3	7.22	0.828	>999	2.54	10.1	cloudy brown
6	7.22	0.824	532	3.28	9.8	same
9	7.20	0.822	215	3.62	9.7	clear
12	7.19	0.820	174	3.60	9.7	clear
15	7.20	0.818	112	3.58	9.7	clear

MW - 102 Development

Date 4/14/09 Method bailer (surge)
Time 1630 peristaltic (purge)
W/L 3.89
depth 24.6

Volume = 24.6 - 3.9 = 20.7 x 0.16 = 3.3 gal/vol.

Vol.	pH	Cond	Turb.	DO	Temp.	W/Q
3.5	6.32	1.42	>999	1.12	10.6	
7.0	6.36	1.42	321	0.55	10.4	
10.5	6.36	1.44	87	0.54	10.4	
14.0	6.38	1.44	48	0.54	10.4	
17.5	6.38	1.44	36	0.53	10.4	

MW-104 Development

Date 4/14/09 Method - S.S. bailer
Time 1432
W/L 11.82
depth 26.5

Volume 26.5 - 11.8 = 14.7 x 0.16 = 2.4 gal./vol.

Vol.	pH	Cond.	Turb.	DO	Temp.	W/Q
2.5	7.01	1.39	-5.0	9.17	12.5	v. cloudy brown
5.0	7.40	9.24	-5.0	12.08	12.6	same
7.5	7.50	1.31	-5.0	12.40	11.9	Same
10.0	7.31	1.29	-5.0	12.52	12.4	silty cloudy, gray
12.5	7.18	1.33	126	12.49	12.1	clear

MW-106F Development

Date 4/14/09 Method bailer (surge)
Time 1450 peristaltic (purge)
W/L 8.32
depth 10.30

Volume - 10.3 - 8.3 = 2.0 x 0.16 = 0.3 gal/vol.

Vol.	pH	Cond.	Turb.	DO	Temp	W/Q
0.5	dry ~ 0.5 gallons					
1.0	let recharge, purge addl. 0.5 gallons					
1.5	let recharge, purge addl. ~ 0.3 gallons					
2.0						
2.5						

MW-101 Sampling

Date 4/15/09
Time 1608
W/L 2.91
depth

start Purge @ 1615
~100 ml/min

Time	pH	Cond.	Turb.	DO	Temp	W/Q
1620	7.09	1.24	80.4	8.01	10.7	clear
1625	7.09	1.24	58.2	6.32	10.7	clear
1630	7.10	1.24	55.6	15.75	10.5	clear
1635	7.10	1.24	45.8	16.62	10.5	clear

Sample ID - WG-630660-041509-JJW-006
Sample Time - 1700

3x 40ml VOCs
2x 1L SVOCs
1x 1L Metals

MW-102 Sampling

Date	4/15/09	Start Purge @ 1154
Time	1140	~ 100ml/min.
WL	3.46	
depth	24.6	

Volume 24.6 - 3.5 = 21.1 x 0.16 = 3.4 gal/vol.

Time	pH	Cond	Turb	DO	Temp.	W/Q
1159	6.40	1.44	6.0	0.98	10.4	clear
1204	6.43	1.44	4.6	0.64	10.2	same
1209	6.44	1.43	1.8	0.57	10.2	clear
1214	6.45	1.43	0	0.55	10.2	clear
1219	6.45	1.43	0	0.53	10.2	Clear

Sample ID - WG-630660-041509-JJW-001/002

Sample Time - 1230/1245 duplicate

2x	3x40ml w/HCl	VOCs
	2x1L gl.	SVOCs
	1x1L pl. w/HNO3	Metals

MW-103 sampling

Date	4/15/09	start Purge @ 1520
Time	1450	~100ml/min.
w/L	4.88	
depth	26.7	

Time	PH	Cond.	Turb.	DO	Temp	W/Q
1525	6.55	1.90	143	3.38	11.2	sltly cloudy brown
1530	6.55	1.90	88.3	3.30	11.0	clear
1535	6.54	1.91	63.3	3.49	11.0	clear
1540	6.54	1.91	60.8	3.32	11.0	clear

Sample ID - WG-630660-041509-JJW-005 MS/MSD
sample Time - 1500
9x 40 ml VOCs
6x 1L SVOCs
3x 1L Metals.

MW-104 Sampling

Date	4/15/09	Start Purge @ 1340
Time	1332	~100 ml/min.
W/L	5.62	
depth	26.5	

Time	pH	Cond	Turb.	DO	Temp.	W/Q
1345	6.77	1.41	0	4.32	12.1	clear
1350	6.77	1.41	0	4.34	12.0	clear
1355	6.77	1.41	0	4.47	12.1	clear
1400	6.77	1.41	0	4.43	12.2	clear

Sample ID - WG-630660-041509-JJW-003
Sample Time - 1415
3 x 40 ml w/HCl VOCs
2 x 1L gl. SVOCs
1 x 1L pl. w/HNO_3 Metals

MW-105 Sampling

Date 4/15/09 Start Purge @ 1710
Time 1708 ~100 ml/min.
W/L 6.61
depth 24.3

Time	pH	Cond	Turb.	DO	Temp	W/Q
1715	7.20	0.821	-5.0	2.05	9.9	clear
1720	7.19	0.810	789	3.64	9.7	clear
1725	7.19	0.806	82.8	3.67	9.7	clear
1730	7.19	0.805	84.9	3.84	9.7	clear

Sample ID NG-630660-041509-JJW-007
Sample Time 1800

3 x 40 ml VOCs
2x 1L SVOCs
1x 1L Metals

MW-106F Sampling

Date 4/15/09 start Purge @
Time 1416
W/L 8.53
depth 10.3

Time pH Cond. Turb. DO Temp. W/Q

Not measured due to extremely low volume, start purging to clear, collect Sample

Sample ID - WG-630660-041509-JJW-004
Sample Time - 1445
3x40 ml VOCs
2x1L SVOCs
1x1L Metals

APPENDIX C

LABORATORY ANALYTICAL DATA PACKAGE

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

PROJECT NO. 630660

CASCADES-DEPEW

Lot #: A9D170133

Paul McMahon

Conestoga-Rovers & Associates,
2055 Niagara Falls Blvd.
Suite Three
Niagara Falls, NY 14304

TESTAMERICA LABORATORIES, INC.

Denise D Heckler

Approved for release.
Denise D. Heckler
Project Manager
4/30/2009 7:31 AM

Denise D. Heckler
Project Manager
denise.heckler@testamericainc.com

April 29, 2009

TestAmerica Laboratories, Inc.
TestAmerica North Canton 4101 Shuffel Street NW, North Canton, OH 44720
Tel (330)497-9396 Fax (330)497-0772 www.testamericainc.com

CASE NARRATIVE (continued)

GC/MS VOLATILES

The sample(s) that contained concentrations of target analyte(s) at a reportable level in the associated Method Blank(s) were flagged with "B". All target analytes in the Method Blank must be below the reporting limit (RL) or the associated sample(s) must be ND with the exception of common laboratory contaminants.

The sample(s) that contain results between the MDL and the RL were flagged with "J". There is a possibility of false positive or mis-identification at these quantitation levels. In analytical methods requiring confirmation of the analyte reported, confirmation was performed only down to the standard reporting limit (SRL). The acceptance criteria for QC samples may not be met at these quantitation levels.

The matrix spike/matrix spike duplicate(s) for WG-630660-041509-JJW-005 had recoveries outside acceptance limits. However, since the associated method blank(s) and laboratory control sample(s) were in control, no corrective action was necessary.

The matrix spike/matrix spike duplicate(s) for batch(es) 9114092 had recoveries outside acceptance limits. However, since the associated method blank(s) and laboratory control sample(s) were in control, no corrective action was necessary.

GC/MS SEMIVOLATILES

The sample(s) that contained concentrations of target analyte(s) at a reportable level in the associated Method Blank(s) were flagged with "B". All target analytes in the Method Blank must be below the reporting limit (RL) or the associated sample(s) must be ND with the exception of common laboratory contaminants.

Result concentration exceeds the calibration range. Refer to the sample report pages for the affected compound(s) flagged with "E".

The sample(s) that contain results between the MDL and the RL were flagged with "J". There is a possibility of false positive or mis-identification at these quantitation levels. In analytical methods requiring confirmation of the analyte reported, confirmation was performed only down to the standard reporting limit (SRL). The acceptance criteria for QC samples may not be met at these quantitation levels.

Two analyses were used to report sample(s) WG-630660-041509-JJW-006 due to high analyte concentrations.

QUALITY CONTROL ELEMENTS NARRATIVE

TestAmerica conducts a quality assurance/quality control (QA/QC) program designed to provide scientifically valid and legally defensible data. Toward this end, several types of quality control indicators are incorporated into the QA/QC program, which is described in detail in QA Policy, QA-003. These indicators are introduced into the sample testing process to provide a mechanism for the assessment of the analytical data. Program or agency specific requirements take precedence over the requirements listed in this narrative.

QC BATCH

Environmental samples are taken through the testing process in groups called QUALITY CONTROL BATCHES (QC batches). A QC batch contains up to twenty environmental samples of a similar matrix (water, soil) that are processed using the same reagents and standards. TestAmerica North Canton requires that each environmental sample be associated with a QC batch.

Several quality control samples are included in each QC batch and are processed identically to the twenty environmental samples.

For SW846/RCRA methods, QC samples include a METHOD BLANK (MB), a LABORATORY CONTROL SAMPLE (LCS) and, where appropriate, a MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD) pair or a MATRIX SPIKE/SAMPLE DUPLICATE (MS/DU) pair. If there is insufficient sample to perform an MS/MSD or an MS/DU, then a LABORATORY CONTROL SAMPLE DUPLICATE (LCSD) is included in the QC batch.

For 600 series/CWA methods, QC samples include a METHOD BLANK (MB), a LABORATORY CONTROL SAMPLE (LCS) and, where appropriate, a MATRIX SPIKE (MS). An MS is prepared and analyzed at a 10% frequency for GC Methods and at a 5% frequency for GC/MS methods.

LABORATORY CONTROL SAMPLE

The Laboratory Control Sample is a QC sample that is created by adding known concentrations of a full or partial set of target analytes to a matrix similar to that of the environmental samples in the QC batch. Multi peak responders may not be included in the target spike list due to co-elution. The LCS analyte recovery results are used to monitor the analytical process and provide evidence that the laboratory is performing the method within acceptable guidelines. All control analytes indicated by a bold type in the LCS must meet acceptance criteria. Failure to meet the established recovery guidelines requires the repreparation and reanalysis of all samples in the QC batch. Comparison of only the failed parameters from the first batch are evaluated. The only exception to the rework requirement is that if the LCS recoveries are biased high and the associated sample is ND (non-detected) for the parameter(s) of interest, the batch is acceptable.

At times, a Laboratory Control Sample Duplicate (LCSD) is also included in the QC batch. An LCSD is a QC sample that is created and handled identically to the LCS. Analyte recovery data from the LCSD is assessed in the same way as that of the LCS. The LCSD recoveries, together with the LCS recoveries, are used to determine the reproducibility (precision) of the analytical system. Precision data are expressed as relative percent differences (RPDs). If the RPD fails for an LCS/LCSD and yet the recoveries are within acceptance criteria, the batch is still acceptable.

METHOD BLANK

The Method Blank is a QC sample consisting of all the reagents used in analyzing the environmental samples contained in the QC batch. Method Blank results are used to determine if interference or contamination in the analytical system could lead to the reporting of false positive data or elevated analyte concentrations. All target analytes must be below the reporting limits (RL) or the associated sample(s) must be ND except under the following circumstances:

- Common organic contaminants may be present at concentrations up to 5 times the reporting limits. Common metals contaminants may be present at concentrations up to 2 times the reporting limit, or the reported blank concentration must be twenty fold less than the concentration reported in the associated environmental samples. (See common laboratory contaminants listed in the table.)

Volatile (GC or GC/MS)	Semivolatile (GC/MS)	Metals ICP-MS	Metals ICP Trace
Methylene Chloride, Acetone, 2-Butanone	Phthalate Esters	Copper, Iron, Zinc, Lead, Calcium, Magnesium, Potassium, Sodium, Barium, Chromium, Manganese	Copper, Iron, Zinc, Lead

EXECUTIVE SUMMARY - Detection Highlights

A9D170133

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
WG-630660-041509-JJW-001 04/15/09 12:30 001				
Aluminum	479	200	ug/L	SW846 6020
Arsenic	0.94 B	5.0	ug/L	SW846 6020
Barium	69.5 B,J	200	ug/L	SW846 6020
Calcium	85200 J	5000	ug/L	SW846 6020
Cobalt	0.76 B	50.0	ug/L	SW846 6020
Chromium	1.2 B	10.0	ug/L	SW846 6020
Copper	4.5 B,J	25.0	ug/L	SW846 6020
Iron	583	100	ug/L	SW846 6020
Potassium	3100 B	5000	ug/L	SW846 6020
Magnesium	107000 J	5000	ug/L	SW846 6020
Manganese	110 J	15.0	ug/L	SW846 6020
Sodium	61700 J	5000	ug/L	SW846 6020
Nickel	1.1 B	40.0	ug/L	SW846 6020
Lead	2.4	1.0	ug/L	SW846 6020
Antimony	0.21 B	2.0	ug/L	SW846 6020
Vanadium	0.79 B	50.0	ug/L	SW846 6020
Zinc	10.5 B,J	20.0	ug/L	SW846 6020
bis(2-Ethylhexyl) phthalate	2.0 B	2.0	ug/L	SW846 8270C
WG-630660-041509-JJW-002 04/15/09 12:45 002				
Aluminum	747	200	ug/L	SW846 6020
Arsenic	1.1 B	5.0	ug/L	SW846 6020
Barium	70.7 B,J	200	ug/L	SW846 6020
Calcium	84200 J	5000	ug/L	SW846 6020
Cobalt	0.85 B	50.0	ug/L	SW846 6020
Chromium	1.9 B	10.0	ug/L	SW846 6020
Copper	6.1 B,J	25.0	ug/L	SW846 6020
Iron	902	100	ug/L	SW846 6020
Potassium	3110 B	5000	ug/L	SW846 6020
Magnesium	106000 J	5000	ug/L	SW846 6020
Manganese	110 J	15.0	ug/L	SW846 6020
Sodium	61000 J	5000	ug/L	SW846 6020
Nickel	1.7 B	40.0	ug/L	SW846 6020
Lead	3.6	1.0	ug/L	SW846 6020
Antimony	0.26 B	2.0	ug/L	SW846 6020
Vanadium	1.3 B	50.0	ug/L	SW846 6020
Zinc	13.0 B,J	20.0	ug/L	SW846 6020
bis(2-Ethylhexyl) phthalate	5.7 B	2.0	ug/L	SW846 8270C

(Continued on next page)

EXECUTIVE SUMMARY - Detection Highlights

A9D170133

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
WG-630660-041509-JJW-004 04/15/09 14:45 004				
Phenanthrene	0.23	0.20	ug/L	SW846 8270C
Acetone	71	10	ug/L	SW846 8260B
Bromodichloromethane	0.46 J	1.0	ug/L	SW846 8260B
2-Butanone	0.67 J	10	ug/L	SW846 8260B
Chloroform	1.1	1.0	ug/L	SW846 8260B
WG-630660-041509-JJW-005 04/15/09 15:00 005				
Aluminum	304	200	ug/L	SW846 6020
Arsenic	1.8 B	5.0	ug/L	SW846 6020
Barium	90.8 B,J	200	ug/L	SW846 6020
Calcium	109000 J	5000	ug/L	SW846 6020
Cobalt	0.46 B	50.0	ug/L	SW846 6020
Copper	0.94 B,J	25.0	ug/L	SW846 6020
Iron	541	100	ug/L	SW846 6020
Potassium	3780 B	5000	ug/L	SW846 6020
Magnesium	108000 J	5000	ug/L	SW846 6020
Manganese	49.7 J	15.0	ug/L	SW846 6020
Sodium	100000 J	5000	ug/L	SW846 6020
Nickel	1.2 B	40.0	ug/L	SW846 6020
Lead	0.37 B	1.0	ug/L	SW846 6020
Antimony	0.28 B	2.0	ug/L	SW846 6020
Vanadium	0.56 B	50.0	ug/L	SW846 6020
bis(2-Ethylhexyl) phthalate	6.0 B	2.0	ug/L	SW846 8270C
WG-630660-041509-JJW-006 04/15/09 17:00 006				
Aluminum	849	200	ug/L	SW846 6020
Arsenic	3.1 B	5.0	ug/L	SW846 6020
Barium	156 B,J	200	ug/L	SW846 6020
Calcium	67200 J	5000	ug/L	SW846 6020
Cobalt	1.3 B	50.0	ug/L	SW846 6020
Chromium	2.0 B	10.0	ug/L	SW846 6020
Copper	44.8 J	25.0	ug/L	SW846 6020
Iron	935	100	ug/L	SW846 6020
Potassium	12500	5000	ug/L	SW846 6020
Magnesium	84300 J	5000	ug/L	SW846 6020
Manganese	173 J	15.0	ug/L	SW846 6020
Sodium	57100 J	5000	ug/L	SW846 6020
Nickel	3.5 B	40.0	ug/L	SW846 6020
Lead	10.9	1.0	ug/L	SW846 6020
Antimony	34.9	2.0	ug/L	SW846 6020

(Continued on next page)

ANALYTICAL METHODS SUMMARY

A9D170133

PARAMETER	ANALYTICAL METHOD
ICP-MS (6020)	SW846 6020
Mercury in Liquid Waste (Manual Cold-Vapor)	SW846 7470A
Semivolatile Organic Compounds by GC/MS	SW846 8270C
Volatile Organics by GC/MS	SW846 8260B

References:

SW846	"Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 and its updates.

Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-001

GC/MS Volatiles

Lot-Sample #...: A9D170133-001 **Work Order #...:** K98001AA **Matrix.........:** WG
Date Sampled...: 04/15/09 12:30 **Date Received..:** 04/17/09
Prep Date......: 04/22/09 **Analysis Date..:** 04/22/09
Prep Batch #...: 9114092
Dilution Factor: 1 **Method.........:** SW846 8260B

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Acetone	ND	10	ug/L	1.1
Benzene	ND	1.0	ug/L	0.13
Bromodichloromethane	ND	1.0	ug/L	0.15
Bromoform	ND	1.0	ug/L	0.64
Bromomethane	ND	1.0	ug/L	0.41
2-Butanone	ND	10	ug/L	0.57
Carbon disulfide	ND	1.0	ug/L	0.13
Carbon tetrachloride	ND	1.0	ug/L	0.13
Chlorobenzene	ND	1.0	ug/L	0.15
Chloroethane	ND	1.0	ug/L	0.29
Chloroform	ND	1.0	ug/L	0.16
Chloromethane	ND	1.0	ug/L	0.30
Cyclohexane	ND	1.0	ug/L	0.12
Dibromochloromethane	ND	1.0	ug/L	0.18
1,2-Dibromo-3-chloropropane	ND	2.0	ug/L	0.67
1,2-Dibromoethane	ND	1.0	ug/L	0.24
1,2-Dichlorobenzene	ND	1.0	ug/L	0.13
1,3-Dichlorobenzene	ND	1.0	ug/L	0.14
1,4-Dichlorobenzene	ND	1.0	ug/L	0.13
Dichlorodifluoromethane	ND	1.0	ug/L	0.31
1,1-Dichloroethane	ND	1.0	ug/L	0.15
1,2-Dichloroethane	ND	1.0	ug/L	0.22
1,1-Dichloroethene	ND	1.0	ug/L	0.19
cis-1,2-Dichloroethene	ND	1.0	ug/L	0.17
trans-1,2-Dichloroethene	ND	1.0	ug/L	0.19
1,2-Dichloropropane	ND	1.0	ug/L	0.18
cis-1,3-Dichloropropene	ND	1.0	ug/L	0.14
trans-1,3-Dichloropropene	ND	1.0	ug/L	0.19
Ethylbenzene	ND	1.0	ug/L	0.17
2-Hexanone	ND	10	ug/L	0.41
Isopropylbenzene	ND	1.0	ug/L	0.13
Methyl acetate	ND	10	ug/L	0.38
Methylene chloride	ND	1.0	ug/L	0.33
Methylcyclohexane	ND	1.0	ug/L	0.13
4-Methyl-2-pentanone	ND	10	ug/L	0.32
Methyl tert-butyl ether	ND	5.0	ug/L	0.17
Styrene	ND	1.0	ug/L	0.11
1,1,2,2-Tetrachloroethane	ND	1.0	ug/L	0.18

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Conestoga-Rovers & Associates, Inc.

Client Sample ID: **WG-630660-041509-JJW-001**

GC/MS Semivolatiles

Lot-Sample #...: A9D170133-001 **Work Order #...:** K98001AC **Matrix.........:** WG
Date Sampled...: 04/15/09 12:30 **Date Received..:** 04/17/09
Prep Date......: 04/19/09 **Analysis Date..:** 04/20/09
Prep Batch #...: 9108058
Dilution Factor: 1 **Method.........:** SW846 8270C

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Acenaphthene	ND	0.20	ug/L	0.10
Acenaphthylene	ND	0.20	ug/L	0.10
Acetophenone	ND	1.0	ug/L	0.34
Anthracene	ND	0.20	ug/L	0.10
Atrazine	ND	1.0	ug/L	0.34
Benzo(a)anthracene	ND	0.20	ug/L	0.10
Benzo(a)pyrene	ND	0.20	ug/L	0.10
Benzo(b)fluoranthene	ND	0.20	ug/L	0.10
Benzo(ghi)perylene	ND	0.20	ug/L	0.10
Benzo(k)fluoranthene	ND	0.20	ug/L	0.10
Benzaldehyde	ND	1.0	ug/L	0.39
1,1'-Biphenyl	ND	1.0	ug/L	0.80
bis(2-Chloroethoxy) methane	ND	1.0	ug/L	0.32
bis(2-Chloroethyl)-ether	ND	1.0	ug/L	0.10
bis(2-Ethylhexyl) phthalate	**2.0 B**	**2.0**	**ug/L**	**0.80**
4-Bromophenyl phenyl ether	ND	2.0	ug/L	0.80
Butyl benzyl phthalate	ND	1.0	ug/L	0.80
Caprolactam	ND	5.0	ug/L	0.80
Carbazole	ND	1.0	ug/L	0.28
4-Chloroaniline	ND	2.0	ug/L	0.80
4-Chloro-3-methylphenol	ND	2.0	ug/L	0.80
2-Chloronaphthalene	ND	1.0	ug/L	0.10
2-Chlorophenol	ND	1.0	ug/L	0.29
4-Chlorophenyl phenyl ether	ND	2.0	ug/L	0.30
Chrysene	ND	0.20	ug/L	0.10
Dibenz(a,h)anthracene	ND	0.20	ug/L	0.10
Dibenzofuran	ND	1.0	ug/L	0.10
3,3'-Dichlorobenzidine	ND	5.0	ug/L	0.37
2,4-Dichlorophenol	ND	2.0	ug/L	0.80
Diethyl phthalate	ND	1.0	ug/L	0.60
2,4-Dimethylphenol	ND	2.0	ug/L	0.80
Dimethyl phthalate	ND	1.0	ug/L	0.29
Di-n-butyl phthalate	ND	1.0	ug/L	0.67
4,6-Dinitro-2-methylphenol	ND	5.0	ug/L	2.4

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Conestoga-Rovers & Associates, Inc.

Client Sample ID: **WG-630660-041509-JJW-001**

GC/MS Semivolatiles

Lot-Sample #...: A9D170133-001 **Work Order #...:** K98001AC **Matrix.........:** WG

NOTE(S):

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-001

TOTAL Metals

Lot-Sample #...: A9D170133-001

Matrix.........: WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Sodium	**61700 J**	**5000** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 6.9	**04/20-04/27/09**	**K98001AV**
Nickel	**1.1 B**	**40.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.20	**04/20-04/27/09**	**K98001AW**
Lead	**2.4**	**1.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.18	**04/20-04/27/09**	**K98001AX**
Antimony	**0.21 B**	**2.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.13	**04/20-04/27/09**	**K98001A0**
Selenium	ND	5.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 1.2	04/20-04/27/09	K98001A1
Thallium	ND	1.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 0.14	04/20-04/27/09	K98001A2
Vanadium	**0.79 B**	**50.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.44	**04/20-04/27/09**	**K98001A3**
Zinc	**10.5 B,J**	**20.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 2.3	**04/20-04/27/09**	**K98001A4**
Mercury	ND	0.20 Dilution Factor: 1	ug/L	SW846 7470A MDL............: 0.12	04/20/09	K98001AD

NOTE(S):

B Estimated result. Result is less than RL.

J Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-002

GC/MS Volatiles

Lot-Sample #...: A9D170133-002 **Work Order #...:** K981C1AG **Matrix.........:** WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Tetrachloroethene	ND	1.0	ug/L	0.29
Toluene	ND	1.0	ug/L	0.13
1,2,4-Trichloro-benzene	ND	1.0	ug/L	0.15
1,1,1-Trichloroethane	ND	1.0	ug/L	0.22
1,1,2-Trichloroethane	ND	1.0	ug/L	0.27
Trichloroethene	ND	1.0	ug/L	0.17
Trichlorofluoromethane	ND	1.0	ug/L	0.21
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	1.0	ug/L	0.28
Vinyl chloride	ND	1.0	ug/L	0.22
Xylenes (total)	ND	2.0	ug/L	0.28

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	101	(73 - 122)
1,2-Dichloroethane-d4	97	(61 - 128)
Toluene-d8	95	(76 - 110)
4-Bromofluorobenzene	79	(74 - 116)

Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-002

GC/MS Semivolatiles

Lot-Sample #...: A9D170133-002 **Work Order #...:** K981C1AH **Matrix.........:** WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
2,4-Dinitrophenol	ND	5.0	ug/L	2.4
2,4-Dinitrotoluene	ND	5.0	ug/L	0.27
2,6-Dinitrotoluene	ND	5.0	ug/L	0.80
Di-n-octyl phthalate	ND	1.0	ug/L	0.80
Fluoranthene	ND	0.20	ug/L	0.10
Fluorene	ND	0.20	ug/L	0.10
Hexachlorobenzene	ND	0.20	ug/L	0.10
Hexachlorobutadiene	ND	1.0	ug/L	0.27
Hexachlorocyclopentadiene	ND	10	ug/L	0.80
Hexachloroethane	ND	1.0	ug/L	0.80
Indeno(1,2,3-cd)pyrene	ND	0.20	ug/L	0.10
Isophorone	ND	1.0	ug/L	0.27
2-Methylnaphthalene	ND	0.20	ug/L	0.10
2-Methylphenol	ND	1.0	ug/L	0.80
4-Methylphenol	ND	1.0	ug/L	0.80
Naphthalene	ND	0.20	ug/L	0.10
2-Nitroaniline	ND	2.0	ug/L	0.80
3-Nitroaniline	ND	2.0	ug/L	0.28
4-Nitroaniline	ND	2.0	ug/L	0.80
Nitrobenzene	ND	1.0	ug/L	0.040
2-Nitrophenol	ND	2.0	ug/L	0.28
4-Nitrophenol	ND	5.0	ug/L	2.4
N-Nitrosodi-n-propylamine	ND	1.0	ug/L	0.80
N-Nitrosodiphenylamine	ND	1.0	ug/L	0.31
2,2'-oxybis (1-Chloropropane)	ND	1.0	ug/L	0.40
Pentachlorophenol	ND	5.0	ug/L	2.4
Phenanthrene	ND	0.20	ug/L	0.10
Phenol	ND	1.0	ug/L	0.60
Pyrene	ND	0.20	ug/L	0.10
2,4,5-Trichlorophenol	ND	5.0	ug/L	0.30
2,4,6-Trichlorophenol	ND	5.0	ug/L	0.80

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Nitrobenzene-d5	75	(27 - 111)
2-Fluorobiphenyl	68	(28 - 110)
Terphenyl-d14	92	(37 - 119)
Phenol-d5	71	(10 - 110)
2-Fluorophenol	77	(10 - 110)
2,4,6-Tribromophenol	75	(22 - 120)

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Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-002

TOTAL Metals

Lot-Sample #...: A9D170133-002
Date Sampled...: 04/15/09 12:45 **Date Received..:** 04/17/09 **Matrix.......:** WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Prep Batch #...: 9110041						
Silver	ND	1.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 0.080	04/20-04/27/09	K981C1AV
Aluminum	**747**	**200** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 19.0	**04/20-04/27/09**	**K981C1AK**
Arsenic	**1.1 B**	**5.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.40	**04/20-04/27/09**	**K981C1AL**
Barium	**70.7 B,J**	**200** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.19	**04/20-04/27/09**	**K981C1AM**
Beryllium	ND	5.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 0.20	04/20-04/27/09	K981C1AN
Calcium	**84200 J**	**5000** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 22.0	**04/20-04/27/09**	**K981C1AP**
Cadmium	ND	1.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 0.13	04/20-04/27/09	K981C1AQ
Cobalt	**0.85 B**	**50.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.058	**04/20-04/27/09**	**K981C1AR**
Chromium	**1.9 B**	**10.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.71	**04/20-04/27/09**	**K981C1AT**
Copper	**6.1 B,J**	**25.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.29	**04/20-04/27/09**	**K981C1AU**
Iron	**902**	**100** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 26.0	**04/20-04/27/09**	**K981C1AW**
Potassium	**3110 B**	**5000** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 8.3	**04/20-04/27/09**	**K981C1AX**
Magnesium	**106000 J**	**5000** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 17.0	**04/20-04/27/09**	**K981C1A0**
Manganese	**110 J**	**15.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.83	**04/20-04/28/09**	**K981C1A1**

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Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-003

GC/MS Volatiles

Lot-Sample #...: A9D170133-003 **Work Order #...:** K981E1AG **Matrix.........:** WG
Date Sampled...: 04/15/09 14:15 **Date Received..:** 04/17/09
Prep Date......: 04/21/09 **Analysis Date..:** 04/21/09
Prep Batch #...: 9112490
Dilution Factor: 1 **Method.........:** SW846 8260B

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Acetone	ND	10	ug/L	1.1
Benzene	ND	1.0	ug/L	0.13
Bromodichloromethane	ND	1.0	ug/L	0.15
Bromoform	ND	1.0	ug/L	0.64
Bromomethane	ND	1.0	ug/L	0.41
2-Butanone	ND	10	ug/L	0.57
Carbon disulfide	ND	1.0	ug/L	0.13
Carbon tetrachloride	ND	1.0	ug/L	0.13
Chlorobenzene	ND	1.0	ug/L	0.15
Chloroethane	ND	1.0	ug/L	0.29
Chloroform	ND	1.0	ug/L	0.16
Chloromethane	ND	1.0	ug/L	0.30
Cyclohexane	ND	1.0	ug/L	0.12
Dibromochloromethane	ND	1.0	ug/L	0.18
1,2-Dibromo-3-chloropropane	ND	2.0	ug/L	0.67
1,2-Dibromoethane	ND	1.0	ug/L	0.24
1,2-Dichlorobenzene	ND	1.0	ug/L	0.13
1,3-Dichlorobenzene	ND	1.0	ug/L	0.14
1,4-Dichlorobenzene	ND	1.0	ug/L	0.13
Dichlorodifluoromethane	ND	1.0	ug/L	0.31
1,1-Dichloroethane	ND	1.0	ug/L	0.15
1,2-Dichloroethane	ND	1.0	ug/L	0.22
1,1-Dichloroethene	ND	1.0	ug/L	0.19
cis-1,2-Dichloroethene	ND	1.0	ug/L	0.17
trans-1,2-Dichloroethene	ND	1.0	ug/L	0.19
1,2-Dichloropropane	ND	1.0	ug/L	0.18
cis-1,3-Dichloropropene	ND	1.0	ug/L	0.14
trans-1,3-Dichloropropene	ND	1.0	ug/L	0.19
Ethylbenzene	ND	1.0	ug/L	0.17
2-Hexanone	ND	10	ug/L	0.41
Isopropylbenzene	ND	1.0	ug/L	0.13
Methyl acetate	ND	10	ug/L	0.38
Methylene chloride	ND	1.0	ug/L	0.33
Methylcyclohexane	ND	1.0	ug/L	0.13
4-Methyl-2-pentanone	ND	10	ug/L	0.32
Methyl tert-butyl ether	ND	5.0	ug/L	0.17
Styrene	ND	1.0	ug/L	0.11
1,1,2,2-Tetrachloroethane	ND	1.0	ug/L	0.18

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Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-003

GC/MS Semivolatiles

Lot-Sample #...: A9D170133-003 **Work Order #...:** K981E1AH **Matrix.........:** WG
Date Sampled...: 04/15/09 14:15 **Date Received..:** 04/17/09
Prep Date......: 04/19/09 **Analysis Date..:** 04/20/09
Prep Batch #...: 9108058
Dilution Factor: 1 **Method.........:** SW846 8270C

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Acenaphthene	ND	0.20	ug/L	0.10
Acenaphthylene	ND	0.20	ug/L	0.10
Acetophenone	ND	1.0	ug/L	0.34
Anthracene	ND	0.20	ug/L	0.10
Atrazine	ND	1.0	ug/L	0.34
Benzo(a)anthracene	ND	0.20	ug/L	0.10
Benzo(a)pyrene	ND	0.20	ug/L	0.10
Benzo(b)fluoranthene	ND	0.20	ug/L	0.10
Benzo(ghi)perylene	ND	0.20	ug/L	0.10
Benzo(k)fluoranthene	ND	0.20	ug/L	0.10
Benzaldehyde	ND	1.0	ug/L	0.39
1,1'-Biphenyl	ND	1.0	ug/L	0.80
bis(2-Chloroethoxy) methane	ND	1.0	ug/L	0.32
bis(2-Chloroethyl)-ether	ND	1.0	ug/L	0.10
bis(2-Ethylhexyl) phthalate	**0.99 J,B**	**2.0**	**ug/L**	**0.80**
4-Bromophenyl phenyl ether	ND	2.0	ug/L	0.80
Butyl benzyl phthalate	ND	1.0	ug/L	0.80
Caprolactam	**18**	**5.0**	**ug/L**	**0.80**
Carbazole	ND	1.0	ug/L	0.28
4-Chloroaniline	ND	2.0	ug/L	0.80
4-Chloro-3-methylphenol	ND	2.0	ug/L	0.80
2-Chloronaphthalene	ND	1.0	ug/L	0.10
2-Chlorophenol	ND	1.0	ug/L	0.29
4-Chlorophenyl phenyl ether	ND	2.0	ug/L	0.30
Chrysene	ND	0.20	ug/L	0.10
Dibenz(a,h)anthracene	ND	0.20	ug/L	0.10
Dibenzofuran	ND	1.0	ug/L	0.10
3,3'-Dichlorobenzidine	ND	5.0	ug/L	0.37
2,4-Dichlorophenol	ND	2.0	ug/L	0.80
Diethyl phthalate	ND	1.0	ug/L	0.60
2,4-Dimethylphenol	ND	2.0	ug/L	0.80
Dimethyl phthalate	ND	1.0	ug/L	0.29
Di-n-butyl phthalate	ND	1.0	ug/L	0.67
4,6-Dinitro-2-methylphenol	ND	5.0	ug/L	2.4

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Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-003

GC/MS Semivolatiles

Lot-Sample #...: A9D170133-003 **Work Order #...:** K981E1AH **Matrix.........:** WG

NOTE(S):

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-003

TOTAL Metals

Lot-Sample #...: A9D170133-003

Matrix.........: WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Sodium	**61200 J**	**5000** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 6.9	**04/20-04/27/09**	**K981E1A2**
Nickel	**0.49 B**	**40.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.20	**04/20-04/27/09**	**K981E1A3**
Lead	**0.66 B**	**1.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.18	**04/20-04/27/09**	**K981E1A4**
Antimony	**0.22 B**	**2.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.13	**04/20-04/27/09**	**K981E1AA**
Selenium	ND	5.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 1.2	04/20-04/27/09	K981E1AC
Thallium	ND	1.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 0.14	04/20-04/27/09	K981E1AD
Vanadium	ND	50.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 0.44	04/20-04/27/09	K981E1AE
Zinc	**3.3 B,J**	**20.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 2.3	**04/20-04/27/09**	**K981E1AF**
Mercury	ND	0.20 Dilution Factor: 1	ug/L	SW846 7470A MDL............: 0.12	04/20/09	K981E1AJ

NOTE(S):

B Estimated result. Result is less than RL.

J Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-004

GC/MS Volatiles

Lot-Sample #...: A9D170133-004 **Work Order #...:** K981F1AG **Matrix.........:** WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Tetrachloroethene	ND	1.0	ug/L	0.29
Toluene	ND	1.0	ug/L	0.13
1,2,4-Trichloro-benzene	ND	1.0	ug/L	0.15
1,1,1-Trichloroethane	ND	1.0	ug/L	0.22
1,1,2-Trichloroethane	ND	1.0	ug/L	0.27
Trichloroethene	ND	1.0	ug/L	0.17
Trichlorofluoromethane	ND	1.0	ug/L	0.21
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	1.0	ug/L	0.28
Vinyl chloride	ND	1.0	ug/L	0.22
Xylenes (total)	ND	2.0	ug/L	0.28

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	101	(73 - 122)
1,2-Dichloroethane-d4	98	(61 - 128)
Toluene-d8	94	(76 - 110)
4-Bromofluorobenzene	79	(74 - 116)

NOTE (S) :

J Estimated result. Result is less than RL.

Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-004

GC/MS Semivolatiles

Lot-Sample #...: A9D170133-004 **Work Order #...:** K981F1AH **Matrix.........:** WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
2,4-Dinitrophenol	ND	5.0	ug/L	2.4
2,4-Dinitrotoluene	ND	5.0	ug/L	0.27
2,6-Dinitrotoluene	ND	5.0	ug/L	0.80
Di-n-octyl phthalate	ND	1.0	ug/L	0.80
Fluoranthene	**0.25**	**0.20**	**ug/L**	**0.10**
Fluorene	ND	0.20	ug/L	0.10
Hexachlorobenzene	ND	0.20	ug/L	0.10
Hexachlorobutadiene	ND	1.0	ug/L	0.27
Hexachlorocyclopenta-diene	ND	10	ug/L	0.80
Hexachloroethane	ND	1.0	ug/L	0.80
Indeno(1,2,3-cd)pyrene	ND	0.20	ug/L	0.10
Isophorone	ND	1.0	ug/L	0.27
2-Methylnaphthalene	ND	0.20	ug/L	0.10
2-Methylphenol	ND	1.0	ug/L	0.80
4-Methylphenol	ND	1.0	ug/L	0.80
Naphthalene	ND	0.20	ug/L	0.10
2-Nitroaniline	ND	2.0	ug/L	0.80
3-Nitroaniline	ND	2.0	ug/L	0.28
4-Nitroaniline	ND	2.0	ug/L	0.80
Nitrobenzene	ND	1.0	ug/L	0.040
2-Nitrophenol	ND	2.0	ug/L	0.28
4-Nitrophenol	ND	5.0	ug/L	2.4
N-Nitrosodi-n-propyl-amine	ND	1.0	ug/L	0.80
N-Nitrosodiphenylamine	ND	1.0	ug/L	0.31
2,2'-oxybis (1-Chloropropane)	ND	1.0	ug/L	0.40
Pentachlorophenol	ND	5.0	ug/L	2.4
Phenanthrene	**0.23**	**0.20**	**ug/L**	**0.10**
Phenol	ND	1.0	ug/L	0.60
Pyrene	ND	0.20	ug/L	0.10
2,4,5-Trichloro-phenol	ND	5.0	ug/L	0.30
2,4,6-Trichloro-phenol	ND	5.0	ug/L	0.80

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Nitrobenzene-d5	68	(27 - 111)
2-Fluorobiphenyl	63	(28 - 110)
Terphenyl-d14	88	(37 - 119)
Phenol-d5	64	(10 - 110)
2-Fluorophenol	70	(10 - 110)
2,4,6-Tribromophenol	83	(22 - 120)

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Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-004

TOTAL Metals

Lot-Sample #...: A9D170133-004
Date Sampled...: 04/15/09 14:45 **Date Received..:** 04/17/09 **Matrix.......:** WG

Prep Batch #...: 9110041

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Silver	ND	1.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 0.080	04/20-04/27/09	K981F1AV
Aluminum	**3200**	**200** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 19.0	**04/20-04/27/09**	**K981F1AK**
Arsenic	**1.9 B**	**5.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.40	**04/20-04/27/09**	**K981F1AL**
Barium	**114 B,J**	**200** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.19	**04/20-04/27/09**	**K981F1AM**
Beryllium	ND	5.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 0.20	04/20-04/27/09	K981F1AN
Calcium	**84900 J**	**5000** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 22.0	**04/20-04/27/09**	**K981F1AP**
Cadmium	ND	1.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 0.13	04/20-04/27/09	K981F1AQ
Cobalt	**0.60 B**	**50.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.058	**04/20-04/27/09**	**K981F1AR**
Chromium	**11.0**	**10.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.71	**04/20-04/27/09**	**K981F1AT**
Copper	**25.1 J**	**25.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.29	**04/20-04/27/09**	**K981F1AU**
Iron	**2380**	**100** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 26.0	**04/20-04/27/09**	**K981F1AW**
Potassium	**7110**	**5000** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 8.3	**04/20-04/28/09**	**K981F1AX**
Magnesium	**46000 J**	**5000** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 17.0	**04/20-04/27/09**	**K981F1A0**
Manganese	**58.9 J**	**15.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.83	**04/20-04/28/09**	**K981F1A1**

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Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-005

GC/MS Volatiles

Lot-Sample #...: A9D170133-005 **Work Order #...:** K981G1AT **Matrix.........:** WG
Date Sampled...: 04/15/09 15:00 **Date Received..:** 04/17/09
Prep Date......: 04/21/09 **Analysis Date..:** 04/21/09
Prep Batch #...: 9112490
Dilution Factor: 1 **Method.........:** SW846 8260B

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Acetone	ND	10	ug/L	1.1
Benzene	ND	1.0	ug/L	0.13
Bromodichloromethane	ND	1.0	ug/L	0.15
Bromoform	ND	1.0	ug/L	0.64
Bromomethane	ND	1.0	ug/L	0.41
2-Butanone	ND	10	ug/L	0.57
Carbon disulfide	ND	1.0	ug/L	0.13
Carbon tetrachloride	ND	1.0	ug/L	0.13
Chlorobenzene	ND	1.0	ug/L	0.15
Chloroethane	ND	1.0	ug/L	0.29
Chloroform	ND	1.0	ug/L	0.16
Chloromethane	ND	1.0	ug/L	0.30
Cyclohexane	ND	1.0	ug/L	0.12
Dibromochloromethane	ND	1.0	ug/L	0.18
1,2-Dibromo-3-chloro-propane	ND	2.0	ug/L	0.67
1,2-Dibromoethane	ND	1.0	ug/L	0.24
1,2-Dichlorobenzene	ND	1.0	ug/L	0.13
1,3-Dichlorobenzene	ND	1.0	ug/L	0.14
1,4-Dichlorobenzene	ND	1.0	ug/L	0.13
Dichlorodifluoromethane	ND	1.0	ug/L	0.31
1,1-Dichloroethane	ND	1.0	ug/L	0.15
1,2-Dichloroethane	ND	1.0	ug/L	0.22
1,1-Dichloroethene	ND	1.0	ug/L	0.19
cis-1,2-Dichloroethene	ND	1.0	ug/L	0.17
trans-1,2-Dichloroethene	ND	1.0	ug/L	0.19
1,2-Dichloropropane	ND	1.0	ug/L	0.18
cis-1,3-Dichloropropene	ND	1.0	ug/L	0.14
trans-1,3-Dichloropropene	ND	1.0	ug/L	0.19
Ethylbenzene	ND	1.0	ug/L	0.17
2-Hexanone	ND	10	ug/L	0.41
Isopropylbenzene	ND	1.0	ug/L	0.13
Methyl acetate	ND	10	ug/L	0.38
Methylene chloride	ND	1.0	ug/L	0.33
Methylcyclohexane	ND	1.0	ug/L	0.13
4-Methyl-2-pentanone	ND	10	ug/L	0.32
Methyl tert-butyl ether	ND	5.0	ug/L	0.17
Styrene	ND	1.0	ug/L	0.11
1,1,2,2-Tetrachloroethane	ND	1.0	ug/L	0.18

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Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-005

GC/MS Semivolatiles

Lot-Sample #...: A9D170133-005 **Work Order #...:** K981G1AW **Matrix.........:** WG
Date Sampled...: 04/15/09 15:00 **Date Received..:** 04/17/09
Prep Date......: 04/19/09 **Analysis Date..:** 04/20/09
Prep Batch #...: 9108058
Dilution Factor: 1 **Method.........:** SW846 8270C

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Acenaphthene	ND	0.20	ug/L	0.10
Acenaphthylene	ND	0.20	ug/L	0.10
Acetophenone	ND	1.0	ug/L	0.34
Anthracene	ND	0.20	ug/L	0.10
Atrazine	ND	1.0	ug/L	0.34
Benzo(a)anthracene	ND	0.20	ug/L	0.10
Benzo(a)pyrene	ND	0.20	ug/L	0.10
Benzo(b)fluoranthene	ND	0.20	ug/L	0.10
Benzo(ghi)perylene	ND	0.20	ug/L	0.10
Benzo(k)fluoranthene	ND	0.20	ug/L	0.10
Benzaldehyde	ND	1.0	ug/L	0.39
1,1'-Biphenyl	ND	1.0	ug/L	0.80
bis(2-Chloroethoxy) methane	ND	1.0	ug/L	0.32
bis(2-Chloroethyl)- ether	ND	1.0	ug/L	0.10
bis(2-Ethylhexyl) phthalate	**6.0 B**	**2.0**	**ug/L**	**0.80**
4-Bromophenyl phenyl ether	ND	2.0	ug/L	0.80
Butyl benzyl phthalate	ND	1.0	ug/L	0.80
Caprolactam	ND	5.0	ug/L	0.80
Carbazole	ND	1.0	ug/L	0.28
4-Chloroaniline	ND	2.0	ug/L	0.80
4-Chloro-3-methylphenol	ND	2.0	ug/L	0.80
2-Chloronaphthalene	ND	1.0	ug/L	0.10
2-Chlorophenol	ND	1.0	ug/L	0.29
4-Chlorophenyl phenyl ether	ND	2.0	ug/L	0.30
Chrysene	ND	0.20	ug/L	0.10
Dibenz(a,h)anthracene	ND	0.20	ug/L	0.10
Dibenzofuran	ND	1.0	ug/L	0.10
3,3'-Dichlorobenzidine	ND	5.0	ug/L	0.37
2,4-Dichlorophenol	ND	2.0	ug/L	0.80
Diethyl phthalate	ND	1.0	ug/L	0.60
2,4-Dimethylphenol	ND	2.0	ug/L	0.80
Dimethyl phthalate	ND	1.0	ug/L	0.29
Di-n-butyl phthalate	ND	1.0	ug/L	0.67
4,6-Dinitro- 2-methylphenol	ND	5.0	ug/L	2.4

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Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-005

GC/MS Semivolatiles

Lot-Sample #...: A9D170133-005 **Work Order #...:** K981G1AW **Matrix.........:** WG

NOTE(S):

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-005

TOTAL Metals

Lot-Sample #...: A9D170133-005

Matrix.........: WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Sodium	**100000 J**	**5000** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 6.9	**04/20-04/27/09**	**K981G1DH**
Nickel	**1.2 B**	**40.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.20	**04/20-04/27/09**	**K981G1DL**
Lead	**0.37 B**	**1.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.18	**04/20-04/27/09**	**K981G1DP**
Antimony	**0.28 B**	**2.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.13	**04/20-04/27/09**	**K981G1AA**
Selenium	ND	5.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 1.2	04/20-04/27/09	K981G1AE
Thallium	ND	1.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 0.14	04/20-04/27/09	K981G1AH
Vanadium	**0.56 B**	**50.0** Dilution Factor: 1	**ug/L**	**SW846 6020** MDL............: 0.44	**04/20-04/27/09**	**K981G1AL**
Zinc	ND	20.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 2.3	04/20-04/27/09	K981G1AP
Mercury	ND	0.20 Dilution Factor: 1	ug/L	SW846 7470A MDL............: 0.12	04/20/09	K981G1A1

NOTE(S):

B Estimated result. Result is less than RL.

J Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-006

GC/MS Volatiles

Lot-Sample #...: A9D170133-006 **Work Order #...:** K981H1AG **Matrix.........:** WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Tetrachloroethene	ND	1.0	ug/L	0.29
Toluene	ND	1.0	ug/L	0.13
1,2,4-Trichloro-benzene	ND	1.0	ug/L	0.15
1,1,1-Trichloroethane	ND	1.0	ug/L	0.22
1,1,2-Trichloroethane	ND	1.0	ug/L	0.27
Trichloroethene	ND	1.0	ug/L	0.17
Trichlorofluoromethane	ND	1.0	ug/L	0.21
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	1.0	ug/L	0.28
Vinyl chloride	ND	1.0	ug/L	0.22
Xylenes (total)	ND	2.0	ug/L	0.28

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	101	(73 - 122)
1,2-Dichloroethane-d4	95	(61 - 128)
Toluene-d8	95	(76 - 110)
4-Bromofluorobenzene	80	(74 - 116)

NOTE(S):

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-006

GC/MS Semivolatiles

Lot-Sample #...: A9D170133-006 **Work Order #...:** K981H1AH **Matrix.........:** WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
2,4-Dinitrophenol	ND	5.0	ug/L	2.4
2,4-Dinitrotoluene	ND	5.0	ug/L	0.27
2,6-Dinitrotoluene	ND	5.0	ug/L	0.80
Di-n-octyl phthalate	ND	1.0	ug/L	0.80
Fluoranthene	ND	0.20	ug/L	0.10
Fluorene	ND	0.20	ug/L	0.10
Hexachlorobenzene	ND	0.20	ug/L	0.10
Hexachlorobutadiene	ND	1.0	ug/L	0.27
Hexachlorocyclopentadiene	ND	10	ug/L	0.80
Hexachloroethane	ND	1.0	ug/L	0.80
Indeno(1,2,3-cd)pyrene	ND	0.20	ug/L	0.10
Isophorone	ND	1.0	ug/L	0.27
2-Methylnaphthalene	ND	0.20	ug/L	0.10
2-Methylphenol	ND	1.0	ug/L	0.80
4-Methylphenol	ND	1.0	ug/L	0.80
Naphthalene	ND	0.20	ug/L	0.10
2-Nitroaniline	ND	2.0	ug/L	0.80
3-Nitroaniline	ND	2.0	ug/L	0.28
4-Nitroaniline	ND	2.0	ug/L	0.80
Nitrobenzene	ND	1.0	ug/L	0.040
2-Nitrophenol	ND	2.0	ug/L	0.28
4-Nitrophenol	ND	5.0	ug/L	2.4
N-Nitrosodi-n-propylamine	ND	1.0	ug/L	0.80
N-Nitrosodiphenylamine	ND	1.0	ug/L	0.31
2,2'-oxybis (1-Chloropropane)	ND	1.0	ug/L	0.40
Pentachlorophenol	ND	5.0	ug/L	2.4
Phenanthrene	ND	0.20	ug/L	0.10
Phenol	ND	1.0	ug/L	0.60
Pyrene	ND	0.20	ug/L	0.10
2,4,5-Trichlorophenol	ND	5.0	ug/L	0.30
2,4,6-Trichlorophenol	ND	5.0	ug/L	0.80

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Nitrobenzene-d5	80	(27 - 111)
2-Fluorobiphenyl	71	(28 - 110)
Terphenyl-d14	100	(37 - 119)
Phenol-d5	63	(10 - 110)
2-Fluorophenol	80	(10 - 110)
2,4,6-Tribromophenol	86	(22 - 120)

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Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-006

GC/MS Semivolatiles

Lot-Sample #...: A9D170133-006 **Work Order #...:** K981H2AH **Matrix.........:** WG
Date Sampled...: 04/15/09 17:00 **Date Received..:** 04/17/09
Prep Date.......: 04/19/09 **Analysis Date..:** 04/21/09
Prep Batch #...: 9108058
Dilution Factor: 6.66 **Method.........:** SW846 8270C

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Acenaphthene	ND	1.3	ug/L	0.67
Acenaphthylene	ND	1.3	ug/L	0.67
Acetophenone	ND	6.7	ug/L	2.3
Anthracene	ND	1.3	ug/L	0.67
Atrazine	ND	6.7	ug/L	2.3
Benzo(a)anthracene	ND	1.3	ug/L	0.67
Benzo(a)pyrene	ND	1.3	ug/L	0.67
Benzo(b)fluoranthene	ND	1.3	ug/L	0.67
Benzo(ghi)perylene	ND	1.3	ug/L	0.67
Benzo(k)fluoranthene	ND	1.3	ug/L	0.67
Benzaldehyde	ND	6.7	ug/L	2.6
1,1'-Biphenyl	ND	6.7	ug/L	5.3
bis(2-Chloroethoxy) methane	ND	6.7	ug/L	2.1
bis(2-Chloroethyl)-ether	ND	6.7	ug/L	0.67
bis(2-Ethylhexyl) phthalate	ND	13	ug/L	5.3
4-Bromophenyl phenyl ether	ND	13	ug/L	5.3
Butyl benzyl phthalate	ND	6.7	ug/L	5.3
Caprolactam	**130**	**33**	**ug/L**	**5.3**
Carbazole	ND	6.7	ug/L	1.9
4-Chloroaniline	ND	13	ug/L	5.3
4-Chloro-3-methylphenol	ND	13	ug/L	5.3
2-Chloronaphthalene	ND	6.7	ug/L	0.67
2-Chlorophenol	ND	6.7	ug/L	1.9
4-Chlorophenyl phenyl ether	ND	13	ug/L	2.0
Chrysene	ND	1.3	ug/L	0.67
Dibenz(a,h)anthracene	ND	1.3	ug/L	0.67
Dibenzofuran	ND	6.7	ug/L	0.67
3,3'-Dichlorobenzidine	ND	33	ug/L	2.5
2,4-Dichlorophenol	ND	13	ug/L	5.3
Diethyl phthalate	ND	6.7	ug/L	4.0
2,4-Dimethylphenol	ND	13	ug/L	5.3
Dimethyl phthalate	ND	6.7	ug/L	1.9
Di-n-butyl phthalate	ND	6.7	ug/L	4.5
4,6-Dinitro-2-methylphenol	ND	33	ug/L	16

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Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-006

GC/MS Semivolatiles

Lot-Sample #...: A9D170133-006 **Work Order #...:** K981H2AH **Matrix.........:** WG

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-006

TOTAL Metals

Lot-Sample #...: A9D170133-006

Matrix.........: WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Sodium	57100 J	5000 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 6.9	04/20-04/27/09	K981H1A2
Nickel	3.5 B	40.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 0.20	04/20-04/27/09	K981H1A3
Lead	10.9	1.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 0.18	04/20-04/27/09	K981H1A4
Antimony	34.9	2.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 0.13	04/20-04/27/09	K981H1AA
Selenium	ND	5.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 1.2	04/20-04/27/09	K981H1AC
Thallium	0.26 B	1.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 0.14	04/20-04/27/09	K981H1AD
Vanadium	2.4 B	50.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 0.44	04/20-04/27/09	K981H1AE
Zinc	45.0 J	20.0 Dilution Factor: 1	ug/L	SW846 6020 MDL............: 2.3	04/20-04/27/09	K981H1AF
Mercury	ND	0.20 Dilution Factor: 1	ug/L	SW846 7470A MDL............: 0.12	04/20/09	K981H1AJ

NOTE(S):

B Estimated result. Result is less than RL.

J Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-007

GC/MS Volatiles

Lot-Sample #...: A9D170133-007 **Work Order #...:** K981J1AG **Matrix.........:** WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Tetrachloroethene	ND	1.0	ug/L	0.29
Toluene	**1.3**	**1.0**	**ug/L**	**0.13**
1,2,4-Trichloro-benzene	ND	1.0	ug/L	0.15
1,1,1-Trichloroethane	ND	1.0	ug/L	0.22
1,1,2-Trichloroethane	ND	1.0	ug/L	0.27
Trichloroethene	ND	1.0	ug/L	0.17
Trichlorofluoromethane	ND	1.0	ug/L	0.21
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	1.0	ug/L	0.28
Vinyl chloride	ND	1.0	ug/L	0.22
Xylenes (total)	**0.73 J**	**2.0**	**ug/L**	**0.28**

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	96	(73 - 122)
1,2-Dichloroethane-d4	95	(61 - 128)
Toluene-d8	97	(76 - 110)
4-Bromofluorobenzene	83	(74 - 116)

NOTE(S):

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Client Sample ID: WG-630660-041509-JJW-007

GC/MS Semivolatiles

Lot-Sample #...: A9D170133-007 **Work Order #...:** K981J1AH **Matrix.........:** WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
2,4-Dinitrophenol	ND	5.0	ug/L	2.4
2,4-Dinitrotoluene	ND	5.0	ug/L	0.27
2,6-Dinitrotoluene	ND	5.0	ug/L	0.80
Di-n-octyl phthalate	ND	1.0	ug/L	0.80
Fluoranthene	ND	0.20	ug/L	0.10
Fluorene	ND	0.20	ug/L	0.10
Hexachlorobenzene	ND	0.20	ug/L	0.10
Hexachlorobutadiene	ND	1.0	ug/L	0.27
Hexachlorocyclopentadiene	ND	10	ug/L	0.80
Hexachloroethane	ND	1.0	ug/L	0.80
Indeno(1,2,3-cd)pyrene	ND	0.20	ug/L	0.10
Isophorone	**1.5**	**1.0**	**ug/L**	**0.27**
2-Methylnaphthalene	ND	0.20	ug/L	0.10
2-Methylphenol	ND	1.0	ug/L	0.80
4-Methylphenol	ND	1.0	ug/L	0.80
Naphthalene	ND	0.20	ug/L	0.10
2-Nitroaniline	ND	2.0	ug/L	0.80
3-Nitroaniline	ND	2.0	ug/L	0.28
4-Nitroaniline	ND	2.0	ug/L	0.80
Nitrobenzene	ND	1.0	ug/L	0.040
2-Nitrophenol	ND	2.0	ug/L	0.28
4-Nitrophenol	ND	5.0	ug/L	2.4
N-Nitrosodi-n-propylamine	ND	1.0	ug/L	0.80
N-Nitrosodiphenylamine	ND	1.0	ug/L	0.31
2,2'-oxybis (1-Chloropropane)	ND	1.0	ug/L	0.40
Pentachlorophenol	ND	5.0	ug/L	2.4
Phenanthrene	ND	0.20	ug/L	0.10
Phenol	ND	1.0	ug/L	0.60
Pyrene	ND	0.20	ug/L	0.10
2,4,5-Trichlorophenol	ND	5.0	ug/L	0.30
2,4,6-Trichlorophenol	ND	5.0	ug/L	0.80

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Nitrobenzene-d5	49	(27 - 111)
2-Fluorobiphenyl	67	(28 - 110)
Terphenyl-d14	101	(37 - 119)
Phenol-d5	74	(10 - 110)
2-Fluorophenol	84	(10 - 110)
2,4,6-Tribromophenol	83	(22 - 120)

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Conestoga-Rovers & Associates, Inc.

Client Sample ID: WG-630660-041509-JJW-007

TOTAL Metals

Lot-Sample #...: A9D170133-007
Date Sampled...: 04/15/09 18:00 **Date Received..:** 04/17/09 **Matrix.......:** WG

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Prep Batch #...: 9110041						
Silver	ND	1.0 Dilution Factor: 1	ug/L	SW846 6020 MDL...........: 0.080	04/20-04/27/09	K981J1AV
Aluminum	13100	200 Dilution Factor: 1	ug/L	SW846 6020 MDL...........: 19.0	04/20-04/27/09	K981J1AK
Arsenic	4.0 B	5.0 Dilution Factor: 1	ug/L	SW846 6020 MDL...........: 0.40	04/20-04/27/09	K981J1AL
Barium	172 B,J	200 Dilution Factor: 1	ug/L	SW846 6020 MDL...........: 0.19	04/20-04/27/09	K981J1AM
Beryllium	0.58 B	5.0 Dilution Factor: 1	ug/L	SW846 6020 MDL...........: 0.20	04/20-04/27/09	K981J1AN
Calcium	252000 J	5000 Dilution Factor: 1	ug/L	SW846 6020 MDL...........: 22.0	04/20-04/27/09	K981J1AP
Cadmium	ND	1.0 Dilution Factor: 1	ug/L	SW846 6020 MDL...........: 0.13	04/20-04/27/09	K981J1AQ
Cobalt	6.0 B	50.0 Dilution Factor: 1	ug/L	SW846 6020 MDL...........: 0.058	04/20-04/27/09	K981J1AR
Chromium	23.6	10.0 Dilution Factor: 1	ug/L	SW846 6020 MDL...........: 0.71	04/20-04/27/09	K981J1AT
Copper	21.8 B,J	25.0 Dilution Factor: 1	ug/L	SW846 6020 MDL...........: 0.29	04/20-04/27/09	K981J1AU
Iron	19000	100 Dilution Factor: 1	ug/L	SW846 6020 MDL...........: 26.0	04/20-04/27/09	K981J1AW
Potassium	13600	5000 Dilution Factor: 1	ug/L	SW846 6020 MDL...........: 8.3	04/20-04/28/09	K981J1AX
Magnesium	107000 J	5000 Dilution Factor: 1	ug/L	SW846 6020 MDL...........: 17.0	04/20-04/27/09	K981J1A0
Manganese	478 J	15.0 Dilution Factor: 1	ug/L	SW846 6020 MDL...........: 0.83	04/20-04/28/09	K981J1A1

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Conestoga-Rovers & Associates, Inc.

Client Sample ID: TRIP BLANK

GC/MS Volatiles

Lot-Sample #...:	A9D170133-008	**Work Order #...:**	K981K1AA	**Matrix.........:**	WQ
Date Sampled...:	04/15/09	**Date Received..:**	04/17/09		
Prep Date......:	04/21/09	**Analysis Date..:**	04/21/09		
Prep Batch #...:	9112490				
Dilution Factor:	1	**Method.........:**	SW846 8260B		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Acetone	ND	10	ug/L	1.1
Benzene	ND	1.0	ug/L	0.13
Bromodichloromethane	ND	1.0	ug/L	0.15
Bromoform	ND	1.0	ug/L	0.64
Bromomethane	ND	1.0	ug/L	0.41
2-Butanone	ND	10	ug/L	0.57
Carbon disulfide	ND	1.0	ug/L	0.13
Carbon tetrachloride	ND	1.0	ug/L	0.13
Chlorobenzene	ND	1.0	ug/L	0.15
Chloroethane	ND	1.0	ug/L	0.29
Chloroform	ND	1.0	ug/L	0.16
Chloromethane	ND	1.0	ug/L	0.30
Cyclohexane	ND	1.0	ug/L	0.12
Dibromochloromethane	ND	1.0	ug/L	0.18
1,2-Dibromo-3-chloropropane	ND	2.0	ug/L	0.67
1,2-Dibromoethane	ND	1.0	ug/L	0.24
1,2-Dichlorobenzene	ND	1.0	ug/L	0.13
1,3-Dichlorobenzene	ND	1.0	ug/L	0.14
1,4-Dichlorobenzene	ND	1.0	ug/L	0.13
Dichlorodifluoromethane	ND	1.0	ug/L	0.31
1,1-Dichloroethane	ND	1.0	ug/L	0.15
1,2-Dichloroethane	ND	1.0	ug/L	0.22
1,1-Dichloroethene	ND	1.0	ug/L	0.19
cis-1,2-Dichloroethene	ND	1.0	ug/L	0.17
trans-1,2-Dichloroethene	ND	1.0	ug/L	0.19
1,2-Dichloropropane	ND	1.0	ug/L	0.18
cis-1,3-Dichloropropene	ND	1.0	ug/L	0.14
trans-1,3-Dichloropropene	ND	1.0	ug/L	0.19
Ethylbenzene	ND	1.0	ug/L	0.17
2-Hexanone	ND	10	ug/L	0.41
Isopropylbenzene	ND	1.0	ug/L	0.13
Methyl acetate	ND	10	ug/L	0.38
Methylene chloride	ND	1.0	ug/L	0.33
Methylcyclohexane	ND	1.0	ug/L	0.13
4-Methyl-2-pentanone	ND	10	ug/L	0.32
Methyl tert-butyl ether	ND	5.0	ug/L	0.17
Styrene	ND	1.0	ug/L	0.11
1,1,2,2-Tetrachloroethane	ND	1.0	ug/L	0.18

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TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

QUALITY CONTROL SECTION

METHOD BLANK REPORT

GC/MS Volatiles

Client Lot #...: A9D170133 **Work Order #...:** LAKGD1AA **Matrix.........:** WATER

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD
1,2,4-Trichloro-benzene	ND	1.0	ug/L	SW846 8260B
1,1,1-Trichloroethane	ND	1.0	ug/L	SW846 8260B
1,1,2-Trichloroethane	ND	1.0	ug/L	SW846 8260B
Trichloroethene	ND	1.0	ug/L	SW846 8260B
Trichlorofluoromethane	ND	1.0	ug/L	SW846 8260B
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	1.0	ug/L	SW846 8260B
Vinyl chloride	ND	1.0	ug/L	SW846 8260B
Xylenes (total)	ND	2.0	ug/L	SW846 8260B

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	96	(73 - 122)
1,2-Dichloroethane-d4	97	(61 - 128)
Toluene-d8	96	(76 - 110)
4-Bromofluorobenzene	81	(74 - 116)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

J Estimated result. Result is less than RL.

METHOD BLANK REPORT

GC/MS Volatiles

Client Lot #...: A9D170133 **Work Order #...:** LANQK1AA **Matrix.........:** WATER

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD
1,2,4-Trichloro-benzene	**0.27 J**	**1.0**	**ug/L**	**SW846 8260B**
1,1,1-Trichloroethane	ND	1.0	ug/L	SW846 8260B
1,1,2-Trichloroethane	ND	1.0	ug/L	SW846 8260B
Trichloroethene	ND	1.0	ug/L	SW846 8260B
Trichlorofluoromethane	ND	1.0	ug/L	SW846 8260B
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	1.0	ug/L	SW846 8260B
Vinyl chloride	ND	1.0	ug/L	SW846 8260B
Xylenes (total)	ND	2.0	ug/L	SW846 8260B

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	102	(73 - 122)
1,2-Dichloroethane-d4	95	(61 - 128)
Toluene-d8	96	(76 - 110)
4-Bromofluorobenzene	80	(74 - 116)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

J Estimated result. Result is less than RL.

METHOD BLANK REPORT

GC/MS Semivolatiles

Client Lot #...: A9D170133 **Work Order #...:** LACFM1AA **Matrix.........:** WATER

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD
2,4-Dinitrotoluene	ND	5.0	ug/L	SW846 8270C
2,6-Dinitrotoluene	ND	5.0	ug/L	SW846 8270C
Di-n-octyl phthalate	ND	1.0	ug/L	SW846 8270C
Fluoranthene	ND	0.20	ug/L	SW846 8270C
Fluorene	ND	0.20	ug/L	SW846 8270C
Hexachlorobenzene	ND	0.20	ug/L	SW846 8270C
Hexachlorobutadiene	ND	1.0	ug/L	SW846 8270C
Hexachlorocyclopentadiene	ND	10	ug/L	SW846 8270C
Hexachloroethane	ND	1.0	ug/L	SW846 8270C
Indeno(1,2,3-cd)pyrene	ND	0.20	ug/L	SW846 8270C
Isophorone	ND	1.0	ug/L	SW846 8270C
2-Methylnaphthalene	ND	0.20	ug/L	SW846 8270C
2-Methylphenol	ND	1.0	ug/L	SW846 8270C
4-Methylphenol	ND	1.0	ug/L	SW846 8270C
Naphthalene	ND	0.20	ug/L	SW846 8270C
2-Nitroaniline	ND	2.0	ug/L	SW846 8270C
3-Nitroaniline	ND	2.0	ug/L	SW846 8270C
4-Nitroaniline	ND	2.0	ug/L	SW846 8270C
Nitrobenzene	ND	1.0	ug/L	SW846 8270C
2-Nitrophenol	ND	2.0	ug/L	SW846 8270C
4-Nitrophenol	ND	5.0	ug/L	SW846 8270C
N-Nitrosodi-n-propylamine	ND	1.0	ug/L	SW846 8270C
N-Nitrosodiphenylamine	ND	1.0	ug/L	SW846 8270C
2,2'-oxybis (1-Chloropropane)	ND	1.0	ug/L	SW846 8270C
Pentachlorophenol	ND	5.0	ug/L	SW846 8270C
Phenanthrene	ND	0.20	ug/L	SW846 8270C
Phenol	ND	1.0	ug/L	SW846 8270C
Pyrene	ND	0.20	ug/L	SW846 8270C
2,4,5-Trichlorophenol	ND	5.0	ug/L	SW846 8270C
2,4,6-Trichlorophenol	ND	5.0	ug/L	SW846 8270C

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Nitrobenzene-d5	76	(27 - 111)
2-Fluorobiphenyl	67	(28 - 110)
Terphenyl-d14	100	(37 - 119)
Phenol-d5	72	(10 - 110)
2-Fluorophenol	77	(10 - 110)
2,4,6-Tribromophenol	73	(22 - 120)

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METHOD BLANK REPORT

TOTAL Metals

Client Lot #...: A9D170133

Matrix.........: WATER

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
MB Lot-Sample #: A9D200000-041	**Prep Batch #...:** 9110041					
Aluminum	ND	200 Dilution Factor: 1	ug/L	SW846 6020	04/20-04/27/09	LADCM1DU
Antimony	ND	2.0 Dilution Factor: 1	ug/L	SW846 6020	04/20-04/27/09	LADCM1CM
Arsenic	ND	5.0 Dilution Factor: 1	ug/L	SW846 6020	04/20-04/27/09	LADCM1CK
Barium	**1.1 B**	**200** Dilution Factor: 1	**ug/L**	**SW846 6020**	**04/20-04/27/09**	**LADCM1DV**
Beryllium	ND	5.0 Dilution Factor: 1	ug/L	SW846 6020	04/20-04/27/09	LADCM1DW
Cadmium	ND	1.0 Dilution Factor: 1	ug/L	SW846 6020	04/20-04/27/09	LADCM1D0
Calcium	**563 B**	**5000** Dilution Factor: 1	**ug/L**	**SW846 6020**	**04/20-04/27/09**	**LADCM1DX**
Chromium	ND	10.0 Dilution Factor: 1	ug/L	SW846 6020	04/20-04/27/09	LADCM1D1
Cobalt	ND	50.0 Dilution Factor: 1	ug/L	SW846 6020	04/20-04/27/09	LADCM1AG
Copper	**0.64 B**	**25.0** Dilution Factor: 1	**ug/L**	**SW846 6020**	**04/20-04/27/09**	**LADCM1D2**
Iron	ND	100 Dilution Factor: 1	ug/L	SW846 6020	04/20-04/27/09	LADCM1CN
Lead	ND	1.0 Dilution Factor: 1	ug/L	SW846 6020	04/20-04/27/09	LADCM1CL
Magnesium	**78.5 B**	**5000** Dilution Factor: 1	**ug/L**	**SW846 6020**	**04/20-04/27/09**	**LADCM1D5**
Manganese	**2.0 B**	**15.0** Dilution Factor: 1	**ug/L**	**SW846 6020**	**04/20-04/27/09**	**LADCM1D6**
Nickel	ND	40.0 Dilution Factor: 1	ug/L	SW846 6020	04/20-04/27/09	LADCM1D8

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LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Volatiles

Client Lot #...: A9D170133 **Work Order #...:** LAKGD1AC **Matrix.........:** WATER
LCS Lot-Sample#: A9D220000-490
Prep Date......: 04/21/09 **Analysis Date..:** 04/21/09
Prep Batch #...: 9112490
Dilution Factor: 1

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	METHOD
Acetone	66	(22 - 200)	SW846 8260B
Benzene	**89**	**(80 - 116)**	**SW846 8260B**
Bromodichloromethane	90	(87 - 130)	SW846 8260B
Bromoform	92	(76 - 150)	SW846 8260B
Bromomethane	103	(64 - 129)	SW846 8260B
2-Butanone	73	(28 - 237)	SW846 8260B
Carbon disulfide	101	(73 - 139)	SW846 8260B
Carbon tetrachloride	104	(75 - 149)	SW846 8260B
Chlorobenzene	**97**	**(76 - 117)**	**SW846 8260B**
Chloroethane	89	(66 - 126)	SW846 8260B
Chloroform	92	(84 - 128)	SW846 8260B
Chloromethane	117	(48 - 123)	SW846 8260B
Cyclohexane	85	(70 - 130)	SW846 8260B
Dibromochloromethane	94	(81 - 138)	SW846 8260B
1,2-Dibromo-3-chloro- propane	81	(70 - 130)	SW846 8260B
1,2-Dibromoethane	93	(70 - 130)	SW846 8260B
1,2-Dichlorobenzene	96	(70 - 130)	SW846 8260B
1,3-Dichlorobenzene	95	(70 - 130)	SW846 8260B
1,4-Dichlorobenzene	96	(70 - 130)	SW846 8260B
Dichlorodifluoromethane	61 a	(70 - 130)	SW846 8260B
1,1-Dichloroethane	94	(86 - 123)	SW846 8260B
1,2-Dichloroethane	88	(79 - 136)	SW846 8260B
1,1-Dichloroethene	**96**	**(63 - 130)**	**SW846 8260B**
cis-1,2-Dichloroethene	94	(85 - 113)	SW846 8260B
trans-1,2-Dichloroethene	94	(80 - 120)	SW846 8260B
1,2-Dichloropropane	93	(82 - 115)	SW846 8260B
cis-1,3-Dichloropropene	83 a	(84 - 130)	SW846 8260B
trans-1,3-Dichloropropene	87	(84 - 130)	SW846 8260B
Ethylbenzene	96	(86 - 116)	SW846 8260B
2-Hexanone	84	(35 - 200)	SW846 8260B
Isopropylbenzene	100	(70 - 130)	SW846 8260B
Methyl acetate	72	(70 - 130)	SW846 8260B
Methylene chloride	95	(78 - 118)	SW846 8260B

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LABORATORY CONTROL SAMPLE DATA REPORT

GC/MS Volatiles

Client Lot #...: A9D170133 **Work Order #...:** LAKGD1AC **Matrix.........:** WATER
LCS Lot-Sample#: A9D220000-490
Prep Date......: 04/21/09 **Analysis Date..:** 04/21/09
Prep Batch #...: 9112490
Dilution Factor: 1

PARAMETER	SPIKE AMOUNT	MEASURED AMOUNT	UNITS	PERCENT RECOVERY	METHOD
Acetone	10	6.6	ug/L	66	SW846 8260B
Benzene	**10**	**8.9**	**ug/L**	**89**	**SW846 8260B**
Bromodichloromethane	10	9.0	ug/L	90	SW846 8260B
Bromoform	10	9.2	ug/L	92	SW846 8260B
Bromomethane	10	10	ug/L	103	SW846 8260B
2-Butanone	10	7.3	ug/L	73	SW846 8260B
Carbon disulfide	10	10	ug/L	101	SW846 8260B
Carbon tetrachloride	10	10	ug/L	104	SW846 8260B
Chlorobenzene	**10**	**9.7**	**ug/L**	**97**	**SW846 8260B**
Chloroethane	10	8.9	ug/L	89	SW846 8260B
Chloroform	10	9.2	ug/L	92	SW846 8260B
Chloromethane	10	12	ug/L	117	SW846 8260B
Cyclohexane	10	8.5	ug/L	85	SW846 8260B
Dibromochloromethane	10	9.4	ug/L	94	SW846 8260B
1,2-Dibromo-3-chloropropane	10	8.1	ug/L	81	SW846 8260B
1,2-Dibromoethane	10	9.3	ug/L	93	SW846 8260B
1,2-Dichlorobenzene	10	9.6	ug/L	96	SW846 8260B
1,3-Dichlorobenzene	10	9.5	ug/L	95	SW846 8260B
1,4-Dichlorobenzene	10	9.6	ug/L	96	SW846 8260B
Dichlorodifluoromethane	10	6.1 a	ug/L	61	SW846 8260B
1,1-Dichloroethane	10	9.4	ug/L	94	SW846 8260B
1,2-Dichloroethane	10	8.8	ug/L	88	SW846 8260B
1,1-Dichloroethene	**10**	**9.6**	**ug/L**	**96**	**SW846 8260B**
cis-1,2-Dichloroethene	10	9.4	ug/L	94	SW846 8260B
trans-1,2-Dichloroethene	10	9.4	ug/L	94	SW846 8260B
1,2-Dichloropropane	10	9.3	ug/L	93	SW846 8260B
cis-1,3-Dichloropropene	10	8.3 a	ug/L	83	SW846 8260B
trans-1,3-Dichloropropene	10	8.7	ug/L	87	SW846 8260B
Ethylbenzene	10	9.6	ug/L	96	SW846 8260B
2-Hexanone	10	8.4	ug/L	84	SW846 8260B
Isopropylbenzene	10	10	ug/L	100	SW846 8260B
Methyl acetate	10	7.2	ug/L	72	SW846 8260B
Methylene chloride	10	9.5	ug/L	95	SW846 8260B

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LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Volatiles

Client Lot #...: A9D170133 Work Order #...: LANQK1AC-LCS Matrix.........: WATER
LCS Lot-Sample#: A9D240000-092 LANQK1AD-LCSD
Prep Date......: 04/22/09 Analysis Date..: 04/22/09
Prep Batch #...: 9114092
Dilution Factor: 1

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Acetone	61	(22 - 200)			SW846 8260B
	67	(22 - 200)	9.4	(0-95)	SW846 8260B
Benzene	99	(80 - 116)			SW846 8260B
	98	(80 - 116)	0.34	(0-20)	SW846 8260B
Bromodichloromethane	98	(87 - 130)			SW846 8260B
	100	(87 - 130)	1.6	(0-30)	SW846 8260B
Bromoform	100	(76 - 150)			SW846 8260B
	100	(76 - 150)	0.37	(0-30)	SW846 8260B
Bromomethane	116	(64 - 129)			SW846 8260B
	110	(64 - 129)	5.6	(0-30)	SW846 8260B
2-Butanone	77	(28 - 237)			SW846 8260B
	82	(28 - 237)	6.4	(0-65)	SW846 8260B
Carbon disulfide	110	(73 - 139)			SW846 8260B
	106	(73 - 139)	4.4	(0-30)	SW846 8260B
Carbon tetrachloride	104	(75 - 149)			SW846 8260B
	102	(75 - 149)	2.3	(0-30)	SW846 8260B
Chlorobenzene	105	(76 - 117)			SW846 8260B
	105	(76 - 117)	0.58	(0-20)	SW846 8260B
Chloroethane	87	(66 - 126)			SW846 8260B
	87	(66 - 126)	0.24	(0-30)	SW846 8260B
Chloroform	101	(84 - 128)			SW846 8260B
	100	(84 - 128)	1.7	(0-30)	SW846 8260B
Chloromethane	135 a	(48 - 123)			SW846 8260B
	133 a	(48 - 123)	1.3	(0-30)	SW846 8260B
Cyclohexane	70	(70 - 130)			SW846 8260B
	74	(70 - 130)	6.3	(0-30)	SW846 8260B
Dibromochloromethane	102	(81 - 138)			SW846 8260B
	103	(81 - 138)	0.90	(0-30)	SW846 8260B
1,2-Dibromo-3-chloropropane	[illegible]4	(70 - 130)			SW846 8260B
	[illegible]0	(70 - 130)	6.6	(0-30)	SW846 8260B
1,2-Dibromoethane	[illegible]9	(70 - 130)			SW846 8260B
	102	(70 - 130)	3.2	(0-30)	SW846 8260B
1,2-Dichlorobenzene	103	(70 - 130)			SW846 8260B
	103	(70 - 130)	0.92	(0-30)	SW846 8260B
1,3-Dichlorobenzene	102	(70 - 130)			SW846 8260B
	104	(70 - 130)	2.2	(0-30)	SW846 8260B
1,4-Dichlorobenzene	103	(70 - 130)			SW846 8260B
	104	(70 - 130)	1.2	(0-30)	SW846 8260B

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LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Volatiles

Client Lot #...: A9D170133 **Work Order #...:** LANQK1AC-LCS **Matrix.........:** WATER
LCS Lot-Sample#: A9D240000-092 LANQK1AD-LCSD

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Toluene	**103**	**(74 - 119)**			**SW846 8260B**
	104	**(74 - 119)**	**0.75**	**(0-20)**	**SW846 8260B**
1,2,4-Trichloro-benzene	95	(70 - 130)			SW846 8260B
	97	(70 - 130)	2.8	(0-30)	SW846 8260B
1,1,1-Trichloroethane	94	(78 - 140)			SW846 8260B
	93	(78 - 140)	1.3	(0-30)	SW846 8260B
1,1,2-Trichloroethane	99	(83 - 122)			SW846 8260B
	101	(83 - 122)	2.1	(0-30)	SW846 8260B
Trichloroethene	**99**	**(75 - 122)**			**SW846 8260B**
	97	**(75 - 122)**	**1.8**	**(0-20)**	**SW846 8260B**
Trichlorofluoromethane	118	(70 - 130)			SW846 8260B
	122	(70 - 130)	3.4	(0-30)	SW846 8260B
1,1,2-Trichloro-1,2,2-trifluoroethane	117	(70 - 130)			SW846 8260B
	130	(70 - 130)	10	(0-30)	SW846 8260B
Vinyl chloride	92	(61 - 120)			SW846 8260B
	90	(61 - 120)	2.7	(0-30)	SW846 8260B
Xylenes (total)	108	(87 - 116)			SW846 8260B
	108	(87 - 116)	0.090	(0-30)	SW846 8260B

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	97	(73 - 122)
	96	(73 - 122)
1,2-Dichloroethane-d4	91	(61 - 128)
	91	(61 - 128)
Toluene-d8	101	(76 - 110)
	102	(76 - 110)
4-Bromofluorobenzene	104	(74 - 116)
	106	(74 - 116)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

a Spiked analyte recovery is outside stated control limits.

LABORATORY CONTROL SAMPLE DATA REPORT

GC/MS Volatiles

Client Lot #...: A9D170133 **Work Order #...:** LANQK1AC-LCS **Matrix.........:** WATER
LCS Lot-Sample#: A9D240000-092 LANQK1AD-LCSD

PARAMETER	SPIKE AMOUNT	MEASURED AMOUNT	UNITS	PERCENT RECOVERY	RPD	METHOD
Dichlorodifluoromethane	10	6.6 a	ug/L	66		SW846 8260B
	10	7.2	ug/L	72	8.3	SW846 8260B
1,1-Dichloroethane	10	10	ug/L	102		SW846 8260B
	10	10	ug/L	101	0.84	SW846 8260B
1,2-Dichloroethane	10	9.4	ug/L	94		SW846 8260B
	10	9.5	ug/L	95	1.4	SW846 8260B
1,1-Dichloroethene	**10**	**10**	**ug/L**	**100**		**SW846 8260B**
	10	**9.9**	**ug/L**	**99**	**1.1**	**SW846 8260B**
cis-1,2-Dichloroethene	10	10	ug/L	103		SW846 8260B
	10	10	ug/L	102	0.41	SW846 8260B
trans-1,2-Dichloroethene	10	10	ug/L	102		SW846 8260B
	10	10	ug/L	100	2.5	SW846 8260B
1,2-Dichloropropane	10	9.9	ug/L	99		SW846 8260B
	10	10	ug/L	101	1.5	SW846 8260B
cis-1,3-Dichloropropene	10	8.8	ug/L	88		SW846 8260B
	10	9.1	ug/L	91	3.7	SW846 8260B
trans-1,3-Dichloropropene	10	9.3	ug/L	93		SW846 8260B
	10	9.8	ug/L	98	5.6	SW846 8260B
Ethylbenzene	10	10	ug/L	102		SW846 8260B
	10	10	ug/L	103	1.0	SW846 8260B
2-Hexanone	10	7.9	ug/L	79		SW846 8260B
	10	8.7	ug/L	87	9.6	SW846 8260B
Isopropylbenzene	10	11	ug/L	106		SW846 8260B
	10	10	ug/L	104	1.4	SW846 8260B
Methyl acetate	10	7.4	ug/L	74		SW846 8260B
	10	7.8	ug/L	78	4.8	SW846 8260B
Methylene chloride	10	10	ug/L	101		SW846 8260B
	10	10	ug/L	101	0.40	SW846 8260B
Methylcyclohexane	10	6.3 a	ug/L	63		SW846 8260B
	10	7.0	ug/L	70	10	SW846 8260B
4-Methyl-2-pentanone	10	7.7 a	ug/L	77		SW846 8260B
	10	8.5	ug/L	85	9.2	SW846 8260B
Methyl tert-butyl ether (MTBE)	10	8.3	ug/L	83		SW846 8260B
	10	8.4	ug/L	84	1.6	SW846 8260B
Styrene	10	11	ug/L	108		SW846 8260B
	10	11	ug/L	108	0.68	SW846 8260B
1,1,2,2-Tetrachloroethane	10	9.3	ug/L	93		SW846 8260B
	10	9.5	ug/L	95	2.5	SW846 8260B
Tetrachloroethene	10	10	ug/L	105		SW846 8260B
	10	10	ug/L	102	2.5	SW846 8260B

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LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A9D170133 **Work Order #...:** LACFM1AC **Matrix.........:** WATER
LCS Lot-Sample#: A9D180000-058
Prep Date......: 04/19/09 **Analysis Date..:** 04/20/09
Prep Batch #...: 9108058
Dilution Factor: 1

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	METHOD
Acenaphthene	**69**	**(40 - 110)**	**SW846 8270C**
Acenaphthylene	76	(43 - 110)	SW846 8270C
Acetophenone	82	(50 - 130)	SW846 8270C
Anthracene	74	(54 - 114)	SW846 8270C
Atrazine	116	(50 - 130)	SW846 8270C
Benzo(a)anthracene	83	(55 - 115)	SW846 8270C
Benzo(a)pyrene	72	(43 - 116)	SW846 8270C
Benzo(b)fluoranthene	97	(43 - 122)	SW846 8270C
Benzo(ghi)perylene	79	(45 - 120)	SW846 8270C
Benzo(k)fluoranthene	68	(43 - 124)	SW846 8270C
Benzaldehyde	108	(10 - 130)	SW846 8270C
1,1'-Biphenyl	75	(50 - 130)	SW846 8270C
bis(2-Chloroethoxy) methane	74	(39 - 110)	SW846 8270C
bis(2-Chloroethyl)-ether	76	(34 - 113)	SW846 8270C
bis(2-Ethylhexyl) phthalate	85	(36 - 163)	SW846 8270C
4-Bromophenyl phenyl ether	79	(51 - 114)	SW846 8270C
Butyl benzyl phthalate	85	(53 - 126)	SW846 8270C
Caprolactam	80	(50 - 130)	SW846 8270C
Carbazole	78	(53 - 120)	SW846 8270C
4-Chloroaniline	66	(10 - 110)	SW846 8270C
4-Chloro-3-methylphenol	**77**	**(39 - 110)**	**SW846 8270C**
2-Chloronaphthalene	73	(39 - 110)	SW846 8270C
2-Chlorophenol	**75**	**(27 - 110)**	**SW846 8270C**
4-Chlorophenyl phenyl ether	77	(50 - 115)	SW846 8270C
Chrysene	75	(55 - 115)	SW846 8270C
Dibenz(a,h)anthracene	81	(46 - 122)	SW846 8270C
Dibenzofuran	74	(46 - 111)	SW846 8270C
3,3'-Dichlorobenzidine	43	(19 - 110)	SW846 8270C
2,4-Dichlorophenol	72	(33 - 110)	SW846 8270C

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LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A9D170133 **Work Order #...:** LACFM1AC **Matrix.........:** WATER
LCS Lot-Sample#: A9D180000-058

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	METHOD
Pyrene	**78**	**(55 - 120)**	**SW846 8270C**
2,4,5-Trichloro-phenol	82	(39 - 110)	SW846 8270C
2,4,6-Trichloro-phenol	76	(35 - 110)	SW846 8270C

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Nitrobenzene-d5	91	(27 - 111)
2-Fluorobiphenyl	82	(28 - 110)
Terphenyl-d14	98	(37 - 119)
Phenol-d5	86	(10 - 110)
2-Fluorophenol	93	(10 - 110)
2,4,6-Tribromophenol	91	(22 - 120)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

LABORATORY CONTROL SAMPLE DATA REPORT

GC/MS Semivolatiles

Client Lot #...: A9D170133 **Work Order #...:** LACFM1AC **Matrix.........:** WATER
LCS Lot-Sample#: A9D180000-058

PARAMETER	SPIKE AMOUNT	MEASURED AMOUNT	UNITS	PERCENT RECOVERY	METHOD
Diethyl phthalate	20	16	ug/L	82	SW846 8270C
2,4-Dimethylphenol	20	11	ug/L	57	SW846 8270C
Dimethyl phthalate	20	16	ug/L	81	SW846 8270C
Di-n-butyl phthalate	20	16	ug/L	82	SW846 8270C
4,6-Dinitro-2-methylphenol	20	15	ug/L	76	SW846 8270C
2,4-Dinitrophenol	20	13	ug/L	64	SW846 8270C
2,4-Dinitrotoluene	**20**	**18**	**ug/L**	**89**	**SW846 8270C**
2,6-Dinitrotoluene	20	16	ug/L	81	SW846 8270C
Di-n-octyl phthalate	20	16	ug/L	81	SW846 8270C
Fluoranthene	20	16	ug/L	80	SW846 8270C
Fluorene	20	15	ug/L	73	SW846 8270C
Hexachlorobenzene	20	16	ug/L	78	SW846 8270C
Hexachlorobutadiene	20	11	ug/L	56	SW846 8270C
Hexachlorocyclopentadiene	20	8.0	ug/L	40	SW846 8270C
Hexachloroethane	20	12	ug/L	58	SW846 8270C
Indeno(1,2,3-cd)pyrene	20	16	ug/L	80	SW846 8270C
Isophorone	20	16	ug/L	78	SW846 8270C
2-Methylnaphthalene	20	16	ug/L	81	SW846 8270C
2-Methylphenol	20	14	ug/L	69	SW846 8270C
4-Methylphenol	40	30	ug/L	76	SW846 8270C
Naphthalene	20	14	ug/L	71	SW846 8270C
2-Nitroaniline	20	17	ug/L	83	SW846 8270C
3-Nitroaniline	20	17	ug/L	83	SW846 8270C
4-Nitroaniline	20	16	ug/L	81	SW846 8270C
Nitrobenzene	20	16	ug/L	81	SW846 8270C
2-Nitrophenol	20	15	ug/L	76	SW846 8270C
4-Nitrophenol	**20**	**16**	**ug/L**	**81**	**SW846 8270C**
N-Nitrosodi-n-propylamine	**20**	**16**	**ug/L**	**80**	**SW846 8270C**
N-Nitrosodiphenylamine	20	15	ug/L	73	SW846 8270C
bis(2-Chloroisopropyl) ether	20	16	ug/L	80	SW846 8270C
Pentachlorophenol	**20**	**16**	**ug/L**	**78**	**SW846 8270C**
Phenanthrene	20	15	ug/L	73	SW846 8270C
Phenol	**20**	**15**	**ug/L**	**74**	**SW846 8270C**

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LABORATORY CONTROL SAMPLE EVALUATION REPORT

TOTAL Metals

Client Lot #...: A9D170133

Matrix.........: WATER

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
LCS Lot-Sample#: A9D200000-041 **Prep Batch #...:** 9110041					
Cobalt	89	(80 - 120) Dilution Factor: 1	SW846 6020	04/20-04/27/09	LADCM1A1
Thallium	87	(80 - 120) Dilution Factor: 1	SW846 6020	04/20-04/27/09	LADCM1A2
Arsenic	92	(80 - 120) Dilution Factor: 1	SW846 6020	04/20-04/27/09	LADCM1DA
Lead	89	(80 - 120) Dilution Factor: 1	SW846 6020	04/20-04/27/09	LADCM1DC
Antimony	94	(80 - 120) Dilution Factor: 1	SW846 6020	04/20-04/27/09	LADCM1DD
Iron	97	(80 - 120) Dilution Factor: 1	SW846 6020	04/20-04/27/09	LADCM1DE
Aluminum	93	(80 - 120) Dilution Factor: 1	SW846 6020	04/20-04/27/09	LADCM1ED
Barium	88	(80 - 120) Dilution Factor: 1	SW846 6020	04/20-04/27/09	LADCM1EE
Beryllium	95	(80 - 120) Dilution Factor: 1	SW846 6020	04/20-04/27/09	LADCM1EF
Calcium	102	(80 - 120) Dilution Factor: 1	SW846 6020	04/20-04/27/09	LADCM1EG
Cadmium	95	(80 - 120) Dilution Factor: 1	SW846 6020	04/20-04/27/09	LADCM1EH
Chromium	91	(80 - 120) Dilution Factor: 1	SW846 6020	04/20-04/27/09	LADCM1EJ
Copper	93	(80 - 120) Dilution Factor: 1	SW846 6020	04/20-04/27/09	LADCM1EK
Silver	95	(80 - 120) Dilution Factor: 1	SW846 6020	04/20-04/27/09	LADCM1EL

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LABORATORY CONTROL SAMPLE DATA REPORT

TOTAL Metals

Client Lot #...: A9D170133

Matrix.........: WATER

LCS Lot-Sample#: A9D200000-041 **Prep Batch #...:** 9110041

PARAMETER	SPIKE AMOUNT	MEASURED AMOUNT	UNITS	PERCNT RECVRY	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Cobalt	100	88.9	ug/L Dilution Factor: 1	89	SW846 6020	04/20-04/27/09	LADCM1A1
Thallium	100	87.5	ug/L Dilution Factor: 1	87	SW846 6020	04/20-04/27/09	LADCM1A2
Arsenic	100	91.7	ug/L Dilution Factor: 1	92	SW846 6020	04/20-04/27/09	LADCM1DA
Lead	100	89.4	ug/L Dilution Factor: 1	89	SW846 6020	04/20-04/27/09	LADCM1DC
Antimony	100	94.3	ug/L Dilution Factor: 1	94	SW846 6020	04/20-04/27/09	LADCM1DD
Iron	10000	9680	ug/L Dilution Factor: 1	97	SW846 6020	04/20-04/27/09	LADCM1DE
Aluminum	10000	9250	ug/L Dilution Factor: 1	93	SW846 6020	04/20-04/27/09	LADCM1ED
Barium	100	87.6	ug/L Dilution Factor: 1	88	SW846 6020	04/20-04/27/09	LADCM1EE
Beryllium	100	95.0	ug/L Dilution Factor: 1	95	SW846 6020	04/20-04/27/09	LADCM1EF
Calcium	10000	10200	ug/L Dilution Factor: 1	102	SW846 6020	04/20-04/27/09	LADCM1EG
Cadmium	100	95.2	ug/L Dilution Factor: 1	95	SW846 6020	04/20-04/27/09	LADCM1EH
Chromium	100	90.5	ug/L Dilution Factor: 1	91	SW846 6020	04/20-04/27/09	LADCM1EJ
Copper	100	93.2	ug/L Dilution Factor: 1	93	SW846 6020	04/20-04/27/09	LADCM1EK
Silver	100	94.5	ug/L Dilution Factor: 1	95	SW846 6020	04/20-04/27/09	LADCM1EL

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MATRIX SPIKE SAMPLE EVALUATION REPORT

GC/MS Volatiles

Client Lot #...: A9D170133
MS Lot-Sample #: A9D170133-005
Date Sampled...: 04/15/09 15:00
Prep Date......: 04/21/09
Prep Batch #...: 9112490
Dilution Factor: 1

Work Order #...: K981G1AU-MS
K981G1AV-MSD
Date Received..: 04/17/09
Analysis Date..: 04/21/09

Matrix.........: WG

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Acetone	62	(45 - 128)			SW846 8260B
	70	(45 - 128)	12	(0-30)	SW846 8260B
Benzene	**92**	**(78 - 118)**			**SW846 8260B**
	93	**(78 - 118)**	**1.4**	**(0-20)**	**SW846 8260B**
Bromodichloromethane	93	(80 - 146)			SW846 8260B
	93	(80 - 146)	0.24	(0-30)	SW846 8260B
Bromoform	94	(58 - 176)			SW846 8260B
	92	(58 - 176)	2.2	(0-30)	SW846 8260B
Bromomethane	111	(55 - 145)			SW846 8260B
	123	(55 - 145)	11	(0-30)	SW846 8260B
2-Butanone	78	(71 - 123)			SW846 8260B
	77	(71 - 123)	1.4	(0-30)	SW846 8260B
Carbon disulfide	105	(69 - 138)			SW846 8260B
	106	(69 - 138)	0.49	(0-41)	SW846 8260B
Carbon tetrachloride	99	(63 - 176)			SW846 8260B
	101	(63 - 176)	1.8	(0-30)	SW846 8260B
Chlorobenzene	**101**	**(76 - 117)**			**SW846 8260B**
	100	**(76 - 117)**	**0.75**	**(0-20)**	**SW846 8260B**
Chloroethane	101	(59 - 142)			SW846 8260B
	105	(59 - 142)	3.7	(0-30)	SW846 8260B
Chloroform	93	(83 - 141)			SW846 8260B
	96	(83 - 141)	3.4	(0-30)	SW846 8260B
Chloromethane	129	(40 - 137)			SW846 8260B
	146 a	(40 - 137)	12	(0-39)	SW846 8260B
Cyclohexane	73	(70 - 130)			SW846 8260B
	74	(70 - 130)	2.2	(0-30)	SW846 8260B
Dibromochloromethane	97	(71 - 158)			SW846 8260B
	97	(71 - 158)	0.04	(0-30)	SW846 8260B
1,2-Dibromo-3-chloro-propane	82	(70 - 130)			SW846 8260B
	84	(70 - 130)	2.3	(0-30)	SW846 8260B
1,2-Dibromoethane	96	(70 - 130)			SW846 8260B
	95	(70 - 130)	1.5	(0-30)	SW846 8260B
1,2-Dichlorobenzene	97	(70 - 130)			SW846 8260B
	99	(70 - 130)	1.8	(0-30)	SW846 8260B
1,3-Dichlorobenzene	96	(70 - 130)			SW846 8260B
	99	(70 - 130)	2.5	(0-30)	SW846 8260B
1,4-Dichlorobenzene	97	(70 - 130)			SW846 8260B
	98	(70 - 130)	1.3	(0-30)	SW846 8260B

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MATRIX SPIKE SAMPLE EVALUATION REPORT

GC/MS Volatiles

Client Lot #...: A9D170133 **Work Order #...:** K981G1AU-MS **Matrix.........:** WG
MS Lot-Sample #: A9D170133-005 K981G1AV-MSD

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Toluene	**100**	**(70 - 119)**			**SW846 8260B**
	99	**(70 - 119)**	**1.6**	**(0-20)**	**SW846 8260B**
1,2,4-Trichloro-benzene	92	(70 - 130)			SW846 8260B
	91	(70 - 130)	0.51	(0-30)	SW846 8260B
1,1,1-Trichloroethane	88	(71 - 162)			SW846 8260B
	89	(71 - 162)	1.6	(0-30)	SW846 8260B
1,1,2-Trichloroethane	98	(86 - 129)			SW846 8260B
	95	(86 - 129)	3.3	(0-30)	SW846 8260B
Trichloroethene	**92**	**(62 - 130)**			**SW846 8260B**
	92	**(62 - 130)**	**0.52**	**(0-20)**	**SW846 8260B**
Trichlorofluoromethane	120	(70 - 130)			SW846 8260B
	123	(70 - 130)	2.5	(0-30)	SW846 8260B
1,1,2-Trichloro-1,2,2-trifluoroethane	127	(70 - 130)			SW846 8260B
	128	(70 - 130)	0.67	(0-30)	SW846 8260B
Vinyl chloride	91	(88 - 126)			SW846 8260B
	93	(88 - 126)	2.5	(0-30)	SW846 8260B
Xylenes (total)	103	(89 - 121)			SW846 8260B
	102	(89 - 121)	0.99	(0-30)	SW846 8260B

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	96	(73 - 122)
	95	(73 - 122)
1,2-Dichloroethane-d4	90	(61 - 128)
	91	(61 - 128)
Toluene-d8	100	(76 - 110)
	99	(76 - 110)
4-Bromofluorobenzene	103	(74 - 116)
	103	(74 - 116)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

a Spiked analyte recovery is outside stated control limits.

MATRIX SPIKE SAMPLE DATA REPORT

GC/MS Volatiles

Client Lot #...: A9D170133 **Work Order #...:** K981G1AU-MS **Matrix.........:** WG
MS Lot-Sample #: A9D170133-005 K981G1AV-MSD

PARAMETER	SAMPLE AMOUNT	SPIKE AMT	MEASRD AMOUNT	UNITS	PERCNT RECVRY	RPD	METHOD
Dichlorodifluoromethane	ND	10	8.0	ug/L	80		SW846 8260B
	ND	10	8.3	ug/L	83	3.8	SW846 8260B
1,1-Dichloroethane	ND	10	9.6	ug/L	96		SW846 8260B
	ND	10	9.8	ug/L	98	1.8	SW846 8260B
1,2-Dichloroethane	ND	10	9.0	ug/L	90		SW846 8260B
	ND	10	9.1	ug/L	91	0.59	SW846 8260B
1,1-Dichloroethene	**ND**	**10**	**9.5**	**ug/L**	**95**		**SW846 8260B**
	ND	**10**	**9.7**	**ug/L**	**97**	**1.9**	**SW846 8260B**
cis-1,2-Dichloroethene	ND	10	9.4	ug/L	94		SW846 8260B
	ND	10	9.8	ug/L	98	3.3	SW846 8260B
trans-1,2-Dichloroethene	ND	10	9.6	ug/L	96		SW846 8260B
	ND	10	9.6	ug/L	96	0.56	SW846 8260B
1,2-Dichloropropane	ND	10	9.5	ug/L	95		SW846 8260B
	ND	10	9.5	ug/L	95	0.15	SW846 8260B
cis-1,3-Dichloropropene	ND	10	7.8	ug/L	78 a		SW846 8260B
	ND	10	8.0	ug/L	80 a	2.4	SW846 8260B
trans-1,3-Dichloropropene	ND	10	9.0	ug/L	90		SW846 8260B
	ND	10	8.9	ug/L	89	1.7	SW846 8260B
Ethylbenzene	ND	10	9.9	ug/L	99		SW846 8260B
	ND	10	9.7	ug/L	97	1.5	SW846 8260B
2-Hexanone	ND	10	8.1	ug/L	81		SW846 8260B
	ND	10	8.2	ug/L	82	1.7	SW846 8260B
Isopropylbenzene	ND	10	9.8	ug/L	98		SW846 8260B
	ND	10	9.8	ug/L	98	0.39	SW846 8260B
Methyl acetate	ND	10	6.7	ug/L	67 a		SW846 8260B
	ND	10	7.1	ug/L	71	5.0	SW846 8260B
Methylene chloride	ND	10	9.5	ug/L	95		SW846 8260B
	ND	10	9.6	ug/L	96	0.98	SW846 8260B
Methylcyclohexane	ND	10	6.7	ug/L	67 a		SW846 8260B
	ND	10	7.0	ug/L	70	3.5	SW846 8260B
4-Methyl-2-pentanone	ND	10	7.6	ug/L	76 a		SW846 8260B
	ND	10	7.8	ug/L	78 a	2.0	SW846 8260B
Methyl tert-butyl ether (MTBE)	ND	10	7.6	ug/L	76		SW846 8260B
	ND	10	8.1	ug/L	81	5.3	SW846 8260B
Styrene	ND	10	10	ug/L	102		SW846 8260B
	ND	10	10	ug/L	101	1.2	SW846 8260B
1,1,2,2-Tetrachloroethane	ND	10	9.2	ug/L	92		SW846 8260B
	ND	10	9.3	ug/L	93	0.82	SW846 8260B
Tetrachloroethene	ND	10	10	ug/L	102		SW846 8260B
	ND	10	9.9	ug/L	99	2.6	SW846 8260B

(Continued on next page)

MATRIX SPIKE SAMPLE EVALUATION REPORT

GC/MS Volatiles

Client Lot #...: A9D170133
MS Lot-Sample #: A9D170172-008
Date Sampled...: 04/15/09 17:12
Prep Date......: 04/22/09
Prep Batch #...: 9114092
Dilution Factor: 1
Work Order #...: K99C31CF-MS
K99C31CG-MSD
Date Received..: 04/17/09
Analysis Date..: 04/22/09
Matrix.........: WATER

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Acetone	73	(45 - 128)			SW846 8260B
	68	(45 - 128)	7.0	(0-30)	SW846 8260B
Benzene	**96**	**(78 - 118)**			**SW846 8260B**
	93	**(78 - 118)**	**3.7**	**(0-20)**	**SW846 8260B**
Bromodichloromethane	96	(80 - 146)			SW846 8260B
	92	(80 - 146)	4.5	(0-30)	SW846 8260B
Bromoform	99	(58 - 176)			SW846 8260B
	95	(58 - 176)	3.3	(0-30)	SW846 8260B
Bromomethane	94	(55 - 145)			SW846 8260B
	106	(55 - 145)	12	(0-30)	SW846 8260B
2-Butanone	82	(71 - 123)			SW846 8260B
	81	(71 - 123)	0.60	(0-30)	SW846 8260B
Carbon disulfide	106	(69 - 138)			SW846 8260B
	105	(69 - 138)	0.94	(0-41)	SW846 8260B
Carbon tetrachloride	107	(63 - 176)			SW846 8260B
	107	(63 - 176)	0.37	(0-30)	SW846 8260B
Chlorobenzene	**102**	**(76 - 117)**			**SW846 8260B**
	100	**(76 - 117)**	**2.4**	**(0-20)**	**SW846 8260B**
Chloroethane	90	(59 - 142)			SW846 8260B
	96	(59 - 142)	6.4	(0-30)	SW846 8260B
Chloroform	97	(83 - 141)			SW846 8260B
	92	(83 - 141)	5.1	(0-30)	SW846 8260B
Chloromethane	124	(40 - 137)			SW846 8260B
	121	(40 - 137)	2.3	(0-39)	SW846 8260B
Cyclohexane	81	(70 - 130)			SW846 8260B
	89	(70 - 130)	10	(0-30)	SW846 8260B
Dibromochloromethane	102	(71 - 158)			SW846 8260B
	97	(71 - 158)	5.1	(0-30)	SW846 8260B
1,2-Dibromo-3-chloro-propane	91	(70 - 130)			SW846 8260B
	93	(70 - 130)	2.2	(0-30)	SW846 8260B
1,2-Dibromoethane	99	(70 - 130)			SW846 8260B
	98	(70 - 130)	0.63	(0-30)	SW846 8260B
1,2-Dichlorobenzene	99	(70 - 130)			SW846 8260B
	97	(70 - 130)	2.4	(0-30)	SW846 8260B
1,3-Dichlorobenzene	98	(70 - 130)			SW846 8260B
	96	(70 - 130)	2.0	(0-30)	SW846 8260B
1,4-Dichlorobenzene	99	(70 - 130)			SW846 8260B
	96	(70 - 130)	2.7	(0-30)	SW846 8260B

(Continued on next page)

MATRIX SPIKE SAMPLE EVALUATION REPORT

GC/MS Volatiles

Client Lot #...: A9D170133
MS Lot-Sample #: A9D170172-008
Work Order #...: K99C31CF-MS
K99C31CG-MSD
Matrix.........: WATER

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Toluene	**102**	**(70 - 119)**			**SW846 8260B**
	101	**(70 - 119)**	**1.3**	**(0-20)**	**SW846 8260B**
1,2,4-Trichloro-benzene	90	(70 - 130)			SW846 8260B
	94	(70 - 130)	4.6	(0-30)	SW846 8260B
1,1,1-Trichloroethane	91	(71 - 162)			SW846 8260B
	91	(71 - 162)	0.92	(0-30)	SW846 8260B
1,1,2-Trichloroethane	100	(86 - 129)			SW846 8260B
	98	(86 - 129)	1.9	(0-30)	SW846 8260B
Trichloroethene	**96**	**(62 - 130)**			**SW846 8260B**
	95	**(62 - 130)**	**0.64**	**(0-20)**	**SW846 8260B**
Trichlorofluoromethane	121	(70 - 130)			SW846 8260B
	135 a	(70 - 130)	11	(0-30)	SW846 8260B
1,1,2-Trichloro-1,2,2-trifluoroethane	143 a	(70 - 130)			SW846 8260B
	154 a	(70 - 130)	7.0	(0-30)	SW846 8260B
Vinyl chloride	92	(88 - 126)			SW846 8260B
	93	(88 - 126)	2.0	(0-30)	SW846 8260B
Xylenes (total)	106	(89 - 121)			SW846 8260B
	103	(89 - 121)	2.6	(0-30)	SW846 8260B

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	97	(73 - 122)
	97	(73 - 122)
1,2-Dichloroethane-d4	93	(61 - 128)
	91	(61 - 128)
Toluene-d8	102	(76 - 110)
	102	(76 - 110)
4-Bromofluorobenzene	105	(74 - 116)
	107	(74 - 116)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

a Spiked analyte recovery is outside stated control limits.

MATRIX SPIKE SAMPLE DATA REPORT

GC/MS Volatiles

Client Lot #...: A9D170133
MS Lot-Sample #: A9D170172-008
Work Order #...: K99C31CF-MS
K99C31CG-MSD
Matrix.........: WATER

PARAMETER	SAMPLE AMOUNT	SPIKE AMT	MEASRD AMOUNT	UNITS	PERCNT RECVRY	RPD	METHOD
Dichlorodifluoromethane	ND	10	7.8	ug/L	78		SW846 8260B
	ND	10	8.9	ug/L	89	13	SW846 8260B
1,1-Dichloroethane	ND	10	10	ug/L	100		SW846 8260B
	ND	10	9.6	ug/L	96	4.6	SW846 8260B
1,2-Dichloroethane	ND	10	9.2	ug/L	92		SW846 8260B
	ND	10	9.0	ug/L	90	2.6	SW846 8260B
1,1-Dichloroethene	**ND**	**10**	**10**	**ug/L**	**102**		**SW846 8260B**
	ND	**10**	**10**	**ug/L**	**101**	**0.72**	**SW846 8260B**
cis-1,2-Dichloroethene	ND	10	9.8	ug/L	98		SW846 8260B
	ND	10	9.5	ug/L	95	3.9	SW846 8260B
trans-1,2-Dichloroethene	ND	10	9.9	ug/L	99		SW846 8260B
	ND	10	9.5	ug/L	95	4.4	SW846 8260B
1,2-Dichloropropane	ND	10	9.9	ug/L	99		SW846 8260B
	ND	10	9.5	ug/L	95	4.1	SW846 8260B
cis-1,3-Dichloropropene	ND	10	8.0	ug/L	80 a		SW846 8260B
	ND	10	7.9	ug/L	79 a	1.6	SW846 8260B
trans-1,3-Dichloropropene	ND	10	9.1	ug/L	91		SW846 8260B
	ND	10	9.1	ug/L	91	0.07	SW846 8260B
Ethylbenzene	ND	10	10	ug/L	100		SW846 8260B
	ND	10	10	ug/L	100	0.39	SW846 8260B
2-Hexanone	ND	10	8.6	ug/L	86		SW846 8260B
	ND	10	8.6	ug/L	86	0.80	SW846 8260B
Isopropylbenzene	ND	10	10	ug/L	102		SW846 8260B
	ND	10	10	ug/L	101	0.77	SW846 8260B
Methyl acetate	ND	10	7.7	ug/L	77		SW846 8260B
	ND	10	7.3	ug/L	73	5.6	SW846 8260B
Methylene chloride	ND	10	9.7	ug/L	97		SW846 8260B
	ND	10	9.1	ug/L	91	6.0	SW846 8260B
Methylcyclohexane	ND	10	7.6	ug/L	76		SW846 8260B
	ND	10	8.6	ug/L	86	12	SW846 8260B
4-Methyl-2-pentanone	ND	10	8.1	ug/L	81 a		SW846 8260B
	ND	10	8.2	ug/L	82	1.0	SW846 8260B
Methyl tert-butyl ether (MTBE)	ND	10	8.0	ug/L	80		SW846 8260B
	ND	10	7.8	ug/L	78	2.0	SW846 8260B
Styrene	ND	10	10	ug/L	103		SW846 8260B
	ND	10	10	ug/L	102	1.5	SW846 8260B
1,1,2,2-Tetrachloroethane	ND	10	9.5	ug/L	95		SW846 8260B
	ND	10	9.5	ug/L	95	0.82	SW846 8260B
Tetrachloroethene	ND	10	11	ug/L	105		SW846 8260B
	ND	10	11	ug/L	105	0.01	SW846 8260B

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MATRIX SPIKE SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A9D170133
MS Lot-Sample #: A9D170133-005
Date Sampled...: 04/15/09 15:00
Prep Date......: 04/19/09
Prep Batch #...: 9108058
Dilution Factor: 1

Work Order #...: K981G1DT-MS
K981G1DU-MSD
Date Received..: 04/17/09
Analysis Date..: 04/20/09

Matrix.........: WG

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Acenaphthene	**72**	**(36 - 110)**			**SW846 8270C**
	76	**(36 - 110)**	**5.4**	**(0-30)**	**SW846 8270C**
Acenaphthylene	78	(39 - 110)			SW846 8270C
	82	(39 - 110)	4.8	(0-30)	SW846 8270C
Acetophenone	75	(50 - 130)			SW846 8270C
	74	(50 - 130)	1.2	(0-30)	SW846 8270C
Anthracene	78	(46 - 110)			SW846 8270C
	82	(46 - 110)	5.1	(0-30)	SW846 8270C
Atrazine	115	(50 - 130)			SW846 8270C
	123	(50 - 130)	6.5	(0-30)	SW846 8270C
Benzo(a)anthracene	82	(52 - 110)			SW846 8270C
	90	(52 - 110)	9.0	(0-30)	SW846 8270C
Benzo(a)pyrene	77	(33 - 110)			SW846 8270C
	83	(33 - 110)	6.5	(0-30)	SW846 8270C
Benzo(b)fluoranthene	92	(33 - 114)			SW846 8270C
	96	(33 - 114)	4.3	(0-30)	SW846 8270C
Benzo(ghi)perylene	85	(34 - 116)			SW846 8270C
	91	(34 - 116)	7.3	(0-30)	SW846 8270C
Benzo(k)fluoranthene	84	(32 - 121)			SW846 8270C
	91	(32 - 121)	7.6	(0-30)	SW846 8270C
Benzaldehyde	94	(10 - 130)			SW846 8270C
	93	(10 - 130)	1.6	(0-30)	SW846 8270C
1,1'-Biphenyl	71	(50 - 130)			SW846 8270C
	74	(50 - 130)	3.6	(0-30)	SW846 8270C
bis(2-Chloroethoxy) methane	78	(35 - 110)			SW846 8270C
	77	(35 - 110)	0.31	(0-30)	SW846 8270C
bis(2-Chloroethyl)-ether	84	(27 - 110)			SW846 8270C
	76	(27 - 110)	11	(0-30)	SW846 8270C
bis(2-Ethylhexyl) phthalate	84	(40 - 140)			SW846 8270C
	93	(40 - 140)	8.7	(0-30)	SW846 8270C
4-Bromophenyl phenyl ether	82	(42 - 113)			SW846 8270C
	87	(42 - 113)	6.7	(0-30)	SW846 8270C

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MATRIX SPIKE SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A9D170133 **Work Order #...:** K981G1DT-MS **Matrix.........:** WG
MS Lot-Sample #: A9D170133-005 K981G1DU-MSD

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
2,4-Dinitrotoluene	**92**	**(46 - 119)**			**SW846 8270C**
	97	**(46 - 119)**	**5.6**	**(0-30)**	**SW846 8270C**
2,6-Dinitrotoluene	82	(48 - 115)			SW846 8270C
	86	(48 - 115)	4.1	(0-30)	SW846 8270C
Di-n-octyl phthalate	89	(36 - 124)			SW846 8270C
	95	(36 - 124)	6.2	(0-30)	SW846 8270C
Fluoranthene	87	(53 - 111)			SW846 8270C
	93	(53 - 111)	7.6	(0-30)	SW846 8270C
Fluorene	76	(43 - 110)			SW846 8270C
	81	(43 - 110)	5.4	(0-30)	SW846 8270C
Hexachlorobenzene	82	(40 - 113)			SW846 8270C
	90	(40 - 113)	8.8	(0-30)	SW846 8270C
Hexachlorobutadiene	64	(14 - 110)			SW846 8270C
	59	(14 - 110)	9.2	(0-30)	SW846 8270C
Hexachlorocyclopentadiene	44	(10 - 110)			SW846 8270C
	47	(10 - 110)	6.2	(0-30)	SW846 8270C
Hexachloroethane	66	(10 - 110)			SW846 8270C
	59	(10 - 110)	11	(0-30)	SW846 8270C
Indeno(1,2,3-cd)pyrene	85	(36 - 116)			SW846 8270C
	92	(36 - 116)	7.7	(0-30)	SW846 8270C
Isophorone	85	(34 - 125)			SW846 8270C
	86	(34 - 125)	1.7	(0-30)	SW846 8270C
2-Methylnaphthalene	86	(35 - 110)			SW846 8270C
	89	(35 - 110)	3.1	(0-30)	SW846 8270C
2-Methylphenol	77	(26 - 110)			SW846 8270C
	75	(26 - 110)	2.4	(0-30)	SW846 8270C
4-Methylphenol	78	(25 - 110)			SW846 8270C
	78	(25 - 110)	0.10	(0-30)	SW846 8270C
Naphthalene	75	(32 - 110)			SW846 8270C
	72	(32 - 110)	4.7	(0-30)	SW846 8270C
2-Nitroaniline	86	(31 - 129)			SW846 8270C
	91	(31 - 129)	6.3	(0-30)	SW846 8270C
3-Nitroaniline	77	(23 - 112)			SW846 8270C
	77	(23 - 112)	0.10	(0-30)	SW846 8270C
4-Nitroaniline	78	(26 - 115)			SW846 8270C
	81	(26 - 115)	3.1	(0-30)	SW846 8270C
Nitrobenzene	85	(26 - 118)			SW846 8270C
	81	(26 - 118)	4.3	(0-30)	SW846 8270C
2-Nitrophenol	80	(30 - 110)			SW846 8270C
	78	(30 - 110)	1.9	(0-30)	SW846 8270C

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MATRIX SPIKE SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A9D170133
MS Lot-Sample #: A9D170133-005
Work Order #...: K981G1DT-MS
K981G1DU-MSD
Matrix.........: WG

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
2,4,6-Tribromophenol	88 96	(22 - 120) (22 - 120)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

MATRIX SPIKE SAMPLE DATA REPORT

GC/MS Semivolatiles

Client Lot #...: A9D170133 **Work Order #...:** K981G1DT-MS **Matrix.........:** WG
MS Lot-Sample #: A9D170133-005 K981G1DU-MSD

PARAMETER	SAMPLE AMOUNT	SPIKE AMT	MEASRD AMOUNT	UNITS	PERCNT RECVRY	RPD	METHOD
Butyl benzyl phthalate	ND	38	35	ug/L	92		SW846 8270C
	ND	38	37	ug/L	97	5.2	SW846 8270C
Caprolactam	ND	38	21	ug/L	56		SW846 8270C
	ND	38	28	ug/L	74	27	SW846 8270C
Carbazole	ND	38	31	ug/L	83		SW846 8270C
	ND	38	34	ug/L	88	6.6	SW846 8270C
4-Chloroaniline	ND	38	24	ug/L	62		SW846 8270C
	ND	38	19	ug/L	49	23	SW846 8270C
4-Chloro-3-methylphenol	**ND**	**38**	**32**	**ug/L**	**83**		**SW846 8270C**
	ND	**38**	**33**	**ug/L**	**86**	**2.6**	**SW846 8270C**
2-Chloronaphthalene	ND	38	28	ug/L	74		SW846 8270C
	ND	38	30	ug/L	78	5.2	SW846 8270C
2-Chlorophenol	**ND**	**38**	**30**	**ug/L**	**78**		**SW846 8270C**
	ND	**38**	**29**	**ug/L**	**76**	**2.0**	**SW846 8270C**
4-Chlorophenyl phenyl ether	ND	38	31	ug/L	81		SW846 8270C
	ND	38	32	ug/L	85	5.0	SW846 8270C
Chrysene	ND	38	32	ug/L	83		SW846 8270C
	ND	38	34	ug/L	90	8.5	SW846 8270C
Dibenz(a,h)anthracene	ND	38	33	ug/L	86		SW846 8270C
	ND	38	34	ug/L	91	5.3	SW846 8270C
Dibenzofuran	ND	38	29	ug/L	76		SW846 8270C
	ND	38	31	ug/L	80	5.1	SW846 8270C
3,3'-Dichlorobenzidine	ND	38	9.0	ug/L	24		SW846 8270C
	ND	38	10	ug/L	26	11	SW846 8270C
2,4-Dichlorophenol	ND	38	30	ug/L	78		SW846 8270C
	ND	38	30	ug/L	80	1.7	SW846 8270C
Diethyl phthalate	ND	38	33	ug/L	86		SW846 8270C
	ND	38	35	ug/L	91	5.6	SW846 8270C
2,4-Dimethylphenol	ND	38	24	ug/L	64		SW846 8270C
	ND	38	25	ug/L	66	3.4	SW846 8270C
Dimethyl phthalate	ND	38	32	ug/L	85		SW846 8270C
	ND	38	34	ug/L	89	4.5	SW846 8270C
Di-n-butyl phthalate	ND	38	35	ug/L	91		SW846 8270C
	ND	38	38	ug/L	99	8.6	SW846 8270C
4,6-Dinitro-2-methylphenol	ND	38	32	ug/L	84		SW846 8270C
	ND	38	32	ug/L	85	1.4	SW846 8270C
2,4-Dinitrophenol	ND	38	29	ug/L	77		SW846 8270C
	ND	38	31	ug/L	82	5.4	SW846 8270C

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MATRIX SPIKE SAMPLE DATA REPORT

GC/MS Semivolatiles

Client Lot #...: A9D170133
MS Lot-Sample #: A9D170133-005
Work Order #...: K981G1DT-MS
K981G1DU-MSD
Matrix.........: WG

PARAMETER	SAMPLE AMOUNT	SPIKE AMT	MEASRD AMOUNT	UNITS	PERCNT RECVRY	RPD	METHOD
4-Nitrophenol	ND	38	33	ug/L	87		SW846 8270C
	ND	38	33	ug/L	88	0.30	SW846 8270C
N-Nitrosodi-n-propyl-amine	ND	38	31	ug/L	82		SW846 8270C
	ND	38	31	ug/L	83	0.30	SW846 8270C
N-Nitrosodiphenylamine	ND	38	28	ug/L	73		SW846 8270C
	ND	38	32	ug/L	85	15	SW846 8270C
bis(2-Chloroisopropyl) ether	ND	38	31	ug/L	82		SW846 8270C
	ND	38	30	ug/L	79	3.7	SW846 8270C
Pentachlorophenol	ND	38	35	ug/L	91		SW846 8270C
	ND	38	38	ug/L	99	7.5	SW846 8270C
Phenanthrene	ND	38	30	ug/L	78		SW846 8270C
	ND	38	32	ug/L	84	7.3	SW846 8270C
Phenol	ND	38	29	ug/L	76		SW846 8270C
	ND	38	29	ug/L	76	0.98	SW846 8270C
Pyrene	ND	38	31	ug/L	82		SW846 8270C
	ND	38	34	ug/L	90	10	SW846 8270C
2,4,5-Trichloro-phenol	ND	38	33	ug/L	88		SW846 8270C
	ND	38	35	ug/L	91	3.4	SW846 8270C
2,4,6-Trichloro-phenol	ND	38	30	ug/L	78		SW846 8270C
	ND	38	32	ug/L	83	6.2	SW846 8270C

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Nitrobenzene-d5	88	(27 - 111)
	81	(27 - 111)
2-Fluorobiphenyl	74	(28 - 110)
	80	(28 - 110)
Terphenyl-d14	92	(37 - 119)
	105	(37 - 119)
Phenol-d5	80	(10 - 110)
	81	(10 - 110)
2-Fluorophenol	88	(10 - 110)
	88	(10 - 110)

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MATRIX SPIKE SAMPLE EVALUATION REPORT

TOTAL Metals

Client Lot #...: A9D170133
Date Sampled...: 04/15/09 15:00 **Date Received..:** 04/17/09
Matrix.........: WG

MS Lot-Sample #: A9D170133-005 **Prep Batch #...:** 9110041

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Aluminum	104	(63 - 128)			SW846 6020	04/20-04/27/09	K981G1A5
	107	(63 - 128)	3.0	(0-20)	SW846 6020	04/20-04/27/09	K981G1A6
		Dilution Factor: 1					
Antimony	105	(44 - 153)			SW846 6020	04/20-04/27/09	K981G1AC
	108	(44 - 153)	2.6	(0-20)	SW846 6020	04/20-04/27/09	K981G1AD
		Dilution Factor: 1					
Arsenic	101	(82 - 123)			SW846 6020	04/20-04/27/09	K981G1A8
	103	(82 - 123)	1.6	(0-20)	SW846 6020	04/20-04/27/09	K981G1A9
		Dilution Factor: 1					
Barium	103	(45 - 144)			SW846 6020	04/20-04/27/09	K981G1CC
	106	(45 - 144)	1.9	(0-20)	SW846 6020	04/20-04/27/09	K981G1CD
		Dilution Factor: 1					
Beryllium	104	(77 - 124)			SW846 6020	04/20-04/27/09	K981G1CF
	104	(77 - 124)	0.19	(0-20)	SW846 6020	04/20-04/27/09	K981G1CG
		Dilution Factor: 1					
Cadmium	103	(78 - 117)			SW846 6020	04/20-04/27/09	K981G1CM
	105	(78 - 117)	1.7	(0-20)	SW846 6020	04/20-04/27/09	K981G1CN
		Dilution Factor: 1					
Calcium	NC,MSB	(70 - 130)			SW846 6020	04/20-04/27/09	K981G1CJ
	NC,MSB	(70 - 130)		(0-20)	SW846 6020	04/20-04/27/09	K981G1CK
		Dilution Factor: 1					
Chromium	101	(72 - 110)			SW846 6020	04/20-04/27/09	K981G1CU
	104	(72 - 110)	2.5	(0-20)	SW846 6020	04/20-04/27/09	K981G1CV
		Dilution Factor: 1					
Cobalt	97	(67 - 114)			SW846 6020	04/20-04/27/09	K981G1CQ
	98	(67 - 114)	1.1	(0-20)	SW846 6020	04/20-04/27/09	K981G1CR
		Dilution Factor: 1					
Copper	98	(60 - 123)			SW846 6020	04/20-04/27/09	K981G1CX
	100	(60 - 123)	2.9	(0-20)	SW846 6020	04/20-04/27/09	K981G1C0
		Dilution Factor: 1					

(Continued on next page)

MATRIX SPIKE SAMPLE EVALUATION REPORT

TOTAL Metals

Client Lot #...: A9D170133

Date Sampled...: 04/15/09 15:00 **Date Received..:** 04/17/09

Matrix.........: WG

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Zinc	107	(49 - 156)			SW846 6020	04/20-04/27/09	K981G1AQ
	109	(49 - 156)	2.2	(0-20)	SW846 6020	04/20-04/27/09	K981G1AR
		Dilution Factor: 1					
Mercury	111	(69 - 134)			SW846 7470A	04/20/09	K981G1A2
	116	(69 - 134)	4.6	(0-20)	SW846 7470A	04/20/09	K981G1A3
		Dilution Factor: 1					

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

NC The recovery and/or RPD were not calculated.

MSB The recovery and RPD may be outside control limits because the sample amount was greater than 4X the spike amount.

MATRIX SPIKE SAMPLE DATA REPORT

TOTAL Metals

Client Lot #...: A9D170133
Date Sampled...: 04/15/09 15:00 **Date Received..:** 04/17/09
Matrix.........: WG

PARAMETER	SAMPLE AMOUNT	SPIKE AMT	MEASRD AMOUNT	UNITS	PERCNT RECVRY	RPD	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Cobalt									
	0.46	100	97.6	ug/L	97		SW846 6020	04/20-04/27/09	K981G1CQ
	0.46	100	98.7	ug/L	98	1.1	SW846 6020	04/20-04/27/09	K981G1CR
			Dilution Factor: 1						
Copper									
	0.94	100	98.4	ug/L	98		SW846 6020	04/20-04/27/09	K981G1CX
	0.94	100	101	ug/L	100	2.9	SW846 6020	04/20-04/27/09	K981G1C0
			Dilution Factor: 1						
Iron									
	541	10000	11300	ug/L	108		SW846 6020	04/20-04/27/09	K981G1C5
	541	10000	11700	ug/L	111	2.9	SW846 6020	04/20-04/27/09	K981G1C6
			Dilution Factor: 1						
Lead									
	0.37	100	104	ug/L	103		SW846 6020	04/20-04/27/09	K981G1DQ
	0.37	100	105	ug/L	105	1.0	SW846 6020	04/20-04/27/09	K981G1DR
			Dilution Factor: 1						
Magnesium									
	108000	10000	119000	ug/L			SW846 6020	04/20-04/27/09	K981G1DC
			Qualifiers: NC,MSB						
	108000	10000	123000	ug/L			SW846 6020	04/20-04/27/09	K981G1DD
			Qualifiers: NC,MSB						
			Dilution Factor: 1						
Manganese									
	49.7	100	131	ug/L	82		SW846 6020	04/20-04/28/09	K981G1DF
	49.7	100	131	ug/L	81	0.38	SW846 6020	04/20-04/28/09	K981G1DG
			Dilution Factor: 1						
Nickel									
	1.2	100	99.8	ug/L	99		SW846 6020	04/20-04/27/09	K981G1DM
	1.2	100	102	ug/L	101	2.1	SW846 6020	04/20-04/27/09	K981G1DN
			Dilution Factor: 1						
Potassium									
	3780	10000	16100	ug/L	123		SW846 6020	04/20-04/27/09	K981G1C8
	3780	10000	16100	ug/L	123	0.06	SW846 6020	04/20-04/27/09	K981G1C9
			Dilution Factor: 1						

(Continued on next page)

MATRIX SPIKE SAMPLE EVALUATION REPORT

TOTAL Metals

Client Lot #...: A9D170133 **Matrix.........:** WATER
Date Sampled...: 04/15/09 13:35 **Date Received..:** 04/17/09

MS Lot-Sample #: A9D170195-001 **Prep Batch #...:** 9110041

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Antimony	93	(44 - 153)			SW846 6020	04/20-04/27/09	K99H31DQ
	89	(44 - 153)	3.9	(0-20)	SW846 6020	04/20-04/27/09	K99H31DR
		Dilution Factor: 1					
Arsenic	93	(82 - 123)			SW846 6020	04/20-04/27/09	K99H31DJ
	90	(82 - 123)	3.3	(0-20)	SW846 6020	04/20-04/27/09	K99H31DK
		Dilution Factor: 1					
Cobalt	88	(67 - 114)			SW846 6020	04/20-04/27/09	K99H31A6
	86	(67 - 114)	2.0	(0-20)	SW846 6020	04/20-04/27/09	K99H31A7
		Dilution Factor: 1					
Iron	99	(22 - 169)			SW846 6020	04/20-04/27/09	K99H31DU
	95	(22 - 169)	3.1	(0-20)	SW846 6020	04/20-04/27/09	K99H31DV
		Dilution Factor: 1					
Lead	92	(73 - 115)			SW846 6020	04/20-04/27/09	K99H31DM
	88	(73 - 115)	4.4	(0-20)	SW846 6020	04/20-04/27/09	K99H31DN
		Dilution Factor: 1					
Thallium	90	(69 - 117)			SW846 6020	04/20-04/27/09	K99H31A8
	86	(69 - 117)	4.6	(0-20)	SW846 6020	04/20-04/27/09	K99H31A9
		Dilution Factor: 1					
Mercury	111	(69 - 134)			SW846 7470A	04/20/09	K99H31CU
	113	(69 - 134)	1.5	(0-20)	SW846 7470A	04/20/09	K99H31CV
		Dilution Factor: 1					

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

CONESTOGA-ROVERS & ASSOCIATES

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

PAGE 1 OF 1

ID # № D 6081

SSOW Ref. Code:

Required Client Information:

Company: CRA, Inc.	Report To: Paul McMahon
Address: 14496 Sheldon Rd.	Copy To:
Suite 200	Invoice To:
Plymouth, MI 48170	P.O.:
Phone: 734-453-5123	Project Name: Cascades-Depew
Fax: 734-453-5201	Project Number: 630660
Email:	

Laboratory: Test America	
Laboratory Location: Ann Arbor, MI	
Laboratory Contact:	
Requested Due Date:	TAT:
QA/QC Requirements:	

Valid Matrix Codes:
WG Groundwater
WB Borehole Water
WS Surface Water
SO Soil
SE Sediment
See Back for Additional Codes

	Sample Identification:	Matrix Code	Date Collected	Time Collected	# Containers	Unpreserved	HCl	H2SO4	HNO3	NaOH	Other:	VOCs	SVOCs	Metals	Remarks/Lab ID
1.	WG-630660-041509-JJW-001	WG	4/15/09	1230	6							X	X	X	
2.	WG-630660-041509-JJW-002	WG		1245	6							X	X	X	
3.	WG-630660-041509-JJW-003	WG		1415	6							X	X	X	
4.	WG-630660-041509-JJW-004	WG		1445	6							X	X	X	
5.	WG-630660-041509-JJW-005 MS/MSD	WG		1500	18							X	X	X	
6.	WG-630660-041509-JJW-006	WG		1700	6							X	X	X	
7.	WG-630660-041509-JJW-007	WG		1800	6							X	X	X	
8.	Trip Blank	—	—	—	1							X			
9.															
10.															
11.															
12.															
13.															
14.															
15.															

TOTAL NUMBER OF CONTAINERS 55

SHIPMENT METHOD	NO. OF COOLERS
Federal Express	4
AIRBILL NO.	

RELINQUISHED BY / AFFILIATION	DATE	TIME	RECEIVED BY / AFFILIATION	DATE	TIME
- CRA	4/15/09	1800		4/16/09	1200
	4/16/09	1700	TANC	4/17/09	0905

Sample Condition

Temp in C	
Received on Ice	Y / N
Sealed Cooler	Y / N
Samples Intact	Y / N

Additional Comments:

Sampler Name: Jon Williams

Sampler Signature:

Date: 4/15/09

Distribution: WHITE - Fully Executed

TestAmerica Cooler Receipt Form/Narrative
North Canton Facility

Client ID	pH	Date	Initials

Cooler #	Temp. °C	Method	Coolant
241-959	1.9	IR	Ice
241-988	1.0	↓	↓
241-990	1.7		

Discrepancies Cont'd:

D

APPENDIX D

DATA VALIDATION REPORT

CONESTOGA-ROVERS
& ASSOCIATES

E-Mail Date:	May 7, 2009
E-Mail To:	Valerie Chan; Robert Adams
c.c.:	Paul McMahon
	E-Mail and Hard Copy if Requested

ANALYTICAL RESULTS AND QA/QC REVIEW
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

PREPARED BY:
CONESTOGA-ROVERS & ASSOCIATES
2055 Niagara Falls Blvd., Suite #3
Niagara Falls, New York 14304
Telephone: 716-297-6150 Fax: 716-297-2265
Contact: Paul McMahon [bjw]
Date: May 7, 2009
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(Following Text)

1.0 INTRODUCTION

Groundwater samples were collected at the Cascades, Inc. site in Depew, New York. The samples were collected in April 2009 and delivered to TestAmerica, Inc. in North Canton, Ohio for analysis. Samples were analyzed for Target Compound List (TCL) volatile organic compounds (VOCs), TCL semi-volatile organic compounds (SVOCs), and Target Analyte List (TAL) metals. A sampling and analysis summary is presented in Table 1. The analytical results are summarized in Table 2 and the analytical methods used are summarized in Table 3.

The final sample results and supporting quality assurance/quality control (QA/QC) results were reported by the laboratory in accordance with the requested deliverables. The QA/QC criteria by which these data were assessed are outlined in the analytical methods used and the following guidance documents:

i) "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review", October 1999; and
ii) "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review", February 1994.

2.0 QA/QC REVIEW

2.1 HOLDING TIMES

The sample holding time criteria are specified in Table 3. All holding time criteria were met. All samples were properly preserved and received chilled.

2.2 SURROGATE SPIKE RECOVERIES -VOCS/SVOCS

All samples and blanks analyzed for VOCs and SVOCs were spiked with surrogate compounds prior to sample extraction and/or analysis. All surrogate spike recoveries were acceptable per the "Guidelines", indicating good analytical efficiency.

2.3 LABORATORY METHOD BLANK ANALYSES

Method blanks were extracted and/or analyzed with the investigative samples for all parameters. Metals, VOCs, and SVOCs were detected in the method blanks. Associated detected sample results with comparable concentrations were qualified as non-detect (See Table 4).

2.4 BLANK SPIKE (BS) ANALYSES

BS and/or laboratory control samples (LCSs) were analyzed for all parameters. Some analyses were performed in duplicate. Most recoveries and all relative percent differences (RPDs) were acceptable, indicating good analytical accuracy. Some high VOC recoveries were reported, but the associated sample results were non-detect and were not impacted by the indicated high bias. Some low VOC BS recoveries were reported, and the associated sample results were qualified as estimated (see Table 5).

2.5 MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD) ANALYSES

One sample was selected for MS/MSD analyses as specified in Table 1. Per the "Guidelines", qualification of data is not required if the sample results exceed four times the spike concentration added.

Most recoveries and all RPDs were acceptable, demonstrating good analytical accuracy and precision. Two slightly low VOC MS recoveries were reported. Based on the acceptable MSD recoveries and RPDs, the results were accepted without qualification. One high VOC MS recovery was reported, but the associated sample result was non-detect and was not impacted by the indicated high bias.

Two slightly low VOC MS/MSD recoveries were reported, and the associated sample results were qualified as estimated (see Table 6).

2.6 FIELD DUPLICATE ANALYSIS

One field duplicate sample was submitted "blind" to the laboratory for analyses as summarized in Table 1. All field duplicate results showed acceptable reproducibility outside of estimated regions of detection, indicating good laboratory and sampling protocol precision.

2.7 TRIP BLANK ANALYSIS

One trip blank was collected for the program and analyzed for VOCs. The trip blank results were non-detect for the compounds of interest.

3.0 CONCLUSION

Based on this QA/QC review, the data presented in Table 2 are acceptable with the noted qualifications.

TABLES

TABLE 1

SAMPLE COLLECTION AND ANALYSIS SUMMARY
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

				Parameter			
Sample ID	*Location I.D.*	*Collection Date*	*Collection Time*	*TCL VOCs*	*TAL Metals*	*TCL SVOCs*	*Comment*
WG-630660-041509-JJW-001	MW-102	04/15/09	12:30	X	X	X	
WG-630660-041509-JJW-002	MW-102	04/15/09	12:45	X	X	X	Duplicate of WG-630660-041509-JJW-001
WG-630660-041509-JJW-003	MW-104	04/15/09	14:15	X	X	X	
WG-630660-041509-JJW-004	MW-106F	04/15/09	14:45	X	X	X	
WG-630660-041509-JJW-005	MW-103	04/15/09	15:00	X	X	X	MS/MSD
WG-630660-041509-JJW-006	MW-101	04/15/09	17:00	X	X	X	
WG-630660-041409-JJW-007	MW-105	04/15/09	18:00	X	X	X	
Trip Blank	-	04/15/09	-	X			Trip Blank

Notes:

- = Not applicable.
TCL - Target Compound List.
TAL - Target Analyte List.
MS - Matrix Spike.
MSD - Matrix Spike Duplicate.
SVOCs - Semi-Volatile Organic Compounds.
VOCs - Volatile Organic Compounds.

TABLE 2

ANALYTICAL RESULTS SUMMARY
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

	Location ID:	*MW-101*	*MW-102*	*MW-102*	*MW-103*
	Sample Name:	*WG-630660-041509-JJW-006*	*WG-630660-041509-JJW-001*	*WG-630660-041509-JJW-002*	*WG-630660-041509-JJW-005*
	Sample Date:	*4/15/2009*	*4/15/2009*	*4/15/2009*	*4/15/2009*
Parameters	***Units***			***Duplicate***	
Volatile Organic Compounds					
1,1,1-Trichloroethane	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
1,1,2,2-Tetrachloroethane	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
1,1,2-Trichloroethane	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethane	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
1,1-Dichloroethene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	2.0 U	2.0 U	2.0 U	2.0 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichlorobenzene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloroethane	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloropropane	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
1,3-Dichlorobenzene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
1,4-Dichlorobenzene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
2-Butanone (Methyl Ethyl Ketone)	µg/L	0.75 J	10 U	10 U	10 U
2-Hexanone	µg/L	10 U	10 U	10 U	10 U
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/L	10 U	10 UJ	10 U	10 UJ
Acetone	µg/L	1.1 J	10 U	10 U	10 U
Benzene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Bromodichloromethane	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Bromoform	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Bromomethane (Methyl Bromide)	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Carbon disulfide	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Carbon tetrachloride	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Chlorobenzene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Chloroethane	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Chloroform (Trichloromethane)	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Chloromethane (Methyl Chloride)	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
cis-1,2-Dichloroethene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
cis-1,3-Dichloropropene	µg/L	1.0 UJ	1.0 U	1.0 UJ	1.0 UJ
Cyclohexane	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Dibromochloromethane	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Dichlorodifluoromethane (CFC-12)	µg/L	1.0 UJ	1.0 UJ	1.0 UJ	1.0 UJ

TABLE 2

ANALYTICAL RESULTS SUMMARY
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

	Location ID:	*MW-101*	*MW-102*	*MW-102*	*MW-103*
	Sample Name:	*WG-630660-041509-JJW-006*	*WG-630660-041509-JJW-001*	*WG-630660-041509-JJW-002*	*WG-630660-041509-JJW-005*
	Sample Date:	*4/15/2009*	*4/15/2009*	*4/15/2009*	*4/15/2009*
Parameters	***Units***			***Duplicate***	
Volatile Organic Compounds (Cont'd.)					
Ethylbenzene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Isopropylbenzene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Methyl acetate	µg/L	10 U	10 U	10 U	10 U
Methyl cyclohexane	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Methyl Tert Butyl Ether	µg/L	5.0 U	1.0 UJ	1.0 U	1.0 U
Methylene chloride	µg/L	1.0 U	5.0 U	5.0 U	5.0 U
Styrene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Tetrachloroethene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Toluene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
trans-1,2-Dichloroethene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
trans-1,3-Dichloropropene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Trichloroethene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Trichlorofluoromethane (CFC-11)	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Trifluorotrichloroethane (Freon 113)	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl chloride	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Xylene (total)	µg/L	2.0 U	2.0 U	2.0 U	2.0 U
Semi-volatile Organic Compounds					
2,2'-oxybis(1-Chloropropane) (bis(2-chloroisopropyl) ether)	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
2,4,5-Trichlorophenol	µg/L	5.0 U	5.0 U	5.0 U	5.0 U
2,4,6-Trichlorophenol	µg/L	5.0 U	5.0 U	5.0 U	5.0 U
2,4-Dichlorophenol	µg/L	2.0 U	2.0 U	2.0 U	2.0 U
2,4-Dimethylphenol	µg/L	2.0 U	2.0 U	2.0 U	2.0 U
2,4-Dinitrophenol	µg/L	5.0 U	5.0 U	5.0 U	5.0 U
2,4-Dinitrotoluene	µg/L	5.0 U	5.0 U	5.0 U	5.0 U
2,6-Dinitrotoluene	µg/L	5.0 U	5.0 U	5.0 U	5.0 U
2-Chloronaphthalene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
2-Chlorophenol	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
2-Methylnaphthalene	µg/L	0.20 U	0.20 U	0.20 U	0.20 U
2-Methylphenol	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
2-Nitroaniline	µg/L	2.0 U	2.0 U	2.0 U	2.0 U
2-Nitrophenol	µg/L	2.0 U	2.0 U	2.0 U	2.0 U

TABLE 2

ANALYTICAL RESULTS SUMMARY
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

	Location ID:	*MW-101*	*MW-102*	*MW-102*	*MW-103*
	Sample Name:	*WG-630660-041509-JJW-006*	*WG-630660-041509-JJW-001*	*WG-630660-041509-JJW-002*	*WG-630660-041509-JJW-005*
	Sample Date:	*4/15/2009*	*4/15/2009*	*4/15/2009*	*4/15/2009*
Parameters	***Units***			***Duplicate***	
Semi-volatile Organic Compounds (Cont'd.)					
3,3'-Dichlorobenzidine	μg/L	5.0 U	5.0 U	5.0 U	5.0 U
3-Nitroaniline	μg/L	2.0 U	2.0 U	2.0 U	2.0 U
4,6-Dinitro-2-methylphenol	μg/L	5.0 U	5.0 U	5.0 U	5.0 U
4-Bromophenyl phenyl ether	μg/L	2.0 U	2.0 U	2.0 U	2.0 U
4-Chloro-3-methylphenol	μg/L	2.0 U	2.0 U	2.0 U	2.0 U
4-Chloroaniline	μg/L	2.0 U	2.0 U	2.0 U	2.0 U
4-Chlorophenyl phenyl ether	μg/L	2.0 U	2.0 U	2.0 U	2.0 U
4-Methylphenol	μg/L	1.0 U	1.0 U	1.0 U	1.0 U
4-Nitroaniline	μg/L	2.0 U	2.0 U	2.0 U	2.0 U
4-Nitrophenol	μg/L	5.0 U	5.0 U	5.0 U	5.0 U
Acenaphthene	μg/L	0.20 U	0.20 U	0.20 U	0.20 U
Acenaphthylene	μg/L	0.20 U	0.20 U	0.20 U	0.20 U
Acetophenone	μg/L	1.0 U	1.0 U	1.0 U	1.0 U
Anthracene	μg/L	0.20 U	0.20 U	0.20 U	0.20 U
Atrazine	μg/L	1.0 U	1.0 U	1.0 U	1.0 U
Benzaldehyde	μg/L	1.0 U	1.0 U	1.0 U	1.0 U
Benzo(a)anthracene	μg/L	0.20 U	0.20 U	0.20 U	0.20 U
Benzo(a)pyrene	μg/L	0.20 U	0.20 U	0.20 U	0.20 U
Benzo(b)fluoranthene	μg/L	0.20 U	0.20 U	0.20 U	0.20 U
Benzo(g,h,i)perylene	μg/L	0.20 U	0.20 U	0.20 U	0.20 U
Benzo(k)fluoranthene	μg/L	0.20 U	0.20 U	0.20 U	0.20 U
Biphenyl	μg/L	1.0 U	1.0 U	1.0 U	1.0 U
bis(2-Chloroethoxy)methane	μg/L	1.0 U	1.0 U	1.0 U	1.0 U
bis(2-Chloroethyl)ether	μg/L	1.0 U	1.0 U	1.0 U	1.0 U
bis(2-Ethylhexyl)phthalate	μg/L	2.0 U	2.0 U	5.7 U	6.0 U
Butyl benzylphthalate	μg/L	1.0 U	1.0 U	1.0 U	1.0 U
Caprolactam	μg/L	130	5.0 U	5.0 U	5.0 U
Carbazole	μg/L	1.0 U	1.0 U	1.0 U	1.0 U
Chrysene	μg/L	0.20 U	0.20 U	0.20 U	0.20 U
Dibenz(a,h)anthracene	μg/L	0.20 U	0.20 U	0.20 U	0.20 U
Dibenzofuran	μg/L	1.0 U	1.0 U	1.0 U	1.0 U
Diethyl phthalate	μg/L	1.0 U	1.0 U	1.0 U	1.0 U

TABLE 2

ANALYTICAL RESULTS SUMMARY
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

	Location ID:	*MW-101*	*MW-102*	*MW-102*	*MW-103*
	Sample Name:	*WG-630660-041509-JJW-006*	*WG-630660-041509-JJW-001*	*WG-630660-041509-JJW-002*	*WG-630660-041509-JJW-005*
	Sample Date:	*4/15/2009*	*4/15/2009*	*4/15/2009*	*4/15/2009*
Parameters	***Units***			***Duplicate***	
Semi-volatile Organic Compounds (Cont'd.)					
Dimethyl phthalate	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Di-n-butylphthalate	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Di-n-octyl phthalate	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Fluoranthene	µg/L	0.20 U	0.20 U	0.20 U	0.20 U
Fluorene	µg/L	0.20 U	0.20 U	0.20 U	0.20 U
Hexachlorobenzene	µg/L	0.20 U	0.20 U	0.20 U	0.20 U
Hexachlorobutadiene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Hexachlorocyclopentadiene	µg/L	10 U	10 U	10 U	10 U
Hexachloroethane	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Indeno(1,2,3-cd)pyrene	µg/L	0.20 U	0.20 U	0.20 U	0.20 U
Isophorone	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Naphthalene	µg/L	0.20 U	0.20 U	0.20 U	0.20 U
Nitrobenzene	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
N-Nitrosodi-n-propylamine	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
N-Nitrosodiphenylamine	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Pentachlorophenol	µg/L	5.0 U	5.0 U	5.0 U	5.0 U
Phenanthrene	µg/L	0.20 U	0.20 U	0.20 U	0.20 U
Phenol	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Pyrene	µg/L	0.20 U	0.20 U	0.20 U	0.20 U
Metals					
Aluminum	µg/L	849	479	747	304
Antimony	µg/L	34.9	0.21 J	0.26 J	0.28 J
Arsenic	µg/L	3.1 J	0.94 J	1.1 J	1.8 J
Barium	µg/L	156 J	69.5 J	70.7 J	90.8 J
Beryllium	µg/L	5.0 U	5.0 U	5.0 U	5.0 U
Cadmium	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Calcium	µg/L	67200	85200	84200	109000
Chromium	µg/L	2.0 J	1.2 J	1.9 J	10.0 U
Cobalt	µg/L	1.3 J	0.76 J	0.85 J	0.46 J
Copper	µg/L	44.8	4.5 J	6.1 J	25.0 U
Iron	µg/L	935	583	902	541

TABLE 2

ANALYTICAL RESULTS SUMMARY
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

	Location ID:	***MW-101***	***MW-102***	***MW-102***	***MW-103***
	Sample Name:	***WG-630660-041509-JJW-006***	***WG-630660-041509-JJW-001***	***WG-630660-041509-JJW-002***	***WG-630660-041509-JJW-005***
	Sample Date:	***4/15/2009***	***4/15/2009***	***4/15/2009***	***4/15/2009***
Parameters	***Units***			***Duplicate***	
Metals (Cont'd.)					
Lead	µg/L	10.9	2.4	3.6	0.37 J
Magnesium	µg/L	84300	107000	106000	108000
Manganese	µg/L	173	110	110	49.7
Mercury	µg/L	0.20 U	0.20 U	0.20 U	0.20 U
Nickel	µg/L	3.5 J	1.1 J	1.7 J	1.2 J
Potassium	µg/L	12500	3100 J	3110 J	3780 J
Selenium	µg/L	5.0 U	5.0 U	5.0 U	5.0 U
Silver	µg/L	1.0 U	1.0 U	1.0 U	1.0 U
Sodium	µg/L	57100	61700	61000	100000
Thallium	µg/L	0.26 J	1.0 U	1.0 U	1.0 U
Vanadium	µg/L	2.4 J	0.79 J	1.3 J	0.56 J
Zinc	µg/L	45.0 U	20.0 U	20.0 U	20.0 U

TABLE 2

ANALYTICAL RESULTS SUMMARY
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

	Location ID:	*MW-104*	*MW-105*	*MW-106F*
	Sample Name:	*WG-630660-041509-JJW-003*	*WG-630660-041509-JJW-007*	*WG-630660-041509-JJW-004*
	Sample Date:	*4/15/2009*	*4/15/2009*	*4/15/2009*
Parameters	*Units*			
Volatile Organic Compounds				
1,1,1-Trichloroethane	µg/L	1.0 U	1.0 U	1.0 U
1,1,2,2-Tetrachloroethane	µg/L	1.0 U	1.0 U	1.0 U
1,1,2-Trichloroethane	µg/L	1.0 U	1.0 U	1.0 U
1,1-Dichloroethane	µg/L	1.0 U	1.0 U	1.0 U
1,1-Dichloroethene	µg/L	1.0 U	1.0 U	1.0 U
1,2,4-Trichlorobenzene	µg/L	1.0 U	1.0 U	1.0 U
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	2.0 U	2.0 U	2.0 U
1,2-Dibromoethane (Ethylene Dibromide)	µg/L	1.0 U	1.0 U	1.0 U
1,2-Dichlorobenzene	µg/L	1.0 U	1.0 U	1.0 U
1,2-Dichloroethane	µg/L	1.0 U	1.0 U	1.0 U
1,2-Dichloropropane	µg/L	1.0 U	1.0 U	1.0 U
1,3-Dichlorobenzene	µg/L	1.0 U	1.0 U	1.0 U
1,4-Dichlorobenzene	µg/L	1.0 U	1.0 U	1.0 U
2-Butanone (Methyl Ethyl Ketone)	µg/L	10 U	1.2 J	0.67 J
2-Hexanone	µg/L	10 U	10 U	10 U
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	µg/L	10 U	10 U	10 U
Acetone	µg/L	10 U	3.8 J	71
Benzene	µg/L	1.0 U	0.79 J	1.0 U
Bromodichloromethane	µg/L	1.0 U	1.0 U	0.46 J
Bromoform	µg/L	1.0 U	1.0 U	1.0 U
Bromomethane (Methyl Bromide)	µg/L	1.0 U	1.0 U	1.0 U
Carbon disulfide	µg/L	1.0 U	1.0 U	1.0 U
Carbon tetrachloride	µg/L	1.0 U	1.0 U	1.0 U
Chlorobenzene	µg/L	1.0 U	1.0 U	1.0 U
Chloroethane	µg/L	1.0 U	1.0 U	1.0 U
Chloroform (Trichloromethane)	µg/L	1.0 U	1.0 U	1.1
Chloromethane (Methyl Chloride)	µg/L	1.0 U	1.0 U	1.0 U
cis-1,2-Dichloroethene	µg/L	1.0 U	1.0 U	1.0 U
cis-1,3-Dichloropropene	µg/L	1.0 UJ	1.0 UJ	1.0 UJ
Cyclohexane	µg/L	1.0 U	1.0 U	1.0 U
Dibromochloromethane	µg/L	1.0 U	1.0 U	1.0 U
Dichlorodifluoromethane (CFC-12)	µg/L	1.0 UJ	1.0 UJ	1.0 UJ

TABLE 2

ANALYTICAL RESULTS SUMMARY
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

	Location ID:	*MW-104*	*MW-105*	*MW-106F*
	Sample Name:	*WG-630660-041509-JJW-003*	*WG-630660-041509-JJW-007*	*WG-630660-041509-JJW-004*
	Sample Date:	*4/15/2009*	*4/15/2009*	*4/15/2009*
Parameters	***Units***			
Volatile Organic Compounds (Cont'd.)				
Ethylbenzene	µg/L	1.0 U	1.0 U	1.0 U
Isopropylbenzene	µg/L	1.0 U	1.0 U	1.0 U
Methyl acetate	µg/L	10 U	10 U	10 U
Methyl cyclohexane	µg/L	1.0 U	1.0 U	1.0 U
Methyl Tert Butyl Ether	µg/L	5.0 U	5.0 U	5.0 U
Methylene chloride	µg/L	1.0 U	1.0 U	1.0 U
Styrene	µg/L	1.0 U	1.0 U	1.0 U
Tetrachloroethene	µg/L	1.0 U	1.0 U	1.0 U
Toluene	µg/L	1.0 U	1.3	1.0 U
trans-1,2-Dichloroethene	µg/L	1.0 U	1.0 U	1.0 U
trans-1,3-Dichloropropene	µg/L	1.0 U	1.0 U	1.0 U
Trichloroethene	µg/L	1.0 U	1.0 U	1.0 U
Trichlorofluoromethane (CFC-11)	µg/L	1.0 U	1.0 U	1.0 U
Trifluorotrichloroethane (Freon 113)	µg/L	1.0 U	1.0 U	1.0 U
Vinyl chloride	µg/L	1.0 U	1.0 U	1.0 U
Xylene (total)	µg/L	2.0 U	0.73 J	2.0 U
Semi-volatile Organic Compounds				
2,2'-oxybis(1-Chloropropane) (bis(2-chloroisopropyl) ether)	µg/L	1.0 U	1.0 U	1.0 U
2,4,5-Trichlorophenol	µg/L	5.0 U	5.0 U	5.0 U
2,4,6-Trichlorophenol	µg/L	5.0 U	5.0 U	5.0 U
2,4-Dichlorophenol	µg/L	2.0 U	2.0 U	2.0 U
2,4-Dimethylphenol	µg/L	2.0 U	2.0 U	2.0 U
2,4-Dinitrophenol	µg/L	5.0 U	5.0 U	5.0 U
2,4-Dinitrotoluene	µg/L	5.0 U	5.0 U	5.0 U
2,6-Dinitrotoluene	µg/L	5.0 U	5.0 U	5.0 U
2-Chloronaphthalene	µg/L	1.0 U	1.0 U	1.0 U
2-Chlorophenol	µg/L	1.0 U	1.0 U	1.0 U
2-Methylnaphthalene	µg/L	0.20 U	0.20 U	0.20 U
2-Methylphenol	µg/L	1.0 U	1.0 U	1.0 U
2-Nitroaniline	µg/L	2.0 U	2.0 U	2.0 U
2-Nitrophenol	µg/L	2.0 U	2.0 U	2.0 U

TABLE 2

ANALYTICAL RESULTS SUMMARY
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

	Location ID:	*MW-104*	*MW-105*	*MW-106F*
	Sample Name:	*WG-630660-041509-JJW-003*	*WG-630660-041509-JJW-007*	*WG-630660-041509-JJW-004*
	Sample Date:	*4/15/2009*	*4/15/2009*	*4/15/2009*
Parameters	***Units***			
Semi-volatile Organic Compounds (Cont'd.)				
3,3'-Dichlorobenzidine	µg/L	5.0 U	5.0 U	5.0 U
3-Nitroaniline	µg/L	2.0 U	2.0 U	2.0 U
4,6-Dinitro-2-methylphenol	µg/L	5.0 U	5.0 U	5.0 U
4-Bromophenyl phenyl ether	µg/L	2.0 U	2.0 U	2.0 U
4-Chloro-3-methylphenol	µg/L	2.0 U	2.0 U	2.0 U
4-Chloroaniline	µg/L	2.0 U	2.0 U	2.0 U
4-Chlorophenyl phenyl ether	µg/L	2.0 U	2.0 U	2.0 U
4-Methylphenol	µg/L	1.0 U	1.0 U	1.0 U
4-Nitroaniline	µg/L	2.0 U	2.0 U	2.0 U
4-Nitrophenol	µg/L	5.0 U	5.0 U	5.0 U
Acenaphthene	µg/L	0.20 U	0.20 U	0.20 U
Acenaphthylene	µg/L	0.20 U	0.20 U	0.20 U
Acetophenone	µg/L	1.0 U	1.0 U	1.5
Anthracene	µg/L	0.20 U	0.20 U	0.20 U
Atrazine	µg/L	1.0 U	1.0 U	1.0 U
Benzaldehyde	µg/L	1.0 U	1.0 U	1.0 U
Benzo(a)anthracene	µg/L	0.20 U	0.20 U	0.20 U
Benzo(a)pyrene	µg/L	0.20 U	0.20 U	0.20 U
Benzo(b)fluoranthene	µg/L	0.20 U	0.20 U	0.20 U
Benzo(g,h,i)perylene	µg/L	0.20 U	0.20 U	0.20 U
Benzo(k)fluoranthene	µg/L	0.20 U	0.20 U	0.20 U
Biphenyl	µg/L	1.0 U	1.0 U	1.0 U
bis(2-Chloroethoxy)methane	µg/L	1.0 U	1.0 U	1.0 U
bis(2-Chloroethyl)ether	µg/L	1.0 U	1.0 U	1.0 U
bis(2-Ethylhexyl)phthalate	µg/L	2.0 U	2.0 U	2.0 U
Butyl benzylphthalate	µg/L	1.0 U	1.0 U	1.0 U
Caprolactam	µg/L	18	5.0 U	5.0 U
Carbazole	µg/L	1.0 U	1.0 U	1.0 U
Chrysene	µg/L	0.20 U	0.20 U	0.20 U
Dibenz(a,h)anthracene	µg/L	0.20 U	0.20 U	0.20 U
Dibenzofuran	µg/L	1.0 U	1.0 U	1.0 U
Diethyl phthalate	µg/L	1.0 U	1.0 U	1.0 U

TABLE 2

ANALYTICAL RESULTS SUMMARY
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

Parameters	*Units*	MW-104 WG-630660-041509-JJW-003 4/15/2009	MW-105 WG-630660-041509-JJW-007 4/15/2009	MW-106F WG-630660-041509-JJW-004 4/15/2009
		Location ID: MW-104	MW-105	MW-106F
		Sample Name: WG-630660-041509-JJW-003	WG-630660-041509-JJW-007	WG-630660-041509-JJW-004
		Sample Date: 4/15/2009	4/15/2009	4/15/2009
Semi-volatile Organic Compounds (Cont'd.)				
Dimethyl phthalate	µg/L	1.0 U	1.0 U	1.0 U
Di-n-butylphthalate	µg/L	1.0 U	1.0 U	1.0 U
Di-n-octyl phthalate	µg/L	1.0 U	1.0 U	1.0 U
Fluoranthene	µg/L	0.20 U	0.20 U	0.25
Fluorene	µg/L	0.20 U	0.20 U	0.20 U
Hexachlorobenzene	µg/L	0.20 U	0.20 U	0.20 U
Hexachlorobutadiene	µg/L	1.0 U	1.0 U	1.0 U
Hexachlorocyclopentadiene	µg/L	10 U	10 U	10 U
Hexachloroethane	µg/L	1.0 U	1.0 U	1.0 U
Indeno(1,2,3-cd)pyrene	µg/L	0.20 U	0.20 U	0.20 U
Isophorone	µg/L	1.0 U	1.5	1.0 U
Naphthalene	µg/L	0.20 U	0.20 U	0.20 U
Nitrobenzene	µg/L	1.0 U	1.0 U	1.0 U
N-Nitrosodi-n-propylamine	µg/L	1.0 U	1.0 U	1.0 U
N-Nitrosodiphenylamine	µg/L	1.0 U	1.0 U	1.0 U
Pentachlorophenol	µg/L	5.0 U	5.0 U	5.0 U
Phenanthrene	µg/L	0.20 U	0.20 U	0.23
Phenol	µg/L	1.0 U	1.0 U	1.0 U
Pyrene	µg/L	0.20 U	0.20 U	0.20 U
Metals				
Aluminum	µg/L	119 J	13100	3200
Antimony	µg/L	0.22 J	0.45 J	5.7
Arsenic	µg/L	8.2	4.0 J	1.9 J
Barium	µg/L	42.6 J	172 J	114 J
Beryllium	µg/L	5.0 U	0.58 J	5.0 U
Cadmium	µg/L	1.0 U	1.0 U	1.0 U
Calcium	µg/L	58100	252000	84900
Chromium	µg/L	10.0 U	23.6	11.0
Cobalt	µg/L	0.20 J	6.0 J	0.60 J
Copper	µg/L	25.0 U	21.8 J	25.1
Iron	µg/L	251	19000	2380

TABLE 2

ANALYTICAL RESULTS SUMMARY
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

	Location ID:	*MW-104*	*MW-105*	*MW-106F*
	Sample Name:	*WG-630660-041509-JJW-003*	*WG-630660-041509-JJW-007*	*WG-630660-041509-JJW-004*
	Sample Date:	*4/15/2009*	*4/15/2009*	*4/15/2009*
Parameters	***Units***			
Metals (Cont'd.)				
Lead	µg/L	0.66 J	14.9	18.2
Magnesium	µg/L	101000	107000	46000
Manganese	µg/L	18.8	478	58.9
Mercury	µg/L	0.20 U	0.17 J	0.20 U
Nickel	µg/L	0.49 J	20.0 J	2.5 J
Potassium	µg/L	2440 J	13600	7110
Selenium	µg/L	5.0 U	5.0 U	1.9 J
Silver	µg/L	1.0 U	1.0 U	1.0 U
Sodium	µg/L	61200	30200	84900
Thallium	µg/L	1.0 U	0.18 J	1.0 U
Vanadium	µg/L	50.0 U	23.6 J	3.4 J
Zinc	µg/L	20.0 U	63.8 U	36.0 U

Notes:

J - Estimated.
U - Not detected.
UJ - Not detected, estimated reporting limit.

TABLE 3

ANALYTICAL METHOD SUMMARY
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

Analyses	*Methodology* [1]	*Holding Time to Extraction (Days)*	*Holding Time to Analyses (Days)*
TCL VOCs	SW-846 8260B	-	14
TCL SVOCs	SW-846 8270C	7	40
TAL Metals (except Mercury)	SW-846 6020	-	180
Mercury	SW-846 7470A	-	28

Notes:

[1] - Referenced from "Test Methods for Evaluating Solid Waste", USEPA OSW, 3rd Edition, 1986 and subsequent revisions.

SVOCs - Semi-Volatile Organic Compounds.
VOCs - Volatile Organic Compounds.
TCL - Target Compound List.
TAL - Target Analyte List.

TABLE 4

QUALIFIED SAMPLE RESULTS DUE TO ANALYTE CONCENTRATIONS IN THE METHOD BLANKS
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

Parameter	*Analysis Date*	*Analyte*	*Blank Result*	*Sample ID*	*Sample Result (ug/L)*	*Qualified Result (ug/L)*
VOCs	04/21/09	Cyclohexane	0.46 J	WG-630660-041509-JJW-006	0.48 J	1.0 U
				WG-630660-041509-JJW-007	0.79 J	1.0 U
VOCs	04/21/09	Methylcyclohexane	0.51 J	WG-630660-041509-JJW-006	0.51 J	1.0 U
				WG-630660-041509-JJW-007	0.81 J	1.0 U
SVOCs	04/20/09	bis(2-Ethylhexyl)phthalate	1.3 J	WG-630660-041509-JJW-001	2.0	2.0 U
				WG-630660-041509-JJW-002	5.7	5.7 U
				WG-630660-041509-JJW-003	0.99 J	2.0 U
				WG-630660-041509-JJW-004	1.9 J	2.0 U
				WG-630660-041509-JJW-005	6.0	6.0 U
				WG-630660-041509-JJW-007	0.83 J	2.0 U
Metals	04/27/09	Copper	0.64 J	WG-630660-041509-JJW-003	1.6 J	25.0 U
				WG-630660-041509-JJW-005	0.94 J	25.0 U
Metals	04/27/09	Zinc	33.2	WG-630660-041509-JJW-001	10.5 J	20.0 U
				WG-630660-041509-JJW-002	13.0 J	20.0 U
				WG-630660-041509-JJW-003	3.3 J	20.0 U
				WG-630660-041509-JJW-004	36.0	36.0 U
				WG-630660-041509-JJW-006	45.0	45.0 U
				WG-630660-041509-JJW-007	63.8	63.8 U

Notes:

J - Estimated.
U - Not detected.
SVOCs - Semi-Volatile Organic Compounds.
VOCs - Volatile Organic Compounds.

TABLE 5

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING BLANK SPIKE/BLANK SPIKE DUPLICATE RECOVERIES
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

Parameter	*Analyte*	*BS Recovery (percent)*	*BSD Recovery (percent)*	*RPD (percent)*	*Control Limits*		*Associated Sample ID*	*Sample Result (ug/L)*	*Qualifier*
					Recovery (percent)	*RPD (percent)*			
VOCs	Dichlorodifluoromethane	61	-	-	70-130	-	WG-630660-041509-JJW-002	1.0 U	UJ
							WG-630660-041509-JJW-003	1.0 U	UJ
							WG-630660-041509-JJW-004	1.0 U	UJ
							WG-630660-041509-JJW-005	1.0 U	UJ
							WG-630660-041509-JJW-006	1.0 U	UJ
							WG-630660-041509-JJW-007	1.0 U	UJ
VOCs	Dichlorodifluoromethane	66	72	8.3	70-130	0-30	WG-630660-041509-JJW-001	1.0 U	UJ
VOCs	Methylcyclohexane	63	70	10	70-130	0-30	WG-630660-041509-JJW-001	1.0 U	UJ
VOCs	4-Methyl -2-Pentanone	77	85	9	78-141	0-32	WG-630660-041509-JJW-001	10 U	UJ
VOCs	cis-1,3-Dichloropropene	83	-	-	84-130	-	WG-630660-041509-JJW-002	1.0 U	UJ
							WG-630660-041509-JJW-003	1.0 U	UJ
							WG-630660-041509-JJW-004	1.0 U	UJ
							WG-630660-041509-JJW-005	1.0 U	UJ
							WG-630660-041509-JJW-006	1.0 U	UJ
							WG-630660-041509-JJW-007	1.0 U	UJ

Notes:

BS - Blank Spike.
BSD - Blank Spike Duplicate.
RPD - Relative Percent Difference.
U - Not detected.
UJ - Not detected, estimated reporting limit.
VOCs - Volatile Organic Compounds.

TABLE 6

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES
GROUNDWATER SAMPLING
CASCADES, INC.
DEPEW, NEW YORK
APRIL 2009

Parameter	*Sample ID*	*Analyte*	*MS Recovery (percent)*	*MSD Recovery (percent)*	*RPD (percent)*	*Control Limits*		*Sample Result (µg/L)*	*Qualifier*
						Recovery (percent)	*RPD (percent)*		
VOCs	WG-630660-041509-JJW-005	4-Methyl -2-Pentanone	76	78	2.0	82-135	0-30	10 U	UJ
		cis-1,3-Dichloropropene	78	80	2.4	82-130	0-30	1.0 U	UJ

Notes:

MS - Matrix Spike.
MSD - Matrix Spike Duplicate.
RPD - Relative Percent Difference.
U - Not detected.
UJ - Not detected, estimated reporting limit.
VOCs - Volatile Organic Compounds.

TIGHE & BOND - MIDDLETOWN
WELL PURGING - FIELD WATER QUALITY MEASUREMENTS FORM

Page _____ of _____

Location (Site/Facility Name) ________________________________
Well Number ____________________ Date ____________________
Field Personnel ________________________________
Sampling Organization ________________________________
Identify MP ________________________________

Depth to _______/________ of screen
(below MP top bottom
Pump Intake at (ft. below MP) ____________________
Purging Device; (pump type) ____________________

Clock Time 24 hr.	Water Depth below MP ft.	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. °C	Spec. Cond.[2] µS/cm	pH	ORP/ Eh[3] mv	DO mg/L	Turbidity NTU	Comments

1. Pump dial setting (for example: hertz, cycles/min., etc.)
2. µSiemens per cm (same as µmhos/cm) at 25oC).
3. Oxidation reduction potential (stand in for Eh).

J:H\\HYDRO\WORKBOOKS\LOWFLOW-MTO.XLS

TIGHE BOND - MIDDLETOWN
GROUNDWATER SAMPLE COLLECTION DATA

Client: ______________________ Job Number: ______________________

______________________ Sampling Location: ______________________

Contact: ______________________

Collected By: ______________________ Well No.: ______________________

Date: ______________________ Time Collected: ______________________

Weather ______________________

Water Table

Diameter of Well ______________________

Well Depth (from top of PVC standpipe) ______________________

Depth of Water Table (from top of PVC standpipe) ______________________

Length of Water Column ______________________ feet

Purge Volume: LWC x 0.17 / 0.38 / 0.08 (circle one) x 3 = ______________ Volume Purged ______________

Purging Method: (please check)

Submersible pump ______________ Teflon Bailer ______________ Other (explain) ______________

Sampling Method:

Type of Bailer: Teflon __________ ID# ________ Other (explain) __________ Dedicated Bailer YES NO

If not explain decontamination procedures

SAMPLE COLLECTION & FIELD DATA

Volume removed prior to analysis	pH	Specific Conductance µmhos/cm @25°C	Temperature °C	Dissolved Oxygen mg/L		Time Analyzed

CONTAINERS & PRESERVATIVES

Type of Container	Number of Containers	Preservative Type/Amount	Analysis Required	Field pH

If sample was taken for dissolved metals, were these samples field filtered? ______________________

Date: ______________ Time: ______________ By: __________ Filter Pore Size & Type: ______________

General Notes: ____

APPENDIX F

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUND WATER SAMPLES FROM MONITORING WELLS

July 30, 1996
Revision 2

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUND WATER SAMPLES FROM MONITORING WELLS

I. SCOPE & APPLICATION

This standard operating procedure (SOP) provides a general framework for collecting ground water samples that are indicative of mobile organic and inorganic loads at ambient flow conditions (both the dissolved fraction and the fraction associated with mobile particulates). The SOP emphasizes the need to minimize stress by low water-level drawdowns, and low pumping rates (usually less than 1 liter/min) in order to collect samples with minimal alterations to water chemistry. This SOP is aimed primarily at sampling monitoring wells that can accept a submersible pump and have a screen, or open interval length of 10 feet or less (this is the most common situation). However, this procedure is flexible and can be used in a variety of well construction and ground-water yield situations. Samples thus obtained are suitable for analyses of ground water contaminants (volatile and semi-volatile organic analytes, pesticides, PCBs, metals and other inorganics), or other naturally occurring analytes.

This procedure does not address the collection of samples from wells containing light or dense non-aqueous phase liquids (LNAPLs and DNAPLs). For this the reader may wish to check: Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation; C.K. Smoley (CRC Press), Boca Raton, Florida and U.S. Environmental Protection Agency, 1992, RCRA Ground-Water Monitoring: Draft Technical Guidance; Washington, DC (EPA/530-R-93-001).

The screen, or open interval of the monitoring well should be optimally located (both laterally and vertically) to intercept existing contaminant plume(s) or along flowpaths of potential contaminant releases. It is presumed that the analytes of interest move (or potentially move) primarily through the more permeable zones within the screen, or open interval.

Proper well construction and development cannot be overemphasized, since the use of installation techniques that are appropriate to the hydrogeologic setting often prevents "problem well" situations from occurring. It is also recommended that as part of development or redevelopment the well should be tested to determine the appropriate pumping rate to obtain stabilization of field indicator parameters with minimal drawdown in shortest amount of time. With this information field crews can then conduct purging and sampling in a more expeditious manner.

The mid-point of the saturated screen length (which should not exceed 10 feet) is used by convention as the location of the pump intake. However, significant chemical or permeability contrast(s) within the screen may require additional field work to determine the optimum vertical location(s) for the intake, and appropriate pumping rate(s) for purging and sampling more localized target zone(s). Primary flow zones (high(er) permealability and/or high(er) chemical concentrations) should be identified in wells with screen lengths longer than 10 feet, or in wells with open boreholes in bedrock. Targeting these zones for water sampling will help insure that the low stress procedure will not underestimate contaminant concentrations. The Sampling and Analysis Plan must provide clear instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the remaining criteria in this procedure are met. If after 4 hours of purging indicator field parameters have not stabilized, one of 3 optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization) c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may not meet the sampling objectives).

Changes to this SOP should be proposed and discussed when the site Sampling and Analysis Plan is submitted for approval. Subsequent requests for modifications of an approved plan must include adequate technical justification for proposed changes. All changes and modifications must be approved before implementation in field.

II.EQUIPMENT

A. Extraction device

Adjustable rate, submersible pumps are preferred (for example, centrifugal or bladder pump constructed of stainless steel or

Teflon).

Adjustable rate, peristaltic pumps (suction) may be used with caution. Note that EPA guidance states: "Suction pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" (EPA/540/P-87/001, 1987, page 8.5-11).

The use of inertial pumps is discouraged. These devices frequently cause greater disturbance during purging and sampling and are less easily controlled than the pumps listed above. This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

B. Tubing

Teflon or Teflon lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for inorganics analyses. However, these materials should be used with caution when sampling for organics. If these materials are used, the equipment blank (which includes the tubing) data must show that these materials do not add contaminants to the sample.

Stainless steel tubing may be used when sampling for VOCs, SVOCs, pesticides, and PCBs. However, it should be used with caution when sampling for metals.

The use of 1/4 inch or 3/8 inch (inner diameter) tubing is preferred. This will help ensure the tubing remains liquid filled when operating at very low pumping rates.

Pharmaceutical grade (Pharmed) tubing should be used for the section around the rotor head of a peristaltic pump, to minimize gaseous diffusion.

C.   Water level measuring device(s), capable of measuring to 0.01 foot accuracy (electronic “tape”, pressure transducer). Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level “tape” at the start and end of each record.

D. Flow measurement supplies (e.g., graduated cylinder and stop watch).

E. Interface probe, if needed.

F. Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate the samples.

G. Indicator field parameter monitoring instruments - pH, Eh, dissolved oxygen (DO), turbidity, specific conductance, and temperature. Use of a flow-through-cell is required when measuring all listed parameters, except turbidity. Standards to perform field calibration of instruments. Analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846. For Eh measurements, follow manufacturer's instructions.

H. Decontamination supplies (for example, non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.).

I. Logbook(s), and other forms (for example, well purging forms).

J. Sample Bottles.

K. Sample preservation supplies (as required by the analytical methods).

L. Sample tags or labels.

M. Well construction data, location map, field data from last sampling event.

N. Well keys.

O. Site specific Sample and Analysis Plan/Quality Assurance Project Plan.

P. PID or FID instrument (if appropriate) to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

III.PRELIMINARY SITE ACTIVITIES

Check well for security damage or evidence of tampering, record pertinent observations.

Lay out sheet of clean polyethylene for monitoring and sampling equipment.

Remove well cap and immediately measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the field logbook.

If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook.

A synoptic water level measurement round should be performed (in the shortest possible time) before any purging and sampling activities begin. It is recommended that water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) be measured the day before, in order to allow for re-settlement of any particulates in the water column. If measurement of total well depth is not made the day before, it should not be measured until after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe are usually not needed unless analytical data or field head space information signal a worsening situation. Note: procedures for collection of LNAPL and DNAPL samples are not addressed in this SOP.

IV.PURGING AND SAMPLING PROCEDURE

Sampling wells in order of increasing chemical concentrations (known or anticipated) is preferred.

1. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the midpoint of the zone to be sampled. The Sampling and Analysis Plan should specify the sampling depth, or provide criteria for selection of intake depth for each well (see Section I). If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well. Collection of turbid free water samples may be especially difficult if there is two feet or less of standing water in the well.

2. Measure Water Level

Before starting pump, measure water level. If recording pressure transducer is used-initialize starting condition.

3. Purge Well

3a. Initial Low Stress Sampling Event

Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Check water level. Adjust pump speed until there is little or no water level drawdown (less than 0.3 feet). If the minimal drawdown that can be achieved exceeds 0.3 feet but remains stable, continue purging until indicator field parameters stabilize.

Monitor and record water level and pumping rate every three to five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump (for example, 0.1 - 0.4 l/min) to ensure stabilization of indicator parameters. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. Do not allow the water level to fall to the intake level (if the static water level is above the well screen, avoid lowering the water level into the screen). The final purge volume must be greater than the stabilized drawdown volume plus the extraction tubing volume.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (bladder, peristaltic), and/or the use of dedicated equipment. If the recharge rate of the well is lower than extraction rate capabilities of currently manufactured pumps and the well is essentially dewatered during purging, then the well should be sampled as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all anticipated samples (ideally the intake should not be moved during this recovery period). Samples may then be collected even though the indicator field parameters have not stabilized.

3b. Subsequent Low Stress Sampling Events

After synoptic water level measurement round, check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). Perform purging operations as above.

4. Monitor Indicator Field Parameters

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, Eh, DO) every three to five minutes (or less frequently, if appropriate). Note: during the early phase of purging emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken at three (3) to five (5) minute intervals, are within the following limits:

turbidity (10% for values greater than 1 NTU),
DO (10%),
specific conductance (3%),
temperature (3%),
pH (± 0.1 unit),
ORP/Eh (± 10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell and may also cause an underestimation of turbidity values measured after the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities.

The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must be submerged in water at all times. If two flow-through-cells are used in series, the one containing the dissolved oxygen probe should come first (this parameter is most susceptible to error if air leaks into the system).

5. Collect Water Samples

Water samples for laboratory analyses must be collected before water has passed through the flow-through-cell (use a by-pass assembly or disconnect cell to obtain sample).

VOC samples should be collected first and directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

During purging and sampling, the tubing should remain filled with water so as to minimize possible changes in water chemistry upon contact with the atmosphere. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use one of the following procedures to collect samples: (1) add clamp, connector (Teflon or stainless steel) or valve to constrict sampling end of tubing; (2) insert small diameter Teflon tubing into water filled portion of pump tubing allowing the end to protrude beyond the end of the pump tubing, collect sample from small diameter tubing; (3) collect non-VOC samples first, then increase flow rate slightly until the water completely fills the tubing, collect sample and record new drawdown, flow rate and new indicator field parameter values.

Add preservative, as required by analytical methods, to samples immediately after they are collected if the sample containers are not pre-preserved. Check analytical methods (e.g. EPA SW-846, water supply, etc.) for additional information on preservation. Check pH for all samples requiring pH adjustment to assure proper pH value. For VOC samples, this will require that a test sample be collected during purging to determine the amount of preservative that needs to be added to the sample containers prior to sampling.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter is required, and the filter size (0.45 um is commonly used) should be based on the sampling objective. Pre-rinse the filter with approximately 25 - 50 ml of ground water prior to sample collection. Preserve filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in ground water for human health risk calculations.

Label each sample as collected. Samples requiring cooling (volatile organics, cyanide, etc.) will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

6. Post Sampling Activities

If recording pressure transducer is used, remeasure water level with tape.

After collection of the samples, the pump tubing may either be dedicated to the well for resampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth is optional after the initial low stress sampling event. However, it is recommended if the well has a “silting” problem or if confirmation of well identity is needed.

Secure the well.

V.DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well and following sampling of each subsequent well. Pumps will not be removed between purging and sampling operations. The pump and tubing (including support cable and electrical wires which are in contact with the well) will be decontaminated by one of the procedures listed below.

Procedure 1

The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump or the pump can be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and isopropyl alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Flush with isopropyl alcohol (pesticide grade). If equipment blank data from the previous sampling event show that the level of contaminants is insignificant, then this step may be skipped.

Flush with distilled/deionized water. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

VI.FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the ground water samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples shall be collected for each batch of samples (a batch may not exceed 20 samples). Trip blanks are required for the VOC samples at a frequency of one set per VOC sample cooler.

Field duplicate.

Matrix spike.

Matrix spike duplicate.

Equipment blank.

Trip blank (VOCs).

Temperature blank (one per sample cooler).

Equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank will only include the pump in subsequent sampling rounds.

Collect samples in order from wells with lowest contaminant concentration to highest concentration. Collect equipment blanks after sampling from contaminated wells and not after background wells.

Field duplicates are collected to determine precision of sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

If split samples are to be collected, collect split for each analyte group in consecutive order (VOC original, VOC split, etc.). Split sample should be as identical as possible to original sample.

All monitoring instrumentation shall be operated in accordance with EPA analytical methods and manufacturer's operating instructions. EPA analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846 with exception of Eh, for which the manufacturer's instructions are to be followed. Instruments shall be calibrated at the beginning of each day. If a measurement falls outside the calibration range, the instrument should be re-calibrated so that all measurements fall within the calibration range. At the end of each day, check calibration to verify that instruments remained in calibration. Temperature measuring equipment, thermometers and thermistors, need not be calibrated to the above frequency. They should be checked for accuracy prior to field use according to EPA Methods and the manufacturer's instructions.

VII.FIELD LOGBOOK

A field log shall be kept to document all ground water field monitoring activities (see attached example matrix), and record all of the following:

Well identification.

Well depth, and measurement technique.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, and clock time, at the appropriate time intervals; calculated or measured total volume pumped.

Well sampling sequence and time of each sample collection.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analysis.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling equipment used, including trade names, model number, diameters, material composition, etc.

VIII. DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, and whatever field logbook information is needed to allow for a full evaluation of data useability.

EXAMPLE (Minimum Requirements) Page____of____

Well PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name)________________________ Depth to _______/________ of screen
Well Number________________Date______________________ (below MP) top bottom
Field Personnel______________________________________ Pump Intake at (ft. below MP)______________
Sampling Organization________________________________ Purging Device; (pump type)________________
Identify MP____

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. °C	Spec. Cond.[2] µS/cm	pH	ORP/ Eh[3] mv	DO mg/L	Turb- idity NTU	Comments

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. µSiemens per cm(same as µmhos/cm)at 25 °C.
3. Oxidation reduction potential (stand in for Eh).

Tighe&Bond

APPENDIX G

Site Inspection Form

Former N.L. Industries
3241 Walden Avenue
Depew, NY

Page 1 of 5

Name of Inspector:
Date of Inspection:

The purpose of this inspection is to monitor the overall integrity of the containment cell, the site wide paving and the building foundation. Please take photographs from all four sides of the containment cell cap, as well as the asphalt pavement and building foundation to document the existing conditions of the consolidated soil area, erosion control technologies in place, and the immediate surrounding area each week. Please fill out the following inspection items. If at any time impacted fill material has been exposed, please notify the Project Manager listed in the SMP immediately.

Monitoring Well Network

Condition of Monitoring Wells

	Good	Fair	Needs Repair	Details
MW-101	☐	☐	☐	
MW-102	☐	☐	☐	
MW-103	☐	☐	☐	
MW-104	☐	☐	☐	
MW-105	☐	☐	☐	
MW-106	☐	☐	☐	
MW-99-01	☐	☐	☐	

Asphalt Only Cover System

Are there any obvious areas of damage to the asphalt in the trucking yard?

YES ☐ NO ☐ If yes, please describe

Site Inspection Form

Former N.L. Industries
3241 Walden Avenue
Depew, NY

Page 2 of 5

Asphalt Only Cover System

Are there any obvious areas of damage to the asphalt in the parking lot?

YES ☐ NO ☐ If yes, please describe ______________________________

Are there any obvious areas of damage to the asphalt in the former rail siding area?

YES ☐ NO ☐ If yes, please describe ______________________________

Building and Apron Concrete Cover System

Are there any obvious areas of damage to the building's foundations?

YES ☐ NO ☐ If yes, please describe ______________________________

Are there any obvious areas of damage to any concrete pads?

YES ☐ NO ☐ If yes, please describe ______________________________

GCL and Soil Cover System

Are there any signs of soil run-off or erosion on the sides of the containment cell?

YES ☐ NO ☐ If yes, please describe ______________________________

Site Inspection Form

Former N.L. Industries
3241 Walden Avenue
Depew, NY

Page 3 of 5

GCL and Soil Cover System

Are there any areas of exposed GCL?

YES ☐ NO ☐ If yes, please describe ____________________

Has the grass appeared to have been mowed at a regular basis during the previous growing season?

YES ☐ NO ☐ If yes, please describe ____________________

Are there any woody types plants growing within the this Cover System?

YES ☐ NO ☐ If yes, please describe ____________________

GCL and Asphalt Cover System

Are there any obvious areas of damage to the asphalt within this cover system?

YES ☐ NO ☐ If yes, please describe ____________________

Are there any obvious signs of cracking within this cover system?

YES ☐ NO ☐ If yes, please describe ____________________

Site Inspection Form

Former N.L. Industries
3241 Walden Avenue
Depew, NY

Page 4 of 5

Pond

Is there standing water in the retention pond?

YES ☐ NO ☐ If yes, approximately how much? ____________________

Is there any debris within the retention pond?

YES ☐ NO ☐ If yes, please describe ____________________

Is the inlet and outlet of the retention pond free of debris?

YES ☐ NO ☐ If no, please describe ____________________

Is there any sign of erosion along the banks of the retention pond?

YES ☐ NO ☐ If yes, please describe ____________________

Vegetatives

Is there any sign of distress, disease or die off of the vegetatives associated with the cover systems?

YES ☐ NO ☐ If yes, please describe ____________________

Site Inspection Form

Former N.L. Industries
3241 Walden Avenue
Depew, NY

Page 5 of 5

Fencing

Is there signs of damage to the fencing around the retention pond or within the area of the environmental easement?

YES ☐ NO ☐ If yes, describe location and extent of damage

____

____

Is there signs of frost heaving within the supports of the fencing?

YES ☐ NO ☐ If yes, please describe ____________________

____

____

Is the chain link still attached to support poles at all locations around the retention pond or within the area of the environmental easement?

YES ☐ NO ☐ If no, please describe ____________________

____

____

Is there any sign of erosion along the banks of the retention pond?

YES ☐ NO ☐ If yes, please describe ____________________

____

____

Please describe any changes to the overall area since the last inspection

____

____

____

____

____

____

____

LEGEND

- ▣ DROP INLET
- ◉ BOLLARD
- UTILITY POLE
- —OHW— OVERHEAD WIRE
- WV WATER VALVE
- Ⓜ MANHOLE (UNKNOWN TYPE)
- Ⓢ SANITARY MANHOLE

VERTICAL DATUM :

ELEVATIONS SHOWN ON THIS DRAWING ARE BASED UPON THE NORTH AMERICAN VERTICAL DATUM OF 1988

HORIZONTAL DATUM :

THIS DRAWING IS BASED ON AN ASSUMED COORDINATE SYSTEM AND ASSUMED NORTH ROTATION

N/F LANDS OF NEW YORK CENTRAL AND HUDSON RIVER RAILROAD COMPANY
LIBER 301 PAGE 202

ZONING

ZONED M-1 (LIGHT INDUSTRIAL)

MINIMUM LOT AREA:	15,000 SQ.FT.
MINIMUM LOT WIDTH:	100 FEET
MINIMUM LOT DEPTH:	150 FEET
MINIMUM FRONT YARD:	30 FEET
MINIMUM SIDE YARD:	15 FEET / 30 FEET TOTAL
MINIMUM SIDE YARD:	50 FEET (ADJACENT TO ANY R-1 OR R-2 DISTRICT)
MINIMUM REAR YARD:	25 FEET
MAXIMUM HEIGHT OF BUILDINGS:	30 FEET / 2 STORIES
MAXIMUM LOT COVERAGE:	40%

POTENTIAL ENCROACHMENTS

Ⓐ FENCE, PAVED PARKING AND CONCRETE WALL ARE ONTO EASTERLY ADJOINER.

Ⓑ FENCE ALONG SOUTHERLY PROPERTY LINE IS UP TO 2.5' ONTO SOUTHERLY ADJOINER.

Ⓒ BLACKTOP IS 2.2' EAST ONTO PROPERTY.

Ⓓ FENCE ALONG WESTERLY PROPERTY LINE IS UP TO 0.4' ONTO WESTERLY ADJOINER.

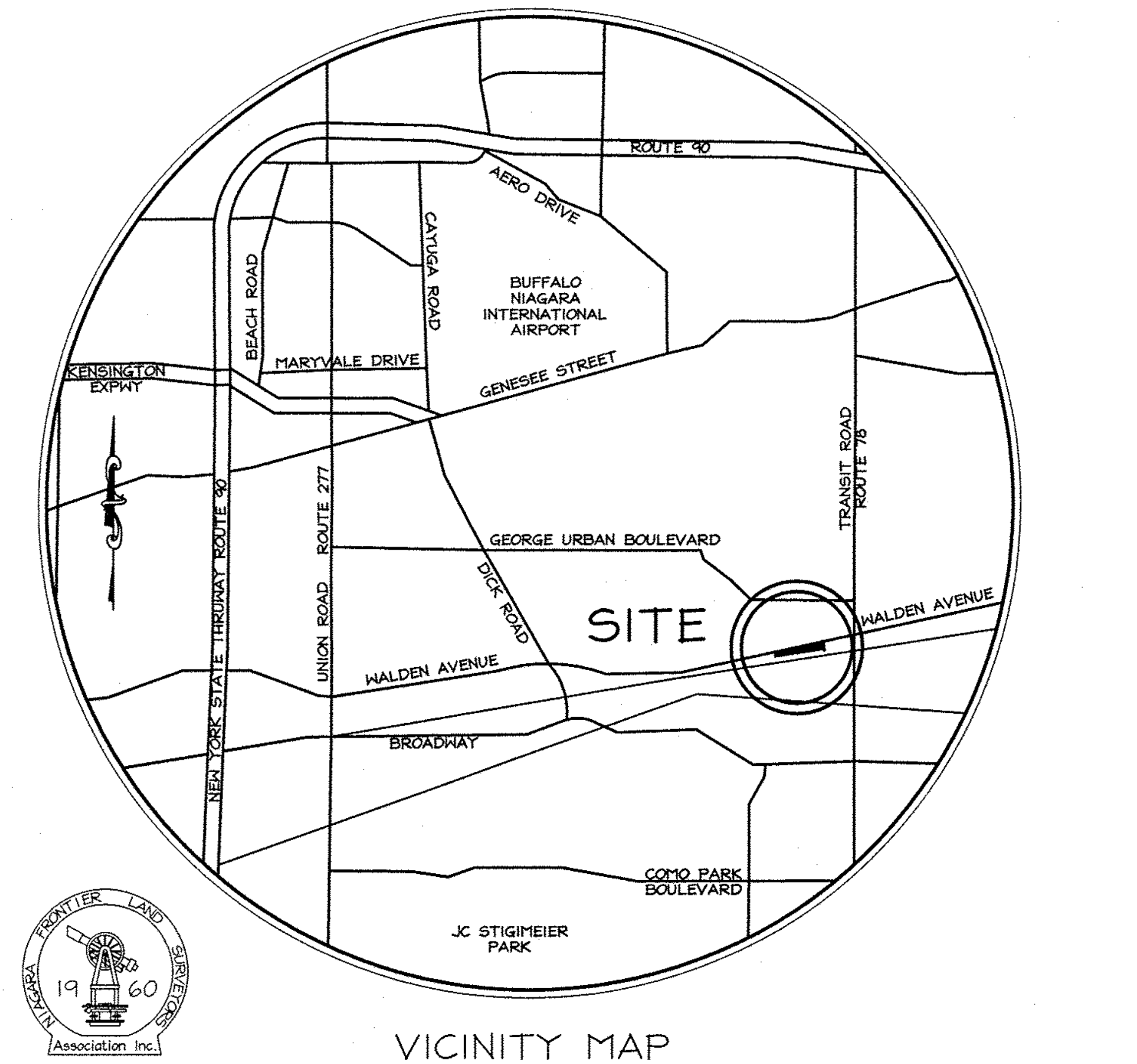
Ⓔ STONE AREA ALONG WESTERLY PROPERTY LINE IS 0.2' TO 0.4' ONTO WESTERLY ADJOINER.

Ⓕ FENCE ALONG NORTHERLY PROPERTY LINE IS UP TO 1.0' INTO WALDEN AVENUE RIGHT OF WAY.

Ⓖ BUILDING IS 0.10' TO 2.29' NORTHERLY INTO WALDEN AVENUE RIGHT OF WAY.

Ⓗ BUILDINGS ARE WITHIN THE 30' FRONT SETBACK.

Ⓙ BUILDING IS WITHIN THE 25' REAR YARD SETBACK.



VICINITY MAP

(NOT TO SCALE)

NOTES

1) THERE ARE NO CHANGES IN STREET RIGHT-OF-WAY LINES EITHER COMPLETED OR PROPOSED TO THE BEST OF OUR KNOWLEDGE, AND AVAILABLE FROM THE CONTROLLING JURISDICTION.

2) THERE IS NO OBSERVABLE EVIDENCE OF RECENT STREET OR SIDEWALK CONSTRUCTION OR REPAIRS.

3) THERE WAS OBSERVABLE EVIDENCE OF EARTH MOVING WORK. CURRENTLY THERE IS NO OBSERVABLE EVIDENCE OF BUILDING CONSTRUCTION OR BUILDING ADDITIONS AT THE SITE.

4) THERE IS NO OBSERVABLE EVIDENCE OF SITE USE AS A CEMETERY.

5) THERE IS NO VISIBLE ABOVE GRADE EVIDENCE OF SITE USE AS A SOLID WASTE DUMP, SUMP OR SANITARY LANDFILL.

5) THERE ARE NO STRIPED PARKING SPACES.

SCHEDULE 'B' SECTION '2'

TICOR TITLE INSURANCE COMPANY, ORDER NO.: 5008-25273
EFFECTIVE DATE: DECEMBER 30, 2008

⑥ RIGHT OF WAY TO CONSTRUCT AND MAINTAIN A POLE LINE ETC. TO THE DEPEW-LANCASTER LIGHT, POWER AND CONDUIT COMPANY RECORDED IN LIBER 1924 OF DEEDS, PAGE 468. RIGHT OF WAY IS FOR UTILITY POLES, GUY WIRES AND OVERHEAD WIRES ALONG WALDEN AVENUE AND RUNNING FROM WALDEN AVENUE TO THE NEW YORK CENTRAL RAILROAD COMPANY. UTILITY POLES, GUY WIRES AND OVERHEAD WIRES ARE PLOTTED HEREON.

⑦ RIGHT OF WAY TO NATIONAL FUEL GAS DISTRIBUTION CORPORATION RECORDED IN LIBER 10852 OF DEEDS, PAGE 800 ON JANUARY 28, 1994 AS PARTIALLY RELEASED BY PARTIAL RELEASE OF RIGHT OF WAY RECORDED IN LIBER 11145 OF DEEDS AT PAGE 7944 ON JUNE 4, 2008. IS PLOTTED HEREON. THE PORTION OF THE RIGHT OF WAY RELEASED IN LIBER 11145 PAGE 7944 IS THE PORTION OF THE EASEMENT WITHIN THE ENVIRONMENTAL EASEMENT AREA AND IS PLOTTED HEREON.

NOTE: SUBORDINATION AGREEMENT FOR THE ABOVE SCHEDULE 'B' SECTION '2' ITEMS WAS NOT PROVIDED TO NUSSBAUMER & CLARKE, INC. AT THE TIME OF THE SURVEY.

SCHEDULE 'A' - DEED DESCRIPTION

TICOR TITLE INSURANCE COMPANY, ORDER NO.: 5008-25273
EFFECTIVE DATE: DECEMBER 30, 2008

ALL THAT CERTAIN PLOT, PIECE OR PARCEL OF LAND, WITH THE BUILDINGS AND IMPROVEMENTS THEREON ERECTED, SITUATE, LYING AND BEING IN THE TOWN OF CHEEKTOWAGA, VILLAGE OF DEPEW, COUNTY OF ERIE AND STATE OF NEW YORK, BEING PART OF LOT 68, TOWNSHIP 11, RANGE 7 OF THE HOLLAND LAND COMPANY'S SURVEY, BOUNDED AND DESCRIBED AS FOLLOWS:

BEGINNING AT A STONE MONUMENT IN THE SOUTHERLY LINE OF THE ELLICOTT ROAD, NOW KNOWN AS WALDEN AVENUE AT A DISTANCE OF 584.42 FEET WESTERLY FROM THE POINT OF THE "TRANSIT LINE" OR THE CENTERLINE OF TRANSIT ROAD; RUNNING THENCE WESTERLY ALONG THE SAID SOUTHERLY LINE OF WALDEN AVENUE 1513.6 FEET TO THE NORTHWESTERLY CORNER OF LANDS CONVEYED TO CHARLES A. FINNEGAN BY GEORGE W. WICKERSHAM AND EDWARD J. HANCY, AS EXECUTORS OF THE LAST WILL AND TESTAMENT OF MARY A.P. DRAPER, DECEASED, DATED MAY 5, 1922 AND RECORDED IN ERIE COUNTY CLERK'S OFFICE IN LIBER 1634 OF DEEDS AT PAGE 96; THENCE SOUTHERLY AT RIGHT ANGLES TO THE SOUTHERLY LINE OF WALDEN AVENUE A DISTANCE OF 173.16 FEET TO THE NORTHERLY LINE OF LANDS CONVEYED TO THE NEW YORK CENTRAL AND HUDSON RIVER RAILROAD COMPANY BY DEED RECORDED IN ERIE COUNTY CLERK'S OFFICE IN LIBER 301 OF DEEDS AT PAGE 202; THENCE EASTERLY AND ALONG THE NORTH LINE OF LANDS SO CONVEYED TO AFORESAID RAILROAD BY AFORESAID DEED 1511.13 FEET; THENCE NORTHERLY IN A STRAIGHT LINE AT RIGHT ANGLES WITH THE PRECEDING COURSE 259.18 FEET TO THE POINT OF BEGINNING.

EASEMENT AREA DESCRIPTION

ALL THAT CERTAIN PLOT, PIECE OR PARCEL OF LAND, WITH THE BUILDINGS AND IMPROVEMENTS THEREON ERECTED, SITUATE, LYING AND BEING IN THE TOWN OF CHEEKTOWAGA, VILLAGE OF DEPEW, COUNTY OF ERIE AND STATE OF NEW YORK, BEING PART OF LOT 68, TOWNSHIP 11, RANGE 7 OF THE HOLLAND LAND COMPANY'S SURVEY, BOUNDED AND DESCRIBED AS FOLLOWS:

BEGINNING AT A STONE MONUMENT IN THE SOUTHERLY LINE OF THE ELLICOTT ROAD, NOW KNOWN AS WALDEN AVENUE AT A DISTANCE OF 584.42 FEET WESTERLY FROM THE POINT OF THE "TRANSIT LINE" OR THE CENTERLINE OF TRANSIT ROAD;

RUNNING THENCE WESTERLY ALONG THE SAID SOUTHERLY LINE OF WALDEN AVENUE 1104.67 FEET;

THENCE SOUTHERLY FORMING AN INTERIOR ANGLE OF 90°00'00" A DISTANCE OF 209.36 FEET TO THE NORTHERLY LINE OF LANDS CONVEYED TO THE NEW YORK CENTRAL AND HUDSON RIVER RAILROAD COMPANY BY DEED RECORDED IN ERIE COUNTY CLERK'S OFFICE IN LIBER 301 OF DEEDS AT PAGE 202;

THENCE EASTERLY AT AN INTERIOR ANGLE OF 93°14'32" AND ALONG THE NORTH LINE OF LANDS SO CONVEYED TO AFORESAID RAILROAD BY AFORESAID DEED 860.15 FEET;

THENCE NORTHERLY IN A STRAIGHT LINE AT RIGHT ANGLES WITH THE PRECEDING COURSE 258.42 FEET TO THE POINT OF BEGINNING, CONTAINING 4.65 ACRES OF LAND MORE OR LESS.

SURVEYOR'S DESCRIPTION

ALL THAT CERTAIN PLOT, PIECE OR PARCEL OF LAND, WITH THE BUILDINGS AND IMPROVEMENTS THEREON ERECTED, SITUATE, LYING AND BEING IN THE TOWN OF CHEEKTOWAGA, VILLAGE OF DEPEW, COUNTY OF ERIE AND STATE OF NEW YORK, BEING PART OF LOT 68, TOWNSHIP 11, RANGE 7 OF THE HOLLAND LAND COMPANY'S SURVEY, BOUNDED AND DESCRIBED AS FOLLOWS:

BEGINNING AT A STONE MONUMENT IN THE SOUTHERLY LINE OF THE ELLICOTT ROAD, NOW KNOWN AS WALDEN AVENUE AT A DISTANCE OF 584.42 FEET WESTERLY FROM THE POINT OF THE "TRANSIT LINE" OR THE CENTERLINE OF TRANSIT ROAD;

RUNNING THENCE WESTERLY ALONG THE SAID SOUTHERLY LINE OF WALDEN AVENUE 1513.60 FEET TO THE NORTHWESTERLY CORNER OF LANDS CONVEYED TO CHARLES A. FINNEGAN BY GEORGE W. WICKERSHAM AND EDWARD J. HANCY, AS EXECUTORS OF THE LAST WILL AND TESTAMENT OF MARY A.P. DRAPER, DECEASED, DATED MAY 5, 1922 AND RECORDED IN ERIE COUNTY CLERK'S OFFICE IN LIBER 1634 OF DEEDS AT PAGE 96;

THENCE SOUTHERLY FORMING AN INTERIOR ANGLE OF 93°14'32" A DISTANCE OF 172.81 FEET TO THE NORTHERLY LINE OF LANDS CONVEYED TO THE NEW YORK CENTRAL AND HUDSON RIVER RAILROAD COMPANY BY DEED RECORDED IN ERIE COUNTY CLERK'S OFFICE IN LIBER 301 OF DEEDS AT PAGE 202;

THENCE EASTERLY AT RIGHT ANGLES AND ALONG THE NORTH LINE OF LANDS SO CONVEYED TO AFORESAID RAILROAD BY AFORESAID DEED 1511.18 FEET;

THENCE NORTHERLY IN A STRAIGHT LINE AT RIGHT ANGLES WITH THE PRECEDING COURSE 258.42 FEET TO THE POINT OF BEGINNING, CONTAINING 7.48 ACRES OF LAND MORE OR LESS.

NOTE: THIS DESCRIPTION IS INTENDED TO DESCRIBE THE SAME PROPERTY AS CONVEYED IN LIBER 10926 PAGE 3284. ANGLES AND DISTANCES IN THIS DESCRIPTION DIFFER FROM THE SCHEDULE 'A' DESCRIPTION SHOWN HEREON BASED UPON BOUNDARY EVIDENCE AND CALCULATIONS IN ORDER TO CREATE A MATHEMATICAL CLOSURE.

UTILITY COMPANIES CONTACTED

TIME WARNER CABLE
(HAS RESPONDED; OVERHEAD WIRES ARE PLOTTED HEREON)

TOWN OF CHEEKTOWAGA ENGINEERING
(HAS NOT RESPONDED)

VILLAGE OF DEPEW ENGINEERING
(HAS RESPONDED; WATERLINE PLOTTED HEREON)
(SANITARY SEWER LINE IS LOCATED ALONG THE NORTHERLY SIDE OF WALDEN AVENUE, WITH THE EXCEPTION OF THE SANITARY MANHOLE AT THE NORTHWEST CORNER OF THE PROPERTY)

NEW YORK STATE ELECTRIC & GAS
(HAS RESPONDED; OVERHEAD WIRES ARE PLOTTED HEREON)

VERIZON
(HAS NOT RESPONDED)

ERIE COUNTY DEPARTMENT OF SEWERAGE MANAGEMENT
(HAS RESPONDED; DOES NOT COVER THIS PROPERTY)

ERIE COUNTY WATER AUTHORITY
(HAS NOT RESPONDED)

NOTE: ALL UNDERGROUND UTILITIES ARE APPROXIMATELY PLOTTED FROM RECORD DOCUMENTS. NO EXCAVATIONS WERE PERFORMED TO LOCATED UNDERGROUND UTILITIES.

CERTIFICATION

TO:

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

THIS IS TO CERTIFY THAT THIS MAP OR PLAT AND THE SURVEY ON WHICH IT IS BASED WERE MADE IN ACCORDANCE WITH THE "MINIMUM STANDARD DETAIL REQUIREMENTS FOR ALTA/ACSM LAND TITLE SURVEYS," JOINTLY ESTABLISHED AND ADOPTED BY ALTA AND NSPS IN 2005, AND INCLUDES ITEMS 1, 2, 3, 4, 5, 7(A), 7(B(1)), 7(B(2)), 7(C), 8, 9, 10, 11(A), 11(B), 13, 14, 16, 17, AND 18 OF TABLE A THEREOF. PURSUANT TO THE ACCURACY STANDARDS AS ADOPTED BY ALTA AND NSPS AND IN EFFECT ON THE DATE OF THIS CERTIFICATION, UNDERSIGNED FURTHER CERTIFIES THAT IN MY PROFESSIONAL OPINION, AS A LAND SURVEYOR REGISTERED IN THE STATE OF NEW YORK, THE RELATIVE POSITIONAL ACCURACY OF THIS SURVEY DOES NOT EXCEED THAT WHICH IS SPECIFIED THEREIN.

DATE:

MICHAEL J. BOROWIAK, PLS   NEW YORK STATE LICENSE NO. 050147

ENGINEERING CONTROLS LEGEND

⬡	COVER SYSTEM A - ASPHALT ONLY
⛆	COVER SYSTEM B - BUILDING & APRON CONCRETE
▒	COVER SYSTEM C - GEOSYNTHETIC CLAY LINER & SOIL
▨	COVER SYSTEM D - GEOSYNTHETIC CLAY LINER, SOIL, & ASPHALT

NOTE: CAP AREA IS COVER SYSTEM C AND COVER SYSTEM D

AREA OF ENGINEERING CONTROLS

ENGINEERING CONTROL A1 = 0.96± ACRES (42,021± SQ.FT.)
ENGINEERING CONTROL A2 = 0.25± ACRES (11,047± SQ.FT.)
ENGINEERING CONTROL B1 = 0.03± ACRES (1,196± SQ.FT.)
ENGINEERING CONTROL B2 = 0.02± ACRES (1,063± SQ.FT.)
ENGINEERING CONTROL B3 = 0.01± ACRES (228± SQ.FT.)
ENGINEERING CONTROL B4 = 1.77± ACRES (77,059± SQ.FT.)
ENGINEERING CONTROL C = 0.49± ACRES (21,181± SQ.FT)
ENGINEERING CONTROL D = 1.01± ACRES (44,175± SQ.FT.)

GRAPHIC SCALE

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

FLOOD NOTE

ZONE 'C' (AREAS OF MINIMAL FLOODING)

REFERENCE: F.I.R.M. (WWW.FEMA.GOV)
COMMUNITY PANEL NO: 360236 0003 B
EFFECTIVE DATE: AUGUST 3, 1981

NOTE: UNAUTHORIZED ALTERATIONS OR ADDITIONS TO ANY SURVEY, DRAWING, DESIGN, SPECIFICATION, PLAN, OR REPORT IS A VIOLATION OF SECTION 7209, PROVISION 2 OF THE NEW YORK STATE EDUCATION LAW.

ALTA/ACSM LAND TITLE SURVEY
OF
3241 WALDEN AVENUE

PART OF LOT(S) 68
TOWNSHIP 11   RANGE 7
VILLAGE OF DEPEW
TOWN OF CHEEKTOWAGA
COUNTY OF ERIE   STATE OF NEW YORK

Nussbaumer & Clarke, Inc.
Engineers and Surveyors
3556 Lake Shore Road
Buffalo, New York 14219-1494
(716) 827-8000
www.nussclarke.com

DRAWN BY: MKB	REV. 07/17/09	SHEET NO. 1 OF 2
DATE: 10/22/08	JOB NO. 07J2-0481A-4	
SCALE: 1"=50'	DWG. NO. SC-3517	

ENGINEERING CONTROL C		
LINE	LENGTH	BEARING
C-1	7.84	S11°54'51"E
C-2	36.16	S56°27'42"W
C-3	29.18	S55°27'07"W
C-4	17.72	S74°14'50"W
C-5	52.62	S79°54'39"W
C-6	57.62	S77°52'21"W
C-7	25.41	S78°29'49"W
C-8	23.03	S78°29'49"W
C-9	18.40	S77°39'26"W
C-10	10.28	S74°57'44"W
C-11	10.41	S10°06'55"E
C-12	45.54	S11°27'13"E
C-13	51.47	S11°49'20"E
C-14	46.76	S11°55'32"E
C-15	31.04	N81°11'13"E
C-16	46.08	N80°51'14"E
C-17	57.59	N80°08'11"E
C-18	59.51	N82°48'28"E
C-19	24.36	N76°54'00"E
C-20	18.82	S72°51'21"E
C-21	21.50	S72°12'18"E
C-22	10.71	S71°44'01"E
C-23	3.70	N81°54'46"E
C-24	3.93	S11°54'51"E
C-25	300.48	S81°19'41"W
C-26	209.36	N11°54'51"W
C-27	300.00	N78°05'09"E

ENGINEERING CONTROL 'C' DESCRIPTION

BEGINNING AT A STONE MONUMENT IN THE SOUTHERLY LINE OF THE ELLICOTT ROAD, NOW KNOWN AS WALDEN AVENUE AT A DISTANCE OF 1157.81 FEET WESTERLY FROM THE POINT OF THE "TRANSIT LINE" OR THE CENTERLINE OF TRANSIT ROAD

THENCE S 11°54'51" E A DISTANCE OF 7.84';
THENCE S 56°27'42" W A DISTANCE OF 36.16';
THENCE S 55°27'07" W A DISTANCE OF 29.18';
THENCE S 74°14'50" W A DISTANCE OF 17.72';
THENCE S 79°54'39" W A DISTANCE OF 52.62';
THENCE S 77°52'21" W A DISTANCE OF 57.62';
THENCE S 78°29'49" W A DISTANCE OF 25.41';
THENCE S 78°29'49" W A DISTANCE OF 23.03';
THENCE S 77°39'26" W A DISTANCE OF 18.40';
THENCE S 74°57'44" W A DISTANCE OF 10.28';
THENCE S 10°06'55" E A DISTANCE OF 10.41';
THENCE S 11°27'13" E A DISTANCE OF 45.54';
THENCE S 11°49'20" E A DISTANCE OF 51.47';
THENCE S 11°55'32" E A DISTANCE OF 46.76';
THENCE N 81°11'13" E A DISTANCE OF 31.04';
THENCE N 80°51'14" E A DISTANCE OF 46.08';
THENCE N 80°08'11" E A DISTANCE OF 57.59';
THENCE N 82°48'28" E A DISTANCE OF 59.51';
THENCE N 76°54'00" E A DISTANCE OF 24.36';
THENCE S 72°51'21" E A DISTANCE OF 18.82';
THENCE S 72°12'18" E A DISTANCE OF 21.50';
THENCE S 71°44'01" E A DISTANCE OF 10.71';
THENCE N 81°54'46" E A DISTANCE OF 3.70';
THENCE S 11°54'51" E A DISTANCE OF 3.93';
THENCE S 81°19'41" W A DISTANCE OF 300.48';
THENCE N 11°54'51" W A DISTANCE OF 209.36';
THENCE N 78°05'09" E A DISTANCE OF 300.00';

ENGINEERING CONTROL D		
LINE	LENGTH	BEARING
D-1	214.58	S11°54'51"E
D-2	3.70	S81°54'46"W
D-3	10.71	N71°44'01"W
D-4	21.50	N72°12'18"W
D-5	18.82	N72°51'21"W
D-6	24.36	S76°54'00"W
D-7	59.51	S82°48'28"W
D-8	57.59	S80°08'11"W
D-9	46.08	S80°51'14"W
D-10	31.04	S81°11'13"W
D-11	46.76	N11°55'32"W
D-12	51.47	N11°49'20"W
D-13	45.54	N11°27'13"W
D-14	10.41	N10°06'55"W
D-15	10.28	N74°57'44"E
D-16	18.40	N77°39'26"E
D-17	23.03	N78°29'49"E
D-18	25.41	N78°29'49"E
D-19	57.62	N77°52'21"E
D-20	52.62	N79°54'39"E
D-21	17.72	N74°14'50"E
D-22	29.18	N55°27'07"E
D-23	36.16	N56°28'02"E

ENGINEERING CONTROL 'D' DESCRIPTION

BEGINNING AT THE INTERSECTION OF COURSE C1 AND COURSE C2 AS SHOWN ON ENGINEERING CONTROL C HEREON;

THENCE S 11°54'51" E A DISTANCE OF 214.58';
THENCE S 81°54'46" W A DISTANCE OF 3.70';
THENCE N 71°44'01" W A DISTANCE OF 10.71';
THENCE N 72°12'18" W A DISTANCE OF 21.50';
THENCE N 72°51'21" W A DISTANCE OF 18.82';
THENCE S 76°54'00" W A DISTANCE OF 24.36';
THENCE S 82°48'28" W A DISTANCE OF 59.51';
THENCE S 80°08'11" W A DISTANCE OF 57.59';
THENCE S 80°51'14" W A DISTANCE OF 46.08';
THENCE S 81°11'13" W A DISTANCE OF 31.04';
THENCE N 11°55'32" W A DISTANCE OF 46.76';
THENCE N 11°49'20" W A DISTANCE OF 51.47';
THENCE N 11°27'13" W A DISTANCE OF 45.54';
THENCE N 10°06'55" W A DISTANCE OF 10.41';
THENCE N 74°57'44" E A DISTANCE OF 10.28';
THENCE N 77°39'26" E A DISTANCE OF 18.40';
THENCE N 78°29'49" E A DISTANCE OF 23.03';
THENCE N 78°29'49" E A DISTANCE OF 25.41';
THENCE N 77°52'21" E A DISTANCE OF 57.62';
THENCE N 79°54'39" E A DISTANCE OF 52.62';
THENCE N 74°14'50" E A DISTANCE OF 17.72';
THENCE N 55°27'07" E A DISTANCE OF 29.18';
THENCE N 56°28'02" E A DISTANCE OF 36.16' TO THE POINT OR PLACE OF BEGINNING;

ENGINEERING CONTROL A1		
LINE	LENGTH	BEARING
A1-1	11.31	N55°56'51"E
A1-2	26.28	N81°16'18"E
A1-3	2.84	N08°18'21"E
A1-4	1.23	N18°08'31"W
A1-5	1.22	N29°18'28"W
A1-6	75.39	N78°05'09"E
A1-7	5.60	S11°57'18"E
A1-8	35.72	N73°40'30"E
A1-9	2.86	N17°07'25"W
A1-10	30.14	N78°05'09"E
A1-11	1.92	S01°08'19"E
A1-12	52.62	N79°11'07"E
A1-13	6.63	N83°01'49"E
A1-14	5.40	S06°58'11"E
A1-15	44.50	S80°24'33"W
A1-16	11.90	S08°24'14"E
A1-17	44.20	N80°24'33"E
A1-18	7.08	S06°58'11"E
A1-19	43.93	S80°56'01"W
A1-20	11.90	S07°57'20"E
A1-21	43.73	N80°56'01"E
A1-22	43.51	S06°58'11"E
A1-23	3.78	S80°54'26"W
A1-24	7.70	N09°05'34"W
A1-25	11.42	S80°54'26"W
A1-26	4.61	N09°05'34"W
A1-27	6.55	S80°54'26"W
A1-28	4.61	S09°05'34"E
A1-29	13.47	S80°54'26"W
A1-30	7.43	S09°05'34"E
A1-31	6.16	S08°43'57"E
A1-32	19.20	S81°34'11"W
A1-33	27.75	S08°34'45"E
A1-34	63.64	S81°24'49"W
A1-35	23.89	S09°00'56"E
A1-36	82.79	N81°38'59"E
A1-37	48.84	S08°43'57"E
A1-38	60.13	S81°08'46"W
A1-39	31.82	S08°13'06"E
A1-40	60.04	N81°31'48"E
A1-41	0.88	N16°20'26"E
A1-42	223.09	N81°30'25"E
A1-43	16.07	S10°34'15"E
A1-44	221.48	S81°27'02"W
A1-45	188.90	S82°03'04"W
A1-46	214.58	N11°54'51"W

ENGINEERING CONTROL 'A1' DESCRIPTION

BEGINNING AT THE INTERSECTION OF COURSE C1 AND COURSE C2 AS SHOWN ON ENGINEERING CONTROL C HEREON;

THENCE N 55°56'51" E A DISTANCE OF 11.31';
THENCE N 81°16'18" E A DISTANCE OF 26.28';
THENCE N 08°18'21" E A DISTANCE OF 2.84';
THENCE N 18°08'31" W A DISTANCE OF 1.23';
THENCE N 29°18'28" W A DISTANCE OF 1.22';
THENCE N 78°05'09" E A DISTANCE OF 75.39';
THENCE S 11°57'18" E A DISTANCE OF 5.60';
THENCE N 73°40'30" E A DISTANCE OF 35.72';
THENCE N 17°07'25" W A DISTANCE OF 2.86';
THENCE N 78°05'09" E A DISTANCE OF 30.14';
THENCE S 01°08'19" E A DISTANCE OF 1.92';
THENCE N 79°11'07" E A DISTANCE OF 52.62';
THENCE N 83°01'49" E A DISTANCE OF 6.63';
THENCE S 06°58'11" E A DISTANCE OF 5.40';
THENCE S 80°24'33" W A DISTANCE OF 44.50';
THENCE S 08°24'14" E A DISTANCE OF 11.90';
THENCE N 80°24'33" E A DISTANCE OF 44.20';
THENCE S 06°58'11" E A DISTANCE OF 7.08';
THENCE S 80°56'01" W A DISTANCE OF 43.93';
THENCE S 07°57'20" E A DISTANCE OF 11.90';
THENCE N 80°56'01" E A DISTANCE OF 43.73';
THENCE S 06°58'11" E A DISTANCE OF 43.51';
THENCE S 80°54'26" W A DISTANCE OF 3.78';
THENCE N 09°05'34" W A DISTANCE OF 7.70';
THENCE S 80°54'26" W A DISTANCE OF 11.42';
THENCE N 09°05'34" W A DISTANCE OF 4.61';
THENCE S 80°54'26" W A DISTANCE OF 6.55';
THENCE S 09°05'34" E A DISTANCE OF 4.61';
THENCE S 80°54'26" W A DISTANCE OF 13.47';
THENCE S 09°05'34" E A DISTANCE OF 7.43';
THENCE S 08°43'57" E A DISTANCE OF 6.16';
THENCE S 81°34'11" W A DISTANCE OF 19.20';
THENCE S 08°34'45" E A DISTANCE OF 27.75';
THENCE S 81°24'49" W A DISTANCE OF 63.64';
THENCE S 09°00'56" E A DISTANCE OF 23.89';
THENCE N 81°38'59" E A DISTANCE OF 82.79';
THENCE S 08°43'57" E A DISTANCE OF 48.84';
THENCE S 81°08'46" W A DISTANCE OF 60.13';
THENCE S 08°13'06" E A DISTANCE OF 31.82';
THENCE N 81°31'48" E A DISTANCE OF 60.04';
THENCE N 16°20'26" E A DISTANCE OF 0.88';
THENCE N 81°30'25" E A DISTANCE OF 223.09';
THENCE S 10°34'15" E A DISTANCE OF 16.07';
THENCE S 81°27'02" W A DISTANCE OF 221.48';
THENCE S 82°03'04" W A DISTANCE OF 188.90';
THENCE N 11°54'51" W A DISTANCE OF 214.58';
TO THE POINT OR PLACE OF BEGINNING;

EXCEPTING HERE FROM ENGINEERING CONTROL 'B1', ENGINEERING CONTROL 'B2' AND ENGINEERING CONTROL 'B3' AS DESCRIBED HEREON.

ENGINEERING CONTROL B1		
LINE	LENGTH	BEARING
B1-1	12.98	N79°16'06"E
B1-2	92.42	S10°31'38"E
B1-3	12.89	S79°10'57"W
B1-4	92.44	N10°34'39"W

ENGINEERING CONTROL B2		
LINE	LENGTH	BEARING
B2-1	30.48	S10°26'14"E
B2-2	34.90	S79°16'32"W
B2-3	30.46	N10°27'04"W
B2-4	34.91	N79°14'15"E

ENGINEERING CONTROL B3		
LINE	LENGTH	BEARING
B3-1	28.12	S09°33'11"E
B3-2	8.12	S81°14'39"W
B3-3	28.14	N09°32'27"W
B3-4	8.11	N81°25'17"E

ENGINEERING CONTROL 'B1' DESCRIPTION

COMMENCING AT THE INTERSECTION OF COURSE A1-1 AND A1-46 AS SHOWN ON ENGINEERING CONTROL A1 HEREON;

THENCE S 81°14'14" E A DISTANCE OF 54.72' TO THE POINT OF BEGINNING;

THENCE N 79°16'06" E A DISTANCE OF 12.98';
THENCE S 10°31'38" E A DISTANCE OF 92.42';
THENCE S 79°10'57" W A DISTANCE OF 12.89';
THENCE N 10°34'39" W A DISTANCE OF 92.44' TO THE POINT OR PLACE OF BEGINNING;

ENGINEERING CONTROL 'B2' DESCRIPTION

COMMENCING AT THE INTERSECTION OF COURSE A1-6 AND COURSE A1-7 AS SHOWN ON ENGINEERING CONTROL A1 HEREON;

THENCE S 58°41'40" W A DISTANCE OF 10.41' TO THE POINT OF BEGINNING;

THENCE S 10°26'14" E A DISTANCE OF 30.48';
THENCE S 79°16'32" W A DISTANCE OF 34.90';
THENCE N 10°27'04" W A DISTANCE OF 30.46';
THENCE N 79°14'15" E A DISTANCE OF 34.91' TO THE POINT OR PLACE OF BEGINNING;

ENGINEERING CONTROL 'B3' DESCRIPTION

COMMENCING AT THE INTERSECTION OF CURSE B2-1 AND B2-2 AS SHOWN ON ENGINEERING CONGROL B2 HEREON;

THENCE S 11°27'00" W A DISTANCE OF 49.49' TO THE POINT OF BEGINNING;

THENCE S 09°33'11" E A DISTANCE OF 28.12';
THENCE S 81°14'39" W A DISTANCE OF 8.12';
THENCE N 09°32'27" W A DISTANCE OF 28.14';
THENCE N 81°25'17" E A DISTANCE OF 8.11' TO THE POINT OR PLACE OF BEGINNING;

ENGINEERING CONTROL B4		
LINE	LENGTH	BEARING
B4-1	31.82	N08°13'06"W
B4-2	60.13	N81°08'46"E
B4-3	48.84	N08°43'57"W
B4-4	82.79	S81°38'59"W
B4-5	23.89	N09°00'56"W
B4-6	63.64	N81°24'49"E
B4-7	27.75	N08°34'45"W
B4-8	19.20	N81°34'11"E
B4-9	13.59	N08°55'46"W
B4-10	13.47	N80°54'26"E
B4-11	4.61	N09°05'34"W
B4-12	6.55	N80°54'26"E
B4-13	4.61	S09°05'34"E
B4-14	11.42	N80°54'26"E
B4-15	7.70	S09°05'34"E
B4-16	3.78	N80°54'26"E
B4-17	43.51	N06°58'11"W
B4-18	43.73	S80°56'01"W
B4-19	11.90	N07°57'20"W
B4-20	43.93	N80°56'01"E
B4-21	7.08	N06°58'11"W
B4-22	44.20	S80°24'33"W
B4-23	11.90	N08°24'14"W
B4-24	44.50	N80°24'33"E
B4-25	8.98	N06°58'11"W
B4-26	76.05	N78°20'31"E
B4-27	55.28	N81°16'47"E
B4-28	3.33	N08°43'13"W
B4-29	41.19	N78°05'09"E
B4-30	7.30	N81°16'47"E
B4-31	0.41	N08°27'00"W
B4-32	13.00	N78°05'09"E
B4-33	52.57	N81°16'17"E
B4-34	32.75	S08°04'31"E
B4-35	4.20	N81°33'00"E
B4-36	0.46	N08°27'00"W
B4-37	46.30	N81°33'00"E
B4-38	201.10	S08°27'00"E
B4-39	332.14	S81°30'27"W
B4-40	0.88	S16°16'33"W
B4-41	60.04	S81°31'48"W

ENGINEERING CONTROL 'B4' DESCRIPTION

BEGINNING AT THE INTERSECTION OF COURSE A1-39 AND COURSE A1-40 AS SHOWN ON ENGINEERING CONTROL A1 HEREON;

THENCE N 08°13'06" W A DISTANCE OF 31.82';
THENCE N 81°08'46" E A DISTANCE OF 60.13';
THENCE N 08°43'57" W A DISTANCE OF 48.84';
THENCE S 81°38'59" W A DISTANCE OF 82.79';
THENCE N 09°00'56" W A DISTANCE OF 23.89';
THENCE N 81°24'49" E A DISTANCE OF 63.64';
THENCE N 08°34'45" W A DISTANCE OF 27.75';
THENCE N 81°34'11" E A DISTANCE OF 19.20';
THENCE N 08°55'46" W A DISTANCE OF 13.59';
THENCE N 80°54'26" E A DISTANCE OF 13.47';
THENCE N 09°05'34" W A DISTANCE OF 4.61';
THENCE N 80°54'26" E A DISTANCE OF 6.55';
THENCE S 09°05'34" E A DISTANCE OF 4.61';
THENCE N 80°54'26" E A DISTANCE OF 11.42';
THENCE S 09°05'34" E A DISTANCE OF 7.70';
THENCE S 80°54'26" E A DISTANCE OF 3.78';
THENCE N 06°58'11" W A DISTANCE OF 43.51';
THENCE S 80°56'01" W A DISTANCE OF 43.73';
THENCE N 07°57'20" W A DISTANCE OF 11.90';
THENCE N 80°56'01" E A DISTANCE OF 43.93';
THENCE N 06°58'11" W A DISTANCE OF 7.08';
THENCE S 80°24'33" W A DISTANCE OF 44.20';
THENCE N 08°24'14" W A DISTANCE OF 11.90';
THENCE N 80°24'33" E A DISTANCE OF 44.50';
THENCE N 06°58'11" W A DISTANCE OF 8.98';
THENCE N 78°20'31" E A DISTANCE OF 76.05';
THENCE N 81°16'47" E A DISTANCE OF 55.28';
THENCE N 08°43'13" W A DISTANCE OF 3.33';
THENCE N 78°05'09" E A DISTANCE OF 41.19';
THENCE N 81°16'47" E A DISTANCE OF 7.30';
THENCE N 08°27'00" W A DISTANCE OF 0.41';
THENCE N 78°05'09" E A DISTANCE OF 13.00';
THENCE N 81°16'17" E A DISTANCE OF 52.57';
THENCE S 08°04'31" E A DISTANCE OF 32.75';
THENCE N 81°33'00" E A DISTANCE OF 4.20';
THENCE N 08°27'00" W A DISTANCE OF 0.46';
THENCE N 81°33'00" E A DISTANCE OF 46.30';
THENCE S 08°27'00" E A DISTANCE OF 201.10';
THENCE S 81°30'27" W A DISTANCE OF 332.14';
THENCE S 16°16'33" W A DISTANCE OF 0.88';
THENCE S 81°31'48" W A DISTANCE OF 60.04' TO THE POINT OR PLACE OF BEGINNING;

ENGINEERING CONTROL A2		
LINE	LENGTH	BEARING
A2-1	230.13	S08°40'19"E
A2-2	35.65	S82°04'38"W
A2-3	5.38	S81°33'00"W
A2-4	200.49	N08°27'00"W
A2-5	46.30	S81°33'00"W
A2-6	0.46	S08°27'00"E
A2-7	4.20	S81°33'00"W
A2-8	31.25	N08°04'31"W
A2-9	54.11	N81°28'19"E
A2-10	7.76	N00°49'50"W
A2-11	14.98	N78°05'09"E
A2-12	9.27	S04°17'42"E
A2-13	21.03	N84°00'13"E

ENGINEERING CONTROL 'A2' DESCRIPTION

BEGINNING AT THE INTERSECTION OF COURSE B4-34 AND COURSE B4-35 AS SHOWN ON ENGINEERING CONTROL B4 HEREON;

THENCE S 08°40'19" E A DISTANCE OF 230.13';
THENCE S 82°04'38" W A DISTANCE OF 35.65';
THENCE S 81°33'00" W A DISTANCE OF 5.38';
THENCE N 08°27'00" W A DISTANCE OF 200.49';
THENCE S 81°33'00" W A DISTANCE OF 46.30';
THENCE S 08°27'00" E A DISTANCE OF 0.46';
THENCE S 81°33'00" W A DISTANCE OF 4.20';
THENCE N 08°04'31" W A DISTANCE OF 31.25';
THENCE N 81°28'19" E A DISTANCE OF 54.11';
THENCE N 00°49'50" W A DISTANCE OF 7.76';
THENCE N 78°05'09" E A DISTANCE OF 14.98';
THENCE S 04°17'42" E A DISTANCE OF 9.27';
THENCE N 84°00'13" E A DISTANCE OF 21.03' TO THE POINT OR PLACE OF BEGINNING;

AREA OF ENGINEERING CONTROLS

ENGINEERING CONTROL A1 = 0.96± ACRES (42,021± SQ.FT.)
ENGINEERING CONTROL A2 = 0.25± ACRES (11,047± SQ.FT.)
ENGINEERING CONTROL B1 = 0.03± ACRES (1,196± SQ.FT.)
ENGINEERING CONTROL B2 = 0.02± ACRES (1,063± SQ.FT.)
ENGINEERING CONTROL B3 = 0.01± ACRES (228± SQ.FT.)
ENGINEERING CONTROL B4 = 1.77± ACRES (77,059± SQ.FT.)
ENGINEERING CONTROL C = 0.49± ACRES (21,181± SQ.FT)
ENGINEERING CONTROL D = 1.01± ACRES (44,175± SQ.FT.)

EASEMENT AREA DESCRIPTION

ALL THAT CERTAIN PLOT, PIECE OR PARCEL OF LAND, WITH THE BUILDINGS AND IMPROVEMENTS THEREON ERECTED, SITUATE, LYING AND BEING IN THE TOWN OF CHEEKTOWAGA, VILLAGE OF DEPEW, COUNTY OF ERIE AND STATE OF NEW YORK, BEING PART OF LOT 68, TOWNSHIP 11, RANGE 7 OF THE HOLLAND LAND COMPANY'S SURVEY, BOUNDED AND DESCRIBED AS FOLLOWS:

BEGINNING AT A STONE MONUMENT IN THE SOUTHERLY LINE OF THE ELLICOTT ROAD, NOW KNOWN AS WALDEN AVENUE AT A DISTANCE OF 584.42 FEET WESTERLY FROM THE POINT OF THE "TRANSIT LINE" OR THE CENTERLINE OF TRANSIT ROAD;

RUNNING THENCE WESTERLY ALONG THE SAID SOUTHERLY LINE OF WALDEN AVENUE 1104.67 FEET;

THENCE SOUTHERLY FORMING AN INTERIOR ANGLE OF 90°00'00" A DISTANCE OF 209.36 FEET TO THE NORTHERLY LINE OF LANDS CONVEYED TO THE NEW YORK CENTRAL AND HUDSON RIVER RAILROAD COMPANY BY DEED RECORDED IN ERIE COUNTY CLERK'S OFFICE IN LIBER 301 OF DEEDS AT PAGE 202;

THENCE EASTERLY AT AN INTERIOR ANGLE OF 93°14'32" AND ALONG THE NORTH LINE OF LANDS SO CONVEYED TO AFORESAID RAILROAD BY AFORESAID DEED 860.15 FEET;

THENCE NORTHERLY IN A STRAIGHT LINE AT RIGHT ANGLES WITH THE PRECEDING COURSE 258.42 FEET TO THE POINT OF BEGINNING, CONTAINING 4.65 ACRES OF LAND MORE OR LESS.

NIAGARA FRONTIER LAND SURVEYORS Association Inc. 1960
MEMBER

GRAPHIC SCALE
50 0 25 50 100 200
(IN FEET)
1 inch = 50 ft.

NOTE: UNAUTHORIZED ALTERATIONS OR ADDITIONS TO ANY SURVEY, DRAWING, DESIGN, SPECIFICATION, PLAN, OR REPORT IS A VIOLATION OF SECTION 7209, PROVISION 2 OF THE NEW YORK STATE EDUCATION LAW.

ALTA/ACSM LAND TITLE SURVEY
OF
3241 WALDEN AVENUE

PART OF LOT(S) 68
TOWNSHIP 11 RANGE 7
VILLAGE OF DEPEW
TOWN OF CHEEKTOWAGA
COUNTY OF ERIE STATE OF NEW YORK

Nussbaumer & Clarke, Inc.
Engineers and Surveyors
3556 Lake Shore Road
Buffalo, New York 14219-1494
(716) 827-8000
www.nussclarke.com

DRAWN BY: MKB	REV. 07/17/09	SHEET NO. 2 OF 2
DATE: 10/22/08	JOB NO. 07J2-0481A-4	
SCALE: 1"=50'	DWG. NO. SC-3517	