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ASSEMBLY B SITE INVESTIGATION PLANS RESOURCE CONSERVATION AND
RECOVERY FACILITY INVESTIGATION MILLINGTON SUPPACT TN
3/15/1995
ENSAFE/ ALLEN AND HOSHALL

**ASSEMBLY B SITE INVESTIGATION PLANS
NAVAL AIR STATION MEMPHIS
MILLINGTON, TENNESSEE**

RCRA FACILITY INVESTIGATION

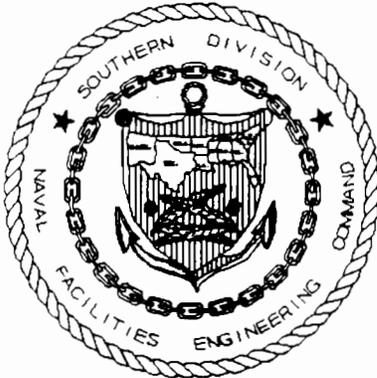
CTO-094

Contract No. N62467-89-D-0318



Prepared for:

**Department of the Navy
Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina**



Prepared by:

**EnSafe/Allen & Hoshall
5720 Summer Trees Drive, Suite 8
Memphis, Tennessee 38134
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March 15, 1995

**RFI WORK PLAN
NAS MEMPHIS**

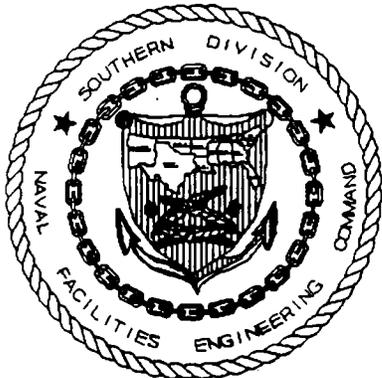
**SITE INVESTIGATION PLAN
SWMUs 4, 6, 10, 31, 38 — DRAINAGE DITCH
AREAS**

**CTO-094
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1.0 INTRODUCTION

As part of the U.S. Navy Comprehensive Long Term Environmental Action Navy (CLEAN) Program, the following Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Site Investigation Plan (SIP) has been prepared for SWMUS 4, 6, 10, 31, and 38 at the Naval Air Station (NAS) Memphis, Millington, Tennessee. The primary reference for this SIP is the *Comprehensive RFI Work Plan* (E/A&H, 1994).

2.0 ENVIRONMENTAL SETTING

SWMUs 4, 6, 10, 31, and 38, are located within the northwest quadrant of NAS Memphis. The drainage ways associated with these SWMUs receive water from surface runoff, storm sewers, and wastewater discharges from various buildings located in the central and southwestern portions of the northern half of NAS Memphis. Figure 1 (Vicinity Map) shows the locations of the SWMUs.

SWMU 4 (Building N-121 Battery Shop Storm Sewer and Drainage Ditch) originates as a storm sewer at Building N-121 and runs westerly along Casablanca Road to First Avenue, then southwesterly to a section of open drainage ditch which eventually discharges into SWMU 38 (Industrial Drainage Ditch).

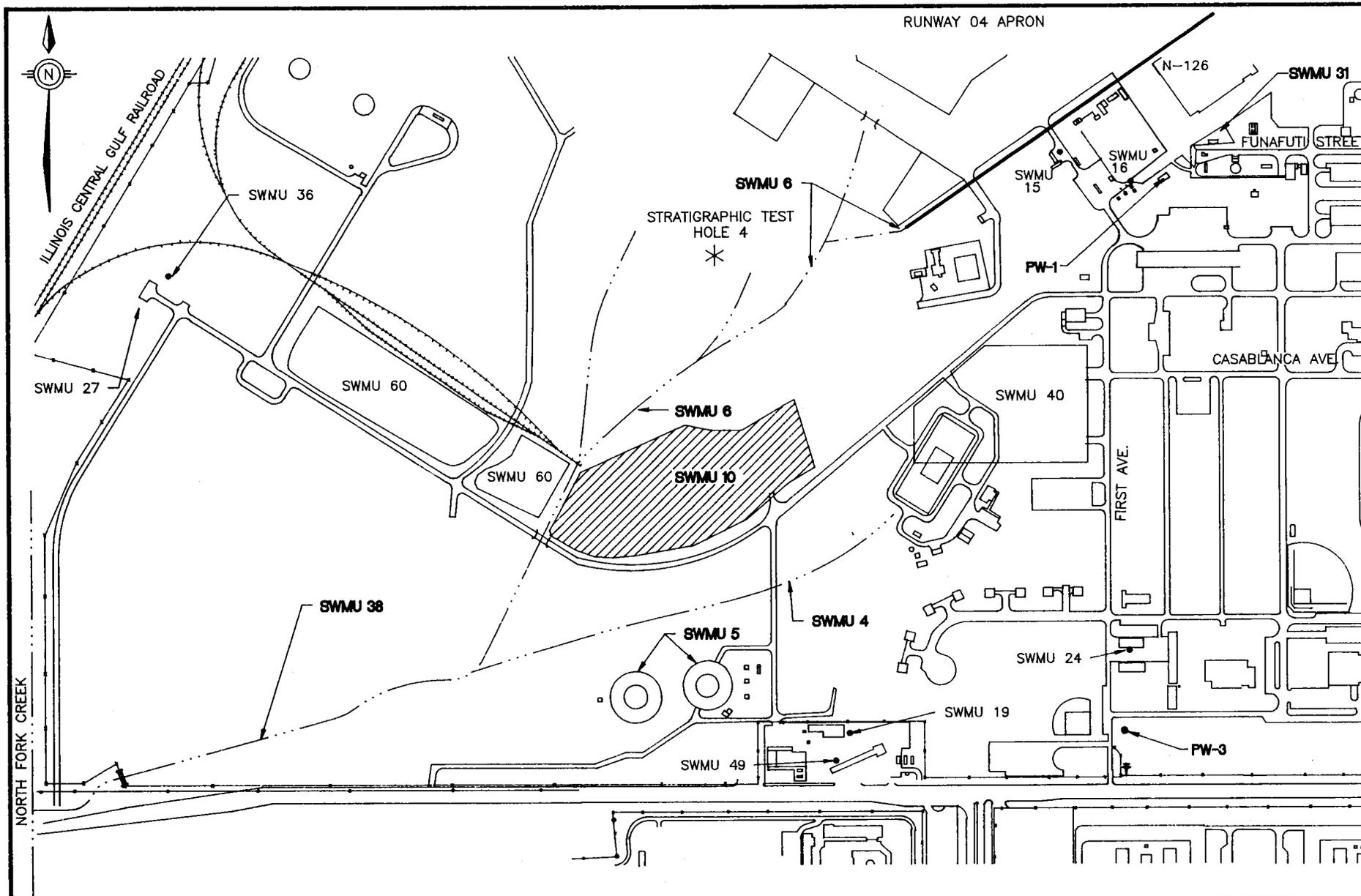
SWMU 6 (Building N-126 Battery Shop Storm Sewer and Drainage Ditch) originates as an underground storm sewer at Building N-126 and flows southwesterly along the apron of Runway 04, then turns due west at the end of the apron and becomes an open drainage ditch. This ditch runs between SWMU 60 (Northside Landfill, Western Portion) and SWMU 10 (Northside Landfill, Eastern Portion) before discharging into SWMU 38 (Industrial Drainage Ditch).

SWMU 10 (Northside Landfill, Eastern Portion) is located north of the existing Fire Fighting Training Facility (SWMU 5) and south of the main runway. Although the specific boundaries of the landfill are unknown, it is suspected to cover 13 to 20 acres. SWMU 10 was originally designated as a "No Further Action" site due to the presumed nature of the landfill's contents (demolition and construction debris). Visual inspections along the banks of SWMU 6 where it flows past SWMU 10 have shown signs of erosion and debris. Because of this and the planned transfer of this property to the City of Millington, SWMU 10 will be assessed by sampling the banks and sediments of SWMUs 6 and 38 to verify that contaminants are not leaching from the landfill.

SWMU 31 (Aircraft Wash Rack at 4th Street) is located at the intersection of Funafuti Street and 4th Street, just southeast of Building N-126. It is connected to the underground storm sewer portion of SWMU 6. According to previous reports and Public Works Office personnel, the wash rack is structurally sound and is presently serviceable, but has not been used for washing aircraft for at least 10 years.

SWMU 38 (Miscellaneous Drainage Ditches in the Industrial Areas of the NAS Memphis) consists of miscellaneous ditches draining the industrial areas in the northern portion and a small part of the southern portion of the base. Only the ditches in the northern portion of the base are included in this investigation because of closure of the northern side of the base under Base Realignment and Closure. The NAS Memphis Southside ditches will be addressed at a later date under Assembly E.

The original design of several buildings at NAS Memphis (circa 1943) provided for floor drains which discharged to storm sewers drains. As buildings were remodeled or replaced, most floor drains had been eliminated or re-routed to the sanitary sewer by 1980. Various substances,



RFI WORKPLAN
 NAS MEMPHIS
 MILLINGTON, TENNESSEE

FIGURE 1
 VICINITY MAP
 SWMUs 4, 6, 10, 31 AND 38

DWG DATE: 03/13/95 | DWG NAME: 16MEM009

525 0 525
 SCALE FEET

RFI Work Plan
NAS Memphis
Site Investigation Plan — SWMUs 4, 6, 10, 31, 38
Revision 1
March 15, 1995

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including solvents, degreasers, oils, and paints, may have been discharged to the drainage ditches in the past.

2.1 Topography and Drainage

The general topography of the area where the SWMUs are located consists of a subtle downward slope to the west of approximately 1 to 3 percent. Drainage from the area is in a southwesterly direction entering North Fork Creek at the southwest corner of NAS Memphis Northside.

2.2 Geologic and Hydrogeologic Information

The general regional and local hydrogeology are described in Sections 2.11 and 2.12, respectively, of the *Comprehensive RFI Work Plan*.

Stratigraphy

Although site-specific geologic data does not exist in areas adjacent to all of the drainage ditches, sufficient data from previous investigations are available to characterize the local stratigraphy. Subsurface soil information, collected while implementing the Interim Measures (IM) (SOUTHNAVFACENGCOM, E/A&H, 1993) and underground storage tank (UST) investigations at SWMU 5 (Aircraft Fire Fighting Training Facility) (E/A&H, 1992), indicates the presence of low- to very low- permeability silts with varying amounts of clay extending to a depth of approximately 20 feet below land surface (bls) underlain by a silt unit. Laboratory-measured vertical hydraulic conductivities for the clayey silt unit range from 10^{-8} to 10^{-7} centimeters per second (cm/sec); no conductivity data are available for the underlying silt unit. Permeability data collected during an UST investigation at Building N-126 (E/A&H, 1993), approximately 1,500 feet northeast of the site, show an average vertical hydraulic conductivity of 4.5×10^{-7} cm/sec at a depth interval of 11 to 13 feet. The boring logs from the SWMU 5 UST investigation are provided in Appendix A of this document.

Stratigraphic Test Borings

The United States Geological Survey (USGS) drilled stratigraphic test hole 4 to a total depth of 220 feet at a location approximately 500 feet south of the main runway (Figure 1). The test hole originally was to be advanced approximately 15 feet into the Cook Mountain Formation (the clay unit separating the Memphis Sand from the overlying Cockfield Formation and shallower units). However, due to the unanticipated thinness of the Cockfield Formation, this borehole was advanced approximately 50 feet into the Memphis Sand. This test hole was visually logged by a field geologist during drilling and geophysically logged following completion. Lithologies encountered in the test hole are as follows:

- Loess:** Approximately 40 feet of wind-blown silt deposits (loess). These materials were described as silt and minor clay.
- Fluvial Deposits:** Approximately 30 feet of fluvial deposits. These materials were described as sand and gravel.
- Cockfield Formation:** Approximately 30 feet of alternating sand, clay and some lignite.
- Cook Mountain Formation:** The Cook Mountain was characterized as a grey to blue-grey dense clay. Defined as the upper confining unit between the surficial aquifer(s) and the Memphis aquifer. The Cook Mountain Formation was described as approximately 44 feet thick at this location.

Shallow Groundwater

No groundwater monitoring wells exist at SWMUs 4, 6, 10, 31, and 38. Monitoring wells do exist at SWMU 5 (near SWMU 4) and Building N-126 (near SWMU 31). During the UST investigations at both Building N-126 and SWMU 5, a saturated zone was encountered at approximately 15 to 20 feet bls. Based on topography, the information contained in the conceptual model of the NAS Memphis hydrogeology (Section 2.12 of the *Comprehensive RFI Work Plan*), and recent data collected during investigations at Assembly A SWMUs, groundwater flows locally toward the drainage ditches in the loess and toward the southwest in the fluvial deposits in this area.

2.3 Climatological Data

Regional climatological data are provided in Section 2.8 of the *Comprehensive RFI Work Plan*.

3.0 SOURCE CHARACTERIZATION

3.1 SWMU 4 - Building N-121 Plating Shop Storm Sewer and Drainage Ditch

Building N-121 is located on the NAS Memphis Northside, just east of the Northside Landfill (SWMU 10). Building N-121 contained a plating shop which conducted cadmium, chromium, copper, and nickel plating using cyanide-based solutions. The Building N-121 Plating Shop Dry Well (SWMU 3) was reportedly used for disposal of concentrated plating solutions and overflow from the plating tanks. Previous reports also estimate that up to 17,000 gallons per day of dilute wastewater was discharged into the storm sewer and drainage ditch from operations at Building N-121 (Harmon, 1983).

Sections of the culverted portion of SWMU 4 were investigated in 1988 prior to construction of the Carrier Deck Fire Training Area (SOUTHDIR, 1988), and again in 1993 during the IM investigation at SWMU 5 (SOUTHNAVFACENGCOM and EnSafe, 1993). During 1988, photographs were taken of the interior joints of the storm sewer to determine where potential

leaks could occur. Soil samples were collected from the areas around any pipe joints that were suspected of leaking. Analytical data did not indicate that releases had occurred from the storm sewer in these areas. Analytical data from sediment samples collected during the IM investigation from an unculverted reach of SWMU 4 upstream and within SWMU 5 and southwest of the Carrier Deck Fire Training Area indicated levels of Total Petroleum Hydrocarbons (TPH) ranging from 32.1 mg/kg to 660 mg/kg.

3.2 SWMU 6 - Building N-126 Battery Shop Storm Sewer and Drainage Ditch

Building N-126 is located on the NAS Memphis Northside in the flight operations area. The battery shop inside the northeast corner of Building N-126 operated from 1955 until 1981. SWMU 6 is part of the storm sewer system which is currently in use and drains the N-126 area. During the period that the battery shop was in operation, approximately 100-gallons per day of a mixture of diluted and neutralized acid were reportedly discharged into the storm sewer. Electrolyte spills and drippings were also discharged into floor drains located in Building N-126. These floor drains were connected to 3- and 4-inch acid resistant pipes which emptied into the storm sewer. Substantial erosion and scouring has been observed at the point where the storm sewer discharges into the ditch west of Building N-126.

3.3 SWMU 10 - Northside Landfill, Eastern Portion

The Northside Landfill, Eastern Portion is located on the NAS Memphis Northside, just north of the existing Aircraft Fire Fighting Training Facility (SWMU 5), and south of the main runway. Although the specific boundaries of the landfill are unknown, it is suspected to be approximately 13 to 20 acres in size.

It is reported that the area was originally a ravine used for the disposal of construction debris. The only documented description of waste disposal at this site is found in several 1980 contract

documents which required contractors to use the area for disposal of rubbish and construction debris (i.e., construction materials, paper, metal scrap, leaves, and ash associated with paper incineration).

3.4 SWMU 31 — Aircraft Wash Rack At 4th Street

The Aircraft Wash Rack is located on the NAS Memphis Northside at the southwest corner of Building N-126. The wash rack is a paved area that slopes to a catch basin in the parking lot. The wash rack was first used in 1956 to rinse treatment chemicals from aircraft. According to Public Works Office personnel, the unit is structurally sound and is presently serviceable, but has not been used for washing aircraft in at least 10 years. Aluminum parts on aircraft were reportedly treated with chromic acid ("alodine") prior to arriving at the wash rack. The aircraft were then washed using a high pressure detergent wash to remove the acid. Wastewater contained within the concrete slab was discharged to the storm sewer that leads to SWMU 6.

3.5 SWMU 38 — Miscellaneous Drainage Ditches in the Industrial Areas of NAS Memphis

The open drainage ditches which comprise that portion of SWMU 38 within the NAS Memphis Northside flow to the southwest where they eventually discharge into North Fork Creek. SWMU 38 is intersected by SWMU 6 south of Runway 04, and SWMU 4 northwest of the Aircraft Fire Fighting Training Facility (SWMU 5) (Figure 1).

Surface-water runoff and numerous other outfalls from the north side of the base also discharge into SWMU 38. Most wastes discharged into the drainage ditch would be transported downstream by rainfall runoff. However, due to their relative immobility, some residual metals in soil and sediment may exist near the outfalls.

4.0 CHARACTERIZATION OF HAZARDOUS CONSTITUENT RELEASES

4.1 Previous Investigations

With the exception of SWMU 4, the areas included in this investigation have not been previously studied. SWMU 4 was included in two previous investigations (SOUTHNAVFACENGCOM, 1988, and SOUTHNAVFACENGCOM, 1993). A brief summary of each report is provided below.

Sampling Report — Southern Division Naval Facilities Engineering Command — (1988)

In 1988, SOUTHNAVFACENGCOM investigated the culverted storm sewer of SWMU 4. As part of the investigation, the storm sewer was photographed internally to determine if leaks had occurred at the joints of the pipe. A total of 26 joints were found to be suspect. The locations of these joints were determined and samples of soil adjacent to the sewer were collected from these areas. Samples were collected from different depth intervals ranging from 5 to 8 feet bls and submitted for metals and cyanide analysis. Analytical data did not indicate that releases had occurred to surrounding soils from the storm sewer.

Technical Memorandum — SWMUs 4 and 5 — Southern Division (1993)

Field work for the IM investigation at the Aircraft Fire Fighting Training Facility (AFFTF) (SWMU 5) was conducted by the USGS during October 1992. The field work was designed to determine if activities associated with a pending construction project would pose a threat to site workers. As part of the IM investigation, a series of sediment samples were collected along a portion of SWMU 4 both upstream of and within SWMU 5, and from locations in ditches draining SWMU 5 and emptying into SWMU 4. The samples were tested for full scan analysis (FSA) to determine if there had been any impact due to training activities at the AFFTF or the Carrier Deck Training Facility, located northeast of SWMU 5. Analytical data indicated TPH concentrations ranging from 32.1 mg/kg to 660 mg/kg. In addition to petroleum constituents,

some of the sediment samples tested positive for 1,2-dichloroethene (0.10 mg/kg), cyanide (3.6 mg/kg), and metals (see Appendix B).

4.2 Data Gaps

The proposed investigation will address the potential for contamination of sediments in all indicated ditches due to movement of contaminants from the Northside Landfill and past disposal practices associated with the various industrial operations on the north side of the base.

4.3 Objective and Proposed Field Investigation

The proposed field investigation is intended to delineate the horizontal and vertical extent of any sediment and soil contamination present at any of the SWMUs. The investigation will begin with a sediment/soil sampling phase as described below. All sample collection and processing will be in accordance with Section 4 of the *Comprehensive RFI Work Plan*.

Contaminant concentrations identified in sediment and soil at these SWMUs will be compared to background soil concentrations across the base and at other SWMUs. These comparisons will determine whether measured values occur naturally or indicate contamination. Background samples will be analyzed for FSA using the following methods:

- Volatile Organic Compounds (VOCs) (USEPA Method 8240)
- Semivolatile Organic Compounds (SVOCs) (USEPA Method 8270)
- Gasoline Range Organics (GRO) (TN Modified 8015/GRO)
- Diesel Range Organics (DRO) (TN Modified 8015/DRO)
- TPH (USEPA Method 418.1)
- Chlorinated Pesticides/PCBs (USEPA Method 8080)
- Organophosphorus Pesticides (USEPA Method 8140)
- Chlorinated Herbicides (USEPA Method 8150)

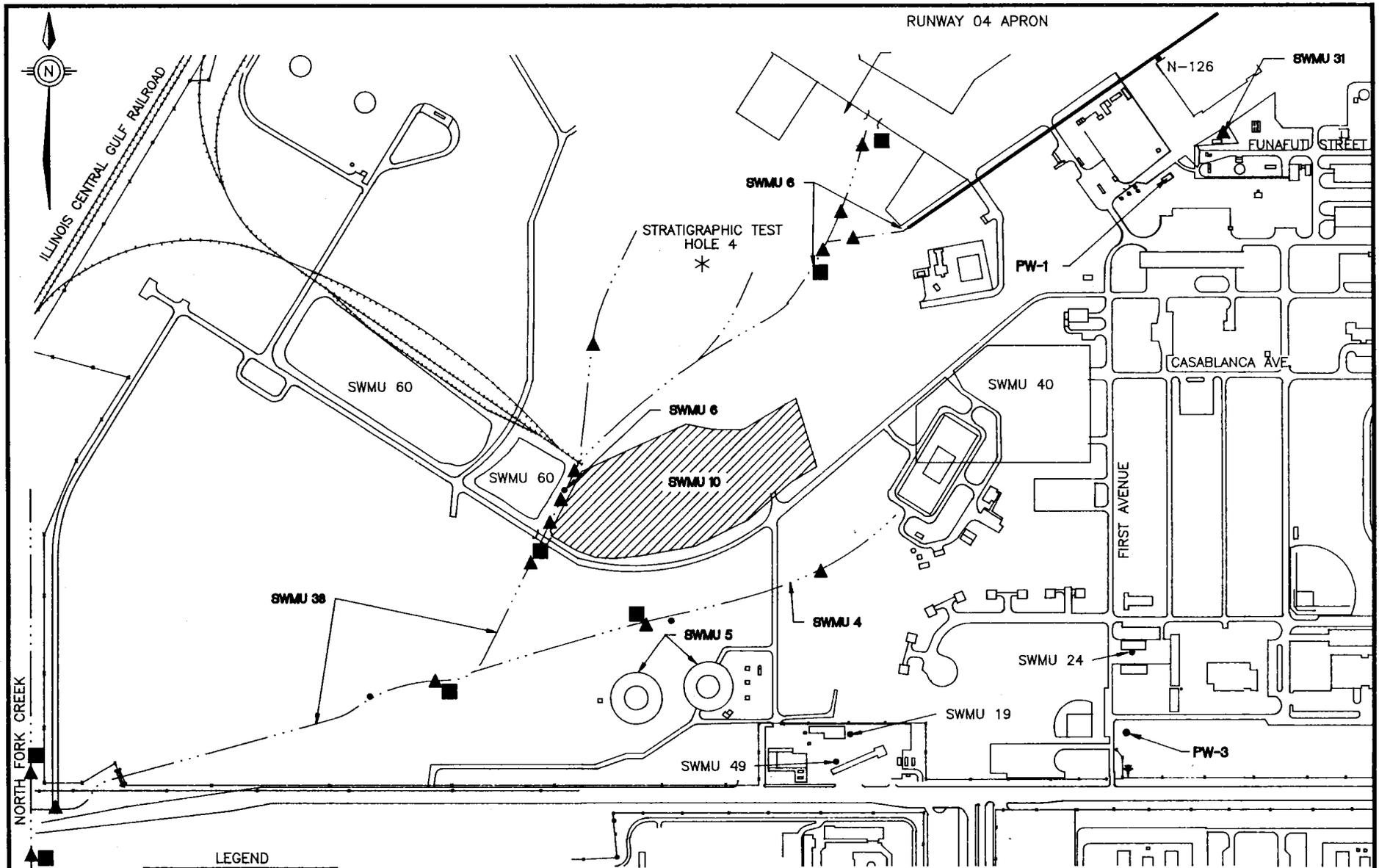
- RCRA Part 264, Appendix IX Total Metals (USEPA Method 6010/7000 series)
- Total Cyanide (USEPA Method 9010)

Reference materials will be used to determine the physical, chemical, and migration/dispersal characteristics of any contaminants identified during the RFI that exceed appropriate action levels. The procedures and references used to determine these characteristics will be documented in the RFI report.

4.3.1 Sediment/Soil Sampling

The first phase of sampling will consist of collecting approximately 17 shallow (0 to 6 inches bls) sediment/soil samples. These shallow samples have been located to ensure that a minimum of two sediment/soil samples will be collected from each outfall or confluence; one each from upstream and downstream of the outfall/confluence to determine if contaminants have been transported by discharge or runoff from the sites. In addition, a deeper (18 to 24 inches bls) sediment/soil sample will be collected from approximately seven locations in areas of standing water and outfalls. Samples will be collected with stainless steel trowels, hand-augers, or push tube samplers using procedures outlined in Sections 4.4.3 and 4.7.2 of the *Comprehensive RFI Work Plan*. If other areas of contamination are found or suspected, additional samples will be collected. Figure 2 shows proposed sample locations for SWMUs 4, 6, 10, 31, and 38.

Samples collected from SWMU 10 will be collected from the left bank of SWMU 6 to determine if contaminants are leaching from the landfill. These samples will be collected using a stainless steel trowel as described in Section 4.4.3 of the *Comprehensive RFI Work Plan*. SWMU 31 samples will be collected from within the wash rack inlet using the same procedures.



LEGEND

- ▲ - SEDIMENT SAMPLE (0 TO 6 INCHES)
- - SOIL/SEDIMENT SAMPLE (18 TO 24 INCHES)



RFI WORKPLAN
 NAS MEMPHIS
 MILLINGTON, TENNESSEE

FIGURE 2
 SAMPLE LOCATION MAP
 SWMUs 4, 6, 10, 31 AND 38

RFI Work Plan
NAS Memphis
Site Investigation Plan — SWMUs 4, 6, 10, 31, 38
Revision 1
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Field personnel may deviate from this rationale should field conditions or data suggest that changing the sampling location, interval, or frequency would yield more useful results. Any deviations will be recorded in the field log book along with an explanation for each deviation.

4.4 Expansion of Investigation

The investigation may be expanded to determine the horizontal and vertical extent of contamination based on an evaluation of the following:

- Analytical results of soil/sediment samples which exceed established background concentrations for soil samples at the activity.

- Analytical results of soil/sediment samples which exceed preliminary remediation goals.

If necessary, groundwater and/or ecological concerns will be addressed in this phase of the investigation.

4.5 Analytical Requirements

Soil/sediment samples will be collected for offsite laboratory analysis. Sampling and analytical requirements are summarized in Table 1.

Level III Data Quality Objectives (DQO) will be used for 95 percent of the samples and Level IV DQO for the remaining 5 percent. A detailed list of the analytical parameters shown in Table 1 are provided in Appendix D of the *Comprehensive RFI Work Plan*. Field sampling personnel will determine which samples will receive a Level IV DQO.

Table 1 Estimated Sampling and Analytical Requirements — SWMUs 4, 6, 10, 31, and 38			
Method	Sample Matrix/Type	Number of Samples ⁽¹⁾	Analysis
Hand Auger/Trowel/Push Tube	Sediment/Soil	23	FSA ⁽²⁾

Notes:

- (1) Does not include QA/QC samples
- (2) FSA (Full Scan Analysis) = TPH; VOCs; SVOCs; chlorinated pesticides/PCBs, organophosphorus pesticides, chlorinated herbicides; and, Total Metals (Appendix IX), total cyanide.

4.6 Sample and Data Management

Sample and data management procedures will adhere to Section 4.12 of the *Comprehensive RFI Work Plan*.

4.7 Sample Custody

Sample custody will adhere to Section 4.12.5 of the *Comprehensive RFI Work Plan*.

4.8 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures to be followed during the investigation will adhere to Section 4.14 of the *Comprehensive RFI Work Plan*.

4.9 Decontamination Procedures

Decontamination procedures will adhere to Section 4.11 of the *Comprehensive RFI Work Plan*.

4.10 Investigation-Derived Waste

Investigation-derived waste (IDW) will be handled as specified in Section 4.13 of the *Comprehensive RFI Work Plan*.

5.0 POTENTIAL RECEPTORS

The SWMUs addressed in this investigation transect the southern part of NAS Memphis Northside. All of the sites are related to drainage ways which are located in populated areas of the base; therefore, the potential exists for contact by base personnel. Off base, the potential exists for contact by the general public due to unrestricted access to the drainage ways. According to base personnel, no fishing or swimming occurs in North Fork Creek or Big Creek, but children may play near these drainage ways.

Other potential receptors include two production wells (Production Well 1 and Production Well 2). Production Well 1 is approximately 200 feet southwest of SWMU 31, 500 feet south of SWMU 6, and 1,500 feet north of SWMU 4. Production Well 2 is approximately 1,000 feet north of SWMU 4, 2,000 feet southeast of SWMU 6, and 1,500 feet southeast of SWMU 31. However, these wells are screened in the Memphis Sand with the Cook Mountain confining unit above the screened intervals. A more detailed analysis of potential receptors will be conducted and presented in the RFI report if contamination is found at SWMUs 4, 6, 10, 31, and 38.

6.0 QUALITY ASSURANCE PLAN

The Quality Assurance Plan (QAP) presented in Section 4.14 of the *Comprehensive RFI Work Plan* will be followed throughout the RFI.

7.0 DATA MANAGEMENT PLAN

The Data Management Plan (DMP) presented in Section 5.0 of the *Comprehensive RFI Work Plan* will be followed during the RFI.

8.0 HEALTH AND SAFETY PLAN

The site-specific Health and Safety Plan for SWMUs 4, 6, 10, 31, and 38 is included in Appendix C of this document. The Comprehensive Health and Safety Plan is included in Section 7.0 of the *Comprehensive RFI Work Plan*.

9.0 REFERENCES

EnSafe/Allen & Hoshall (October 1992). *Environmental Assessment Report, Tank Systems 1489 and 1508, Aircraft Fire Fighting Training Facility, Naval Air Station Memphis, Millington, Tennessee*. E/A&H: Memphis, Tennessee.

EnSafe/Allen & Hoshall (September 1993). *Final EAR - Building N-126 USTs; Facility I.D. 0-791709, Naval Air Station Memphis*. E/A&H: Memphis, Tennessee.

EnSafe/Allen & Hoshall (October 1994). *Comprehensive RFI Work Plan for Naval Air Station Memphis*. E/A&H: Memphis, Tennessee.

ERC/EDGE (September 1990). *RCRA Facility Assessment (RFA), NAS Memphis*. ERC/EDGE: Nashville, Tennessee.

Harmon Engineering & Testing/NEESA (November 1983). *Initial Assessment Study of Naval Air Station Memphis, Millington, Tennessee*. Harmon Engineering and Testing: Auburn, Alabama.

Southern Division Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) and EnSafe/Allen & Hoshall (February 1993). *NAS Memphis Technical Memorandum SWMUs 4 and 5. Subject: NAS Memphis RFI — Interim Measures Field and Analytical Summary*. SOUTHNAVFACENGCOM: Charleston, SC.

Southern Division Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) (August 1988). *Sampling Report (SWMUs 3, 4, and 40), NAS Memphis*. SOUTHNAVFACENGCOM: Charleston, SC.

APPENDIX A
MISCELLANEOUS BORING LOGS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW01 1/2	0			0-0.5 LIGHT BROWN SAND AND SILT WITH ORGANICS AND ROOTS.	<p>CEMENT-BENTONITE GROUT</p> <p>2" DIAMETER SCHEDULE 40 PVC RISER</p> <p>BENTONITE SEAL FROM 4 TO 6 FT.</p> <p>10-20 SAND FROM 6 TO 18.5 FT.</p> <p>10' LONG 0.010 SLOT SCHEDULE 40 PVC SCREEN FROM 8 TO 18 FT.</p> <p>10.5 IN. DIAMETER BOREHOLE</p>
0.5	MW01 1/2	2			0.5-2 DARK BROWN SILT AND CLAY WITH LAYERED TEXTURE. TIGHT, DRY.	
2	MW01 1/2	4			2-4 MOTTLED BROWN, LIGHT-BROWN, ORANGE-BROWN SILT AND CLAY WITH DARK ORGANIC SPECKS. TIGHT, DRY.	
4	MW01 1/2	6			4-12 MOTTLED CLAY, SOME SILT BECOMING LIGHT GRAY/BROWN. TIGHT, MOIST.	
6	MW01 1/2	8				
8	MW01 1/3	10		GRD. BTX	● WATER AT 10-12 FT.	
10	MW01 1/3	12			12-18 HOMOGENOUS GRAY SILT. FIRM TO SOFT, WET	
12	MW01 1/5	14				
14	MW01 1/3	16				
16					18-18.5 NO SAMPLE END OF BORING AT 18.5 FT.	

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW STEM AUGERS
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER

DATE OF COMPLETION: 06/22/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-01
MW-01

DATE: 08/08/92

DWG NAME: 026MW-01

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW02 0	1 11			0-0.5 LIGHT BROWN SAND AND SILT WITH ORGANICS AND ROOTS.	<p>CEMENT-BENTONITE GROUT</p> <p>2" DIAMETER SCHEDULE 40 PVC RISER</p> <p>BENTONITE SEAL FROM 4 TO 6 FT.</p> <p>10-20 SAND FROM 6 TO 18.5 FT.</p> <p>10' LONG 0.010 SLOT SCHEDULE 40 PVC SCREEN FROM 8 TO 18 FT.</p> <p>10.5 IN. DIAMETER BOREHOLE</p>
2	MW02 2	28 25			0.5-2 MOTTLED BROWN, ORANGE-BROWN SILT AND CLAY. TIGHT, DRY.	
4	MW02 4	100 200			2-5 MOTTLED BROWN, ORANGE-BROWN, GREEN-GRAY SILT AND CLAY WITH FEW BLACK ORGANIC SPECKS. TIGHT, MOIST, WITH HYDROCARBON ODOR.	
6	MW02 6	100 NH*		K, GRD, BTX, RFI-SCAN		
8	MW02 8	100 NH*				
10	MW02 10	200 NH*		K, GRD, BTX	5-11.5 DARK GRAY HYDROCARBON-STAINED SILT AND CLAY. TIGHT, SOFT, WET TO MOIST. STRONG HYDROCARBON ODOR.	
11.5					● WATER AT 11.5 FT.	
12	MW02 12	200 200			11.5-12 BROWN SAND, SOME GRAVEL AND SILT. WET, LOOSE, NO APPARENT ODOR.	
14	MW02 14	10 14			12-12.5 GRAY, BROWN, ORANGE-BROWN SILT AND CLAY TIGHT, MOIST TO WET.	
16	MW02 16	20 11			12.5-18 HOMOGENOUS GRAY SILT. FIRM, WET. -WITH A GRAVEL ISOLATE AT 15 FT.	
18.5					18-18.5 NO SAMPLE END OF BORING AT 18.5 FT.	
					* NH-NO 15 MINUTE HEADSPACE ANALYSIS.	

DRILLER:

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.
SHELBY TUBE FOR PERMEABILITY SAMPLES.

DATE OF COMPLETION: 06/22/92 MONITORING WELL
06/27/92 SHELBY TUBE



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-02
MW-02

DATE: 08/08/92

DWG NAME: 026MW-02

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	
		B03 0	5/5		0-17 BROWN SAND,SILT AND ORGANICS,SOME GRAVEL 17-4 BROWN TO DARK BROWN SILT,LITTLE CLAY. TIGHT,DRY.
		B03 2	10/4		
		B03 4	5/4		4-6 MOTTLED LIGHT-BROWN,GRAY,ORANGE-BROWN SILT AND CLAY,WITH SOME BLACK ORGANIC SPECKS. LOOSE,WET.
5		B03 6	2/5		6-6.5 ORANGE-BROWN SILT AND GRAVEL. LOOSE,WET. 6.5-8 MOTTLED LIGHT-BROWN,GRAY,ORANGE-BROWN SILT AND CLAY,WITH SOME BLACK ORGANIC SPECKS.
		B03 8	2/4	GRD, BTX	8-12 GRADING TO MOTTLED GRAY,ORANGE-BROWN SILT WITH SOME BLACK ORGANIC SPECKS.
10		B03 10	2/4		● WATER AT 10 FT.
					END OF BORING AT 12 FT.
15					
20					
25					
30					

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/22/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIREFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-03

DATE: 07/28/92

DWG NAME: 026B-03

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	
					GRAVEL ROAD BEDDING.
	B04	0/1			2-4 BROWN SILT, WITH MINOR BLACK ORGANIC SPECKS. TIGHT, DRY.
	2				
	B04	0/1			4-6 BROWN SILT AND CLAY, WITH MINOR BLACK ORGANIC SPECKS. TIGHT, DRY.
	4				
5	B04	0/4			6-7 LIGHT GRAY SILT AND CLAY, MOTTLED WITH ORANGE - BROWN PATCHES. TIGHT, DRY.
	6				
	B04	6/40		GRD, BTX	7-10 DARK GRAY CLAY, MOTTLED WITH ORANGE - BROWN PATCHES. TIGHT, DRY TO MOIST. - WITH HYDROCARBON ODOR AT 8-10 FT.
	8				
10	B04	5/5		GRD, BTX	10-11 DARK GRAY SILT AND CLAY, MOTTLED WITH ORANGE - BROWN PATCHES. TIGHT, MOIST, WITH HYDROCARBON ODOR.
	10				
	B04	2/4		GRD, BTX	11-16 LIGHT GRAY SILT AND CLAY, MOTTLED WITH ORANGE - BROWN PATCHES. TIGHT, MOIST TO WET NO APPARENT ODOR.
	12				
15	B04	2/3			● WATER AT 14 FT.
	14				
	B04	1/2			16-19.5 MOTTLED GRAY, BROWN, ORANGE - BROWN SILT, SOME CLAY. TIGHT, WET.
	16				
	B04	3/2			19.5-20 GRAY UNIFORM SILT. FIRM, WET.
	18				END OF BORING AT 20 FT.
20					
25					
30					

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/22/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIREFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-04

DATE: 07/28/92

DWG NAME: 026B-04

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW03 3/2	0			0-1 BROWN SAND,SILT AND ORGANICS,SOME GRAVEL. LOOSE,DRY.	
2	MW03 2/2	2			1-4 BROWN, ORANGE-BROWN SILT,SOME GRAVEL AND CLAY,BECOMING (AT 4 FT.) MOTTLED BROWN, ORANGE-BROWN SILT,LITTLE CLAY.	
4	MW03 1/2	4			4-7 GRAY-BROWN SILT,LITTLE CLAY,BECOMING (AT 4.5 FT.) GRAY SILT AND CLAY WITH ORANGE-BROWN MOTTLING AND BLACK ORGANIC SPECKS.	
6	MW03 1/2	6			7-10 GRADING TO DARK-GRAY CLAY, LITTLE SILT, WITH ORANGE-BROWN MOTTLES AND BLACK ORGANIC SPECKS. VERY TIGHT,MOIST.	
8	MW03 1/2	8			10-12 LIGHT GRAY SILT AND CLAY WITH ORANGE-BROWN MOTTLES AND BLACK ORGANIC SPECKS. TIGHT,MOIST TO WET.	
10	MW03 1/2	10	GRD, BTX		● WATER AT 12 FT.	
12	MW03 1/2	12			12-17 MOTTLED GRAY,BROWN,ORANGE-BROWN SILT AND CLAY,WITH BLACK ORGANIC SPECKS. SOFT,WET.	
14	MW03 1/3	14			17- 19 BECOMING MOTTLED LIGHT-GRAY, ORANGE-BROWN SILT,WITH SCATTERED BLACK ORGANIC SPECKS.	
16	MW03 1/4	16			19-19.5 NO SAMPLE END OF BORING AT 19.5 FT.	
19.5						

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/23/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-05
MW-03

DATE:08/08/92

DWG NAME:026MW-03

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PTD (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW04 3/3	0			0-2 BROWN SAND, SILT AND ORGANICS; BECOMING (AT 1 FT.) BROWN, ORANGE SAND AND SILT, SOME GRAVEL. LOOSE TO TIGHT, DRY TO MOIST.	<p>CEMENT-BENTONITE GROUT</p> <p>2" DIAMETER SCHEDULE 40 PVC RISER</p> <p>BENTONITE SEAL FROM 2 TO 4 FT.</p> <p>10-20 SAND FROM 4 TO 16.5 FT.</p> <p>10' LONG 0.010 SLOT SCHEDULE 40 PVC SCREEN FROM 6 TO 16 FT.</p> <p>10.5 IN. DIAMETER BOREHOLE</p>
2	MW04 2/4	2			2-4 LAYERED BROWN, LIGHT-BROWN SILT, SOME CLAY, WITH MINOR ORANGE-BROWN MOTTLES AND BLACK ORGANIC SPECKS; BECOMING (AT 3 FT.) LIGHT-BROWN, ORANGE-BROWN SILT AND CLAY. TIGHT, MOIST.	
4	MW04 2/4	4			4-6 BECOMING LIGHT-BROWN TO GRAY CLAY, WITH ORANGE-BROWN MOTTLED ZONES AND BLACK TO BROWN-DARK RED ORGANIC SPECKS.	
6	MW04 2/3	6			6-10 BECOMING LIGHT BROWN TO GRAY SILT AND CLAY, WITH ORANGE-BROWN MOTTLING AND DARK BROWN TO DARK RED ORGANIC NODULES.	
8	MW04 1/3	8	GRD, BTX		● WATER AT 10 FT.	
10	MW04 1/2	10			10-15.5 BECOMING GRAY SILT, SOME CLAY, WITH ORANGE-BROWN MOTTLING AND DARK BROWN TO DARK RED ORGANIC NODULES. TIGHT, WET.	
12	MW04 1/3	12			15.5-16.5 BECOMING MOTTLED GRAY AND ORANGE-BROWN SILT AND CLAY. TIGHT, WET.	
14	MW04 1/3	14			16-16.5 NO SAMPLE END OF BORING AT 16.5 FT.	
15						
20						
25						
30						

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/23/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIREFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-06
MW-04

DATE: 08/08/92

DWG NAME: 026MW-04

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN)	LABORATORY ANALYSIS	DESCRIPTION
0		B07 0	1000 700		0-0.5 BROWN AND GRAY-BLACK SILT AND ASH, LITTLE SAND. LOOSE, DRY, HYDROCARBON ODOR.
2		B07 2	1000 1000	RFI- SCAN	0.5-3.5 BROWN TO GRAY-BROWN SILT, SOME CLAY, ORGANICS AND ROOTS, BECOMING (AT 2 FT.) MOTTLED GRAY-BROWN, ORANGE-BROWN SILT, SOME CLAY WITH BLACK TO DARK-RED ORGANIC SPECKS AND SOME ROOTS. TIGHT, DRY, HYDROCARBON ODOR.
4		B07 4	900 900	GRD, BTX	
6		B07 6	700 900		3.5-11 DARK GRAY-BROWN TO GRAY-GREEN-BROWN, HYDROCARBON STAINED SILT AND CLAY, WITH GRAY MOTTLED PATCHES. TIGHT, MOIST TO WET, HYDROCARBON ODOR.
8		B07 8	300 NH*	GRD, BTX	
10		B07 10	5 10		● WATER AT 10 FT.
12		B07 12	3 7		11-16 GRAY, DARK-GRAY SILT. FIRM, WET.
14		B07 14	2 5		
16		B07 16			END OF BORING AT 16 FT.
18		B07 18			

* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/23/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-07

DATE: 07/28/92

DWG NAME: 026B-07

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN)	LABORATORY ANALYSIS	
		B08 0	20 30		0-0.5 COMPACTED SAND AND GRAVEL OVERLYING 1/2" THICK LAYER OF ASH.
		B08 2	4 25		0.5-2 BROWN SILT AND CLAY. COMPACT, DRY TO MOIST. 2-5 MOTTLED BROWN, ORANGE-BROWN SILT, SOME CLAY, WITH DARK-BROWN, DARK-RED ORGANIC NODULES.
5		B08 4	1000 1000	RFI-SCAN	
		B08 6	200 200	GRD, BTX	5-11 DARK GREEN-GRAY, HYDROCARBON STAINED SILT AND CLAY, WITH FAINT LIGHT-GRAY AND ORANGE-BROWN MOTTLING. TIGHT, MOIST, CHEMICAL ODOR.
		B08 8	600 800		
10		B08 10	600 NH*	GRD, BTX, VDC	● WATER AT 11 FT. 11-12 GRAY, DARK-GRAY SILT. WET. END OF BORING AT 12 FT.
15					
20					
25					
30					

* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/23/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIREFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-08

DATE: 07/28/92

DWG NAME: 026B-08

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS
		B09 0	40 30		0-1 BROWN SILT AND ORGANICS, SOME GRAVEL, LITTLE SAND; BECOMING (AT 1 FT.) MOTTLED BROWN, ORANGE-BROWN SILT, SOME ORGANICS.
		B09 2	20 55		2-4 DARK GRAY CLAY WITH SUBDUED ORANGE-BROWN, LIGHT-GRAY MOTTLING. TIGHT, MOIST.
5		B09 4	600 1100	RFI- SCAN, GRD, BTX	4-7 DARK GRAY CLAY, SOME SILT. TIGHT, MOIST, CHEMICAL ODOR.
		B09 6	500 600		7-12 BECOMING MOTTLED LIGHT-GRAY AND ORANGE-BROWN SILT, SOME CLAY, WITH SCATTERED BLACK ORGANIC SPECKS. TIGHT, MOIST TO WET.
10		B09 8	20 20		
		B09 10	6 2	GRD, BTX	● WATER AT 11 FT. END OF BORING AT 12 FT.
15					
20					
25					
30					

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/24/92

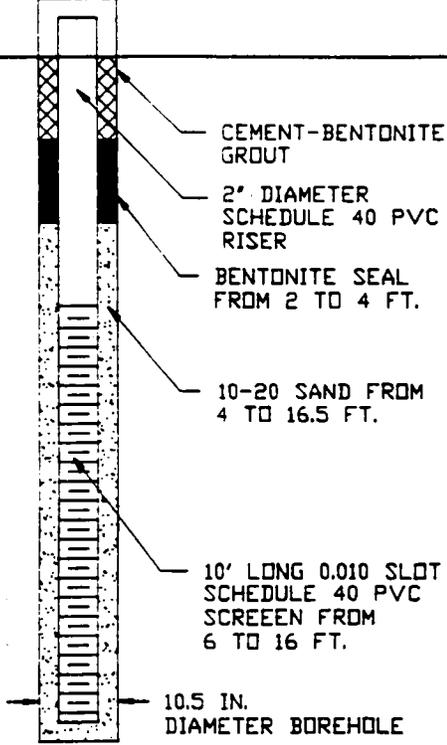


ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIREFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-09

DATE: 07/28/92

DWG NAME: 026B-09

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW05 1/4				0-2 DARK BROWN SILT AND ORGANICS.	 <p>CEMENT-BENTONITE GROUT</p> <p>2" DIAMETER SCHEDULE 40 PVC RISER</p> <p>BENTONITE SEAL FROM 2 TO 4 FT.</p> <p>10-20 SAND FROM 4 TO 16.5 FT.</p> <p>10' LONG 0.010 SLOT SCHEDULE 40 PVC SCREEN FROM 6 TO 16 FT.</p> <p>10.5 IN. DIAMETER BOREHOLE</p>
2	MW05 2/2				2-6 DARK BROWN CLAY, WITH INTERSPERSED ORANGE-BROWN NODULES. VERY TIGHT TO MOIST.	
4	MW05 1/3					
6	MW05 1/2				6-13 BECOMING MOTTLED BROWN-GRAY, ORANGE-BROWN SILT AND CLAY. TIGHT, MOIST TO WET.	
8	MW05 1/2			RFI-SCAN, BTX		
10	MW05 1/10			NH*	● WATER AT 10 FT.	
12	MW05 0/2				13-14.5 BECOMING DARK BROWN CLAY, LITTLE SILT, BECOMING DARK BROWN TO BLACK CLAY WITH ROOTS AND ORGANICS. VERY TIGHT.	
14	MW05 1/1				14.5-16.5 NO SAMPLE END OF BORING AT 16.5 FT.	
15						
20						
25						
30						

* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/24/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

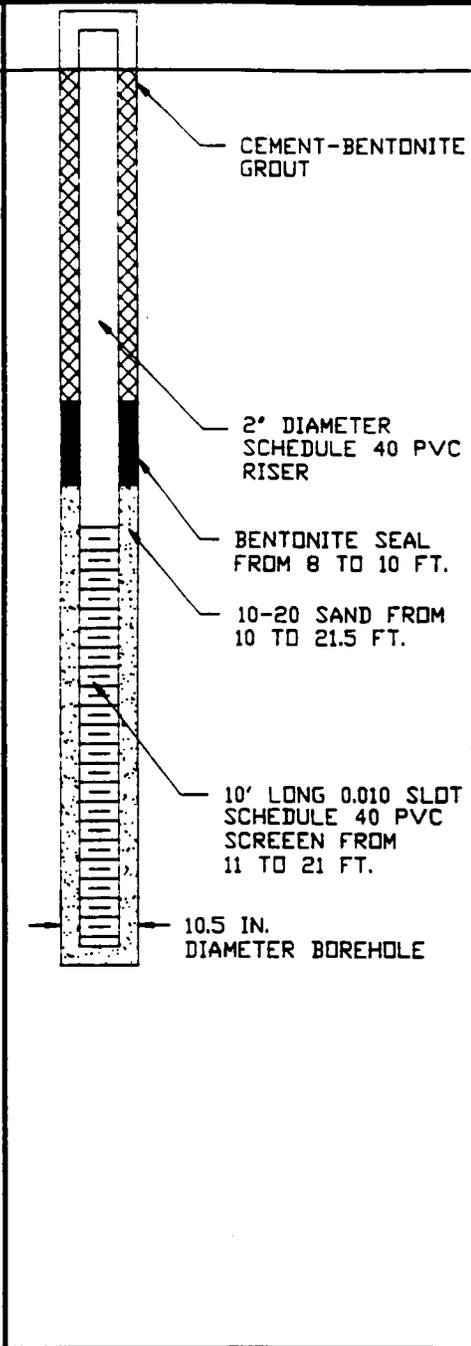
BORING B-10
MW-05

DATE: 08/08/92

DWG NAME: 026MW-05

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
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	MW06 1/3 0				0-2 BROWN SILT AND SAND, SOME GRAVEL AND ORGANICS. LOOSE, DRY.	
	MW06 1/5 2				2-3.5 BROWN-GRAY SILT AND CLAY, SOME ORGANICS AND ROOTS. TIGHT, MOIST.	
	MW06 200 4 400				3.5-7.5 BECOMING DARK GRAY, BLACK CLAY. PLIABLE TO HARD, MOIST TO WET TO MOIST. HYDROCARBON ODDOR.	
5	MW06 1500 6			RFI-SCAN, GRD, BTX	7.5-10.5 BECOMING DULL GREEN-GRAY, HYDROCARBON STAINED SILT AND CLAY WITH ORANGE-BROWN MOTTLING AND MINOR DARK BROWN-RED NODULES.	
	MW06 400 8 500				10.5-11 DARK BROWN-GRAY CLAY, LITTLE SILT. PLIABLE, MOIST.	
10	MW06 3/7 10			GRD, BTX	11-20 MOTTLED LIGHT-BROWN-GRAY AND ORANGE-BROWN SILT, SOME CLAY, WITH BLACK ORGANIC PATCHES. WET.	
	MW06 3/1 12				● WATER AT 12 FT.	
	MW06 1/1 14					
15	MW06 0/2 16					
	MW06 1/1 18					
20					20-21.5 NO SAMPLE. END OF BORING AT 21.5 FT.	
25						
30						



* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/24/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-11
MW-06

DATE: 07/29/92

DWG NAME: 026MW-06

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN)	LABORATORY ANALYSIS	
		B12 0	50 NH*		0-1 TAN-BROWN SAND AND GRAVEL. LOOSE, DRY.
		B12 2	200 NH*		1-2 DARK GREEN-GRAY SILT AND ASH, WITH A PIECE OF BLACK RUBBER-TAR-LIKE MATERIAL. TIGHT, DRY.
		B12 4	500 650	GRD, BTX	2-11 DARK GRAY-GREEN SILT AND CLAY, WITH SUBDUED LIGHT-GRAY AND ORANGE-BROWN MOTTLING. HYDROCARBON STAINED. TIGHT, MOIST.
5		B12 6	300 700		
		B12 8	500 850		
10		B12 10	500 750	GRD, BTX	● WATER AT 11 FT. 11-12 DARK GRAY-GREEN SILT END OF BORING AT 12 FT.
15					
20					
25					
30					

* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/24/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-12

DATE: 07/28/92

DWG NAME: 026B-12

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW07 2/2	0			0-1 BROWN SILT AND ORGANICS, SOME CLAY AND ROOTS.	
2	MW07 200/700	2			1-3 DARK BROWN SILT AND CLAY WITH FAINT GRAY AND ORANGE-BROWN MOTTLING, AND BLACK ORGANIC SPECKS TO RUST-BROWN NODULES. TIGHT, MOIST.	
4	MW07 250/850	4	GRD, BTX		3-6 BECOMING GRAY-GREEN HYDROCARBON STAINED CLAY, WITH SUBDUED ORANGE-BROWN MOTTLING AND RUST-BROWN NODULES. VERY TIGHT, MOIST, HYDROCARBON ODOR.	
6	MW07 50/400	6	GRD, BTX		6-9.5 BECOMING DARK GREEN-GRAY SILT AND CLAY. TIGHT, MOIST.	
8	MW07 1/5	8	GRD, BTX		9.5 BECOMING DARK BROWN CLAY. WET, VERY PLIABLE.	
10	MW07 2/5	10			● WATER AT 9.5 FT.	
12	MW07 2/2	12			10-16 MOTTLED LIGHT-BROWN, GRAY, ORANGE-BROWN SILT, WITH DARK-BROWN, RED-BLACK NODULES. FIRM, WET.	
14	MW07 1/2	14				
16.5					16-16.5 NO SAMPLE. END OF BORING AT 16.5 FT.	

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/25/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-13
MW-07

DATE: 08/08/92

DWG NAME: 026MW-07

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW08 1/0	0			0-0.5 BROWN SILT, ORGANICS AND ROOTS 0.5-2 MOTTLED LIGHT-BROWN-GRAY, ORANGE-BROWN SILT, SOME CLAY AND ROOTS. DRY.	<p>CEMENT-BENTONITE GROUT</p> <p>2" DIAMETER SCHEDULE 40 PVC RISER</p> <p>BENTONITE SEAL FROM 2 TO 4 FT.</p> <p>10-20 SAND FROM 4 TO 16.5 FT.</p> <p>10' LONG 0.010 SLOT SCHEDULE 40 PVC SCREEN FROM 6 TO 16 FT.</p> <p>10.5 IN. DIAMETER BOREHOLE</p>
2	MW08 1000	2	1100	GRD, BTX	2-10 DARK GREEN-GRAY SILT AND CLAY. HYDROCARBON-STAINED. TIGHT, MOIST TO WET. UNIDENTIFIED ODDR.	
4	MW08 1000	4	1100	VDC		
6	MW08 500	6	700			
8	MW08 10/8	8		GRD, BTX	● WATER AT 9-10 FT.	
10	MW08 7/0	10			10-13 BECOMING MOTTLED GRAY, ORANGE-BROWN SILT. FIRM, WET.	
12	MW08 200	12	20	VDC	13 THIN HORIZON (3") OF BLACK SILT. PASTE-LIKE, WET.	
14	MW08 3/16	14			13-15 MOTTLED GRAY, ORANGE-BROWN SILT; BECOMING RED-BROWN SILT WITH MINOR ORANGE-BROWN STREAKS.	
15					15-16 UNIFORM GRAY SILT.	
16.5					16-16.5 NO SAMPLE. END OF BORING AT 16.5 FT.	
20						
25						
30						

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/25/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-14
MW-08

DATE: 08/08/92

DWG NAME: 026MW-08

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	
5	B16 0	1/1			0-1 BROWN,ORANGE-BROWN SILT,ORGANICS AND ROOTS.
	B16 2	1/0			1-4 DARK BROWN ORGANIC-RICH SILT AND CLAY; BECOMING (AT 2 FT.) DARK BROWN-BLACK ORGANIC-RICH CLAY. TIGHT TO VERY TIGHT,DRY.
	B16 4	1/1			4-6 BECOMING MOTTLED GRAY-GREEN,GRAY-BROWN, DARK-BROWN SILT AND CLAY.
	B16 6	1/2			6-7.5 BECOMING GREEN-GRAY SILT,LITTLE CLAY. FIRM,WET.
	B16 8	1/1			7.5-10 BECOMING LIGHT-BROWN,GRAY-BROWN SILT AND CLAY. TIGHT,MOIST.
10	B16 10	1/1		GRO. BTX	10-12 BECOMING MOTTLED GRAY,ORANGE-BROWN SILT, SOME CLAY. TIGHT,MOIST. ● WATER AT 11 FT. END OF BORING AT 12 FT.
15					
20					
25					
30					

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/25/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-16

DATE: 07/28/92

DWG NAME: 026B-16

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW09 0/0	0			0-1.5 BROWN SILT, CLAY, ORGANICS AND ROOTS; BECOMING MOTTLED BROWN, ORANGE-BROWN SILT, CLAY AND ROOTS.	<p>CEMENT-BENTONITE GROUT</p> <p>2" DIAMETER SCHEDULE 40 PVC RISER</p> <p>BENTONITE SEAL FROM 2 TO 4 FT.</p> <p>10-20 SAND FROM 4 TO 16.5 FT.</p> <p>10' LONG 0.010 SLOT SCHEDULE 40 PVC SCREEN FROM 6 TO 16 FT.</p> <p>10.5 IN. DIAMETER BOREHOLE</p>
1.5	MW09 0/0	2			1.5-4 BECOMING DARK BROWN CLAY, TURNING DARK BROWN-BLACK ORGANIC-RICH CLAY WITH SOME ROOTS, TIGHT, MOIST.	
4	MW09 0/0	4			4-6 BECOMING GRAY SILT AND CLAY WITH FAINT ORANGE-BROWN INTERBEDS. TIGHT, MOIST.	
6	MW09 0/0	6			6-10 MOTTLED GRAY-BROWN, BLUE-GRAY SILT AND CLAY. BECOMING (AT 8 FT.) MOTTLED LIGHT-BROWN AND BLUE-GRAY. TIGHT, MOIST.	
8	MW09 0/0	8		GRD, BTX		
9.5					● WATER AT 9.5 FT.	
10	MW09 0/0	10			10-12 GRAY-BROWN SILT.	
12	MW09 0/0	12			12-16 MOTTLED GRAY, ORANGE-BROWN SILT, WITH MINOR BLACK TO DARK-RED NODULES OR PATCHES. FIRM, WET.	
14	MW09 0/0	14			16-16.5 NO SAMPLE END OF BORING AT 16.5 FT.	

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/26/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-17
MW-09

DATE: 08/08/92

DWG NAME: 026MW-09

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW10 0/0				0-0.5 BROWN SILT, CLAY AND ORGANICS	<p>CEMENT-BENTONITE GROUT</p> <p>2" DIAMETER SCHEDULE 40 PVC RISER</p> <p>BENTONITE SEAL FROM 3 TO 5 FT.</p> <p>10-20 SAND FROM 5 TO 17.5 FT.</p> <p>10' LONG 0.010 SLOT SCHEDULE 40 PVC SCREEN FROM 7 TO 17 FT.</p> <p>10.5 IN. DIAMETER BOREHOLE</p>
0.5-2	MW10 12/2	600	GRD, BTX	0.5-2 MOTTLED BROWN, GRAY-BROWN, ORANGE-BROWN SILT AND CLAY WITH MINOR BLACK ORGANIC NODULES. FIRM, MOIST.		
2-4	MW10 14/4	600		2-4 BECOMING DARK GRAY CLAY. TIGHT, MOIST, HYDROCARBON ODDR.		
4-6				4-6 BECOMING DARK-GREEN-GRAY, HYDROCARBON STAINED SILT AND CLAY. TIGHT, MOIST, HYDROCARBON ODDR.		
6-8	MW10 1/5/6		GRD, BTX	6-8 GREEN-GRAY SILT AND CLAY.		
8-10	MW10 1/0/8			8-10 MOTTLED GREEN-GRAY ORANGE-BROWN SILT AND CLAY.		
10-12	MW10 1/0/10		GRD, BTX	10-12 BECOMING GREEN-GRAY SILT. FIRM, MOIST.		
12-16	MW10 1/1/12			● WATER AT 12 FT. 12-16 MOTTLED GRAY-BROWN, ORANGE-BROWN SILT WITH BLACK TO RED NODULES OR PATCHES FIRM, WET.		
16-17.5	MW10 1/1/14			16-17.5 NO SAMPLE. END OF BORING AT 17.5 FT.		

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/26/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-18
MW-10

DATE: 07/29/92

DWG NAME: 026MW-10

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW11 0	13 10			0-1 SILT AND ORGANICS, SOME CLAY.	<p>CEMENT-BENTONITE GROUT</p> <p>2" DIAMETER SCHEDULE 40 PVC RISER</p> <p>BENTONITE SEAL FROM 2 TO 4 FT.</p> <p>10-20 SAND FROM 4 TO 16.5 FT.</p> <p>10' LONG 0.010 SLOT SCHEDULE 40 PVC SCREEN FROM 6 TO 16 FT.</p> <p>10.5 IN. DIAMETER BOREHOLE</p>
1-2					1-2 INTERLAYERED BROWN, GRAY-BROWN, ORANGE-BROWN SILT AND CLAY, MINOR GRAVEL. TIGHT, MOIST.	
2	MW11 2	300 500			2-9 BECOMING DARK GREEN-GRAY, HYDROCARBON-STAINED SILT AND CLAY. TIGHT, MOIST, HYDROCARBON ODOR.	
4	MW11 4	1300 NH*		K GRD, BTX, RFI-SCAN	● PERCHED WATER AT 7 FT. -WITH FAINT GRAY, ORANGE-BROWN MOTTLING FROM 7 TO 10 FT.	
5	MW11 6	500 1100			9-11 MOTTLED GRAY, ORANGE-BROWN SILT. FIRM, MOIST.	
8	MW11 8	150 300			11 THIN (3" THICK) HORIZON OF ORANGE-BROWN SILT AND CLAY. EXTREMELY TIGHT AND COMPACT, DRY.	
10	MW11 10	20 80		K GRD, BTX	● WATER AT ~ 11.5 FT.	
12	MW11 12	1 1			11-16 GRAY UNIFORM SILT. FIRM, WET.	
14	MW11 14	0 0			16-16.5 NO SAMPLE. END OF BORING AT 16.5 FT.	
15						
20						
25						
30						

* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/26/92-MONITORING WELL
06/27/92-SHELBY TUBE

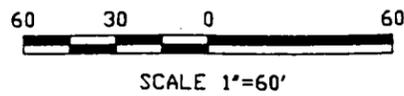
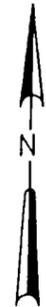


ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

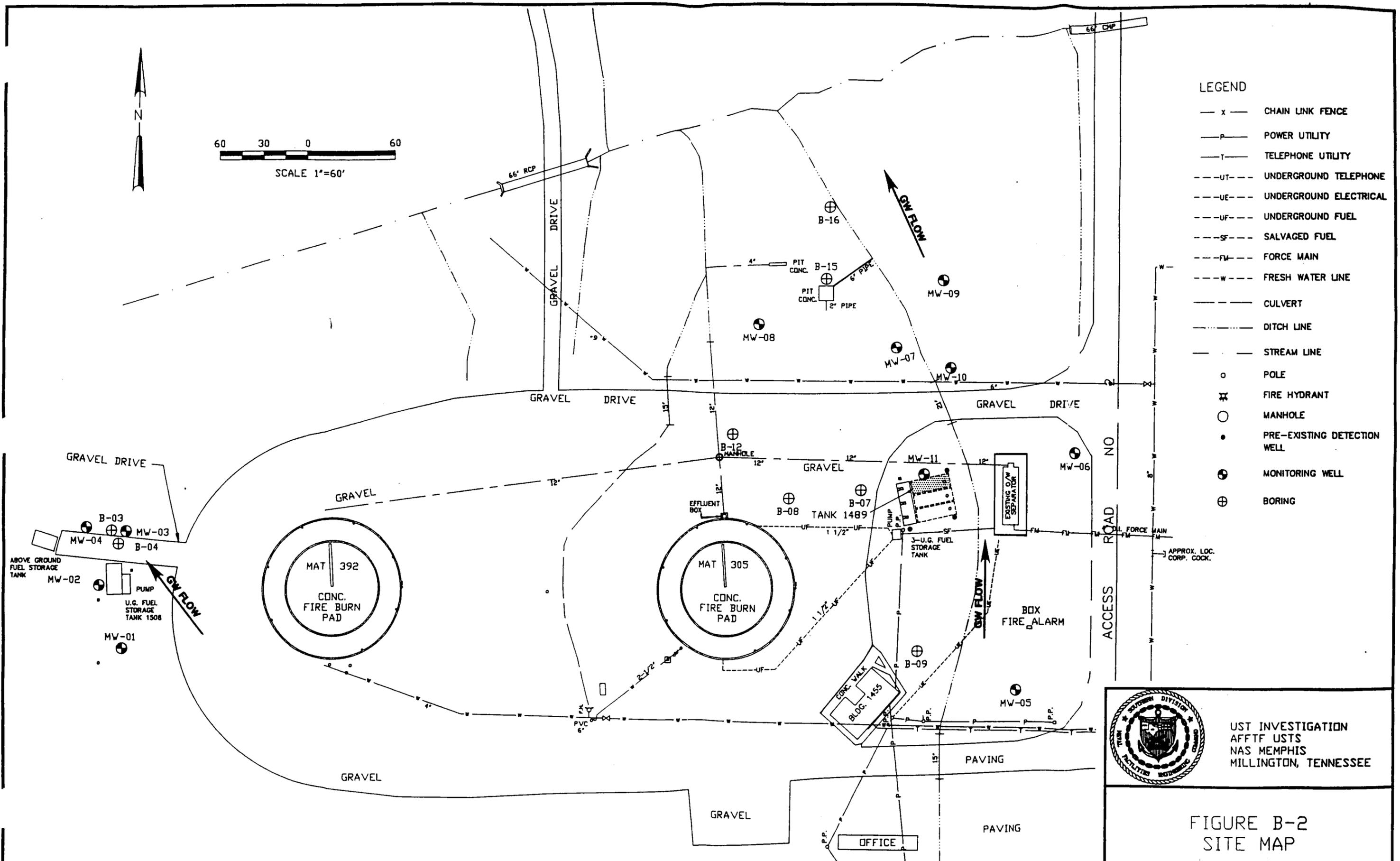
BORING B-19
MW-11

DATE: 08/08/92

DWG NAME: 026MW-11



- LEGEND
- x — CHAIN LINK FENCE
 - P — POWER UTILITY
 - T — TELEPHONE UTILITY
 - - - UT - - - UNDERGROUND TELEPHONE
 - - - UE - - - UNDERGROUND ELECTRICAL
 - - - UF - - - UNDERGROUND FUEL
 - - - SF - - - SALVAGED FUEL
 - - - FM - - - FORCE MAIN
 - - - W - - - FRESH WATER LINE
 - — — CULVERT
 - — — DITCH LINE
 - — — STREAM LINE
 - o POLE
 - ⊕ FIRE HYDRANT
 - MANHOLE
 - PRE-EXISTING DETECTION WELL
 - ⊙ MONITORING WELL
 - ⊕ BORING



UST INVESTIGATION
AFFTF USTs
NAS MEMPHIS
MILLINGTON, TENNESSEE

FIGURE B-2
SITE MAP

APPENDIX B
INTERIM MEASURES FIELD AND ANALYTICAL SUMMARY FOR SWMUs 4 & 5

**NAS MEMPHIS
TECHNICAL MEMORANDUM
SWMUs 4 and 5**

Prepared for:

**ALLISON DREW, RPM
EPA REGION IV**

Prepared by:

**SOUTHERN DIVISION
AND ENSAFE/ALLEN & HOSHALL
5720 SUMMER TREES DRIVE
MEMPHIS, TENNESSEE 38134
(901) 383-9115**

FEBRUARY 23, 1993

TECHNICAL MEMORANDUM

TO: Allison Drew, RPM, EPA Region IV

FROM: Mark Taylor, EIC, SOUTHNAVFACENGCOM

SUBJECT: NAS Memphis RFI — Interim Measures Field and Analytical Summary

DATE: February 23, 1993

INTRODUCTION

Field work for the NAS Memphis Interim Measures activity at the Aircraft Fire Fighting Training Area (FFTA) was conducted by the U.S. Geological Survey (USGS) during October 19-25, 1992 with additional sampling accomplished on December 17, 1992. This work was conducted in support of two planned Military Construction Projects (Firemat Training Mock-Up Facility/Shore Aircraft Fire and Rescue Training Facility [SATF]). The field work was designed to determine if activities at Solid Waste Management Units (SWMUs) 4 and 5 have impacted the soils and sediments in the planned construction areas, and also the potential impact that any contaminants would have on site workers during construction.

FIELD WORK SUMMARY

Field work consisted of drilling 10 shallow soil borings from the surface to the water table. Three subsurface soil samples were collected from each boring and nine sediment samples were collected from the ditches and drainageways that traverse the investigation area. On December 17, five supplemental sediment samples were collected from the drainage ditch upgradient of the investigation area to further characterize the limited portion of SWMU 4 affected by the proposed construction of the SATF.

Each soil boring location was laid out by compass and tape measure consistent with the locations identified on Interim Measures Work Plan (IMWP) Figure 3-5. Minor adjustments had to be made to the location of Boring #3 because it was not possible to position the drill rig directly over the SWMU 4 drainage ditch. The locations of all soil borings are shown in Figure TM-1 (Attachment A) of this technical memorandum.

In accordance with Sections 2.2 and 4.5 of the IMWP, samples were collected from the intervals of 0-2 feet, 5-7 feet, and 10-12 feet below land surface in all the borings except Boring #1 and Boring #10. Boring #1 was the first soil boring drilled and samples were collected from intervals of 0-2 feet, 4-6 feet, and 16-18 feet below land surface to determine the approximate depth that water could be expected to be encountered in each of the subsequent borings. In Boring #10, the deepest sample interval was 11-13 feet below land surface because of an increase in land-surface altitude of approximately 1-2 feet from the location of Boring #9.

In most of the soil borings, visual confirmation of water table intersection occurred in the 10-12 foot sampling interval. Due to the shallow depth of the water table and for consistency, the intermediate samples for analysis were collected from the 5-7 foot range in all borings. Nine sediment samples were collected from the drainage ditches following the methods described in Sections 2.2 and 4.5 of the IMWP. Seven of the sediment sample locations conformed to the locations shown in Figure 4-4 of the IMWP. Two additional sediment samples were collected from a low area parallel to Access Road No. 2 because this appeared to be a pathway for runoff to the SWMU 4 ditch. Five additional locations were sampled in the ditch upgradient of the FFTA. The five additional samples were needed to characterize a limited section of the ditch that will be re-contoured in conjunction with planned construction of the SATF. The locations of all sediment samples are shown in Figure TM-2 (Attachment A).

ANALYTICAL QUALITY ASSURANCE/QUALITY CONTROL SUMMARY

In all, 50 solid-phase environmental samples were collected, including 30 subsurface soil samples, three soil duplicates, one soil matrix spike, one soil matrix spike duplicate, 14 sediment samples, and one sediment duplicate. All samples were shipped under chain of custody by overnight carrier to the Enseco-Rocky Mountain Analytical Laboratory (RMAL) in Arvada, Colorado, for determination of the following RCRA Facility Investigation (RFI) analytes:

- Volatile Organic Compounds (EPA Method 8240)
- Semivolatile Organic Compounds (EPA Method 8270)
- Total Petroleum Hydrocarbons (EPA Method 418.1)
- Total Cyanide (EPA Method 9010)
- Organochlorine Pesticides/PCBs (EPA Method 8080)
- RCRA Part 264, Appendix IX Metals (EPA Method 6010/7000 series)

Quality assurance/quality control protocols were adhered to throughout the investigation as described in the IMWP. In addition to the solid-phase samples listed above, QA/QC included the collection of potable and deionized/organic-free water field blanks, five sets of rinsate blanks, and one trip blank for each of the 13 coolers used to ship samples to the lab. All expendable field sampling supplies (i.e., bottles, preservatives, labels, chain-of-custody forms, and trip blanks) used in the investigation were supplied by RMAL.

Potable and deionized/organic-free water for field blanks were obtained from the NAS Memphis public water system and the Memphis Subdistrict Office of the USGS, respectively. All pertinent data from the field investigation was recorded in a bound field logbook, or on boring logs and specially designed forms for recording field equipment calibration and data results.

INTERIM MEASURES FIELD INVESTIGATION DATA SUMMARIES

Tables TM-1 through TM-5 (Attachment B) summarize validated positive results for volatile organic compounds, semivolatile organic compounds, pesticides, total petroleum hydrocarbons, and inorganic analytical data, respectively.

Tables TM-1 and TM-2 indicate that the only significant hits for volatile and semivolatile organic compounds were outside the area where the proposed fire mat will be physically located. Petroleum constituents were detected in samples from Boring #10 at depths of 5 feet and greater. As Figure TM-1 illustrates, Boring #10 is located southwest of the proposed area of construction.

Boring #10 was also the only boring with positive results for total petroleum hydrocarbons (TPH), as shown in Table TM-3. At the mid-boring interval of 5 to 7 feet, a concentration of 1,010 mg/kg TPH was obtained. Other significant TPH hits were obtained in sediment samples in the SWMU #4 ditch east of the FFTA (samples IM-M-6-0, IM-M-6R-0, and IM-M-10-0) and in a side ditch leading from the existing fire mat area to SWMU #4 (sample IM-M-5-0). Sample IM-M-6R-0 was a set of duplicate samples collected during the second sampling event to check the accuracy of the original sample from that location. Sample results were approximately 50 percent lower for the second sampling event. The presence of TPH in these ditches could be attributable to ongoing training activities at both the FFTA and the Carrier Deck FFTA which is northeast of SWMU #5. TPH was not detected in the sediment sample (IM-M-9-0) which was collected farthest downstream toward Big Creek.

Dieldrin was detected near the surface in 8 of 10 borings and in two sediment samples. Its widespread presence near the surface is a result of soil treatment around runways in the early 1970s. The treatment was part of a U.S. Department of Agriculture (USDA) quarantine program aimed at controlling the spread of white fringed beetles. The presence of dieldrin should be prevalent over the entire north side of NAS Memphis due to aerial application of this pesticide during the USDA program. Of the contaminants detected at the site, construction workers are more likely to be exposed to dieldrin because of its presence near the surface. The presence of dieldrin may not be a significant problem because the area of construction is lower than the rest of the FFTA, so excavation activities should be limited, if required at all. A more likely scenario is bringing in fill material to raise the elevation of the new fire mat, decreasing the likelihood of exposure.

To further evaluate the risk of dieldrin exposure, a risk calculation (Attachment C) was performed for ingestion and dermal contact of dieldrin in an industrial area assuming a 25-year duration (260 days/year). The amount of dieldrin required in an air pathway exposure (soil suspended in air) that would exceed the PEL for a worker equals 287 grams/m³ (assumes 100 percent transfer to the bloodstream). This worst-case exposure concentration should not occur. However, engineering controls such as dust suppression or real-time air monitoring could be implemented to protect workers, if deemed necessary by a health and safety professional.

Results of inorganic analyses for metals and cyanide are summarized in Table TM-5. In general, concentrations were higher in the sediment samples than in the subsurface samples. However, a literature search indicates that all of the values are within the range of typical concentrations found in uncontaminated soils. The values for inorganic analytes were also compared to the RCRA Subpart S action levels in 40 CFR Part 264.521(a)(2)(i-iv). With the exception of beryllium, all values were well below their respective action levels. All of the beryllium values exceeded the 0.2 mg/kg action level for soil. Naturally occurring levels of beryllium could easily exceed this low action level. All but one of the beryllium values reported for the Interim Measure samples were less than 1 mg/kg which is well within the typical range of 0 to 5 mg/kg beryllium found in uncontaminated soils (*Criteria for Contaminated Soil/Sediment Cleanup*, J. Fitchko, 1989). Soil samples from the Interim Measure Investigation at SWMU 1 had similar beryllium concentrations. Therefore, the beryllium that was reported for samples from SWMUs 4 and 5 is believed to be naturally occurring.

CONCLUSIONS AND RECOMMENDATIONS

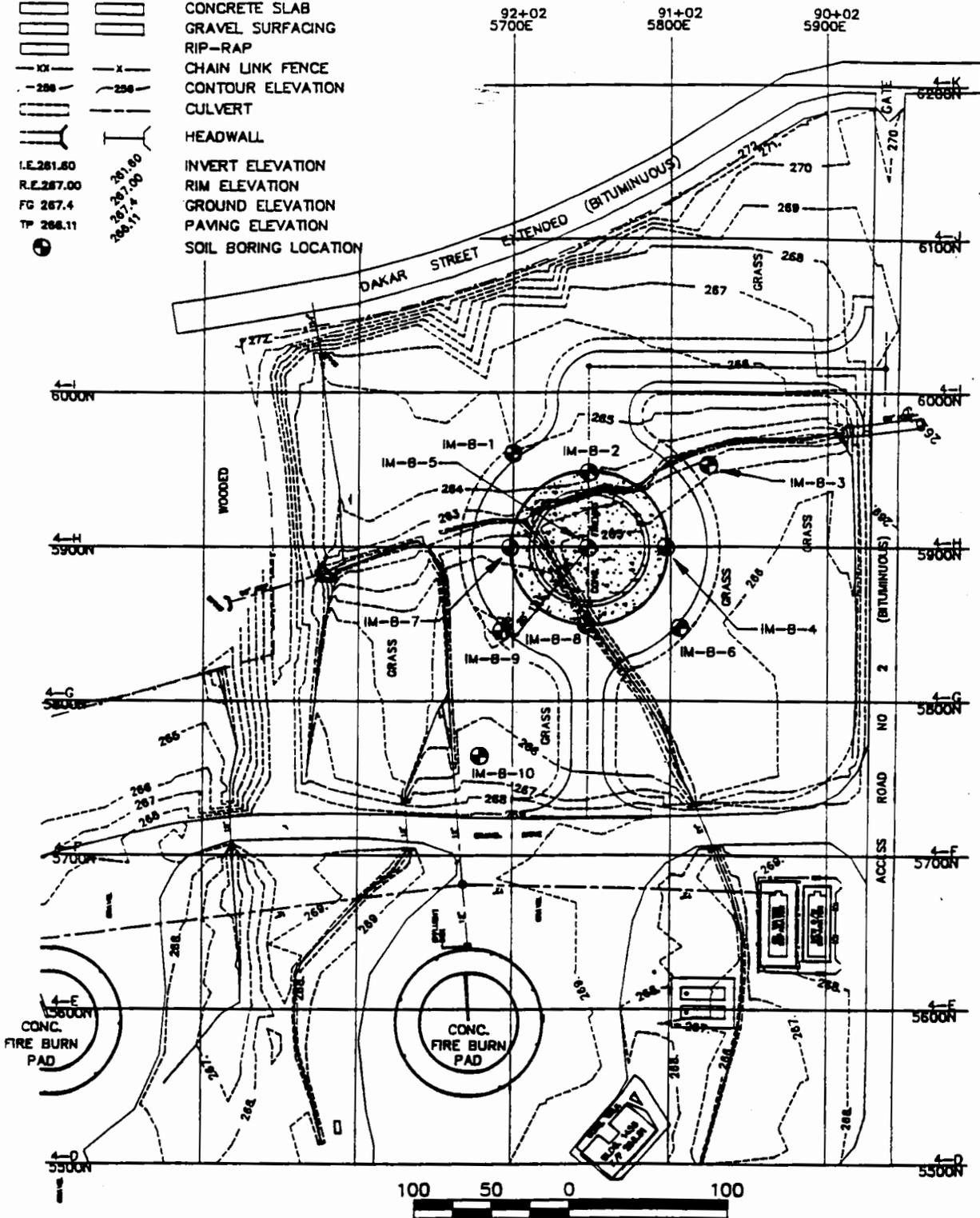
After reviewing the data generated from the Interim Measures Investigation, SOUTHDIV does not feel that workers involved in construction of the additional fire mat and SATF will be exposed to adverse health risks from surficial contamination in the areas proposed for construction. SOUTHDIV believes the risk is low because construction of the new fire mat will be more likely to require filling in low areas than excavating new areas. Also, the SATF will fill approximately 400 feet of SWMU 4, and a new ditch will be constructed to reroute storm water. Therefore, SOUTHDIV recommends that no further action be required in the Interim Measures Investigation area and all data generated under this investigation be cataloged as supplemental data for use in the RFI for SWMUs 4 and 5. Corrective measures, if any, should be included with those for the entire site following complete RFI characterization.

ATTACHEMENT A

Figures

LEGEND

NEW	EXISTING	DESCRIPTION
		BUILDING
		PAVING
		WALK
		CONCRETE SLAB
		GRAVEL SURFACING
		RIP-RAP
		CHAIN LINK FENCE
		CONTOUR ELEVATION
		CULVERT
		HEADWALL
I.E. 261.60		INVERT ELEVATION
R.E. 267.00		RIM ELEVATION
FG 267.4		GROUND ELEVATION
TP 266.11		PAVING ELEVATION
		SOIL BORING LOCATION



INTERIM MEASURE
 TECHNICAL MEMO
 NAS MEMPHIS
 MILLINGTON, TENNESSEE

FIGURE TM-1
 INTERIM MEASURE
 SOIL BORING
 LOCATION MAP

ATTACHEMENT B

Data Summary Tables

NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-1 Summary of Validated Positive Results Volatile Organic Compounds (mg/kg)									
	Sample IM-B-1-0 (0-2 ft)	Sample IM-B-1-4 (4-6 ft)	Sample IM-B-1-16 (16-18 ft)	Sample IM-B-6-0 (0-2 ft)	Sample IM-B-6-5 (5-7 ft)	Sample IM-B-7-5 (5-7 ft)	Sample IM-B-10-5 (5-7 ft)	Sample IM-B-10-11 (11-13 ft) (duplicates)	Sample IM-M-8-0 (Sediment)
Acetone	4.60		0.35	0.34	0.22	0.96	6.70	0.43/0.15	
Benzene							5.20	0.17/0.10	
1,1-Dichloroethene						0.27/0.29 MS/MSD			
1,2-Dichloroethene									0.10
Xylenes (total)		0.52					14.00		

Table TM-2 Summary of Validated Positive Results Semivolatile Organic Compounds (mg/kg)			
	Sample IM-B-10-5 (5-7 ft)	Sample IM-B-10-11 (11-13 ft) (duplicates)	Sample IM-M-2-0 (Sediment)
Naphthalene	10.00		
2-Methylnaphthalene	44.00	1.20/ND	
Benzo(b)fluoranthene			1.80
Fluoranthene			2.30

NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-3 Summary of Validated Positive Results Total Petroleum Hydrocarbons (mg/kg)		
Sample I.D. Number	Sample Depth	TPH Concentration
IM-B-10-5	5-7 ft	1,010
IM-B-10-11 (duplicates)	11-13 ft	33.1/ND
IM-M-1-0	Sediment	23.0
IM-M-2-0	Sediment	28.6
IM-M-3-0	Sediment	29.7
IM-M-4-0	Sediment	45.4
IM-M-5-0	Sediment	292
IM-M-6-0	Sediment	660
IM-M-6R-0 (duplicates)	Sediment	279/332
IM-M-7-0	Sediment	50.9
IM-M-10-0	Sediment	261
IM-M-11-0	Sediment	43.9
IM-M-12-0	Sediment	32.1

NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-4 Summary of Validated Positive Results Pesticides (mg/kg)			
Sample I.D. Number	Sample Depth	Dieldrin Concentration	Data Qualifier
IM-B-1-0	0-2 ft	0.31	V
IM-B-2-0	0-2 ft	0.78	V
IM-B-2-5	5-7 ft	0.07	V
IM-B-3-0	0-2 ft	1.0	V
IM-B-5-0	0-2 ft	0.14	
IM-B-5-5	5-7 ft	0.04	
IM-B-6-0	0-2 ft	0.24	
IM-B-6-5	5-7 ft	0.07	
IM-B-7-0	0-2 ft	0.46	
IM-B-7-5 (MS/MSD)	5-7 ft	0.11/0.10	
IM-B-7-5	5-7 ft	0.10	
IM-B-10-0	0-2 ft	0.48	
IM-M-1-0	Sediment	3.0	
IM-M-2-0	Sediment	1.4	

V = Second column value

Dieldrin was only pesticide detected.

NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-5 (1 of 3) Summary of Validated Positive Results Inorganic Analytical Data (mg/kg)									
	Sample IM-B-1-0 (0-2 ft)	Sample IM-B-1-4 (4-6 ft)	Sample IM-B-1-16 (16-18 ft)	Sample IM-B-2-0 (0-2 ft)	Sample IM-B-2-5 (5-7 ft)	Sample IM-B-2-10 (10-12 ft)	Sample IM-B-3-0 (0-2 ft)	Sample IM-B-3-5 (5-7 ft)	Sample IM-B-3-10 (10-12 ft)
Lead	6.2	7.3	6.2	19.0	6.2	6.2	19.3	6.3	5.2
Nickel	14.0	12.6	8.9	17.2	12.9	17.3	12.8	22.9	11.7
Silver	1.1			1.2				1.2	
Arsenic		0.57	0.57		1.8	9.7		4.6	6.0
Barium	154	173	58.4	273	158	152	146	276	76.1
Beryllium	0.51	0.66	0.27	0.95	0.57	0.36	0.51	0.49	0.27
Cadmium	0.61						0.87	0.78	
Chromium	12.0	12.0	6.4	10.3	11.8	9.4	14.5	9.8	8.8
Cobalt	6.6	2.5	4.9	7.3	2.3	5.0	5.5	7.8	3.8
Copper	17.8	11.2	7.7	11.3	10.4	11.3	12.8	12.9	9.7
Vanadium	18.4	8.6	10.6	21.5	12.0	14.5	15.9	17.9	11.5
Zinc	46.5	61.3	31.4	47.9	53.3	47.9	53.4	53.2	33.8

NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-5 (2 of 3) Summary of Validated Positive Results Inorganic Analytical Data (mg/kg)									
	Sample IM-B-5-0 (0-2 ft)	Sample IM-B-5-5 (5-7 ft)	Sample IM-B-5-10 (10-12 ft)	Sample IM-B-6-0 (0-2 ft)	Sample IM-B-6-5 (5-7 ft)	Sample IM-B-6-10 (10-12 ft)	Sample IM-B-7-0 (0-2 ft)	Sample IM-B-7-5 (5-7 ft) (MS)	Sample IM-B-7-5 (5-7 ft)
Mercury								0.57	
Lead	14.4	10.6	7.8	12.3	14.8	3.9	22.6	9.5	7.4
Nickel	13.8	11.4	16.5	22.5	13.5	11.6	11.1	57.3	13.8
Silver	1.0								
Arsenic	5.7	1.5	6.8	3.7	4.1	1.5	5.9	3.1	
Barium	194	153	178	273	175	92.5	148	298	125
Beryllium	0.72	0.54	0.38	0.75	0.59	0.38	0.60	5.0	0.47
Cadmium				0.76			0.97	5.1	
Chromium	9.6	11.4	9.2	12.3	12.2	10.4	10.7	29.4	11.2
Cobalt	6.8	4.0	8.8	7.4	5.4	3.2	4.5		2.5
Copper	11.1	10.7	11.8	12.7	13.1	8.6	10.7	30.9	8.8
Vanadium	19.7	12.0	16.4	19.6	14.7	10.8	18.1	57.1	12.0
Zinc	44.5	53.2	44.2	58.4	58.8	47.3	50.9	90.7	47.8

NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-5 (3 of 3)
Summary of Validated Positive Results
Inorganic Analytical Data
(mg/kg)

	Sample IM-B-10-0 (0-2 ft)	Sample IM-B-10-5 (5-7 ft)	Sample IM-B-10-11 (11-13 ft) Duplicates	Sample IM-M-1-0 (Sediment)	Sample IM-M-2-0 (Sediment)	Sample IM-M-3-0 (Sediment)	Sample IM-M-4-0 (Sediment)	Sample IM-M-5-0 (Sediment)	Sample IM-B-6-0 (Sediment)	Sample IM-B-7-0 (Sediment)
Cyanide									3.6	
Mercury									0.62	0.20
Tin		249					94.6	450		
Lead	14.9	5.9	6.2/5.8	44.0	25.2	31.2	39.0	18.8	63.7	66.6
Nickel	7.2	33.1	11.2/10.5	10.2	11.2	11.5	22.0	47.0	32.8	14.9
Silver										
Arsenic	4.6	8.3	1.4/2.1	5.7	6.9	3.6	3.5	1.9	12.2	5.3
Barium	80.3	201	35.5/33.2	105	111	162	235	200	196	106
Beryllium	0.50	0.45	0.25/0.23	0.44	0.47	0.56	0.59	0.61	0.61	0.43
Cadmium						0.82	1.0	2.3	5.7	4.8
Chromium	5.9	44.8	6.7/6.9	8.0	8.0	10.3	25.5	83.5	25.6	18.7
Cobalt	4.4	4.7	3.7/3.1	3.9	4.8	4.0	4.1	2.9	19.9	4.8
Copper	8.7	11.4	9.1/9.8	11.1	11.2	16.7	28.6	29.0	21.4	21.4
Vanadium	13.7	17.6	11.1/12.7	14.9	16.1	15.3	14.5	10.1	22.8	12.6
Zinc	25.9	34.3	29.5/33.2	63.0	49.9	82.2	85.1	96.2	170	80.5

ATTACHMENT C

Risk Calculation

**TABLE 1 - SOIL EXPOSURE RISK (HAZARD INDEX)
UNDER A INDUSTRIAL/COMMERCIAL EXPOSURE SCENARIO
NAS - MEMPHIS, MEMPHIS, TENNESSEE**

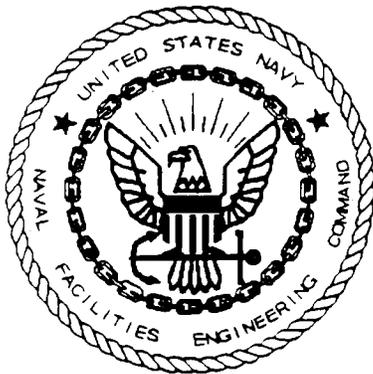
PARAMETER	SLOPE FACTOR ORAL (MG/KG/DAY) ⁻¹	REFERENCE DOSE ORAL (MG/KG/DAY)	CANCER RISK @ AVERAGE	CANCER RISK @ MAXIMUM	HAZARD INDEX @ AVERAGE	HAZARD INDEX @ MAXIMUM	AVERAGE SOIL CONCENTRATION (0 TO 3 FEET) (MG/KG)	MAXIMUM SOIL CONCENTRATION (0 TO 3 FEET) (MG/KG)
PESTICIDES								
Dieldrin	18	0.0005	8.22E-06	2.12E-05	1.20E-02	4.48E-04	0.87	3

NOTE: RD and Slope Factor (a.k.a. Cancer Potency Factor) values obtained from NIS and/or HEAST (1991 & 1992); IRIS Search Date 1/18/93.
 Inhalation exposure is not a factor for these parameters; inhalation exposure pathway risk is not considered appropriate due to the non-volatility (or limited volatility) of the compounds in the soil earth and state.
 The highest concentration of each parameter detected in site soils (at a depth of three feet or less) and the average concentrations was used to compute risk (or hazard quotient); average was computed on the basis of positive results only.
 Exposure assumed to be similar in nature to an agricultural scenario, therefore a daily ingestion of 100 mg soil was assumed at a frequency of 200 days/year.

**TABLE 2 - AIR PATHWAY EXPOSURE EVALUATION
REQUIRED MASS OF SOIL TO EXCEED TLVs
PARTICULATES - NOT OTHERWISE REGULATED
NAS - MEMPHIS
MEMPHIS, TENNESSEE**

SOURCE CONSTITUENT	SOIL AVERAGE CONCENTRATION (UG/KG)	THRESHOLD LIMIT VALUE (MG/M3)	PEL TLV DESIGNATION OR QUALIFIER	SUSPENDED SOIL REQUIRED TO EXCEED PEL (MG/M3)	(GRAMS/M3)	COMPUTED LIGHT OBSCURATION (%)
PESTICIDES/PCBS (UG/KG)						
Dieldrin	870.0	0.25	TWA	2.67E+05	2.67E+02	88.2000

APPENDIX C
SITE SPECIFIC HEALTH AND SAFETY PLAN

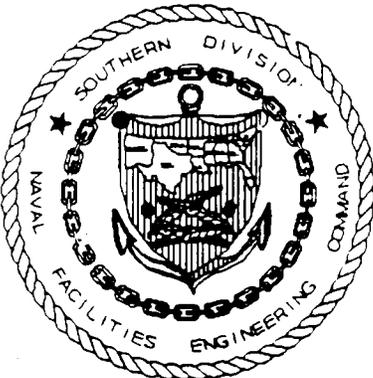


**COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY
NAVAL AIR STATION
MEMPHIS, TENNESSEE**

**SITE-SPECIFIC HEALTH AND SAFETY PLAN
SWMUs 4, 6, 10, 31, 38 — DRAINAGE DITCH
AREAS**

Prepared for:

**SOUTHDIV CONTRACT NUMBER:
N62467-89-D-0318
CTO-016**



Prepared by:

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January 3, 1995

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Attachments

- Attachment A Material Safety Data Sheets
- Attachment B Directions to Emergency Medical Facilities
- Attachment C Health and Safety Plan Forms

1.0 INTRODUCTION

A RCRA Facility Investigation (RFI) is being conducted at the miscellaneous Drainage Ditch Areas (SWMUs 4, 6, 10, 31, and 38) located at the Naval Air Station Memphis (NAS Memphis), Millington, Tennessee. The purpose of the monitoring program is to assess the nature and extent of potential contamination at the site and to determine if additional action is required to maintain compliance with environmental regulations.

This Site-Specific Health and Safety Plan (SSHSP) is written for field operations to be conducted at SWMUs 4, 6, 10, 31, and 38. This plan is to be used in conjunction with the approved NAS Memphis Comprehensive Health and Safety Plan (CHASP). Copies of both this plan and the CHASP should be onsite during all field operations. The Navy project contract number with EnSafe/Allen & Hoshall (E/A&H) is N62467-89-D-0318, CTO-094.

Applicability

See CHASP Section 7.0.

Current Hazardous Waste and Emergency Response Operators (HAZWOPER) training certificates for E/A&H and U.S. Geological Survey (USGS) employees and all subcontractors anticipated to be conducting field work onsite will be filed onsite and available for review. Individuals whose certifications are not on file, or those who have a more recent certificate (have attended a refresher course), will provide the Site Supervisor with a copy of their certificate before being allowed to enter a work area.

Current OSHA refresher training certificates will be available onsite for all employees involved in field activities if their refresher course requirements come up for renewal before the project begins. All subcontractors, Navy oversight personnel, and any other site visitors must provide health and safety certification with appropriate refresher course documentation prior to site entry.

2.0 SITE CHARACTERIZATION

2.1 Site Descriptions

SWMU 4 originates as a storm sewer at Building N-121 and runs westerly along Casablanca Road to First Avenue, then southwesterly to a section of open drainage ditch which eventually discharges into SWMU 38 (Industrial Drainage Ditch).

SWMU 6 originates as a storm sewer at Building N-126 and flows southwesterly along the apron of Runway 04, turns due west at the end of the apron into a section of open drainage ditch. This ditch runs through SWMU 10 (Demolition/Construction Debris Landfill) which discharges into SWMU 38 (Industrial Drainage Ditch).

SWMU 10 (Demolition/Construction Debris Landfill) is located north of the existing Fire Fighting Training Facility (SWMU 5) and south of the main runway. Although the specific boundaries of the landfill are unknown, it is suspected to cover 13- to 20-acres. SWMU 10 was originally designated as a "No Further Action" site due to the presumed nature of the landfill. Sediment sampling along the junction of SWMU 6 where SWMU 10 has shown signs of erosion and old debris have been uncovered has now become one point of the investigation.

SWMU 31 (Aircraft Wash Rack) is located at the intersection of Funafuti Street and 4th Street, just southeast of building N-126. The unit is structurally sound and is presently serviceable, but does not appear to be routinely used.

SWMU 38 is a series miscellaneous drainage ditches of concern in the industrial area which encompasses a major part of the northern portion and a small part of the southern portion of the base. The original design of a number of buildings at NAS Memphis (circa 1943) provided for floor drains which discharged to storm sewers and storm drains. As buildings were remodeled and replaced, these drains were eliminated or re-routed to the sanitary sewer. By 1980, most

had been replaced. It is believed that various substances, including solvents, degreasers, oils, and paints, may have been discharged to the drainage ditches in the past.

2.2 Work Areas

See Section 7.1.1 of the CHASP for a description of the following work zones:

- Exclusion Zone (EZ)
- Contaminant Reduction Zone (CRZ), and
- Support Zone (SZ).

For a description of field activities to be conducted at the site and within each work area see the Site Investigation Plan (SIP).

2.3 Work Area Access

Authorized personnel will be allowed access to work areas as long as they follow the requirements of this SSHSP and the CHASP. See also Work Area Access, Section 7.1.2 of the CHASP.

2.4 Site Map and Work Zones

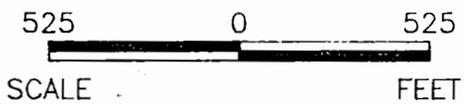
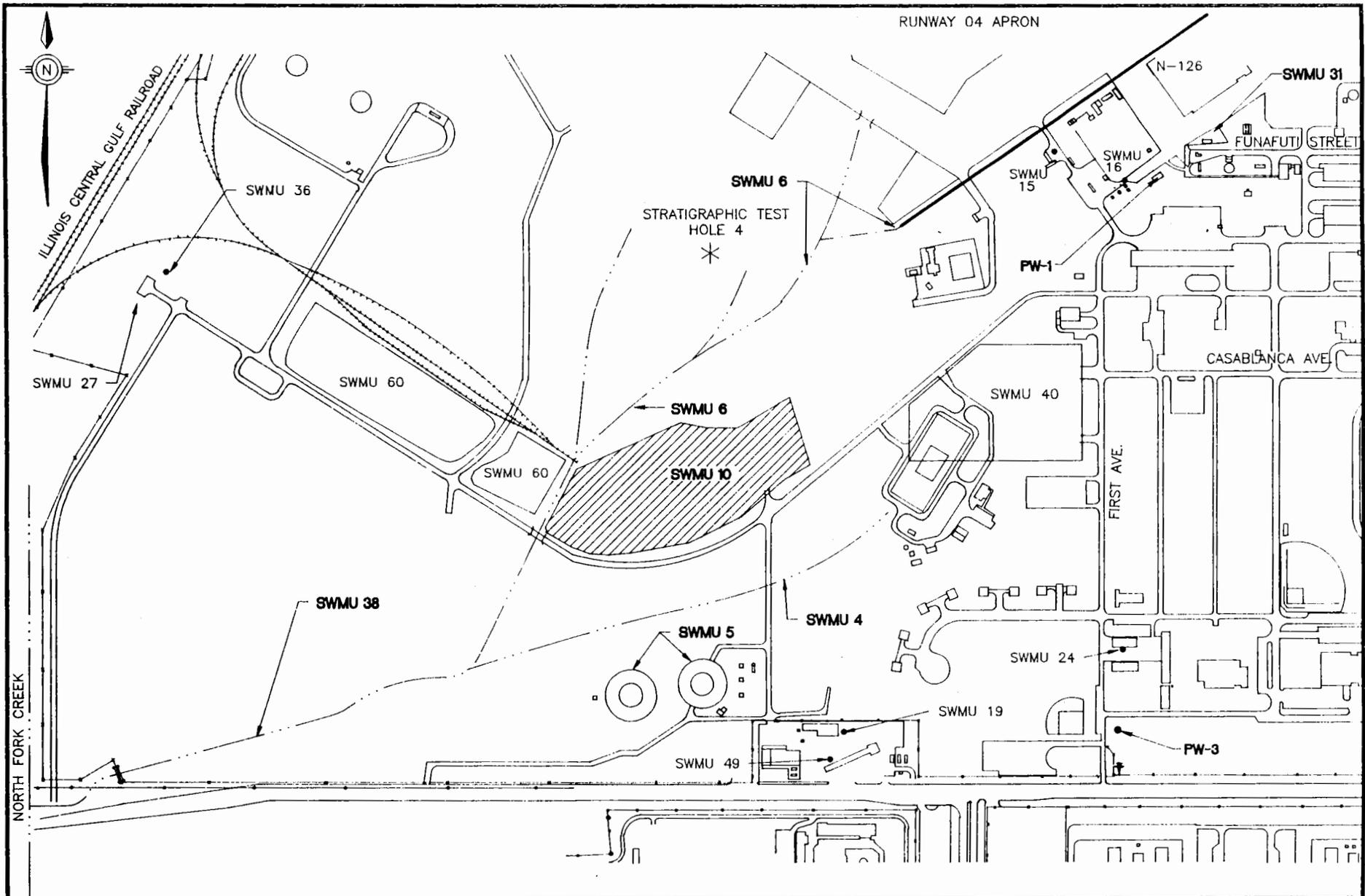
The location and layout of the sites are shown in Figure 1, the vicinity map. The EZ, CRZ, and SZ locations will be based on physical layout of the site, work task requirements, and current meteorological conditions.

3.0 SITE ACTIVITIES

Site activities will include soil and sediment sampling. Subsequent activities may include monitoring well installations, well development, purging, and sampling as required. Field methods are described in the *Comprehensive RFI Work Plan*.

*RFI Work Plan
Naval Air Station Memphis
Site-Specific Health and Safety Plan — SWMUs 4, 6, 10, 31 and 38
January 3, 1995*

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RFI WORKPLAN
 NAS MEMPHIS
 MILLINGTON, TENNESSEE

FIGURE 1
 VICINITY MAP
 SWMUs 4, 6, 10, 31 AND 38

DWG DATE: 03/13/95 DWG NAME: 16MEM009

4.0 CHEMICAL HAZARDS

The site history suggests a potential for exposure to chemicals. Table 4-1 lists exposure guidelines for potential site chemicals.

Table 4-1 Exposure Guidelines For Expected Site Chemical Hazards						
Chemical Name	Odor ^(a) Threshold (ppm)	OSHA PEL ^(b) (ppm)	ACGIH TLV ^(c) (ppm)	NIOSH REL ^(d) (ppm)	Auto-ignition Temp.(°F)	Flammable range (% by volume)
Toluene	40	100 150 STEL	50	100 150 STEL	996.5	1.3 to 7.1%
Ethylbenzene	140	100 125 STEL	100 125 STEL	N.A.	860	1.0 to 6.7%
Benzene	4.68	1 5 STEL	0.1 Confirmed Human Carc.	0.1 1 STEL Potential Occupational Carcinogen	1097	1.3 to 7.1%
Xylene	Not Listed	100 150 STEL	100 150 STEL	100 150 STEL	Not Listed	1.0 to 7.0%
Chromium	N.A.	1 mg/m ³	0.5 mg/m ³	Not Listed	N.A.	N.A.
Cadmium	N.A.	0.005 mg/m ³	0.05 mg/m ³	Lowest Feasible (Potential Human Carc.)	N.A.	N.A.
Copper	N.A.	1 mg/m ³	1 mg/m ³	Not Listed	N.A.	N.A.
Nickel	N.A.	1 mg/m ³	1 mg/m ³	0.015 mg/m ³	N.A.	N.A.
Potassium Cyanide	N.A.	5 mg/m ³	5 mg/m ³ Skin	5 mg/m ³ Skin	N.A.	N.A.
Sodium Cyanide	N.A.	5 mg/m ³	5 mg/m ³ Skin	5 mg/m ³ Skin	N.A.	N.A.
Trichloroethane (Methyl Chloroform)	100 ppm	350 ppm 450 STEL	350 ppm 450 STEL	350 ppm Ceiling	1490 °F	7% to 16%

Notes:

- ^a Odor Thresholds for Chemicals with Established Occupational Health Standards, American Industrial Hygiene Association, 1989. Range of All Reference Values
 - ^b 29 CFR 1910.1000, Table Z-1-A. Limits For Air Contaminants, as amended through 1/15/91. (PEL = Permissible Exposure Limit)
 - ^c 1990-1991 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference for Governmental Industrial Hygienist. (STEL = Short Term Exposure Limit)
 - ^d NIOSH Pocket Guide to Chemical Hazards, June 1990. (REL = Recommended Exposure Limit)
- N.A. = Substance information not available, or substance unlisted.
NIOSH = National Institute of Occupational Safety and Health.

Material Safety Data Sheets (MSDS) for these materials are included in Attachment A.

5.0 OPERATIONS AND PHYSICAL HAZARDS

Physical hazards typically encountered during environmental investigations will be present at this site. These hazards include heat and cold-related illnesses, uneven terrain, slippery surfaces, lifting, and use of heavy equipment. The Site Supervisor and Site Health and Safety Officer shall be aware of the potential for heat and/or cold stress and other weather-related illnesses, and as necessary, implement appropriate work regimens to minimize the likelihood of field personnel becoming ill or injured.

Heavy equipment and drill rig operations will be conducted in accordance with the procedures outlined in the CHASP, Attachment A, Drilling Safety Guide. When conducting operations or survey work on foot, personnel will walk at all times. Running greatly increases the probability of slipping, tripping, and falling. If working in areas supporting habitat for poisonous snakes, personnel should wear protective chaps made of a heavy material designed to prevent snake bites to the legs.

6.0 EMPLOYEE PROTECTION

Employee protection for this project includes standard safe work practices, NAS Memphis rules of conduct, personal protective equipment (PPE), personal decontamination procedures, and equipment for extreme weather conditions, work limitations, and exposure evaluation.

6.1 Standard Safe Work Practices

- Eating, drinking, chewing gum or tobacco, smoking, or any activity that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited in any area designated as contaminated, unless authorized by the Site Health and Safety Officer.
- Hands and face must be thoroughly washed upon leaving the work area.

- No contact lenses will be worn in work areas while invasive actions are conducted.

- Whenever decontamination procedures for outer garments are in effect, the entire body should be thoroughly washed as soon as possible after the protective garment is removed.

- Contact with contaminated or suspected contaminated surfaces should be avoided. Whenever possible, do not walk through puddles, leachate or discolored surfaces, or lean, sit, or place equipment on drums, containers, or on soil suspected of being contaminated.

- Medicine and alcohol can exacerbate the effects from exposure to toxic chemicals. Prescribed drugs should not be taken by personnel on cleanup or response operations where the potential for absorption, inhalation, or ingestion of toxic substances exists unless specifically approved by a qualified physician. Consumption of alcoholic beverages is prohibited.

- Due to the possible presence of overhead power lines, adequate side and overhead clearance should be maintained to ensure that the drill rig boom does not touch or pass close to any overhead lines.

- Due to the possible presence of underground utilities (including electric, natural gas, water, sewer, telephone, etc.), the activity and local utility representatives should be contacted and requested to identify all lines at the ground surface using characteristic spray paint or labeled stakes. A 3-yard buffer zone should be maintained during all subsurface investigations.

- Due to the flammable properties of the potential chemical hazards, all spark or ignition sources should be bonded and/or grounded or mitigated before soil boring advancement or other site activities begin.

6.2 NAS Memphis General Rules of Conduct

- Liquor, firearms, narcotics, tape recorders, and other contraband items are not permitted on the premises.
- Any violation of local, state, or federal laws, or conduct which is outside the generally accepted moral standards of the community is prohibited.
- Violation of the Espionage Act, willfully hindering or limiting production, or sabotage is not permitted.
- Willfully damaging or destroying property, or removing government records is forbidden.
- Misappropriation or unauthorized altering of any government records is forbidden.
- Securing government tools in a personal or contractors tool box is forbidden.
- Gambling in any form. selling tickets or articles, taking orders, soliciting subscriptions, taking up collections, etc. is forbidden.
- Doing personal work in government shop or office, using government property or material for unauthorized purposes, or using government telephones for unnecessary or unauthorized local or long distance telephone calls is forbidden.

- Compliance with posted signs and notices is required.

- Boisterousness and noisy or offensive work habits, abusive language, or any verbal, written, symbolic, or other communicative expression which tends to disrupt the work or morale of others is forbidden.

- Fighting or threatening bodily harm to another is forbidden.

- Defacing any government property is forbidden.

- Wearing shorts of any type and/or offensive logos, pictures, or phrases on clothing is forbidden. Shirts, shoes and pants or slacks, or coverall-type garments will be worn at all times on government property.

- All persons operating motor vehicles will obey all NAS Memphis traffic regulations.

6.3 Selection of Personal Protective Equipment

It is important that PPE be appropriate to protect against the potential or known hazards at each cleanup or investigation site. Protective equipment will be selected based on the types, concentrations, and routes of personal exposure that may be encountered. In situations where the types of materials and possibilities of contact are unknown or the hazards are not clearly identifiable, a more subjective determination must be made of the PPE required, based on past experiences and sound safety practices.

The Project Health and Safety Officer will determine the appropriate level of PPE prior to the initial entry based on the best available information. PPE requirements are subject to change as site information is updated or changes. **The decision to upgrade or downgrade levels of PPE shall be made by the Project Health and Safety Officer.**

Field activities which disturb soils will be initiated in modified Level D protection except when stated otherwise in the SSHSP or when site conditions (e.g., sampling results from previous studies) indicate that modified Level D is inappropriate. Modified Level D protection consists of a hard hat, appropriate chemical-resistant gloves (vinyl or nitrile), eye protection, and chemical-resistant, steel-toed and shank boots. Work coveralls (full length sleeves and pants) will be worn if free product or contaminants identified as skin irritants are encountered. This level of protection was selected because the levels of contamination detected in previous studies were low and free product was not detected.

PPE upgrades to Level C will be initiated if airborne concentrations exceed 2 ppm above the background concentration in the breathing zone or if the concentration of any contaminant exceeds 50 percent of the OSHA Permissible Exposure Limit (PEL). See Table 6-1 for the specific criteria for use and equipment for each level of protection.

Table 6-1 Level Of Protection And Criteria		
Level of Protection	Criteria for Use	Equipment
Level A	<ul style="list-style-type: none"> • When atmospheres are "immediately dangerous to life and health" (IDLH in the NIOSH/OSHA Pocket Guide to Chemical Hazards or other guides.) • When known atmospheres or potential situations exist that would affect the skin or eyes or be absorbed into the body through these surfaces. Consult standard references to obtain concentrations hazardous to skin, eyes, or mucous membranes. • Potential situations include those where immersion may occur, vapors may be generated, or splashing may occur through site activities. • Where atmospheres are deficient oxygen with the conditions above • When the type(s) and or potential concentration of toxic substances are not known 	<ul style="list-style-type: none"> • Positive pressure-demand full facepiece; self-contained breathing apparatus (SCBA) or positive pressure-demand supplied air respirator with escape SCBA • Totally encapsulating chemical protective suit • Chemical-resistant inner and outer gloves • Steel-toe-and-shank chemical resistant boots • Hard hat under suit • Two-way radios worn inside suit • Coveralls, long cotton underwear, disposable protective suit, gloves and boots, worn over fully encapsulating suit

Table 6-1 Level Of Protection And Criteria		
Level of Protection	Criteria for Use	Equipment
Level B	<ul style="list-style-type: none"> • When work areas contain less than 19.5 percent oxygen • When vinyl chloride is detected in the breathing zone 	<ul style="list-style-type: none"> • Chemical resistant clothes, long sleeves, hooded, one or two pieces • Full-faced positive-pressure demand supplied air breathing apparatus or airline system with a 30-minute escape bottle • Hard hat • Inner gloves and chemical resistant gloves • Steel-toe-and-shank boots • Coveralls and disposable outer boots
Level C	<ul style="list-style-type: none"> • When airborne dust particles warrant respiratory protection • When work areas contain at least 19.5 percent oxygen 	<ul style="list-style-type: none"> • Chemical resistant clothes, long sleeves, hood optional, one or two pieces • Full-face piece, air purifying respirator equipped with cartridges suitable for the hazard • Hard hat • Inner gloves and chemical resistant gloves • Steel-toe-and-shank boots • Coveralls and disposable outer boots
Level D	<ul style="list-style-type: none"> • When level B or C is not indicated • When airborne particles do not warrant respiratory protection • When work areas contain at least 19.5 percent oxygen 	<ul style="list-style-type: none"> • Inner gloves and chemical-resistant gloves needed to handle soil or water samples • Steel-toe-and-shank boots • Hard hat (ANSI Z89.1-1969 standard) • Eye protection (ANSI Z87.1-1968) standard • Sunscreen (SPF 15 or greater) • Coveralls and disposable outer boots

Notes:

Level A protection will be selected when the highest available level of respiratory, skin, and eye protection is needed. Level A protection will be required in Area A of the exclusion zone.

Contraindications for use of Level A:

- Environmental measures contiguous to the site indicate that air contaminants do not represent a serious dermal hazard.
- Reliable, accurate historical data do not indicate the presence of severe dermal hazards.
- Open, unconfined areas.
- Minimal probability of vapors or liquids (splash hazards) present which could affect or be absorbed through the skin.
- Total vapor readings indicate 500 ppm to 1,000 ppm

Level B protection will be selected when the highest level of respiratory protection is needed, but cutaneous exposure to the small unprotected areas of the body, (neck and back of head) is unlikely, or where concentrations are not known to be within acceptable standards. Additionally, the permissible limit for exposure to mixtures of all site gases will be checked using the requirements of 1910.1000(d)(2)(i) to ensure that PEL is not exceeded. If the value calculated using this method exceeds 1.0, Level B PPE is required.

Level C protection will be selected when the types and concentrations of inseparable material are known, or reasonably assumed to be no greater than the protection factors associated with air-purifying respirators, and exposure to the unprotected areas of the body is unlikely to cause harm. Dust concentrations require Level C PPE, where the respirable fractions exceed the PEL of 5 mg/m³ or the total concentrations exceed the PEL of 15 mg/m³.

Level D protection will be chosen when measurements of atmospheric concentrations are at background levels and work functions preclude splashes, immersion, or the potential for unexpected inhalation or contact with hazardous levels of any chemicals.

6.4 Air Monitoring

Site history and previous site work indicates that workers may potentially be exposed to low concentrations of numerous chemicals including VOCs, halogenated compounds, and combustible gases/vapors. Based on site history and existing sampling data, "worst case" contaminated areas will be identified before field activities begin.

Air monitoring using a PID and/or other appropriate sampling equipment will be conducted prior to beginning field activities at a new EZ and during ground-disturbing activities. The PID will be field calibrated to measure VOCs relative to a 100 ppm isobutylene standard. If VOCs are detected downhole, colorimetric detector tubes and/or other sampling media may be used to determine the identification and approximate concentration of these compounds.

A combustible gas indicator (CGI) will be used during all soil borings and well installation activities. The CGI will be field calibrated to measure flammable gases relative to a 23 percent lower explosive limit (LEL) methane standard. Downhole CGI readings will be collected continuously during all soil disturbing operations. Field activities will immediately cease if downhole readings exceed 10 percent LEL. If CGI readings do not subside, a careful investigation and mapping of the area will be made. Operations may not proceed until readings are below 10 percent LEL. The area will be immediately evacuated and the situation re-evaluated to determine how to proceed.

If breathing zone levels exceed 2 ppm above background or site conditions indicate that additional health and safety precautions are needed, field activities in the area shall stop. Field staff shall notify the Site Supervisor of the situation and he/she shall contact both the Project Manager and the Project Health and Safety Officer. The Project Health and Safety Officer will be responsible for reassessing the hazards and prescribing revised health and safety requirements as necessary, including upgraded PPE requirements, revised work schedules, and revised decontamination procedures. (Typically, PPE will be upgraded to Level C assuming that

cartridge respirators are appropriate, otherwise Level B.) See Table 6-1 for specific criteria for each protection level. Work shall not proceed until breathing zone levels return to background levels and it is reasonably anticipated that breathing zone samples will stay approximately at background levels, or the chemical constituent(s) are identified and appropriate PPE is donned.

Field monitoring values will be recorded in a field logbook and copies must be posted for field personnel review.

On a daily basis, PIDs, CGIs, and other monitoring equipment shall be calibrated or their proper function verified before being used. Throughout the day this equipment shall be periodically checked to ensure that it is working properly. A final calibration shall be conducted at the end of the work day, at which time each instrument will be checked to ensure that it is free from surface contamination. Field staff shall note in their field notebooks that they conducted these calibrations and checks and note whether the equipment was or was not functioning properly. When equipment is not functioning properly it should be brought to the attention of the Site Supervisor or Site Health and Safety Officer who will arrange for repairs and/or replacement of that equipment as needed.

6.5 Procedures and Equipment for Extreme Hot or Cold Weather Conditions

See CHASP Section 7.5.5.

Severe Weather Conditions

All field work shall immediately cease at the first sign of thunder or lightning. Field personnel shall perform emergency personal and equipment decontamination (see Section 6.6) and seek immediate shelter.

6.6 Personal Decontamination

A CRZ will be established immediate to each sampling/boring site and will include a station for decontaminating equipment and personnel. The CRZ will be covered with sheets of 6-mil polyethylene (typically an area 20 feet x 20 feet is sufficient) with specific stations that will accommodate the removal and disposal of the protective clothing, boot covers, gloves, and respiratory protection if required.

As a general rule, equipment will be decontaminated using a soap and clean water wash solution. Equipment decontamination will be completed by personnel in Level D PPE. In the event of inclement weather (e.g., lightning) or an emergency requiring immediate evacuation, all contaminated equipment will be wrapped and taped in 6-mil polyethylene sheeting and tagged as "contaminated" for later decontamination.

Personnel working in the CRZ will be in one Level of PPE lower than personnel in the EZ. For example, if personnel in the EZ are in Level B, decontamination workers will be in Level C.

6.6.1 Personal Decontamination Procedures

The decontamination procedures, based on Level D protection, will consist of the following:

- Brushing heavily soiled boots and rinsing outer gloves and boots with soap and water.
- Removing outer gloves and depositing them in a labeled plastic-lined container.
- Remove outer chemical protective clothing.
- Wash and rinse inner gloves.

- **Hard hats and eye protection should be washed thoroughly at the end of each work day with a soap and water solution.**

- **Disposable gloves and other disposable clothing will be disposed of in sealable bags and placed in a labeled 55-gallon drum for disposal at the site.**

- **All field personnel are to be instructed to shower as soon as possible after leaving the site.**

Decontamination procedures will be conducted at the lunch break and at the end of each work day. If higher levels of PPE are needed, adjustments will be made to these procedures, and an amendment will be made to this SSHSP.

All wastes (soil and water) generated during personal decontamination will be collected in 55-gallon drums. The drums will be labeled by E/A&H and USGS personnel for final disposal by the Navy.

6.6.2 Closure of the Personal Decontamination Station

All disposable clothing and plastic sheeting used during site activities will be double-bagged and disposed of in a refuse container. Decontamination and rinse solutions will be placed in a labeled 55-gallon drum for later analysis and disposal. All washtubs, pails, buckets, etc. will be washed, rinsed, and dried at the end of each workday.

6.7 Work Limitations

All site activities will be conducted during daylight hours only. All personnel scheduled for these activities will have completed initial health and safety training and actual field training as specified in 29 CFR 1910.120(e). All supervisors must complete an additional 8 hours of

training in site management. All personnel must complete an 8-hour refresher training course on an annual basis in order to continue working at the site.

6.8 Exposure Evaluation

All personnel scheduled for site activities will have had a baseline physical examination which includes a stressing exam of the neurologic, cardiopulmonary, musculoskeletal and dermatological systems, pulmonary function testing, multi-chemistry panel and urinalysis, and have been declared fit for duty. An exposure history form will be completed for each worker participating in site activities. An examination and updated occupational history will be repeated on an annual basis and upon termination of employment as required by 29 CFR 1910.120(f). The content of the annual or termination examination will be the same as the baseline physical. A qualified physician will review the results of the annual examination and exposure data and request further tests or issue medical clearances as appropriate.

After any job-related injury or illness, there will be a medical examination to determine fitness for duty or any job restrictions. The Site Health and Safety Officer will review the results with the examining physician before releasing the employee for work. A similar examination will be performed if an employee has missed at least three days of work due to a non-job related injury or illness requiring medical attention. Medical records shall be maintained by the employer or the physician for at least 30 years following the termination of employment.

7.0 MEDICAL MONITORING PROGRAM

See CHASP Section 7.6.

8.0 AUTHORIZED PERSONNEL

Personnel anticipated to be onsite at various times during site activities include:

- Principal-In-Charge — Dr. James Speakman (E/A&H)
- Task Order Manager/Project Manager — Mr. Lawson Anderson (E/A&H)
- Project Health & Safety Officer — Mr. Doug Petty (E/A&H)
- Site Supervisor — To Be Determined
- Site Health & Safety Officer — To Be Determined
- Engineer-in-Charge — Mr. Mark Taylor (SOUTHDIV)
- Naval Air Station Memphis Site Contact — Ms. Tonya Barker

8.1 Responsibilities of Site Supervisor

The Site Supervisor will direct the site operations and, relative to health and safety, is responsible for assuring that:

- Field staff follow the CHASP, SSHSP, and other safety and health standard operating procedures (SOPs). Personnel that do not comply are retrained and/or instructed to leave the site and not allowed to return.
- Field staff have current HAZWOPER training.
- Field staff know who the Site Health and Safety Officer is.
- Field staff know the site-specific safety and health concerns.
- There is an adequate onsite supply of health and safety equipment.

- Field staff participate in the E/A&H Medical surveillance program (or in the case of the USGS or subcontractors, an equivalent program).
- Field staff attend safety and health "kick-off" orientation and other site safety briefings.

The Site Supervisor is also responsible for assuring that field staff who may be exposed to unique or special hazards have the training or experience necessary to safely conduct their work.

8.2 Responsibilities of Site Health and Safety Officer

The responsibilities of the Site Health and Safety Officer include:

- Providing the Site Supervisor technical input on site health and safety issues.
- Observing field personnel and reporting to the Site Supervisor on the effectiveness of the CHASP and SSHSP and whether field staff are utilizing proper work practices and decontamination procedures.
- Reporting significant safety violations to the Project Manager and/or Project Health and Safety Officer.
- Conducting safety briefings during field activities.
- Assuring that a copies of the CHASP and SSHSP are maintained onsite during all field activities.
- Maintaining a file of HAZWOPER training certificates and appropriate refresher training certificates for onsite personnel.

The Site Health and Safety Officer will have the following qualifications: (1) 40 hours OSHA training or equivalent experience, (2) 24 hours of supervisory training or equivalent experience, (3) knowledge of the health and safety concerns for the specific work tasks being conducted, and (4) shall be trained to use the air monitoring equipment; be able interpret the data collected with the instruments; be familiar with symptoms of chemical exposure, heat stress and cold exposure, and know the location and proper use of onsite safety equipment. He will also be familiar with the CHASP and SSHSP.

The position of Site Health and Safety Officer may rotate. Often, particularly on small projects, this function is not a full time responsibility, rather a member of the field team is selected to serve as the Site Health and Safety Officer. Then when that task is completed and/or field staff change, the Site Health and Safety Officer may change as well.

The following criteria outline when the Site Health and Safety Officer will be replaced: (1) termination of employment, (2) end of work task, (3) end of shift, (4) sickness, (5) injury, or (6) death. It should be noted that under site work schedules only one shift will be working. As a result, the Site Health and Safety Officer will be responsible for the day shift. If circumstances arise that require work during other periods, an alternate Site Health and Safety Officer will be designated.

8.3 Responsibilities of Onsite Field Staff

The health and safety responsibilities of field staff include:

- Being familiar with and complying with this CHASP and SSHSP.

- Attending site health and safety briefings and being aware of anticipated chemical, physical, and biological hazards and what to do when these hazards are encountered.

- Being properly trained on PPE to be used, safety work practices, decontamination procedures to be followed, and emergency procedures and communications.
- Utilizing required PPE including respiratory protective.
- Having up to date HAZWOPER training and providing the Site Supervisor with documentation that their training is current.
- Being an up to date participant in an acceptable medical surveillance program.
- Being fit-tested and physically capable of using a respirator and being in a position where using a respirator may be a requirement. Should the use of respiratory protection be required, field workers shall not have facial hair which intrudes into the sealing surface of the respirator.
- Using the buddy system when wearing respiratory protective equipment. When working in Level C or higher, a third person shall be at the work area. This person shall be suitably equipped to provide logistical and safety support to the entry team.

In addition, field staff should always be alert and use their senses (sight, smell, etc.) to identify and react to potentially dangerous situations. When working in the EZ, visual contact should be maintained between personnel; field personnel should be close enough to assist each other during an emergency. Procedures for leaving a contaminated area must be planned and implemented before going onsite in accordance with the CHASP and SSHSP.

The number of personnel and equipment in the contaminated area should be kept to a minimum, consistent with effective site operations. All visitors to the job site must comply with the

CHASP and SSHSP procedures. PPE may be modified for visitors depending on the situation. Modifications must be approved by the Project Health and Safety Officer.

9.0 EMERGENCY INFORMATION

All hazardous waste site activities present a potential risk to onsite personnel. During routine operations risk is minimized by establishing good work practices, staying alert, and using proper PPE. Unpredictable events such as physical injury, chemical exposure, or fire may occur and must be anticipated.

If any situation or unplanned occurrence requires outside or support service, Tonya Barker, NAS Memphis Site Contact, will be informed and the appropriate contact from the following list will be made:

Contact	Agency or Organization	Telephone
Tonya Barker	NAS Memphis	(901) 873-5461/5462
Mark Taylor	SOUTHDIV EIC	(803) 743-0573
Law Enforcement	NAS Memphis Base Security	9-911
Fire Department	NAS Memphis	9-911
Ambulance Service	Naval Hospital, Millington Navy Road	(901) 873-5801/5802 or 9-911
Hospital	Methodist North Hospital 3960 Covington Pike	(901) 372-5211 or 9-911
Southern Poison Control Center	—	(901) 528-6048
Lawson Anderson	EnSafe/Allen & Hoshall	(901) 372-7962
Doug Petty	EnSafe/Allen & Hoshall	(901) 372-7962

Mark Taylor, SOUTHDIV Engineer-in-Charge (EIC) will be contacted after appropriate emergency measures have been initiated onsite.

9.1 Site Resources

Cellular telephones or the telephone at the nearby Aircraft Firefighting Training Facility office trailer will be used for emergency use and communication/coordination with NAS Memphis. First aid and eye wash equipment will be available at the work area.

9.2 Emergency Procedures

Conditions which may constitute an emergency include any member of the field crew being involved in an accident or experiencing any adverse effects or symptoms of exposure while onsite, or if a condition is discovered that suggests the existence of a situation more hazardous than anticipated.

The following emergency procedures should be followed:

- Site work area entrance and exit routes will be planned and emergency escape routes delineated by the Site Health and Safety Officer. Copies of emergency contacts and routes will be posted onsite.
- If any member of the field team experiences any effects or symptoms of exposure while on the scene, the entire field crew will immediately stop work and act according to the instructions provided by the Site Health and Safety Officer.
- For applicable site activities, wind indicators visible to all onsite personnel will be provided by the Site Health and Safety Officer to indicate possible routes for upwind escape.

- The discovery of any conditions that would suggest the existence of a situation more hazardous than anticipated will result in the suspension of work until the Site Health and Safety Officer has evaluated the situation and provided the appropriate instructions to the field team.

- If an accident occurs, the Field Project Manager is to complete an Accident Report Form (See Attachment C) for submittal to the managing principal-in-charge of the project.

- If a member of the field crew suffers a personal injury, the Site Health and Safety Officer will call **(901) 372-5211** or **9-911** (serious injury) to alert appropriate emergency response agencies or administer onsite first aid (minor injury) as the situation dictates. An Accident Report Form will be completed for any such incident.

- If a member of the field crew suffers chemical exposure, the affected areas should be flushed immediately with copious amounts of clean water, and if the situation dictates, the Site Health and Safety Officer should alert appropriate emergency response agencies, or personally ensure that the exposed individual is transported to the nearest medical treatment facility for prompt treatment. (See Attachment B for directions to the emergency medical facility.) An Accident Report Form will be completed for any such incident.

Additional information on appropriate chemical exposure treatment methods will be provided through Material Safety Data Sheets (MSDS) in Attachment A.

10.0 FORMS

The following forms will be used to implement this Health and Safety Plan:

- Plan Acceptance Form
- Plan Feedback Form
- Exposure History Form
- Accident Report Form

The Plan Acceptance Form will be filled out by all employees working on the site before site activities begin. The Plan Feedback Form will be filled out by the Site Safety Officer and any other onsite employee who wishes to fill one out. The Exposure History Form will be completed by both the Field Project Manager and the individual(s) for whom the form is intended. Examples of each form are provided in Attachment C of this plan.

All completed forms must be returned to the Task Order Manager at EnSafe/Allen & Hoshall, Memphis, Tennessee.

ATTACHMENT A
MATERIAL SAFETY DATA SHEETS

ODOR DETECTED AT (ppm): 100 ppm
ODOR DESCRIPTION: Chloroform-like; sweetish Source:CHRIS
100 % ODOR DETECTION: No data

----- REGULATIONS -----

DOT hazard class: 6.1 POISON
DOT guide: 74
Identification number: UN2831
DOT shipping name: 1,1,1-Trichloroethane
Packing group: III
Label(s) required: KEEP AWAY FROM FOOD
Special provisions: N36,T7
Packaging exceptions: 173.153
Non bulk packaging: 173.203
Bulk packaging: 173.241
Quantity limitations-
Passenger air/rail: 60 L
Cargo aircraft only: 220 L
Vessel stowage: A
Other stowage provisions:40,M2

STCC NUMBER: Not listed

CLEAN WATER ACT Sect.307:Yes

CLEAN WATER ACT Sect.311:No

National Primary Drinking Water Regulations

Maximum Contaminant Levels (MCL): 0.2 mg/L (01/09/89)

Maximum Contaminant Level Goals (MCLG): 0.2 mg/L (01/09/89)

EAN AIR ACT: CAA '90 Listed

EPA WASTE NUMBER: U226

CERCLA REF: Not listed

RQ DESIGNATION: C 1000 pounds (454 kg) CERCLA

SARA TPQ VALUE: Not listed

SARA Sect. 312

categories:

Acute toxicity: Irritant

Acute toxicity: adverse effect to target organs.

Chronic toxicity: adverse effect to target organ
after long period of exposure.

Chronic toxicity: mutagen.

Chronic toxicity: reproductive toxin.

Chronic toxicity: carcinogen

LISTED IN SARA Sect 313: Yes

de minimus CONCENTRATION: 1.0 percent

UNITED STATES POSTAL SERVICE MAILABILITY:

Hazard class: ORM-A

Mailability: Domestic service and air transportation; shipper's declaratic

Max per parcel: 10 GAL; 1 PT

NFPA CODES:

HEALTH HAZARD (BLUE): (3) Extremely hazardous to health. Full protection required. No skin surface should be exposed.
FLAMMABILITY (RED) : (1) This material must be preheated before ignition can occur.
REACTIVITY (YELLOW): (1) Normally stable, but may become unstable at elevated temperature and pressures.
SPECIAL : Unspecified

----- SUMMARY OF REGULATORY LISTS THIS SUBSTANCE APPEARS ON -----

ACGIH TLV list "Threshold Limit Values for 1992-1993"
California Assembly Bill 1803 Well Monitoring Chemicals.
California Assembly Bill 2588 Air Toxics "Hot Spots" Chemicals.
Canadian Domestic Substances List
Canadian Ingredient Disclosure List. 20/01/88 Canada Gazette part II, Vol 122.
Clean Air Act Section 111 List.
Clean Air Act of November 15, 1990. List of pollutants.
Clean Water Act Section 307 Priority Pollutants
DOT Hazardous Materials Table. 49 CFR 172.101
EPA Carcinogen Assessment Group List
EPA List of VOC chemicals from 40 CFR 60.489
EPA TSCA 8(a) Preliminary Assessment Information Rule - effective 11/19/82
EPA TSCA 8(d) Health and Safety Data Rule - effective date 10/04/82
EPA TSCA Chemical Inventory List 1986
EPA TSCA Chemical Inventory List 1989
EPA TSCA Chemical Inventory List 1990
EPA TSCA Chemical Inventory List 1992
EPA TSCA Section 12(b) Export Rule Notification.
EPA TSCA Test Submission (TSCATS) Database - April 1990
EPA TSCA Test Submission (TSCATS) Database - September 1989
First Third Wastes List. 40 CFR 268.10. 54 FR 26594 (June 23, 1989)
METHYL CHLOROFORM [71-55-6]
Massachusetts Substance List.
New Jersey DEQ100 list for release reporting.
New Jersey Right To Know Substance List. (December 1987)
OSHA Air Contaminant (Table Z-1-A). 54 FR 4332, Jan. 19, 1989 and revised.
Pennsylvania Hazardous Substance List
RCRA Hazardous Constituents for Ground Water Monitoring. Ap'dx IX to 40 CFR 26.
RCRA Hazardous Waste
SARA Section 110 Priority List of CERCLA Hazardous Substances
SARA Section 313 Toxic Chemicals List
Superfund/CERCLA RQ list. Table 302.4 in 54 FR 50968 (December 11, 1989)
Washington State Discarded Chemical Products List, November 17, 1989

----- TOXICITY DATA -----

SHORT TERM TOXICITY: INHALATION: levels above 900 ppm can cause dizziness, mental confusion, drowsiness, loss of coordination and unconsciousness. death may result. SKIN: can cause irritation and rash. absorption is moderate; may contribute significantly to health hazard. Eyes: has

caused irritation at levels of 450 ppm. INGESTION: may cause symptoms similar to inhalation. in addition, may cause mouth, throat and stomach irritation. (NYDH)

LONG TERM TOXICITY: repeated or prolonged contact at levels of 450 ppm or above may result in irritation and dry, scaly, fractured skin . dizziness, mental confusion, slowed response time and generally reversible liver and kidney damage may result from prolonged inhalation. (NYDH)

TARGET ORGANS: skin, cvs, CNS, eyes

SYMPTOMS: INHALATION: symptoms range from loss of equilibrium and incoordination to loss of consciousness; high concentration can be fatal due to simple asphyxiation combined with loss of consciousness. INGESTION: produces effects similar to inhalation and may cause some feeling of nausea. EYES: slightly irritating and lachrymatory. SKIN: defatting action may cause dermatitis. Source: CHRIS

CONC IDLH: 1000PPM

NIOSH REL: 350 ppm Ceiling exposures which shall at no time be exceeded 1900 mg/M3 Ceiling exposures which shall at no time be exceeded

ACGIH TLV: TLV = 350ppm(1,900 mg/M3)
ACGIH STEL: STEL = 450 ppm(2,450 mg/M3)

OSHA PEL: Transitional Limits:
PEL = 350 ppm(1900mg/M3)
Final Rule Limits:
TWA = 350 ppm (1900 mg/M3)
STEL = 450 ppm(2450 mg/M3)

MAK INFORMATION: 200 ppm
1080 mg/M3
Substance with systemic effects, onset of effect less than or equal to 2 hrs: Peak = 5xMAK for 30 minutes, 2 times per shift of 8 hours.
There is no reason to fear a risk of damage to the developing embryo or fetus when MAK values are adhered to.

CARCINOGEN?: N STATUS: See below

CARCINOGEN LISTS: IARC: Not classified as to human carcinogenicity or probably not carcinogenic to humans.

MAK: Not listed
NIOSH: Not listed
NTP: Not listed
ACGIH: Not listed
OSHA: Not listed

HUMAN TOXICITY DATA: (Source: NIOSH RTECS)

ihl-man TClO:350 ppm WEHRBJ 10,82,73
BEHAVIORAL
Hallucinations, distorted perceptions
BEHAVIORAL
Changes in motor activity(specific assay)
BEHAVIORAL
Change in psycophysiiological tests

orl-hmn TDLo:670 mg/kg NTIS** PB257-185
GASTROINTESTINAL
Hypermotility,diarrhea
GASTROINTESTINAL
Nausea or vomiting
GASTROINTESTINAL
Other changes

ihl-hmn TClO:920 ppm/70M AIHAAP 19,353,58
BEHAVIORAL
Changes in motor activity(specific assay)
SENSE ORGANS
Eye
Conjunctive irritation

LD50 value: orl-rat LD50:9600 mg/ kg

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)

orl-rat LD50:9600 mg/kg
ihl-rat LC50:18000 ppm/4H
ipr-rat LD50:3593 mg/kg
orl-mus LD50:6 gm/kg
ihl-mus LC50:3911 ppm/2H
ipr-mus LD50:3636 mg/kg
scu-mus LD50:16 gm/kg
orl-dog LD50:750 mg/kg
ipr-dog LD50:3100 mg/kg
ivn-dog LDLo:95 mg/kg
ihl-cat LC50:24400 mg/m3
orl-rbt LD50:5660 mg/kg
skn-rbt LD50:>20 gm/kg
scu-rbt LDLo:500 mg/kg
orl-gpg LD50:9470 mg/kg

IRRITATION DATA: (Source: NIOSH RTECS 1992)

eye-man 450 ppm/8H

skn-rbt 5 gm/12D-I MLD
skn-rbt 500 mg/24H MOD
eye-rbt 100 mg MLD
eye-rbt 2 mg/24H SEV

Reproductive toxicity (1992 RTECS):

This chemical is a mammalian reproductive toxin.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

orl-rat TDLo:43 mg/kg (1-22D preg/21D post) TJADAB
29(2), 25A, 84

SPECIFIC DEVELOPMENTAL ABNORMALITIES
Cardiovascular(circulatory) system

California Prop 65: Not listed

----- EPA's IRIS DATA SUMMARY -----
1,1,1-Trichloroethane; CASRN 71-55-6 (04/01/92)

II. CARCINOGENICITY ASSESSMENT FOR LIFETIME EXPOSURE

Substance Name -- 1,1,1-Trichloroethane
CASRN -- 71-55-6
Last Revised -- 09/01/90

Section II provides information on three aspects of the carcinogenic risk assessment for the agent in question; the U.S. EPA classification, and quantitative estimates of risk from oral exposure and from inhalation exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in three ways. The slope factor is the result of application of a low-dose extrapolation procedure and is presented as the risk per (mg/kg)/day. The unit risk is the quantitative estimate in terms of either risk per ug/L drinking water or risk per ug/cu.m air breathed. The third form in which risk is presented is a drinking water or air concentration providing cancer risks of 1 in 10,000, 1 in 100,000 or 1 in 1,000,000. Background Document 2 (Service Code 5) provides details on the rationale and methods used to derive the carcinogenicity values found in IRIS. Users are referred to Section I for information on long-term toxic effects other than carcinogenicity.

II.A. EVIDENCE FOR CLASSIFICATION AS TO HUMAN CARCINOGENICITY

II.A.1. WEIGHT-OF-EVIDENCE CLASSIFICATION

Classification -- D; not classifiable as to human carcinogenicity.

Basis -- There are no reported human data and animal studies (one lifetime gavage, one intermediate-term inhalation) have not demonstrated carcinogenicity. Technical grade 1,1,1-trichloroethane has been shown to be weakly mutagenic, although the contaminant, 1,4-dioxane, a known animal carcinogen, may be responsible for this response.

II.A.2. HUMAN CARCINOGENICITY DATA

None.

II.A.3. ANIMAL CARCINOGENICITY DATA

Inadequate. The NCI (1977) treated Osborne-Mendel rats (50/sex/dose) with 750 or 1500 mg/kg technical-grade 1,1,1-trichloroethane 5 times/week for 78 weeks by gavage. The rats were observed for an additional 32 weeks. Twenty rats of each sex served as untreated controls. Low survival of both male and female treated rats (3%) may have precluded detection of a significant number of tumors late in life. Although a variety of neoplasms was observed in both treated and matched control rats, they were common to aged rats and were not dose-related. Similar results were obtained when the NCI (1977) treated B6C3F1 hybrid mice with the time-weighted average doses of 2807 or 5615 mg/kg 1,1,1-trichloroethane by gavage 5 days/week for 78 weeks. The mice were observed for an additional 12 weeks. The control and treated groups had 20 and 50 animals of each sex, respectively. Only 25 to 45% of those treated survived until the time of terminal sacrifice. A variety of neoplasms were observed in treated groups, but the incidence not statistically different from matched controls.

Quast et al. (1978) exposed 96 Sprague-Dawley rats of both sexes to 875 - 1750 ppm 1,1,1-trichloroethane vapor for 6 hours/day, 5 days/week for 12 nths, followed by an additional 19-month observation period. The only significant sign of toxicity was an increased incidence of focal hepatocellular alterations in female rats at the highest dosage. It was not evident that a maximum tolerated dose (MTD) was used nor was a range-finding study conducted. No significant dose-related neoplasms were reported, but these dose levels were below those used in the NCI study.

II.A.4. SUPPORTING DATA FOR CARCINOGENICITY

Mutagenicity testing of 1,1,1-trichloroethane has produced positive results in *S. typhimurium* strain TA100 (Simmon et al., 1977; Fishbein, 1979; Snow et al., 1979) as well as some negative results (Henschler et al., 1977; Taylor, 1978).

It was mutagenic for *S. typhimurium* strain TA1535 both with exogenous metabolic activation (Farber, 1977) and without activation (Nestmann et al., 1980). 1,1,1-Trichloroethane did not result in gene conversion or mitotic recombination in *Saccharomyces cerevisiae* (Farber, 1977; Simmon et al., 1977) nor was it positive in a host-mediated forward mutation assay using *Schizosaccharomyces pombe* in mice. The chemical also failed to produce chromosomal aberrations in the bone marrow of cats (Rampy et al., 1977), but responded positively in a cell transformation test with rat embryo cells

(Price et al., 1978).

An isomer, 1,1,2-trichloroethane, is carcinogenic in mice, inducing liver cancer and pheochromocytomas in both sexes. Dichloroethanes, tetrachloroethanes and hexachloroethanes also produced liver cancer in mice and other types of neoplasms in rats.

It should be noted that 1,4-dioxane, a known animal carcinogen that causes liver and nasal tumors in more than one strain of rats and hepatocellular carcinomas in mice, is a contaminant of technical-grade 1,1,1-trichloroethane.

__II.B. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM ORAL EXPOSURE

Not available.

__II.C. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM INHALATION EXPOSURE

Not available.

__II.D. EPA DOCUMENTATION, REVIEW, AND CONTACTS (CARCINOGENICITY ASSESSMENT)

__II.D.1. EPA DOCUMENTATION

U.S. EPA. 1984a. Health Effects Assessment for 1,1,1-Trichloroethane. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Emergency and Remedial Response, Washington, DC.

U.S. EPA. 1984b. Health Assessment Document for 1,1,1-Trichloroethane. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Research Triangle Park, NC. EPA-600/8-82-003F.

__II.D.2. REVIEW (CARCINOGENICITY ASSESSMENT)

The 1984 Health Effects Assessment for 1,1,1-Trichloroethane has received limited Agency review. The values in the 1984 Health Assessment Document for 1,1,1-Trichloroethane have received both Agency and public review.

Agency Work Group Review: 08/05/87

Verification Date: 08/05/87

___II.D.3. U.S. EPA CONTACTS (CARCINOGENICITY ASSESSMENT)

Charlingayya Hiremath / ORD -- (202)260-5898 / FTS 260-5898

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED
FROM THE CHRIS MANUAL:

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS:

- ** WEAR APPROPRIATE EQUIPMENT TO PREVENT:
Repeated or prolonged skin contact.
- ** WEAR EYE PROTECTION TO PREVENT:
Reasonable probability of eye contact.
- ** EXPOSED PERSONNEL SHOULD WASH:
Promptly when skin becomes contaminated.
- ** REMOVE CLOTHING:
Promptly remove non-impervious clothing that becomes wet.
- ** REFERENCE: NIOSH

FIRST AID SOURCE: NIOSH

EYE: irr immed

SKIN: soap wash promptly

INHALATION: art resp

INGESTION: ipecac, vomit

FIRST AID SOURCE: CHRIS Manual 1991

Get medical attention for all eye exposures and any other serious over-exposures. Do NOT administer adrenalin or epinephrine; otherwise, treatment is symptomatic.

INHALATION: remove victim to fresh air; if necessary, apply artificial respiration and/or administer oxygen.

INGESTION: have victim drink water and induce vomiting.

EYES: flush thoroughly with water.

SKIN: remove contaminated clothing and wash exposed area thoroughly with

soap and warm water.

FIRST AID SOURCE: DOT Emergency Response Guide 1990.

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen. In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water. Remove and isolate contaminated clothing and shoes at the site. Use first aid treatment according to the nature of the injury.

----- INITIAL INCIDENT RESPONSE -----

FIRE EXTINGUISHMENT: Dry chemical, foam, or carbon dioxide. CHRIS91

US Department of Transportation Guide to Hazardous Materials Transport Information - Publication DOT 5800.5 (1990).

DOT SHIPPING NAME: 1,1,1-Trichloroethane

DOT ID NUMBER: UN2831

ERG93

GUIDE 74

POTENTIAL HAZARDS

*HEALTH HAZARDS

Vapors may cause dizziness or suffocation.
Exposure in an enclosed area may be very harmful.
Contact may irritate or burn skin and eyes.
Fire may produce irritating or poisonous gases.
Runoff from fire control or dilution water may cause pollution.

*FIRE OR EXPLOSION

Some of these materials may burn, but none of them ignites readily.
Vapors heavier than air.

*Air/vapor mixtures may explode when ignited.
Container may explode in heat of fire.

EMERGENCY ACTION

Keep unnecessary people away; isolate hazard area and deny entry.
Stay upwind, out of low areas, and ventilate closed spaces before entering.
Positive pressure self-contained breathing apparatus (SCBA) and structural fire
*Isolate for 1/2 mile in all directions if tank, rail car or tank truck is involved.
Remove and isolate contaminated clothing at the site.
CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping
If water pollution occurs, notify the appropriate authorities.

*FIRE

Small Fires: Dry chemical or CO2.

Large Fires: Water spray, fog or regular foam.

Apply cooling water to sides of containers that are exposed to flames until well cooled.

*SPILL OR LEAK

Shut off ignition sources; no flares, smoking or flames in hazard area.
Stop leak if you can do it without risk.

Small Liquid Spills: Take up with sand, earth or other noncombustible absorber

Large Spills: Dike far ahead of liquid spill for later disposal.

*FIRST AID

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration.
In case of contact with material, immediately flush eyes with running water for at least 15 minutes.
Remove and isolate contaminated clothing and shoes at the site.

Use first aid treatment according to the nature of the injury.

DISCLAIMER: The data shown above on this chemical represents a best effort on the part of the compilers of the CHEMTOX database to obtain useful, accurate, and factual data. The use of these data shall be in accordance with the guidelines and limitations of the user's CHEMTOX license agreement. The COMPILERS of the CHEMTOX database shall not be held liable for inaccuracies or omissions within this database, or in any of its printed or displayed output forms.

SLIGHT ODOR OF HYDROCYANIC ACID.

Source: CHRIS

No data

100 % ODOR DETECTION:

----- REGULATIONS -----

DOT hazard class: 6.1 POISON
DOT guide: 55
Identification number: UN1689
DOT shipping name: Sodium cyanide
(after shipping description):
Packing group: I
Label(s) required: POISON
Special provisions: B69, B77, N74, N75, T42
Packaging exceptions: 173. None
Non bulk packaging: 173.211
Bulk packaging: 173.242
Quantity limitations-
Passenger air/rail: 5 kg
Cargo aircraft only: 50 kg
Vessel stowage: B
Other stowage provisions: 52

STCC NUMBER: 4923227, 4923228

CLEAN WATER ACT Sect. 307: Yes

CLEAN WATER ACT Sect. 311: Yes

CLEAN AIR ACT: CAA '90 By category

TPQ WASTE NUMBER: P106

CERCLA REF: Y

RQ DESIGNATION: A 10 pounds (4.54 kg) CERCLA

SARA TPQ VALUE: 100 pounds

SARA Sect. 312
categories:

Acute toxicity: Highly toxic. LD50 is 50 mg/kg
or less (oral rat).

Chronic toxicity: adverse effect to target organ
after long period of exposure.

Chronic toxicity: reproductive toxin.

LISTED IN SARA Sect 313: Yes

de minimus CONCENTRATION: 1.0 percent

UNITED STATES POSTAL SERVICE MAILABILITY:

Hazard class: Poison, Class B - Mailable as ORM-D

Mailability: Domestic service and air transportation shipper's declaration

Max per parcel: 8 OZ

NFPA CODES:

HEALTH HAZARD (BLUE): (3) Extremely hazardous to health. Full protection
required. No skin surface should be exposed.

FLAMMABILITY (RED) : (0) This material does not readily burn.

REACTIVITY (YELLOW): (0) Stable even under fire conditions.
SPECIAL : Unspecified

----- SUMMARY OF REGULATORY LISTS THIS SUBSTANCE APPEARS ON -----

ACGIH TLV list "Threshold Limit Values for 1992-1993"
Canadian Domestic Substances List
Clean Air Act of November 15, 1990. List of pollutants.
Clean Water Act Section 307 Priority Pollutants
Clean Water Act Section 311 Hazardous Chemicals List.
DOT Hazardous Materials Table. 49 CFR 172.101
EPA TSCA Chemical Inventory List 1990
EPA TSCA Chemical Inventory List 1992
EPA TSCA Test Submission (TSCATS) Database - September 1989
Massachusetts Substance List.
New Jersey DEQ100 list for release reporting.
New Jersey Right To Know Substance List. (December 1987)
OSHA Air Contaminant (Table Z-1-A). 54 FR 4332, Jan. 19, 1989 and revised.
Pennsylvania Hazardous Substance List
RCRA Hazardous Waste
SARA Section 313 Toxic Chemicals List
SARA Title III Extremely Hazardous Substance. Sections 302 and 304.
SODIUM CYANIDE [143-33-9]
Superfund/CERCLA RQ list. Table 302.4 in 54 FR 50968 (December 11, 1989)
Washington State Discarded Chemical Products List, November 17, 1989
Wisconsin Air Toxics Control Regulation NR-445 (December 1988)

----- TOXICITY DATA -----

SHORT TERM TOXICITY: Unknown

LONG TERM TOXICITY: unknown

TARGET ORGANS: cvs,CNS,liver,kidneys,skin

SYMPTOMS: As little as 180 milligrams is a rapidly fatal poison if ingested. Non-lethal doses may cause toxic symptoms. Strong water solutions, or the solid itself, can be absorbed by the skin and cause deep ulcers which heal slowly. Source: CHRIS

CONC IDLH: 50mg/M3

NIOSH REL: 4.7 ppm Ceiling exposures which shall at no time be exceeded (10-MIN) 5 mg/M3 Ceiling exposures which shall at no time be exceeded (10-MIN)

ACGIH TLV: TLV = 5mg/M3 as CYANIDE - SKIN
ACGIH STEL: as CYANIDE - SKIN

OSHA PEL: Transitional Limits:
PEL = 5mg/M3

Final Rule Limits:
TWA = 5 mg/M3

MAK INFORMATION: 75 ppm
200 mg/M3

CARCINOGEN?: N STATUS: See below

CARCINOGEN LISTS:

IARC: Not listed
MAK: Not listed
NIOSH: Not listed
NTP: Not listed
ACGIH: Not listed
OSHA: Not listed

HUMAN TOXICITY DATA: (Source: NIOSH RTECS)

orl-man LDLo:6557 ug/kg APTOA6 1,18,45
BEHAVIORAL
Fluid intake
GASTROINTESTINAL
Gastritis

* orl-hmn LDLo:2857 ug/kg 34ZIAG -,191,69

orl-man TDLo:714 ug/kg APTOA6 20,291,63
BEHAVIORAL
Hallucinations, distorted perceptions
BEHAVIORAL
Muscle weakness

LD50 value: orl-rat LD50:6440 ug/ kg

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)

orl-rat LD50:6440 ug/kg
ipr-rat LD50:4300 ug/kg
ipr-mus LD50:5881 ug/kg
scu-mus LD50:3600 ug/kg
unr-mus LD50:10 mg/kg
scu-dog LDLo:6 mg/kg
ivn-dog LDLo:1300 ug/kg
scu-rbt LDLo:2200 ug/kg
ims-rbt LD50:1666 ug/kg
ocu-rbt LD50:5048 ug/kg
scu-gpg LD50:5800 ug/kg
orl-ckn LD50:21 mg/kg
orl-qal LD50:8500 ug/kg
par-frg LDLo:60 mg/kg
orl-dom LD50:4 mg/kg
orl-mam LD50:8 mg/kg
orl-bwd LD50:4 mg/kg

IRRITATION DATA: (Source: NIOSH RTECS 1992)

Reproductive toxicity (1992 RTECS):

This chemical is a mammalian reproductive toxin.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

imp-ham TDLo:5999 mg/kg (6-9D preg) TXAPA9 64,456,82

EFFECTS ON EMBRYO OR FETUS

Fetotoxicity(except death,e.g.,stunted fetus)

SPECIFIC DEVELOPMENTAL ABNORMALITIES

Musculoskeletal system

SPECIFIC DEVELOPMENTAL ABNORMALITIES

Cardiovascular(circulatory) system

California Prop 65: Not listed

----- EPA's IRIS DATA SUMMARY -----

Sodium cyanide; CASRN 143-33-9 (04/01/92)

_II. CARCINOGENICITY ASSESSMENT FOR LIFETIME EXPOSURE

Substance Name -- Sodium cyanide

CASRN -- 143-33-9

This substance/agent has not been evaluated by the U.S. EPA for evidence of human carcinogenic potential.

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED
FROM THE CHRIS MANUAL:

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS:

** WEAR APPROPRIATE EQUIPMENT TO PREVENT:

Any possibility of skin contact.

** WEAR EYE PROTECTION TO PREVENT:

Any possibility of eye contact.

** EXPOSED PERSONNEL SHOULD WASH:

Immediately when skin becomes contaminated.

** WORK CLOTHING SHOULD BE CHANGED DAILY:

If there is any possibility that the clothing may be contaminated.

**** REMOVE CLOTHING:**

Immediately remove non-impervious clothing that becomes contaminated.

THE FOLLOWING EQUIPMENT SHOULD BE MADE AVAILABLE:

Eyewash, quick drench.

**** REFERENCE: NIOSH**

FIRST AID SOURCE: NIOSH

EYE: irr immed

SKIN: soap wash immed

INHALATION: art resp

INGESTION: water, vomit; use amyl nitrite pearls

FIRST AID SOURCE: CHRIS Manual 1991

INGESTION: start treatment immediately; call a physician; carry victim to fresh air; have him lie down; keep him quiet and warm until physician arrives. If victim is conscious and breathing: induce vomiting by giving emetic of warm salt water (1 tablespoon salt/cup water); repeat until vomit fluid is clear; then have victim drink one pint of 1% solution of sodium thiosulfate, to be repeated in 15 min. If victim has stopped breathing: give artificial respiration until breathing starts. If victim is unconscious but breathing: give oxygen from an inhalator. For all of above conditions, have victim breathe amyl nitrite. Break nitrite pearl in a cloth and hold lightly under victim's nose for 15 sec., repeating 5 times at about 15-sec. intervals. If necessary, repeat this procedure every 3 min. with fresh pearls until 3 or 4 have been given. (Pearls must be over 2 years old. Avoid breathing amyl nitrite while administering it to victim.)

FIRST AID SOURCE: DOT Emergency Response Guide 1990.

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes. Speed in removing material from skin is of extreme importance. Removal of solidified molten material from skin requires medical assistance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

----- INITIAL INCIDENT RESPONSE -----

US Department of Transportation Guide to Hazardous Materials Transport Information - Publication DOT 5800.5 (1990).

DOT SHIPPING NAME: Sodium cyanide

DOT ID NUMBER: UN1689

ERG93

GUIDE 55

POTENTIAL HAZARDS

***HEALTH HAZARDS**

Poisonous; may be fatal if inhaled, swallowed or absorbed through skin.

Contact may cause burns to skin and eyes.
Runoff from fire control or dilution water may give off poisonous gases and ca
Fire may produce irritating or poisonous gases.

***FIRE OR EXPLOSION**

Some of these materials may burn, but none of them ignites readily.
Container may explode violently in heat of fire.
Material may be transported in a molten form.

EMERGENCY ACTION

Keep unnecessary people away; isolate hazard area and deny entry.
Stay upwind, out of low areas, and ventilate closed spaces before entering.
Positive pressure self-contained breathing apparatus (SCBA) and chemical protec
*Structural firefighters' protective clothing is not effective for these materi
See the Table of Initial Isolation and Protective Action Distances. If you fir
Remove and isolate contaminated clothing at the site.

CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping
***FIRE**

Small Fires: Dry chemical, water spray or regular foam.

Large Fires: Water spray, fog or regular foam.

Move container from fire area if you can do it without risk.

Fight fire from maximum distance. Stay away from ends of tanks.

Dike fire control water for later disposal; do not scatter the material.

***SPILL OR LEAK**

Do not touch or walk through spilled material; stop leak if you can do it witho
Fully-encapsulating, vapor-protective clothing should be worn for spills and le
Use water spray to reduce vapors.

Small Spills: Take up with sand or other noncombustible absorbent material and

Small Dry Spills: With clean shovel place material into clean, dry container a

Large Spills: Dike far ahead of liquid spill for later disposal.

***FIRST AID**

ve victim to fresh air and call emergency medical care; if not breathing, giv
In case of contact with material, immediately flush skin or eyes with running w
Speed in removing material from skin is of extreme importance.

Removal of solidified molten material from skin requires medical assistance.

Remove and isolate contaminated clothing and shoes at the site.

Keep victim quiet and maintain normal body temperature.

Effects may be delayed; keep victim under observation.

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or omissions within this database, or in any of its printed or displayed output
forms.

DOT shipping name: POTASSIUM CYANIDE
(after shipping description):
Packing group: I
Label(s) required: POISON
Special provisions: B69, B77, N74, N75, T18, T26
Packaging exceptions: 173.NONE
Non bulk packaging: 173.211
Bulk packaging: 173.242
Quantity limitations-
Passenger air/rail: 5 KG
Cargo aircraft only: 50 KG
Vessel stowage: B
Other stowage provisions:52

STCC NUMBER: 4923225

CLEAN WATER ACT Sect.307:Yes
CLEAN WATER ACT Sect.311:No
CLEAN AIR ACT: CAA '90 By category
EPA WASTE NUMBER: P098
CERCLA REF: Not listed
RQ DESIGNATION: A 10 pounds (4.54 kg) CERCLA
SARA TPQ VALUE: 100 pounds
SARA Sect. 312
categories:

Acute toxicity: Highly toxic. LD50 is 50 mg/kg
or less (oral rat).
Chronic toxicity: mutagen.
Chronic toxicity: reproductive toxin.

LISTED IN SARA Sect 313: Yes
Minimum CONCENTRATION: 1.0 percent

UNITED STATES POSTAL SERVICE MAILABILITY:
Hazard class: Poison, Class B - Mailable as ORM-D
Mailability: Domestic service and air transportation shipper's declaration
Max per parcel: 8 OZ

NFPA CODES:
HEALTH HAZARD (BLUE): Unspecified
FLAMMABILITY (RED) : Unspecified
REACTIVITY (YELLOW): Unspecified
SPECIAL : Unspecified

----- SUMMARY OF REGULATORY LISTS THIS SUBSTANCE APPEARS ON -----

ACGIH TLV list "Threshold Limit Values for 1992-1993"
Canadian Domestic Substances List
Clean Air Act of November 15, 1990. List of pollutants.
Clean Water Act Section 307 Priority Pollutants
DOT Hazardous Materials Table. 49 CFR 172.101
EPA TSCA Chemical Inventory List 1989

EPA TSCA Chemical Inventory List 1990
EPA TSCA Chemical Inventory List 1992
EPA TSCA Test Submission (TSCATS) Database - April 1990
EPA TSCA Test Submission (TSCATS) Database - September 1989
Massachusetts Substance List.
New Jersey DEQ100 list for release reporting.
New Jersey Right To Know Substance List. (December 1987)
OSHA Air Contaminant (Table Z-1-A). 54 FR 4332, Jan. 19, 1989 and revised.
POTASSIUM CYANIDE SOLUTION [151-50-8]
Pennsylvania Hazardous Substance List
RCRA Hazardous Waste
SARA Section 313 Toxic Chemicals List
SARA Title III Extremely Hazardous Substance. Sections 302 and 304.
Superfund/CERCLA RQ list. Table 302.4 in 54 FR 50968 (December 11, 1989)
Wisconsin Air Toxics Control Regulation NR-445 (December 1988)

----- TOXICITY DATA -----

SHORT TERM TOXICITY: Unknown

LONG TERM TOXICITY: unknown

TARGET ORGANS:

SYMPTOMS: A DEADLY POISON. Source: SAX

CONC IDLH: 50mg/M3

OSHA REL: 4.7 ppm Ceiling exposures which shall at no time be exceeded (10-MIN) 5 mg/M3 Ceiling exposures which shall at no time be exceeded (10-MIN)

ACGIH TLV: TLV = 5mg/M3 as CYANIDE - SKIN

ACGIH STEL: as CYANIDE - SKIN

OSHA PEL: Transitional Limits:
PEL = 5mg/M3
Final Rule Limits:
TWA = 5 mg/M3

MAK INFORMATION: 75 ppm
200 mG/M3

CARCINOGEN?: N STATUS: See below

CARCINOGEN LISTS:
IARC: Not listed
MAK: Not listed
NIOSH: Not listed
NTP: Not listed
ACGIH: Not listed

OSHA: Not listed

HUMAN TOXICITY DATA: (Source: NIOSH RTECS)

* orl-hmn LDLo:2857 ug/kg 34ZIAG -,191,69

LD50 value: orl-rat LD50:5 mg/ kg

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)

orl-rat LD50:5 mg/kg
ipr-rat LD50:4 mg/kg
scu-rat LD50:9 mg/kg
ivn-rat LD50:3600 ug/kg
ims-rat LDLo:8 mg/kg
orl-mus LD50:8500 ug/kg
ipr-mus LD50:5991 ug/kg
scu-mus LD50:6500 ug/kg
ivn-mus LD50:2600 ug/kg
scu-dog LD50:6 mg/kg
ivn-dog LDLo:5 mg/kg
ivn-cat LD50:2200 ug/kg
orl-rbt LD50:5 mg/kg
scu-rbt LD50:4 mg/kg
ims-rbt LD50:3256 ug/kg
ocu-rbt LD50:7870 ug/kg
ipr-gpg LDLo:8 mg/kg
scu-gpg LDLo:8 mg/kg
ivn-gpg LDLo:5 mg/kg
iat-gpg LDLo:5 mg/kg
ims-pgn LD50:4 mg/kg
scu-frg LDLo:60 mg/kg

IRRITATION DATA: (Source: NIOSH RTECS 1992)

Reproductive toxicity (1992 RTECS):

This chemical is a mammalian reproductive toxin.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

orl-rat TDLo:65 gm/kg (14D pre/1-22D preg) BNEOBV
36,233,79

EFFECTS ON FERTILITY

Other measures of fertility

ipr-rat TDLo:45 mg/kg (1-15D preg) TJADAB 25(2),84A,82

EFFECTS ON EMBRYO OR FETUS

Fetotoxicity(except death,e.g.,stunted fetus)

California Prop 65: Not listed

----- EPA's IRIS DATA SUMMARY -----
Potassium cyanide; CASRN 151-50-8 (04/01/92)

II. CARCINOGENICITY ASSESSMENT FOR LIFETIME EXPOSURE

Substance Name -- Potassium cyanide
SRN -- 151-50-8

This substance/agent has not been evaluated by the U.S. EPA for evidence of human carcinogenic potential.

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED
FROM THE CHRIS MANUAL:

FIRST AID SOURCE: NIOSH
EYE: None given
SKIN: None given
INHALATION: None given
INGESTION: None given

FIRST AID SOURCE: DOT Emergency Response Guide 1990.
Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes. Speed in removing material from skin is of extreme importance. Removal of solidified molten material from skin requires medical assistance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

----- INITIAL INCIDENT RESPONSE -----

US Department of Transportation Guide to Hazardous Materials Transport Information - Publication DOT 5800.5 (1990).
DOT SHIPPING NAME: POTASSIUM CYANIDE
DOT ID NUMBER: UN1680

ERG93

GUIDE 55

POTENTIAL HAZARDS

*HEALTH HAZARDS

Poisonous; may be fatal if inhaled, swallowed or absorbed through skin. Contact may cause burns to skin and eyes.
Runoff from fire control or dilution water may give off poisonous gases and cause fire. Fire may produce irritating or poisonous gases.

*FIRE OR EXPLOSION

Some of these materials may burn, but none of them ignites readily. Container may explode violently in heat of fire.

Material may be transported in a molten form.

EMERGENCY ACTION

Keep unnecessary people away; isolate hazard area and deny entry.

Move upwind, out of low areas, and ventilate closed spaces before entering.

Use positive pressure self-contained breathing apparatus (SCBA) and chemical protective clothing.

*Structural firefighters' protective clothing is not effective for these materials.

See the Table of Initial Isolation and Protective Action Distances. If you find a spill, isolate the area.

Remove and isolate contaminated clothing at the site.

CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping Paper is not available, call 1-800-424-9303.

***FIRE**

Small Fires: Dry chemical, water spray or regular foam.

Large Fires: Water spray, fog or regular foam.

Move container from fire area if you can do it without risk.

Fight fire from maximum distance. Stay away from ends of tanks.

Dike fire control water for later disposal; do not scatter the material.

***SPILL OR LEAK**

Do not touch or walk through spilled material; stop leak if you can do it without risk.

Fully-encapsulating, vapor-protective clothing should be worn for spills and leaks from large containers.

Use water spray to reduce vapors.

Small Spills: Take up with sand or other noncombustible absorbent material and place in clean, dry container.

Small Dry Spills: With clean shovel place material into clean, dry container and move from spill area.

Large Spills: Dike far ahead of liquid spill for later disposal.

***FIRST AID**

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration.

In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes.

Speed in removing material from skin is of extreme importance.

Removal of solidified molten material from skin requires medical assistance.

Remove and isolate contaminated clothing and shoes at the site.

Keep victim quiet and maintain normal body temperature.

Medical effects may be delayed; keep victim under observation.

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CHEMTOX DATA

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----- IDENTIFIERS -----

CHEMTOX RECORD 284 LAST UPDATE OF THIS RECORD: 06/03/93
 NAME: NICKEL
 SYNONYMS: C.I. 77775; Ni 270; NICKEL 270; NICKEL CATALYST, WET
 (DOT); NICHEL (Italian); NICKEL PARTICLES; NICKEL SPONGE;
 Ni 0901-S; Ni 4303T; NP 2; PULVERIZED NICKEL; RANEY ALLOY;
 RANEY NICKEL; RCH 55/5
 CAS: 7440-02-0 RTECS: QR5950000
 FORMULA: Ni MOL WT: 58.71
 WLN: NI
 CHEMICAL CLASS: Metal

See other identifiers listed below under Regulations.

----- PROPERTIES -----

PHYSICAL DESCRIPTION:

BOILING POINT:	3110 K	2836.8 C	5138.3 F
MELTING POINT:	1828 K	1554.8 C	2830.7 F
FLASH POINT:	Not applicable		
AUTO IGNITION:	Not applicable		
VAPOR PRESSURE:			
UEL:	Not applicable		
UFL:	Not applicable		
POR DENSITY:	No data		
SPECIFIC GRAVITY:	No data		
DENSITY:			
WATER SOLUBILITY:	INSOLUBLE		
INCOMPATIBILITIES:	strong acids, sulfur, ni(no3)2, wood, other combustibles		

REACTIVITY WITH WATER:	No data on water reactivity
REACTIVITY WITH COMMON MATERIALS:	No data
STABILITY DURING TRANSPORT:	No Data
NEUTRALIZING AGENTS:	No data
POLYMERIZATION POSSIBILITIES:	No data

TOXIC FIRE GASES:	None reported other than possible unburned vapors
ODOR DETECTED AT (ppm):	Unknown
ODOR DESCRIPTION:	No data
100 % ODOR DETECTION:	No data

----- REGULATIONS -----

DOT hazard class: 4.2 SPONTANEOUSLY COMBUSTIBLE
 DOT guide: 32
 Identification number: UN1378

DOT shipping name: METAL CATALYST, WETTED WITH NOT LESS THAN 40 PER CENT WATER OR OTHER SUITABLE LIQUID, BY MASS, FINELY DIVIDED, ACTIVATED OR SPENT
Packaging group: II
Label(s) required: SPONTANEOUSLY COMBUSTIBLE
Special provisions: A2, A8, N34
Packaging exceptions: 173.NONE
Non bulk packaging: 173.212
Bulk packaging: 173.NONE
Quantity limitations-
Passenger air/rail: FORBIDDEN
Cargo aircraft only: 50 KG
Vessel stowage: C
Other stowage provisions:

STCC NUMBER: Not listed

CLEAN WATER ACT Sect.307:Yes

CLEAN WATER ACT Sect.311:No

National Primary Drinking Water Regulations

Maximum Contaminant Levels (MCL): 0.1 mg/L (01/17/94)

Maximum Contaminant Level Goals (MCLG): 0.1 mg/L (01/17/94)

CLEAN AIR ACT: CAA '90 By category

EPA WASTE NUMBER: None

CERCLA REF: Y

RQ DESIGNATION: B 100 pounds (45.4 kg) CERCLA for pieces of solid r with diameter less than 100 micrometers (0.004 inches).

TPQ VALUE: Not listed

RA Sect. 312

categories:

Acute toxicity: adverse effect to target organs.

Chronic toxicity: carcinogen

Chronic toxicity: mutagen.

Chronic toxicity: reproductive toxin.

Fire hazard: flammable.

Fire hazard: pyrophoric.

LISTED IN SARA Sect 313: Yes

de minimus CONCENTRATION: 1.0 percent

UNITED STATES POSTAL SERVICE MAILABILITY:

Not given

NFPA CODES:

HEALTH HAZARD (BLUE): Unspecified

FLAMMABILITY (RED) : Unspecified

REACTIVITY (YELLOW): Unspecified

SPECIAL : Unspecified

----- SUMMARY OF REGULATORY LISTS THIS SUBSTANCE APPEARS ON -----

ACGIH TLV list "Threshold Limit Values for 1992-1993"
SDR Toxicology Profile available (NTIS** PB/89/160378/AS)
California Assembly Bill 2588 Air Toxics "Hot Spots" Chemicals.
California Assembly Bill 1807 Toxic Air Contaminants.
Canadian Domestic Substances List
Canadian Ingredient Disclosure List. 20/01/88 Canada Gazette part II, Vol 122.
Clean Air Act of November 15, 1990. List of pollutants.
Clean Water Act Section 307 Priority Pollutants
DOT Hazardous Materials Table. 49 CFR 172.101
EPA Carcinogen Assessment Group List
EPA TSCA Chemical Inventory List 1986
EPA TSCA Chemical Inventory List 1989
EPA TSCA Chemical Inventory List 1990
EPA TSCA Chemical Inventory List 1992
EPA TSCA Test Submission (TSCATS) Database - April 1990
EPA TSCA Test Submission (TSCATS) Database - September 1989
Massachusetts Substance List.
NICKEL [7440-02-0]
National Toxicology Program (NTP) list of human carcinogens
National Toxicology Program list of anticipated human carcinogens
New Jersey DEQ100 list for release reporting.
New Jersey Right To Know Substance List. (December 1987)
New Jersey Right to Know Substance List. Listed as a carcinogen.
OSHA Air Contaminant (Table Z-1-A). 54 FR 4332, Jan. 19, 1989 and revised.
Pennsylvania Hazardous Substance List
SARA Section 110 Priority List of CERCLA Hazardous Substances
SARA Section 313 Toxic Chemicals List
Wisconsin Air Toxics Control Regulation NR-445 (December 1988)

----- TOXICITY DATA -----

SHORT TERM TOXICITY: Unknown

LONG TERM TOXICITY: may cause dermatitis in sensitive individuals -
ingestion of soluble salts causes nausea, vomiting,
diarrhea. ** source: sax, mi

TARGET ORGANS: nasal cavities, lung, skin.

SYMPTOMS: CANCER LUNGS, NASAL CAVITIES; PNEUMONITIS; ALLERGIC
ASTH SENS DERM. GINGIVITIS, STOMATITIS (INFLAMMATION
OF THE MOUTH), METALLIC TASTE, METAL FUME FEVER,
NICKEL DERMATITIS, ECZEMA (SWELLING) BY SENSITIZATION,
ANOSMIA, SINUS AND PULMONARY CARCINOGENESIS BY LONG
PERIOD EXPOSURE. Source: THIC

CONC IDLH: Nonegiven

NIOSH REL: Potential occupational carcinogen 0.015 mg/M3 Time
weighted averages for 8-hour exposure

ACGIH TLV: TLV = 1mg/M3 as NICKEL
ACGIH STEL: as NICKEL

OSHA PEL: Transitional Limits:
PEL = 1mg/M3
Final Rule Limits:
TWA = 1 mg/M3

MAK INFORMATION: 100 ppm
250 mg/M3
Carcinogenic working material without MAK

CARCINOGEN?: Y STATUS: See below

CARCINOGEN LISTS:

IARC: Carcinogen defined by IARC
to be possibly carcinogenic to
humans, but having (usually) no
human evidence.
MAK: Not listed
NIOSH: Carcinogen defined by NIOSH
with no further categorization.
NTP: Carcinogen defined by NTP as
reasonably anticipated to be
carcinogenic, with limited
evidence in humans or sufficient
evidence in experimental animals.
ACGIH: Carcinogen defined by ACGIH
TLV Committee as a confirmed human
carcinogen, recognized to have
carcinogenic or cocarcinogenic
potential.
OSHA: Not listed

LD50 value: No LD50 in RTECS 1992

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)

orl-rat LDLo:5 gm/kg
itr-rat LDLo:12 mg/kg
ivn-mus LDLo:50 mg/kg
scu-cat LDLo:12500 ug/kg
ipr-rbt LDLo:7 mg/kg
scu-rbt LDLo:7500 ug/kg
orl-gpg LDLo:5 mg/kg

IRRITATION DATA: (Source: NIOSH RTECS 1992)

Reproductive toxicity (1992 RTECS):

This chemical is a mammalian reproductive toxin.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

 orl-rat TDLo:158 mg/kg (multigenerations) AEHLAU
 23,102,71

 EFFECTS ON EMBRYO OR FETUS

 Fetotoxicity(except death,e.g.,stunted fetus)

 EFFECTS ON EMBRYO OR FETUS

 Fetal death

California Prop 65: No significant risk level .8 ugD (01/01/94)

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED
FROM THE CHRIS MANUAL:

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS:

** WEAR APPROPRIATE EQUIPMENT TO PREVENT:

 Repeated or prolonged skin contact.

** EXPOSED PERSONNEL SHOULD WASH:

 Immediately when skin becomes contaminated.

** WORK CLOTHING SHOULD BE CHANGED DAILY:

 If there is any reasonable possibility that the clothing may be contaminat

REMOVE CLOTHING:

 Promptly remove non-impervious clothing that becomes contaminated.

** REFERENCE: NIOSH

RECOMMENDED RESPIRATION PROTECTION Source: NIOSH POCKET GUIDE (85-114)
NIOSH (NICKEL)

Greater at any detectable concentration. : Any self-contained breathing apparatus with full facepiece and operated in a pressure-demand or other positive pressure mode. / Any supplied-air respirator with a full facepiece and operated in 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 with a high-efficiency particulate filter. / Any appropriate escape-type self-contained breathing apparatus.

FIRST AID SOURCE: NIOSH

EYE: None given

SKIN: water flush immed

INHALATION: art resp

INGESTION: water, vomit

FIRST AID SOURCE: DOT Emergency Response Guide 1990.

Move victim to fresh air; call emergency medical care. In case of contact

with material, immediately flush skin or eyes with running water for at least 15 minutes. Removal of solidified molten material from skin requires medical assistance. Remove and isolate contaminated clothing and shoes at the site.

----- INITIAL INCIDENT RESPONSE -----

US Department of Transportation Guide to Hazardous Materials Transport
Information - Publication DOT 5800.5 (1990).
DOT SHIPPING NAME: METAL CATALYST, WETTED WITH NOT LESS THAN 40 PER CENT WATER
DOT ID NUMBER: UN1378

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GUIDE 32

POTENTIAL HAZARDS

*FIRE OR EXPLOSION

Flammable/combustible material; may be ignited by heat, sparks or flames. May burn rapidly with flare-burning effect. Material may be transported in a molten form.

*HEALTH HAZARDS

Fire may produce irritating or poisonous gases. Contact may cause burns to skin and eyes. Runoff from fire control or dilution water may cause pollution.

EMERGENCY ACTION

Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Positive pressure self-contained breathing apparatus (SCBA) and structural fire CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping If water pollution occurs, notify the appropriate authorities.

*FIRE

All Fires: Dry chemical, sand, earth, water spray or regular foam.
Large Fires: Water spray, fog or regular foam.
Move container from fire area if you can do it without risk.
Apply cooling water to sides of containers that are exposed to flames until well cooled.
For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if
For massive fire in cargo area, use unmanned hose holder or monitor nozzles.
Magnesium Fires: Use dry sand, sodium chloride powder or graphite powder.

*SPILL OR LEAK

Shut off ignition sources; no flames, smoking or flames in hazard area. Do not touch or walk through spilled material.
Small Dry Spills: With clean shovel place material into clean, dry container.
Large Spills: Wet down with water and dike for later disposal.

*FIRST AID

Move victim to fresh air; call emergency medical care. In case of contact with material, immediately flush skin or eyes with running water. Removal of solidified molten material from skin requires medical assistance. Remove and isolate contaminated clothing and shoes at the site.

DISCLAIMER: The data shown above on this chemical represents a best effort on the part of the compilers of the CHEMTOX database to obtain useful, accurate, and factual data. The use of these data shall be in accordance with the guidelines and limitations of the user's CHEMTOX license agreement.

The COMPILERS of the CHEMTOX database shall not be held liable for inaccuracies or omissions within this database, or in any of its printed or displayed output forms.

Special provisions: 8.,B54
Packaging exceptions: 173.155
Non bulk packaging: 173.213
 lk packaging: 173.240
Quantity limitations-
Passenger air/rail: None
Cargo aircraft only: None
Vessel stowage: A
Other stowage provisions:

STCC NUMBER: Not listed

CLEAN WATER ACT Sect.307:Yes

CLEAN WATER ACT Sect.311:No

National Primary Drinking Water Regulations

Maximum Contaminant Levels (MCL): Treatment technique (12/07/92)

Maximum Contaminant Level Goals (MCLG): 1.3 mg/L (12/07/92)

CLEAN AIR ACT: Not listed

EPA WASTE NUMBER: None

CERCLA REF: Not listed

RQ DESIGNATION: D 5000 pounds (2270 kg) CERCLA for pieces of solid metal with diameter less than 100 micrometers (0.004 inches).

SARA TPQ VALUE: Not listed

SARA Sect. 312

categories:

Acute toxicity: adverse effect to target organs.

LISTED IN SARA Sect 313: Yes

Minimum CONCENTRATION: 1.0 percent

UNITED STATES POSTAL SERVICE MAILABILITY:

Not given

NFPA CODES:

HEALTH HAZARD (BLUE): Unspecified

FLAMMABILITY (RED) : Unspecified

REACTIVITY (YELLOW): Unspecified

SPECIAL : Unspecified

----- SUMMARY OF REGULATORY LISTS THIS SUBSTANCE APPEARS ON -----

ACGIH TLV list "Threshold Limit Values for 1992-1993"

COPPER [7440-50-8]

California Assembly Bill 2588 Air Toxics "Hot Spots" Chemicals.

Canadian Domestic Substances List

Canadian Ingredient Disclosure List. 20/01/88 Canada Gazette part II, Vol 122.

Clean Water Act Section 307 Priority Pollutants

EPA TSCA Chemical Inventory List 1989

EPA TSCA Chemical Inventory List 1990

EPA TSCA Chemical Inventory List 1992
EPA TSCA Test Submission (TSCATS) Database - April 1990
EPA TSCA Test Submission (TSCATS) Database - September 1989
Massachusetts Substance List.

New Jersey DEQ100 list for release reporting.

OSHA Air Contaminant (Table Z-1-A). 54 FR 4332, Jan. 19, 1989 and revised.

Pennsylvania Hazardous Substance List

SARA Section 110 Priority List of CERCLA Hazardous Substances

SARA Section 313 Toxic Chemicals List

Wisconsin Air Toxics Control Regulation NR-445 (December 1988)

----- TOXICITY DATA -----

SHORT TERM TOXICITY: COLD, IRRITATION OF RESPIRATORY TRACT, NASAL DISCOMFORT, CONJUNCTIVITIS, CORNEAL ULCERATION, AND EDEMA. ** Source: 1

LONG TERM TOXICITY: skin discoloration, kidney and liver damage, ulceration and perforation of nasal septum, mucous membrane change. ** source: 1

TARGET ORGANS: resp system, skin, eyes, increased risk of wilson's disease

SYMPTOMS: Source:

CONC IDLH: None given

NIOSH REL:

ACGIH TLV: TLV = FUME 0.2 MG/M3; DUST AND MISTS 1mg/M3 as COPPER
ACGIH STEL: as COPPER

OSHA PEL: Transitional Limits:
PEL = (FUME) 0.1 MG/M3; (DUST AND MISTS) 1mg/M3
Final Rule Limits:
TWA = (FUME) 0.1 MG/M3; (DUST AND MISTS) 1 mg/M3

MAK INFORMATION: 1 calculated as total dust mg/M3
Substance with systemic effects, onset of effect less than or equal to 2 hrs: Peak = 2xMAK for 30 minutes, 4 times per shift of 8 hours.

CARCINOGEN?: N STATUS: See below

CARCINOGEN LISTS:

IARC: Not listed
MAK: Not listed
NIOSH: Not listed
NTP: Not listed
ACGIH: Not listed
OSHA: Not listed

HUMAN TOXICITY DATA: (Source: NIOSH RTECS)
 orl-hmn TDLo:120 ug/kg PHRPA6 73,910,58
 GASTROINTESTINAL
 Nausea or vomiting

LD50 value: No LD50 in RTECS 1992

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)

 ipr-mus LD50:3500 ug/kg

IRRITATION DATA: (Source: NIOSH RTECS 1992)

Reproductive toxicity (1992 RTECS):

 This chemical is a mammalian reproductive toxin.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

 orl-rat TDLo:152 mg/kg (22W pre) GISAAA 45(3),8,80
 EFFECTS ON EMBRYO OR FETUS
 Fetotoxicity(except death,e.g.,stunted fetus)
 SPECIFIC DEVELOPMENTAL ABNORMALITIES
 Central nervous system

 orl-rat TDLo:1520 ug/kg (22W pre) GISAAA 45(3),8,80
 SPECIFIC DEVELOPMENTAL ABNORMALITIES
 Musculoskeletal system

 orl-rat TDLo:1210 ug/kg (35W pre) GISAAA 42(8),30,77
 EFFECTS ON FERTILITY
 Pre-implantation mortality
 EFFECTS ON FERTILITY
 Post-implantation mortality

California Prop 65: Not listed

----- EPA's IRIS DATA SUMMARY -----
Copper; CASRN 7440-50-8 (04/01/92)

II. CARCINOGENICITY ASSESSMENT FOR LIFETIME EXPOSURE

Substance Name -- Copper
CASRN -- 7440-50-8
Last Revised -- 08/01/91

Section II provides information on three aspects of the carcinogenic risk assessment for the agent in question; the U.S. EPA classification, and quantitative estimates of risk from oral exposure and from inhalation exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in three ways. The slope factor is the result of application of a

low-dose extrapolation procedure and is presented as the risk per (mg/kg)/day. The unit risk is the quantitative estimate in terms of either risk per ug/L drinking water or risk per ug/cu.m air breathed. The third form in which risk presented is a drinking water or air concentration providing cancer risks . 1 in 10,000, 1 in 100,000 or 1 in 1,000,000. Background Document 2 (Service Code 5) provides details on the rationale and methods used to derive the carcinogenicity values found in IRIS. Users are referred to Section I for information on long-term toxic effects other than carcinogenicity.

__II.A. EVIDENCE FOR CLASSIFICATION AS TO HUMAN CARCINOGENICITY

___II.A.1. WEIGHT-OF-EVIDENCE CLASSIFICATION

Classification -- D; not classified

Basis -- There are no human data, inadequate animal data from assays of copper compounds, and equivocal mutagenicity data.

___II.A.2. HUMAN CARCINOGENICITY DATA

None.

_II.A.3. ANIMAL CARCINOGENICITY DATA

Inadequate. Bionetics Research Labs (1968) studied the carcinogenicity of a copper-containing compound, copper hydroxyquinoline, in two strains of mice (B6C3F1 and B6AKF1). Groups of 18 male and 18 female 7-day-old mice were administered 1000 mg copper hydroxyquinoline/kg bw (180.6 mg Cu/kg) suspended in 0.5% gelatin daily until they were 28 days old, after which they were administered 2800 ppm (505.6 ppm Cu) in the feed for 50 additional weeks. No statistically significant increases in tumor incidence were observed in the treated 78-week-old animals.

In the same study, Bionetics Research Labs (1968) administered a single subcutaneous injection of gelatin (control) or 1000 mg of copper hydroxyquinoline/kg bw (180.6 mg Cu/kg) suspended in 0.5% gelatin to groups of 28-day-old mice of both strains. After 50 days of observation, the male B6C3F1 had an increased incidence of reticulum cell sarcomas compared with controls. No tumors were observed in the treated male B6AKF1 mice, and a low incidence of reticulum cell sarcomas was observed in the treated female mice of both strains.

Gilman (1962) administered intramuscular injections containing 20 mg of cupric oxide (16 mg Cu), cupric sulfide (13.3 mg Cu), and cuprous sulfide (16 mg Cu) into the left and right thighs of 2- to 3-month-old Wistar rats. After 20 months of observations, no injection-site tumors were observed in any animals, but other tumors were observed at very low incidence in the

animals receiving cupric sulfide (2/30) and cuprous sulfide (1/30). As the relevance of the organic copper compound to the observation of sarcoma induction is uncertain and the incidence of tumors in rats treated i.m. with organic copper was very low, data are considered inadequate for classification.

___II.A.4. SUPPORTING DATA FOR CARCINOGENICITY

Moriya et al. (1983) reported no increase in mutations in *E. coli* and *S. typhimurium* strains TA98, TA1535, TA1537 and TA1538 incubated with up to 5 mg copper quinolinolate/plate and in *S. typhimurium* TA98 and TA100 incubated with up to 5 mg copper sulfate/plate. Demerec et al. (1951) reported dose-related mutagenic effects in *E. coli* with 2 to 10 ppm copper sulfate in a reverse mutation assay. Negative results were obtained with copper sulfate or copper chloride in assays using *S. cerevisiae* (Singh, 1983) and *Bacillus subtilis* (Nishioka, 1975, Matsui, 1980, Kanematsu et al., 1980). Errors in DNA synthesis from poly(c) templates have been induced in viruses incubated with copper chloride or copper acetate (Sirover and Loeb, 1976). Chromosomal aberrations were induced in isolated rat hepatocytes when incubated with copper sulfate (Sina et al., 1983). Casto et al. (1979) showed enhanced cell transformation in Syrian hamster embryo cells infected with simian adenovirus with the addition of cuprous sulfide and copper sulfate. High concentrations of copper compounds have been reported to induce mitosis in rat ascites cells and recessive lethals in *Drosophila melanogaster*. Law (1938) reported increases in the percent lethals observed in *Drosophila* larvae and eggs when exposed to copper by microinjection (0.1% copper sulfate) or immersion (concentrated aqueous copper sulfate), respectively.

___II.B. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM ORAL EXPOSURE

Not available.

___II.C. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM INHALATION EXPOSURE

Not available.

___II.D. EPA DOCUMENTATION, REVIEW, AND CONTACTS (CARCINOGENICITY ASSESSMENT)

II.D.1. EPA DOCUMENTATION

U.S. EPA. 1987. Drinking Water Criteria Document for Copper. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Drinking Water, Washington, DC. ECAO-CIN 417.

II.D.2. REVIEW (CARCINOGENICITY ASSESSMENT)

The values in the 1987 Drinking Water Criteria Document for Copper have received peer and administrative review.

Agency Work Group Review: 09/15/87

Verification Date: 09/15/87

II.D.3. U.S. EPA CONTACTS (CARCINOGENICITY ASSESSMENT)

David J. Reisman / ORD -- (513)569-7588 / FTS 684-7588

W. Bruce Peirano / ORD -- (513)569-7540 / FTS 684-7540

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED
FROM THE CHRIS MANUAL:

RECOMMENDED RESPIRATION PROTECTION Source: NIOSH POCKET GUIDE (85-114)
OSHA (COPPER)

5 mg/M3: Any dust and mist respirator except single-use respirators. * Substance reported to cause eye irritation or damage may require eye protection.

10 mg/M3: Any dust and mist respirator except single-use and quarter-mask respirators. * Substance reported to cause eye irritation or damage may require eye protection. / Any supplied-air respirator. * Substance reported to cause eye irritation or damage may require eye protection. / Any self-contained breathing apparatus. * Substance reported to cause eye irritation or damage may require eye protection.

25 mg/M3: Any powered air-purifying respirator with a dust and mist filter. * Substance reported to cause eye irritation or damage may require eye protection. / Any supplied-air respirator operated in a continuous flow mode. * Substance reported to cause eye irritation or damage may require eye protection.

50 mg/M3: Any air-purifying full facepiece respirator with a

high-efficiency particulate filter. / Any self-contained breathing apparatus with a full facepiece. / Any supplied-air respirator with a full facepiece. / Any powered air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter. * Substance reported to cause eye irritation or damage may require eye protection.

1000 mg/M3: Any supplied-air respirator with a half-mask and operated in a pressure-demand or other positive pressure mode. * Substance reported to cause eye irritation or damage may require eye protection.

2000 mg/M3: Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode.

EMERGENCY OR PLANNED ENTRY IN UNKNOWN CONCENTRATIONS OR IDLH CONDITIONS.: Any self-contained breathing apparatus with full facepiece and operated in a pressure-demand or other positive pressure mode. / Any supplied-air respirator with a full facepiece and operated in 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 with a high-efficiency particulate filter. / Any appropriate escape-type self-contained breathing apparatus.

FIRST AID SOURCE: DOT Emergency Response Guide 1990.

In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water. Remove and isolate contaminated clothing and shoes at the site.

----- INITIAL INCIDENT RESPONSE -----

Department of Transportation Guide to Hazardous Materials Transport Information - Publication DOT 5800.5 (1990).

DOT SHIPPING NAME: ENVIRONMENTALLY HAZARDOUS SUBSTANCES, SOLID, N.O.S. (Copper)
DOT ID NUMBER: UN3077

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GUIDE 31

POTENTIAL HAZARDS

*FIRE OR EXPLOSION

Some of these materials may burn, but none of them ignites readily. Material may be transported hot.

*HEALTH HAZARDS

Contact may cause burns to skin and eyes.

Inhalation of asbestos dust may have a damaging effect on the lungs.

Fire may produce irritating or poisonous gases.

Runoff from fire control or dilution water may cause pollution.

EMERGENCY ACTION

Keep unnecessary people away; isolate hazard area and deny entry.

Positive pressure self-contained breathing apparatus (SCBA) and structural fire CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping

If water pollution occurs, notify the appropriate authorities.

*FIRE

Small Fires: Dry chemical, CO2, water spray or regular foam.

Large Fires: Water spray, fog or regular foam.

Move container from fire area if you can do it without risk.

*Do not scatter spilled material with high-pressure water streams.
Dike fire control water for later disposal.

***SPILL OR LEAK**

Stop leak if you can do it without risk.
Avoid inhalation of asbestos dust.

Small Dry Spills: With clean shovel place material into clean, dry container.

Small Spills: Take up with sand or other noncombustible absorbent material and

Large Spills: Dike far ahead of liquid spill for later disposal.

Cover powder spill with plastic sheet or tarp to minimize spreading.

***FIRST AID**

In case of contact with material, immediately flush eyes with running water for
Remove and isolate contaminated clothing and shoes at the site.

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CHEMTOX DATA

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----- IDENTIFIERS -----

CHEMTOX RECORD 116
NAME: CHROMIUM
SYNONYMS:
CAS: 7440-47-3
FORMULA: Cr
WLN: CR
CHEMICAL CLASS: Metal

LAST UPDATE OF THIS RECORD: 06/03/93
RTECS: GB4200000
MOL WT: 51.996

See other identifiers listed below under Regulations.

----- PROPERTIES -----

PHYSICAL DESCRIPTION: steel-gray metal or silver metal powder. (nydh)

BOILING POINT:	2915 K	2641.8 C	4787.3 F
MELTING POINT:	2173 K	1899.8 C	3451.7 F
FLASH POINT:	Not applicable		
AUTO IGNITION:	Not applicable		
VAPOR PRESSURE:			
UEL:	Not applicable		
LEL:	Not applicable		
VAPOR DENSITY:	No data		
SPECIFIC GRAVITY:	No data		
DENSITY:	7.200		
WATER SOLUBILITY:			
INCOMPATIBILITIES:	strong oxidizers		
REACTIVITY WITH WATER:	No data on water reactivity		
REACTIVITY WITH COMMON MATERIALS:	No data		
STABILITY DURING TRANSPORT:	No Data		
NEUTRALIZING AGENTS:	No data		
POLYMERIZATION POSSIBILITIES:	No data		
TOXIC FIRE GASES:	None reported other than possible unburned vapors		
ODOR DETECTED AT (ppm):	Unknown		
ODOR DESCRIPTION:	NONE Source: NYDH		
100 % ODOR DETECTION:	No data		

----- REGULATIONS -----

DOT hazard class: 9 CLASS 9
DOT guide: 31
Identification number: UN3077
DOT shipping name: ENVIRONMENTALLY HAZARDOUS SUBSTANCES, SOLID, N.O.S. (CHROMIUM)
Packing group: III
Label(s) required: CLASS 9

Special provisions: 8, B54
Packaging exceptions: 173.155
Non bulk packaging: 173.213
Bulk packaging: 173.240
Quantity limitations-
Passenger air/rail: NONE
Cargo aircraft only: NONE
Vessel stowage: A
Other stowage provisions:

STCC NUMBER: Not listed

CLEAN WATER ACT Sect.307:Yes

CLEAN WATER ACT Sect.311:No

National Primary Drinking Water Regulations

Maximum Contaminant Levels (MCL): 0.1 mg/L (07/30/92)

Maximum Contaminant Level Goals (MCLG): 0.1 mg/L (07/30/92)

CLEAN AIR ACT: CAA '90 By category

EPA WASTE NUMBER: D007

CERCLA REF: Y

RQ DESIGNATION: D 5000 pounds (2270 kg) CERCLA for pieces of solid metal with diameter less than 100 micrometers (0.004 inches).

SARA TPQ VALUE: Not listed

SARA Sect. 312

categories:

Chronic toxicity: carcinogen

LISTED IN SARA Sect 313: Yes

Minimum CONCENTRATION: 1.0 percent

UNITED STATES POSTAL SERVICE MAILABILITY:

Not given

NFPA CODES:

HEALTH HAZARD (BLUE): Unspecified

FLAMMABILITY (RED) : Unspecified

REACTIVITY (YELLOW): Unspecified

SPECIAL : Unspecified

----- SUMMARY OF REGULATORY LISTS THIS SUBSTANCE APPEARS ON -----

ACGIH TLV list "Threshold Limit Values for 1992-1993"

ATSDR Toxicology Profile available (NTIS** PB/89/236665/AS)

CHROMIUM [7440-47-3]

California Assembly Bill 1807 Toxic Air Contaminants.

Canadian Domestic Substances List

Canadian Ingredient Disclosure List. 20/01/88 Canada Gazette part II, Vol 122.

Clean Air Act of November 15, 1990. List of pollutants.

Clean Water Act Section 307 Priority Pollutants

EPA TSCA Chemical Inventory List 1986
EPA TSCA Chemical Inventory List 1989
EPA TSCA Chemical Inventory List 1990
A TSCA Chemical Inventory List 1992
A TSCA Test Submission (TSCATS) Database - April 1990
EPA TSCA Test Submission (TSCATS) Database - September 1989
Massachusetts Substance List.
National Toxicology Program (NTP) list of human carcinogens
New Jersey DEQ100 list for release reporting.
New Jersey Right To Know Substance List. (December 1987)
New Jersey Right to Know Substance List. Listed as a carcinogen.
New Jersey Right to Know Substance List. Listed as a mutagen.
OSHA Air Contaminant (Table Z-1-A). 54 FR 4332, Jan. 19, 1989 and revised.
Pennsylvania Hazardous Substance List
RCRA Hazardous Waste
RCRA Toxicity Characteristics (TC) list dated March 29, 1990
SARA Section 110 Priority List of CERCLA Hazardous Substances
SARA Section 313 Toxic Chemicals List
Wisconsin Air Toxics Control Regulation NR-445 (December 1988)

----- TOXICITY DATA -----

SHORT TERM TOXICITY: INHALATION: dust may cause irritation of the nose,
throat and lungs. SKIN: dust may cause irritation.
Eyes: dust may cause irritation. INGESTION: dust may
cause irritation of the mouth and throat. (NYDH)

LONG TERM TOXICITY: no information found on exposure to chromium metal.
see specific chromium compounds. (NYDH)

TARGET ORGANS:

SYMPTOMS: HISTOLOGIC FIBROSIS OF LUNGS Source: NIOSHP

CONC IDLH: Nonegiven

NIOSH REL:

ACGIH TLV: TLV = 0.5mg/M3

ACGIH STEL: Not listed

OSHA PEL: Transitional Limits:
PEL = 1mg/M3
Final Rule Limits:
TWA = 1 mg/M3

MAK INFORMATION: Not listed

CARCINOGEN?: N STATUS: See below

REFERENCES:

ANIMAL SUSPECTED IARC** 2,100,73
ANIMAL INDEFINITE IARC** 23,205,80

CARCINOGEN LISTS:

IARC: Not classified as to human
carcinogenicity or probably not
carcinogenic to humans.
MAK: Not listed
NIOSH: Not listed
NTP: Not listed
ACGIH: Not classifiable as a Human
Carcinogen due to inadequate data.
OSHA: Not listed

LD50 value: No LD50 in RTECS 1992

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)

unr-rat LD50:27500 ug/kg

IRRITATION DATA: (Source: NIOSH RTECS 1992)

Reproductive toxicity (1992 RTECS):

This chemical has no known mammalian reproductive toxicity.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

California Prop 65: Not listed

----- EPA's IRIS DATA SUMMARY -----
Chromium(VI); CASRN 7440-47-3 (04/01/92)

_II. CARCINOGENICITY ASSESSMENT FOR LIFETIME EXPOSURE

Substance Name -- Chromium(VI)
CASRN -- 7440-47-3
Last Revised -- 03/01/91

Section II provides information on three aspects of the carcinogenic risk assessment for the agent in question; the U.S. EPA classification, and quantitative estimates of risk from oral exposure and from inhalation exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in three ways. The slope factor is the result of application of a low-dose extrapolation procedure and is presented as the risk per (mg/kg)/day. The unit risk is the quantitative estimate in terms of either risk per ug/L drinking water or risk per ug/cu.m air breathed. The third form in which risk is presented is a drinking water or air concentration providing cancer risks of 1 in 10,000, 1 in 100,000 or 1 in 1,000,000. Background Document 2 (Service Code 5) provides details on the rationale and methods used to derive the carcinogenicity values found in IRIS. Users are referred to Section I for

information on long-term toxic effects other than carcinogenicity.

II.A. EVIDENCE FOR CLASSIFICATION AS TO HUMAN CARCINOGENICITY

___ II.A.1. WEIGHT-OF-EVIDENCE CLASSIFICATION

Classification -- A; human carcinogen

Basis -- Results of occupational epidemiologic studies of chromium-exposed workers are consistent across investigators and study populations. Dose-response relationships have been established for chromium exposure and lung cancer. Chromium-exposed workers are exposed to both chromium III and chromium VI compounds. Because only chromium VI has been found to be carcinogenic in animal studies, however, it was concluded that only chromium VI should be classified as a human carcinogen.

___ II.A.2. HUMAN CARCINOGENICITY DATA

Sufficient. Epidemiologic studies of chromate production facilities in the United States (Machle and Gregorius, 1948; Brinton et al., 1952; Mancuso and Hueper, 1951, Mancuso, 1975; Baetjer, 1950; Taylor, 1966; Enterline, 1974; Hayes et al., 1979; Hill and Ferguson, 1979), Great Britain (Bidstrup, 1951; Bidstrup and Case, 1956; Alderson et al., 1981), Japan (Watanabe and Fukuchi, 1975; Ohsaki et al., 1978; Sano and Mitohara, 1978; Satoh et al., 1981) and West Germany (Korallus et al., 1982; Bittersohl, 1971) have established an association between chromium (Cr) exposure and lung cancer. Most of these studies did not attempt to determine whether Cr III or Cr VI compounds were the etiologic agents.

Three studies of the chrome pigment industry, one in Norway (Langard and Norseth, 1975), one in England (Davies, 1978, 1979), and the third in the Netherlands and Germany (Frentzel-Beyme, 1983) also found an association between occupational chromium exposure (predominantly to Cr VI) and lung cancer.

Results of two studies of the chromium plating industry (Royle, 1975; Silverstein et al., 1981) were inconclusive, while the findings of a Japanese study of chrome platers were negative (Okubo and Tsuchiya, 1979). The results of studies of ferrochromium workers (Pokrovskaya and Shabynina, 1973; Langard et al., 1980; Axelsson et al., 1980) were inconclusive as to lung cancer risk.

___ II.A.3. ANIMAL CARCINOGENICITY DATA

Sufficient. Hexavalent chromium compounds were carcinogenic in animal assays producing the following tumor types: intramuscular injection site tumors in Fischer 344 and Bethesda Black rats and in C57BL mice (Furst et al., 1976; Maltoni, 1974, 1976; Payne, 1960; Heuper and Payne, 1959); intra-

plural implant site tumors for various chromium VI compounds in Sprague-Dawley and Bethesda Black rats (Payne, 1960; Heuper 1961; Heuper and Payne, 1962); intrabronchial implantation site tumors for various Cr VI compounds Wistar rats (Levy and Martin, 1983; Laskin et al., 1970; Levy as quoted in NIOSH, 1975); and subcutaneous injection site sarcomas in Sprague-Dawley rats (Maltoni, 1974, 1976).

___II.A.4. SUPPORTING DATA FOR CARCINOGENICITY

A large number of chromium compounds have been assayed in in vitro genetic toxicology assays. In general, hexavalent chromium is mutagenic in bacterial assays whereas trivalent chromium is not (Lofroth, 1978; Petrellie and Flora, 1977, 1978). Likewise Cr VI but not Cr III was mutagenic in yeasts (Bonatti et al., 1976) and in V79 cells (Newbold et al., 1979). Chromium III and VI compounds decrease the fidelity of DNA synthesis in vitro (Loeb et al., 1977), while Cr VI compounds inhibit replicative DNA synthesis in mammalian cells (Levis et al., 1978) and produce unscheduled DNA synthesis, presumably repair synthesis, as a consequence of DNA damage (Raffetto, 1977). Chromate has been shown to transform both primary cells and cell lines (Fradkin et al., 1975; Tsuda and Kato, 1977; Casto et al., 1979). Chromosomal effects produced by treatment with chromium compounds have been reported by a number of authors; for example, both Cr VI and Cr III salts were clastogenic for cultured human leukocytes (Nakamuro et al., 1978).

There are no long-term studies of ingested Cr VI. There appears to be significant in vivo conversion of Cr VI to Cr III and III to VI; Cr III is an essential trace element.

___II.B. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM ORAL EXPOSURE

Not available.

___II.C. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM INHALATION EXPOSURE

___II.C.1. SUMMARY OF RISK ESTIMATES

Inhalation Unit Risk -- 1.2E-2 per (ug/cu.m)

Extrapolation Method -- Multistage, extra risk

Air Concentrations at Specified Risk Levels:

Risk Level	Concentration
E-4 (1 in 10,000)	8E-3 ug/cu.m
E-5 (1 in 100,000)	8E-4 ug/cu.m
E-6 (1 in 1,000,000)	8E-5 ug/cu.m

II.C.2. DOSE-RESPONSE DATA FOR CARCINOGENICITY, INHALATION EXPOSURE

Species/Strain Tumor Type	Dose	Tumor Incidence	Reference
human	Route: Occupational exposure (inhalation)		
Age (years)	Midrange (ug/cu.m)	Deaths from Lung Cancer	Person Years
50	5.66	3	1345
	25.27	6	931
	46.83	6	299
60	4.68	4	1063
	20.79	5	712
	39.08	5	211
70	4.41	2	401
	21.29	4	345

II.C.3. ADDITIONAL COMMENTS (CARCINOGENICITY, INHALATION EXPOSURE)

The cancer mortality in Mancuso (1975) was assumed to be due to Cr VI, which was further assumed to be no less than one-seventh of total chromium. It was also assumed that the smoking habits of chromate workers were similar to those of the U.S. white male population. The unit risks of Langard et al. (1980), Axelsson et al. (1980), and Pokrovskaya and Shabynina (1973) are 1.3E-1, 3.5E-2 and 9.2E-2 per (ug/cu.m), respectively.

Hexavalent chromium compounds have not produced lung tumors in animals by inhalation. Trivalent chromium compounds have not been reported as carcinogenic by any route of administration.

The unit risk should not be used if the air concentration exceeds 8E-1 ug/cu.m, since above this concentration the unit risk may not be appropriate.

II.C.4. DISCUSSION OF CONFIDENCE (CARCINOGENICITY, INHALATION EXPOSURE)

Results of studies of chromium exposure are consistent across investi-

gators and countries. A dose-relationship for lung tumors has been established. The assumption that the ratio of Cr III to Cr VI is 6:1 may lead to a 7-fold underestimation of risk. The use of 1949 hygiene data, which may derestimate worker exposure, may result in an overestimation of risk. Further overestimation of risk may be due to the implicit assumption that the smoking habits of chromate workers were similar to those of the general white male population, since it is generally accepted that the proportion of smokers is higher for industrial workers than for the general population.

__II.D. EPA DOCUMENTATION, REVIEW, AND CONTACTS (CARCINOGENICITY ASSESSMENT)

___II.D.1. EPA DOCUMENTATION

Mancuso, T.F. 1975. International Conference on Heavy Metals in the Environment. Toronto, Ontario, Canada.

U.S. EPA. 1984. Health Assessment Document for Chromium. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH. EPA 600/8-83-014F.

___II.D.2. REVIEW (CARCINOGENICITY ASSESSMENT)

The quantification of cancer risk in the 1984 Health Assessment Document has received peer review in public sessions of the Environmental Health Committee of the U.S. EPA's Science Advisory Board.

Agency Work Group Review: 06/26/86

Verification Date: 06/26/86

___II.D.3. U.S. EPA CONTACTS (CARCINOGENICITY ASSESSMENT)

Herman J. Gibb / ORD -- (202)260-5898 / FTS 260-5898

Chao W. Chen / ORD -- (202)260-5719 / FTS 260-5719

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED
FROM THE CHRIS MANUAL:

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS:

** WEAR APPROPRIATE EQUIPMENT TO PREVENT:

Repeated or prolonged skin contact.

** WEAR EYE PROTECTION TO PREVENT:

Reasonable probability of eye contact.

** EXPOSED PERSONNEL SHOULD WASH:

Promptly when skin becomes contaminated.

** REMOVE CLOTHING:

Promptly remove non-impervious clothing that becomes contaminated.

** REFERENCE: NIOSH

RECOMMENDED RESPIRATION PROTECTION Source: NIOSH POCKET GUIDE (85-114)
OSHA (CHROMIUM)

2.5 mg/M3: Any dust and mist respirator except single-use respirators. * Substance reported to cause eye irritation or damage may require eye protection.

5 mg/M3: Any dust and mist respirator except single-use and quarter-mask respirators. * Substance reported to cause eye irritation or damage may require eye protection. / Any supplied-air respirator. * Substance reported to cause eye irritation or damage may require eye protection. / Any self-contained breathing apparatus. * Substance reported to cause eye irritation or damage may require eye protection.

12.5 mg/M3: Any powered air-purifying respirator with a dust and mist filter. * Substance reported to cause eye irritation or damage may require eye protection. / Any supplied-air respirator operated in a continuous flow mode. * Substance reported to cause eye irritation or damage may require eye protection.

25 mg/M3: Any air-purifying full facepiece respirator with a high-efficiency particulate filter. / Any powered air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter. * Substance reported to cause eye irritation or damage may require eye protection. / Any self-contained breathing apparatus with a full facepiece. / Any supplied-air respirator with a full facepiece.

250 mg/M3: Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode.

EMERGENCY OR PLANNED ENTRY IN UNKNOWN CONCENTRATIONS OR IDLH CONDITIONS.: Any self-contained breathing apparatus with full facepiece and operated in a pressure-demand or other positive pressure mode. / Any supplied-air respirator with a full facepiece and operated in 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 with a high-efficiency particulate filter. / Any appropriate escape-type self-contained breathing apparatus.

FIRST AID SOURCE: NIOSH

EYE: irr immed
SKIN: soap wash
INHALATION: art resp
INGESTION: water, vomit

FIRST AID SOURCE: DOT Emergency Response Guide 1990.
In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water. Remove and isolate contaminated clothing and shoes at the site.

----- INITIAL INCIDENT RESPONSE -----

US Department of Transportation Guide to Hazardous Materials Transport Information - Publication DOT 5800.5 (1990).
DOT SHIPPING NAME: ENVIRONMENTALLY HAZARDOUS SUBSTANCES, SOLID, N.O.S. (CHROM
DOT ID NUMBER: UN3077

ERG93

GUIDE 31

POTENTIAL HAZARDS

*FIRE OR EXPLOSION

Some of these materials may burn, but none of them ignites readily. Material may be transported hot.

*HEALTH HAZARDS

Contact may cause burns to skin and eyes.
Inhalation of asbestos dust may have a damaging effect on the lungs.
Fire may produce irritating or poisonous gases.
Runoff from fire control or dilution water may cause pollution.

EMERGENCY ACTION

Keep unnecessary people away; isolate hazard area and deny entry.
Positive pressure self-contained breathing apparatus (SCBA) and structural CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping If water pollution occurs, notify the appropriate authorities.

*FIRE

Small Fires: Dry chemical, CO2, water spray or regular foam.
Large Fires: Water spray, fog or regular foam.
Move container from fire area if you can do it without risk.
*Do not scatter spilled material with high-pressure water streams.
Dike fire control water for later disposal.

*SPILL OR LEAK

Stop leak if you can do it without risk.
Avoid inhalation of asbestos dust.
Small Dry Spills: With clean shovel place material into clean, dry container
Small Spills: Take up with sand or other noncombustible absorbent material and
Large Spills: Dike far ahead of liquid spill for later disposal.
Cover powder spill with plastic sheet or tarp to minimize spreading.

*FIRST AID

In case of contact with material, immediately flush eyes with running water for
Remove and isolate contaminated clothing and shoes at the site.

DISCLAIMER: The data shown above on this chemical represents a best effort on the part of the compilers of the CHEMTOX database to obtain useful, accurate,

and factual data. The use of these data shall be in accordance with the guidelines and limitations of the user's CHEMTOX license agreement. The COMPILERS of the CHEMTOX database shall not be held liable for inaccuracies or omissions within this database, or in any of its printed or displayed output forms.

Label(s) required: CLASS 9
Special provisions: 8, B54
Packaging exceptions: 173.155
In bulk packaging: 173.213
Bulk packaging: 173.240
Quantity limitations-
Passenger air/rail: NONE
Cargo aircraft only: NONE
Vessel stowage: A
Other stowage provisions:

STCC NUMBER: Not listed

CLEAN WATER ACT Sect.307:Yes

CLEAN WATER ACT Sect.311:No

National Primary Drinking Water Regulations

Maximum Contaminant Levels (MCL): 0.005 mg/L (07/30/92)

Maximum Contaminant Level Goals (MCLG): 0.005 mg/L (07/30/92)

CLEAN AIR ACT: CAA '90 By category

EPA WASTE NUMBER: D006

CERCLA REF: Y

RQ DESIGNATION: A 10 pounds (4.54 kg) CERCLA for pieces of solid m
with diameter less than 100 micrometers (0.004
inches).

SARA TPQ VALUE: Not listed

SARA Sect. 312
categories:

Acute toxicity: adverse effect to target organs.

Chronic toxicity: carcinogen

Chronic toxicity: adverse effect to target organ
after long period of exposure.

Chronic toxicity: mutagen.

Chronic toxicity: reproductive toxin.

Fire hazard: flammable.

Acute toxicity: Toxic. LD50 > 50 and <= 500
mg/kg (oral rat).

LISTED IN SARA Sect 313: Yes

de minimus CONCENTRATION: 1.0 percent

UNITED STATES POSTAL SERVICE MAILABILITY:
Not given

NFPA CODES:

HEALTH HAZARD (BLUE): Unspecified

FLAMMABILITY (RED) : Unspecified

REACTIVITY (YELLOW): Unspecified

SPECIAL : Unspecified

----- SUMMARY OF REGULATORY LISTS THIS SUBSTANCE APPEARS ON -----

ACGIH TLV list "Threshold Limit Values for 1992-1993"
 ATSDR Toxicology Profile available (NTIS**
 CADIUM [7440-43-9]
 California Assembly Bill 2588 Air Toxics "Hot Spots" Chemicals.
 California Assembly Bill 1807 Toxic Air Contaminants.
 Canadian Domestic Substances List
 Canadian Ingredient Disclosure List. 20/01/88 Canada Gazette part II, Vol 122.
 Clean Air Act of November 15, 1990. List of pollutants.
 Clean Water Act Section 307 Priority Pollutants
 EPA Carcinogen Assessment Group List
 EPA TSCA Chemical Inventory List 1986
 EPA TSCA Chemical Inventory List 1989
 EPA TSCA Chemical Inventory List 1990
 EPA TSCA Chemical Inventory List 1992
 EPA TSCA Test Submission (TSCATS) Database - April 1990
 EPA TSCA Test Submission (TSCATS) Database - September 1989
 Massachusetts Substance List.
 National Toxicology Program list of anticipated human carcinogens
 New Jersey DEQ100 list for release reporting.
 New Jersey Right To Know Substance List. (December 1987)
 New Jersey Right to Know Substance List. Listed as a carcinogen.
 OSHA Air Contaminant (Table Z-1-A). 54 FR 4332, Jan. 19, 1989 and revised.
 Pennsylvania Hazardous Substance List
 RCRA Hazardous Waste
 RCRA Toxicity Characteristics (TC) list dated March 29, 1990
 SARA Section 110 Priority List of CERCLA Hazardous Substances
 SARA Section 313 Toxic Chemicals List
 Wisconsin Air Toxics Control Regulation NR-445 (December 1988)

----- TOXICITY DATA -----

SHORT TERM TOXICITY: Unknown

LONG TERM TOXICITY: unknown

TARGET ORGANS: resp sys, lungs, kidneys, prostate, blood

SYMPTOMS: PULM EDEMA, CYPS, COUGH, TIGHT CHEST, SUBS PAIN; HEAD,
 CHILLS, MUSCLE ACHE; NAU, DIAR ANOSMIA, EMPHY;
 PROTEINURIA, ANEMIA Source: NIOSHP

CONC IDLH: 50mg/M3

NIOSH REL: Potential occupational carcinogen --LOWEST FEASIBLE
 (LOQ 0.01 mg/M3)

ACGIH TLV: TLV = DUST 0.05mg/M3 as CADMIUM
 ACGIH STEL: as CADMIUM

OSHA PEL: Final Rule Limits:
 TWA = 5 ug/M3

Consult 29CFR 1910.1027

MAK INFORMATION: Carcinogenic working material without MAK
In the Commission's view, an animal carcinogen.

CARCINOGEN?: Y STATUS: See below

REFERENCES:

ANIMAL POSITIVE IARC** 2,74,73
ANIMAL POSITIVE IARC** 11,39,76

CARCINOGEN LISTS:

IARC: Carcinogen defined by IARC
to be probably carcinogenic to
humans with (usually) at least
limited human evidence.
MAK: An animal carcinogen.
NIOSH: Carcinogen defined by NIOSH
with no further categorization.
NTP: Carcinogen defined by NTP as
reasonably anticipated to be
carcinogenic, with limited
evidence in humans or sufficient
evidence in experimental animals.
ACGIH: Carcinogen defined by ACGIH
TLV Committee as a suspected
carcinogen, based on either
limited epidemiological evidence or
demonstration of carcinogenicity
in experimental animals.
OSHA: Cancer hazard

HUMAN TOXICITY DATA: (Source: NIOSH RTECS)

ihl-man TCLo:88 ug/m3/8.6Y AEHLAU 28,147,74
KIDNEY, URETER, BLADDER
Proteinuria

ihl-hmn LCLo:39 mg/m3/20M AIHAAP 31,180,70
CARDIAC

Other changes

VASCULAR

Thrombosis distant from injection
site(except brain,heart)

LUNGS, THORAX, OR RESPIRATION

Respiratory depression

LD50 value: orl-rat LD50:225 mg/ kg

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)

orl-rat LD50:225 mg/kg
ihl-rat LC50:25 mg/m3/30M
ipr-rat LD50:4 mg/kg
scu-rat LD50:9 mg/kg

ivn-rat LD50:1800 ug/kg
unr-rat LD50:1140 mg/kg
orl-mus LD50:890 mg/kg
ihl-mus LCLo:170 mg/m3
ipr-mus LD50:5700 ug/kg
unr-mus LD50:890 mg/kg
orl-rbt LDLo:70 mg/kg
scu-rbt LDLo:6 mg/kg
ivn-rbt LDLo:5 mg/kg

IRRITATION DATA: (Source: NIOSH RTECS 1992)

Reproductive toxicity (1992 RTECS):

This chemical is a mammalian reproductive toxin.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

orl-rat TDLo:155 mg/kg (13W male/13W pre-3W preg)
BECTA6 20,96,78

EFFECTS ON NEWBORN

Growth statistics(e.g.,reduced weight gain)

EFFECTS ON NEWBORN

Behavioral

orl-rat TDLo:220 mg/kg (1-22D preg) TOLED5 11,233,82

EFFECTS ON EMBRYO OR FETUS

Other effects on embryo or fetus

orl-rat TDLo:21500 ug/kg (multigenerations) ENVRAL
22,466,80

EFFECTS ON FERTILITY

Pre-implantation mortility

EFFECTS ON NEWBORN

Germ cell effects(in offspring)

orl-rat TDLo:23 mg/kg (1-22D preg) PSEBAA 158,614,78

SPECIFIC DEVELOPMENTAL ABNORMALITIES

Blood and lymphatic systems(including spleen and
marrow)

ipr-rat TDLo:1124 ug/kg (1D male) TXAPA9 41,194,77

PATERNAL EFFECTS

Spermatogenesis

scu-rat TDLo:250 ug/kg (19D preg) APTOD9 19,A122,80

EFFECTS ON NEWBORN

ivn-rat TDLo:1250 ug/kg (14D preg) JJATDK 1,264,81

SPECIFIC DEVELOPMENTAL ABNORMALITIES

Body wall

SPECIFIC DEVELOPMENTAL ABNORMALITIES

Urogenital system

ivn-rat TDLo:1250 ug/kg (9D preg) JJATDK 1,264,81
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Central nervous system
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Eye, ear

ivn-rat TDLo:8 mg/kg (8-15D preg) JJATDK 1,264,81
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)

orl-mus TDLo:448 mg/kg (multigenerations) AEHLAU
23,102,71
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
EFFECTS ON EMBRYO OR FETUS
Fetal death

orl-mus TDLo:1700 mg/kg (8-12D preg) TCMUD8 6,361,86
EFFECTS ON NEWBORN
Viability index(# alive at day 4 per # born alive)
EFFECTS ON NEWBORN
Growth statistics(e.g.,reduced weight gain)

ipr-mus TDLo:1686 ug/kg (7D preg) TJADAB 28,39A,83
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Central nervous system

California Prop 65: No significant risk level .05 ugD (01/01/94)

----- EPA's IRIS DATA SUMMARY -----
Cadmium; CASRN 7440-43-9 (04/01/92)

_II. CARCINOGENICITY ASSESSMENT FOR LIFETIME EXPOSURE

Substance Name -- Cadmium
CASRN -- 7440-43-9
Last Revised -- 03/01/91

Section II provides information on three aspects of the carcinogenic risk assessment for the agent in question; the U.S. EPA classification, and quantitative estimates of risk from oral exposure and from inhalation exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in three ways. The slope factor is the result of application of a low-dose extrapolation procedure and is presented as the risk per (mg/kg)/day. The unit risk is the quantitative estimate in terms of either risk per ug/L drinking water or risk per ug/cu.m air breathed. The third form in which risk is presented is a drinking water or air concentration providing cancer risks of 1 in 10,000, 1 in 100,000 or 1 in 1,000,000. Background Document 2 (Service Code 5) provides details on the rationale and methods used to derive the carcinogenicity values found in IRIS. Users are referred to Section I for

information on long-term toxic effects other than carcinogenicity.

II.A. EVIDENCE FOR CLASSIFICATION AS TO HUMAN CARCINOGENICITY

II.A.1. WEIGHT-OF-EVIDENCE CLASSIFICATION

Classification -- B1; probable human carcinogen

Basis -- Limited evidence from occupational epidemiologic studies of cadmium is consistent across investigators and study populations. There is sufficient evidence of carcinogenicity in rats and mice by inhalation and intramuscular and subcutaneous injection. Seven studies in rats and mice wherein cadmium salts (acetate, sulfate, chloride) were administered orally have shown no evidence of carcinogenic response.

II.A.2. HUMAN CARCINOGENICITY DATA

Limited. A 2-fold excess risk of lung cancer was observed in cadmium smelter workers. The cohort consisted of 602 white males who had been employed in production work a minimum of 6 months during the years 1940-1969. The population was followed to the end of 1978. Urine cadmium data available for 261 workers employed after 1960 suggested a highly exposed population. The authors were able to ascertain that the increased lung cancer risk was probably not due to the presence of arsenic or to smoking (Thun et al., 1985). An evaluation by the Carcinogen Assessment Group of these possible confounding factors has indicated that the assumptions and methods used in accounting for them may not be valid. As the SMRs observed were low and there is a lack of clear cut evidence of a causal relationship of the cadmium exposure only, this study is considered to supply only limited evidence of human carcinogenicity.

An excess lung cancer risk was also observed in three other studies which were, however, compromised by the presence of other carcinogens (arsenic, smoking) in the exposure or by a small population (Varner, 1983; Sorahan and Waterhouse, 1983; Armstrong and Kazantzis, 1983).

Four studies of workers exposed to cadmium dust or fumes provided evidence of a statistically significant positive association with prostate cancer (Kipling and Waterhouse, 1967; Lemen et al., 1976; Holden, 1980; Sorahan and Waterhouse, 1983), but the total number of cases was small in each study. The Thun et al. (1985) study is an update of an earlier study (Lemen et al., 1976) and does not show excess prostate cancer risk in these workers. Studies of human ingestion of cadmium are inadequate to assess carcinogenicity.

II.A.3. ANIMAL CARCINOGENICITY DATA

Exposure of Wistar rats to cadmium as cadmium chloride at concentrations of 12.5, 25 and 50 ug/cu.m for 18 months, with an additional 13-month obser-

vation period, resulted in significant increases in lung tumors (Takenaka et al., 1983). Intratracheal instillation of cadmium oxide did not produce lung tumors in Fischer 344 rats but rather mammary tumors in females and tumors at multiple sites in males (Sanders and Mahaffey, 1984). Injection site tumor and distant site tumors (for example, testicular) have been reported by a number of authors as a consequence of intramuscular or subcutaneous administration of cadmium metal and chloride, sulfate, oxide and sulfide compounds of cadmium to rats and mice (U.S. EPA, 1985). Seven studies in rats and mice where cadmium salts (acetate, sulfate, chloride) were administered orally have shown no evidence of a carcinogenic response.

___II.A.4. SUPPORTING DATA FOR CARCINOGENICITY

Results of mutagenicity tests in bacteria and yeast have been inconclusive. Positive responses have been obtained in mutation assays in Chinese hamster cells (Dom and V79 lines) and in mouse lymphoma cells (Casto, 1976; Ochi and Ohsawa, 1983; Oberly et al., 1982).

Conflicting results have been obtained in assays of chromosomal aberrations in human lymphocytes treated in vitro or obtained from exposed workers. Cadmium treatment in vivo or in vitro appears to interfere with spindle formation and to result in aneuploidy in germ cells of mice and hamsters (Shimada et al., 1976; Watanabe et al., 1979; Gilliavod and Leonard, 1975).

___II.B. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM ORAL EXPOSURE

Not available. There are no positive studies of orally ingested cadmium suitable for quantitation.

___II.C. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM INHALATION EXPOSURE

___II.C.1. SUMMARY OF RISK ESTIMATES

Inhalation Unit Risk -- $1.8E-3$ per (ug/cu.m)

Extrapolation Method -- Two stage; only first affected by exposure; extra risk

Air Concentrations at Specified Risk Levels:

Risk Level	Concentration
E-4 (1 in 10,000)	$6E-2$ ug/cu.m

E-5 (1 in 100,000) 6E-3 ug/cu.m
 E-6 (1 in 1,000,000) 6E-4 ug/cu.m

___ II.C.2. DOSE-RESPONSE DATA FOR CARCINOGENICITY, INHALATION EXPOSURE

Tumor Type -- lung, trachea, bronchus cancer deaths
 Test Animals -- human/white male
 Route -- inhalation, exposure in the workplace
 Reference -- Thun et al., 1985

Cumulative Exposure (mg/day/cu.m)	Median Observation	24 hour/ug/cu.m Equivalent	No. of Expected Lung, Trachea and Bronchus Cancers Assuming No Cadmium Effect	Observed No. of Deaths (lung, trachea, bronchus cancers)
less than or equal to 584	280	168	3.77	2
585-2920	1210	727	4.61	7
greater than or equal to 2921	4200	2522	2.50	7

e 24-hour equivalent = median observation x 10E-3 x 8/24 x 1/365 x 240/365.

___ II.C.3. ADDITIONAL COMMENTS (CARCINOGENICITY, INHALATION EXPOSURE)

The unit risk should not be used if the air concentration exceeds 6 ug/cu.m, since above this concentration the unit risk may not be appropriate.

___ II.C.4. DISCUSSION OF CONFIDENCE (CARCINOGENICITY, INHALATION EXPOSURE)

The data were derived from a relatively large cohort. Effects of arsenic and smoking were accounted for in the quantitative analysis for cadmium effects.

An inhalation unit risk for cadmium based on the Takenaka et al. (1983) analysis is 9.2E-2 per (ug/cu.m). While this estimate is higher than that derived from human data [1.8E-3 per (ug/cu.m)] and thus more conservative, it was felt that the use of available human data was more reliable because of species variations in response and the type of exposure (cadmium salt vs. cadmium fume and cadmium oxide).

__II.D. EPA DOCUMENTATION, REVIEW, AND CONTACTS (CARCINOGENICITY ASSESSMENT),

__II.D.1. EPA DOCUMENTATION

U.S. EPA. 1985. Updated Mutagenicity and Carcinogenicity Assessment of Cadmium: Addendum to the Health Assessment Document for Cadmium (May 1981, EPA 600/B-B1-023). EPA 600/B-83-025F.

__II.D.2. REVIEW (CARCINOGENICITY ASSESSMENT)

The Addendum to the Cadmium Health Assessment has received both Agency and external review.

Agency Work Group Review: 11/12/86

Verification Date: 11/12/86

__II.D.3. U.S. EPA CONTACTS (CARCINOGENICITY ASSESSMENT)

William E. Pepelko / ORD -- (202)260-5904 / FTS 260-5904

David Bayliss / ORD -- (202)260-5726 / FTS 260-5726

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED
FROM THE CHRIS MANUAL:

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS:

** WEAR EYE PROTECTION TO PREVENT:

** EXPOSED PERSONNEL SHOULD WASH:

At the end of each work shift when there was a reasonable probability of c

** WORK CLOTHING SHOULD BE CHANGED DAILY:

If there is any possibility that the clothing may be contaminated.

** THE FOLLOWING EQUIPMENT SHOULD BE MADE AVAILABLE:

Eyewash.

** REFERENCE: NIOSH

COMMENDED RESPIRATION PROTECTION Source: NIOSH POCKET GUIDE (85-114)
SHA (CADMIUM)

50 ug/M3 or less: Half mask, air purifying respirator equipped with a HEPA filter.

125 ug/M3 or less: A powered air purifying respirator (PAPR) with a loose-fitting hood or helmet equipped with a HEPA filter, or a supplied air respirator with a loose-fitting hood or helmet facepiece operated in the continuous flow mode.

250 ug/M3 or less: A full facepiece air-purifying respirator equipped with a HEPA filter, or a powered air-purifying respirator with a tight-fitting half-mask equipped with a HEPA filter, or a supplied-air respirator with a tight-fitting half mask operated in the continuous flow mode.

1250 ug/M3 or less: A powered air-purifying respirator with a tight fitting full facepiece equipped with a HEPA filter, or a supplied air respirator with a tight-fitting full facepiece operated in the continuous flow mode.

5000 ug/M3 or less: A supplied air respirator with half-mask or full facepiece operated in the pressure demand or other positive pressure mode.

Greater than 5000 ug/M3 or unknown concentration: A self-contained breathing apparatus with a full facepiece operated in the pressure demand or other positive pressure mode, or a supplied-air respirator with a full facepiece operated in the pressure demand or other positive pressure mode and equipped with an auxiliary escape type self-contained breathing apparatus operated in the pressure demand mode.

EMERGENCY OR PLANNED ENTRY IN UNKNOWN CONCENTRATIONS OR IDLH CONDITIONS.: Any self-contained breathing apparatus with full facepiece and operated in a pressure-demand or other positive pressure mode.

FIRST AID SOURCE: NIOSH

EYE: irr immed

SKIN: soap wash

INHALATION: art resp

INGESTION: water, vomit

FIRST AID SOURCE: DOT Emergency Response Guide 1990.

In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water. Remove and isolate contaminated clothing and shoes at the site.

----- INITIAL INCIDENT RESPONSE -----

US Department of Transportation Guide to Hazardous Materials Transport Information - Publication DOT 5800.5 (1990).

DOT SHIPPING NAME: ENVIRONMENTALLY HAZARDOUS SUBSTANCES, SOLID, N.O.S. (CADMIUM)

DOT ID NUMBER: UN3077

ERG93

GUIDE 31

POTENTIAL HAZARDS

***FIRE OR EXPLOSION**

Some of these materials may burn, but none of them ignites readily. Material may be transported hot.

HEALTH HAZARDS

Contact may cause burns to skin and eyes.

Inhalation of asbestos dust may have a damaging effect on the lungs.

Fire may produce irritating or poisonous gases.

Runoff from fire control or dilution water may cause pollution.

EMERGENCY ACTION

Keep unnecessary people away; isolate hazard area and deny entry.

Positive pressure self-contained breathing apparatus (SCBA) and structural fire

CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping

If water pollution occurs, notify the appropriate authorities.

***FIRE**

Small Fires: Dry chemical, CO₂, water spray or regular foam.

Large Fires: Water spray, fog or regular foam.

Move container from fire area if you can do it without risk.

*Do not scatter spilled material with high-pressure water streams.

Dike fire control water for later disposal.

***SPILL OR LEAK**

Stop leak if you can do it without risk.

Avoid inhalation of asbestos dust.

Small Dry Spills: With clean shovel place material into clean, dry container.

Small Spills: Take up with sand or other noncombustible absorbent material and

Large Spills: Dike far ahead of liquid spill for later disposal.

Cover powder spill with plastic sheet or tarp to minimize spreading.

***FIRST AID**

In case of contact with material, immediately flush eyes with running water for

Remove and isolate contaminated clothing and shoes at the site.

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CHEMTOX DATA

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----- IDENTIFIERS -----

CHEMTOX RECORD 382 LAST UPDATE OF THIS RECORD: 06/03/93

NAME: 1,1,2,2-TETRACHLOROETHANE

SYNONYMS: ACETYLENE TETRACHLORIDE; BONOFORM; CELLON;
 1,1,2,2-CZTEROCHLOROETAN (Polish);
 1,1-DICHLORO-2,2-DICHLOROETHANE; NCI-C03554; TCE;
 1,1,2,2-TETRACHLOORETHAAN (Dutch);
 1,1,2,2-TETRACHLORAETHAN (German); TETRACHLORETHANE;
 1,1,2,2-TETRACHLORETHANE (French); sym-TETRACHLOROETHANE;
 1,1,2,2-TETRACHLOROETHANE; 1,1,2,2-TETRACHLOROETANO
 (Italian); TETRACHLORURE D'ACETYLENE (French); WESTRON;
 ETHANE, 1,1,2,2-TETRACHLORO-; SYMMETRICAL
 TETRACHLOROETHANE; SYM-TETRACHLOROETHANE

CAS: 79-34-5 RTECS: KI8575000

FORMULA: C2H2Cl4 MOL WT: 168

WLN: GYGYGG

CHEMICAL CLASS: Halogenated h-carbon

See other identifiers listed below under Regulations.

----- PROPERTIES -----

PHYSICAL DESCRIPTION: colorless or pale yellow liquid with a sickly sweet
 odor like chloroform

BOILING POINT:	417.81 K	144.6 C	292.3 F
MELTING POINT:	230.81 K	-42.4 C	-44.3 F
FLASH POINT:	Not available		
AUTO IGNITION:	Not available		
VAPOR PRESSURE:	8 MM		
UEL:	~		
LEL:	~		
IONIZATION POTENTIAL (eV):	11.1		
VAPOR DENSITY:	No data		
EVAPORATION RATE:	0.68 (n-BUTYL ACETATE=1)		
SPECIFIC GRAVITY:	1.595 @ 20 C		
DENSITY:	1.610		
WATER SOLUBILITY:	0.29%		
INCOMPATIBILITIES:	chemically active metals: strong caustics; hot iron, aluminum, zinc in presence of steam		
REACTIVITY WITH WATER:	No data on water reactivity		
REACTIVITY WITH COMMON MATERIALS:	No data		
STABILITY DURING TRANSPORT:	No Data		
NEUTRALIZING AGENTS:	No data		
POLYMERIZATION POSSIBILITIES:	No data		
TOXIC FIRE GASES:	HCL AND PHOSGENE\CORROSIVE		

ODOR DETECTED AT (ppm): 5 PPM
ODOR DESCRIPTION: SWEETISH, LIKE CHLOROFORM Source:NYDH
100 % ODOR DETECTION: No data

----- REGULATIONS -----

DOT hazard class: 6.1 POISON
DOT guide: 55
Identification number: UN1702
DOT shipping name: TETRACHLOROETHANE
Packing group: II
Label(s) required: POISON
Special provisions: N36, T14
Packaging exceptions: 173.NONE
Non bulk packaging: 173.202
Bulk packaging: 173.243
Quantity limitations-
Passenger air/rail: 5 L
Cargo aircraft only: 60 L
Vessel stowage: A
Other stowage provisions:40

STCC NUMBER: Not listed

CLEAN WATER ACT Sect.307:Yes
CLEAN WATER ACT Sect.311:No
CLEAN AIR ACT: CAA '90 Listed
EPA WASTE NUMBER: U209
CERCLA REF: Not listed
RQ DESIGNATION: B 100 pounds (45.4 kg) CERCLA
SARA TPQ VALUE: Not listed
SARA Sect. 312
categories:

Acute toxicity: adverse effect to target organs.
Chronic toxicity: carcinogen
Chronic toxicity: adverse effect to target organ
after long period of exposure.
Chronic toxicity: mutagen.

LISTED IN SARA Sect 313: Yes
de minimus CONCENTRATION: 0.1 percent

UNITED STATES POSTAL SERVICE MAILABILITY:
Not given

NFPA CODES:
HEALTH HAZARD (BLUE): Unspecified
FLAMMABILITY (RED) : Unspecified
REACTIVITY (YELLOW): Unspecified
SPECIAL : Unspecified

----- SUMMARY OF REGULATORY LISTS THIS SUBSTANCE APPEARS ON -----

1,2,2-TETRACHLOROETHANE [79-34-5]
ACGIH TLV list "Threshold Limit Values for 1992-1993"
ATSDR Toxicology Profile available (NTIS** PB/90/182148/AS)
California Assembly Bill 1803 Well Monitoring Chemicals.
Canadian Domestic Substances List
Canadian Ingredient Disclosure List. 20/01/88 Canada Gazette part II, Vol 122.
Clean Air Act Section 111 List.
Clean Air Act of November 15, 1990. List of pollutants.
Clean Water Act Section 307 Priority Pollutants
DOT Hazardous Materials Table. 49 CFR 172.101
EPA Carcinogen Assessment Group List
EPA List of VOC chemicals from 40 CFR 60.489
EPA TSCA Chemical Inventory List 1986
EPA TSCA Chemical Inventory List 1989
EPA TSCA Chemical Inventory List 1990
EPA TSCA Chemical Inventory List 1992
EPA TSCA Test Submission (TSCATS) Database - April 1990
EPA TSCA Test Submission (TSCATS) Database - September 1989
Massachusetts Substance List.
New Jersey DEQ100 list for release reporting.
New Jersey Right To Know Substance List. (December 1987)
New Jersey Right to Know Substance List. Listed as a carcinogen.
OSHA Air Contaminant (Table Z-1-A). 54 FR 4332, Jan. 19, 1989 and revised.
Pennsylvania Hazardous Substance List
RCRA Hazardous Constituents for Ground Water Monitoring. Ap'dx IX to 40 CFR 264
RCRA Hazardous Waste
RCRA Section 313 Toxic Chemicals List
Superfund/CERCLA RQ list. Table 302.4 in 54 FR 50968 (December 11, 1989)
TSCA Chemical Hazard Information Profile (CHIP) available - dated 05/14/79
Washington State Discarded Chemical Products List, November 17, 1989
Wisconsin Air Toxics Control Regulation NR-445 (December 1988)

----- TOXICITY DATA -----

SHORT TERM TOXICITY: INHALATION: exposure of 116 ppm for 20 minutes has caused dizziness and vomiting. at 260 ppm for 10 minutes, irritation of nose and throat were felt in addition. at 335 ppm for 10 minutes, rapid fatigue was also experienced. these symptoms generally disappear when exposure stops. large accidental exposures have resulted in death. SKIN: absorption through skin is possible. significant skin absorption may occur to produce toxic effects. earliest and most common symptom is tremors of hands, followed by skin irritation, numbness and effects listed above. death has occurred from a combination of inhalation and skin absorption. Eyes: irritation and tearing. INGESTION: abdominal pain, nausea, and vomiting followed by similar symptoms as inhalation. as little as 3 ml

(1/10 liq. oz.) may cause unconsciousness. (NYDH)

LONG TERM TOXICITY: symptoms may include nervousness, loss of appetite, constipation, tremors, fatigue, dizziness, nausea, vomiting and headache. may result in long lasting liver damage. these symptoms have been reported after prolonged exposure to 75 ppm. tetrachloroethane at high levels has caused liver cancer in mice. whether it causes cancer in humans is unknown. (NYDH)

TARGET ORGANS: mu membranes of eyes, upper resp. tract; liver, kidneys, CNS.

SYMPTOMS: NAUSEA, VOMITING, ABDOMINAL PAIN, TREMOR OF FINGERS; JAUNDICE, ENL TEND LIVER, DERM. MONOCY, KIDNEY DAMAGE, PARES, LACRIMATION, SALIVATION, IRR OF NOSE AND THROAT. MOST COMPLAINTS RELATED TO DIGESTIVE AND NERVOUS SYSTEM. MONOCY KIDNEY DAMAGE, PARES Source: SAX

CONC IDLH: 150PPM

NIOSH REL: Potential occupational carcinogen --LOWEST FEASIBLE (Limit of quantitation 0.7 ppm)

ACGIH TLV: TLV = 1ppm(7 mg/M3) SKIN
ACGIH STEL: Not listed

OSHA PEL: Transitional Limits:
PEL = 5 ppm(35mg/M3) (SKIN)
Final Rule Limits:
TWA = 1 ppm (7 mg/M3) (SKIN)

MAK INFORMATION: 1 ppm
7 mg/M3
Danger of cutaneous absorption
A compound which is justifiably suspected of having carcinogenic potential.

CARCINOGEN?: Y STATUS: See below

CARCINOGEN LISTS: IARC: Not classified as to human carcinogenicity or probably not carcinogenic to humans.
MAK: A compound which is justifiably suspected of having carcinogenic potential.
NIOSH: Carcinogen defined by NIOSH with no further categorization.
NTP: Not listed
ACGIH: Not listed

OSHA: Not listed

HUMAN TOXICITY DATA: (Source: NIOSH RTECS)

orl-hmn TDLo:30 mg/kg PCOC** -,1110,66

BEHAVIORAL

General anesthetic

LD50 value: orl-rat LD50:800 mg/ kg

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)

orl-rat LD50:800 mg/kg
ihl-rat LCLo:1000 ppm/4H
ihl-mus LC50:4500 mg/m3/2H
ipr-mus LDLo:30 mg/kg
scu-mus LD50:1108 mg/kg
orl-dog LDLo:300 mg/kg
ivn-dog LDLo:50 mg/kg
ihl-cat LCLo:19 gm/m3/45M
scu-rbt LDLo:500 mg/kg

IRRITATION DATA: (Source: NIOSH RTECS 1992)

Reproductive toxicity (1992 RTECS):

This chemical has no known mammalian reproductive toxicity.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

California Prop 65: Carcinogen (07/01/90)

No significant risk level 3. ugD (01/01/94)

----- EPA's IRIS DATA SUMMARY -----

1,1,2,2-Tetrachloroethane; CASRN 79-34-5 (04/01/92)

_II. CARCINOGENICITY ASSESSMENT FOR LIFETIME EXPOSURE

Substance Name -- 1,1,2,2-Tetrachloroethane

CASRN -- 79-34-5

Last Revised -- 01/01/91

Section II provides information on three aspects of the carcinogenic risk assessment for the agent in question; the U.S. EPA classification, and quantitative estimates of risk from oral exposure and from inhalation exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in three ways. The slope factor is the result of application of a low-dose extrapolation procedure and is presented as the risk per (mg/kg)/day. The unit risk is the quantitative estimate in terms of either risk per ug/L drinking water or risk per ug/cu.m air breathed. The third form in which risk is presented is a drinking water or air concentration providing cancer risks

of 1 in 10,000, 1 in 100,000 or 1 in 1,000,000. Background Document 2 (Service Code 5) provides details on the rationale and methods used to derive the carcinogenicity values found in IRIS. Users are referred to Section I for information on long-term toxic effects other than carcinogenicity.

___II.A. EVIDENCE FOR CLASSIFICATION AS TO HUMAN CARCINOGENICITY

___II.A.1. WEIGHT-OF-EVIDENCE CLASSIFICATION

Classification -- C; possible human carcinogen

Basis -- Increased incidence of hepatocellular carcinomas in mice

___II.A.2. HUMAN CARCINOGENICITY DATA

None.

___II.A.3. ANIMAL CARCINOGENICITY DATA

In a bioassay undertaken by NCI (1978) 50 each male and female Osborne-Mendel rats and B6C3F1 mice were gavaged with technical grade (90% pure) 1,1,2,2,-tetrachloroethane in corn oil, 5 days/week. Treatment was over 78 weeks, followed by observation periods of 32 weeks for the rats and 12 weeks for the mice. The high and low average doses (incorporating varying dosage levels throughout the treatment period) were, respectively, 108 and 62 mg/kg/day for male rats, 76 and 43 mg/kg/day for female rats, and 282 and 142 mg/kg/day for mice of both sexes. Control groups consisted of 20 animals/sex and species. Vehicle controls received corn oil at the same rate as the high-dose animals; untreated controls were not intubated. Ten of the high-dose female rats died within the first 5 weeks of the study, but the association between increased dosage and elevated mortality was not statistically significant for male rats. Significantly increased mortality was also evident in the high-dose mice of both sexes. No statistically significant incidence of neoplasms was observed in rats. A highly significant dose-related increase in the incidence of hepatocellular carcinomas was observed in both male and female mice.

___II.A.4. SUPPORTING DATA FOR CARCINOGENICITY

1,1,2,2-Tetrachloroethane is mutagenic for the Salmonella typhimurium missense mutants TA1530 and TA1535 and selectively inhibits growth of E. coli polA (Rosenkranz 1977; Brem et al., 1974).

II.B. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM ORAL EXPOSURE

II.B.1. SUMMARY OF RISK ESTIMATES

Oral Slope Factor -- 2.0E-1 per (mg/kg)/day

Drinking Water Unit Risk -- 5.8E-6 per (ug/L)

Extrapolation Method -- Linearized multistage procedure, extra risk

Drinking Water Concentrations at Specified Risk Levels:

Risk Level	Concentration
E-4 (1 in 10,000)	2E+1 ug/L
E-5 (1 in 100,000)	2E+0 ug/L
E-6 (1 in 1,000,000)	2E-1 ug/L

II.B.2. DOSE-RESPONSE DATA (CARCINOGENICITY, ORAL EXPOSURE)

Tumor Type -- hepatocellular carcinoma

Test Animals -- Mouse/B6CC3F1

Route -- gavage

Reference -- NCI, 1978

Administered Dose (mg/kg)/day	Human Equivalent Dose (mg/kg)/day	Tumor Incidence
0	0	0/20
87	6.56	30/48
174	13.12	43/47

II.B.3. ADDITIONAL COMMENTS (CARCINOGENICITY, ORAL EXPOSURE)

Administered doses are TWAs, adjusted for frequency (5/7 days) and length of exposure (546 days of an assumed lifespan of 637). Control group received vehicle (corn oil) by stomach tube. Weight of animals was assumed to be 0.030 kg. Human equivalent dose was adjusted by $(0.03/70)^{1/3}$ for body weight.

The unit risk should not be used if the water concentration exceeds 2E+3 ug/L, since above this concentration the unit risk may not be appropriate.

II.B.4. DISCUSSION OF CONFIDENCE (CARCINOGENICITY, ORAL EXPOSURE)

An adequate number of animals was treated. Malignancies increased as a function of treatment dose, and their incidence was significantly increased at both doses.

___II.C. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM INHALATION EXPOSURE

___II.C.1. SUMMARY OF RISK ESTIMATES

Inhalation Unit Risk -- 5.8E-5 per (ug/cu.m)

Extrapolation Method -- Linearized multistage procedure, extra risk

Air Concentrations at Specified Risk Levels:

Risk Level	Concentration
E-4 (1 in 10,000)	2E+0 ug/cu.m
E-5 (1 in 100,000)	2E-1 ug/cu.m
E-6 (1 in 1,000,000)	2E-2 ug/cu.m

___II.C.2. DOSE-RESPONSE DATA FOR CARCINOGENICITY, INHALATION EXPOSURE

The inhalation risk estimates were calculated from the oral exposure data in II.B.2.

___II.C.3. ADDITIONAL COMMENTS (CARCINOGENICITY, INHALATION EXPOSURE)

The unit risk should not be used if the air concentration exceeds 2E+2 ug/cu.m, since above this concentration the unit risk may not be appropriate.

___II.C.4. DISCUSSION OF CONFIDENCE (CARCINOGENICITY, INHALATION EXPOSURE)

See II.B.4.

___II.D. EPA DOCUMENTATION, REVIEW, AND CONTACTS (CARCINOGENICITY ASSESSMENT)

___II.D.1. EPA DOCUMENTATION

U.S. EPA. 1980. Ambient Water Quality Criteria for Chlorinated Ethanes. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Water Regulations and Standards, Washington, DC. EPA 440/5-80-029. NTIS PB 81117400.

___II.D.2. REVIEW (CARCINOGENICITY ASSESSMENT)

The values in the Ambient Water Quality Criteria Document for Chlorinated Ethanes (1980) received extensive peer and public review.

Agency Work Group Review: 06/26/86

Verification Date: 06/26/86

___II.D.3. U.S. EPA CONTACTS (CARCINOGENICITY ASSESSMENT)

Robert E. McGaughy / ORD -- (202)260-5898 / FTS 260-5898

Charalingayya B. Hiremath / ORD -- (202)260-5725 / FTS 260-5725

___II.D.4. U.S. EPA CONTACTS (CARCINOGENICITY ASSESSMENT)

Robert E. McGaughy / ORD -- (202)260-5898 / FTS 260-5898

Charalingayya B. Hiremath / ORD -- (202)260-5725 / FTS 260-5725

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED
FROM THE CHRIS MANUAL:

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS:

** WEAR APPROPRIATE EQUIPMENT TO PREVENT:
Any possibility of skin contact.

** WEAR EYE PROTECTION TO PREVENT:
Any possibility of eye contact.

** EXPOSED PERSONNEL SHOULD WASH:

Immediately when skin becomes contaminated.

**** REMOVE CLOTHING:**

Immediately remove non-impervious clothing that becomes contaminated.

**** THE FOLLOWING EQUIPMENT SHOULD BE MADE AVAILABLE:**

Eyewash, quick drench.

**** REFERENCE: NIOSH**

RECOMMENDED RESPIRATION PROTECTION Source: NIOSH POCKET GUIDE (85-114)
NIOSH (1,1,2,2-TETRACHLOROETHANE)

Greater at any detectable concentration. : Any supplied-air respirator with a full facepiece and operated in 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. / Any self-contained breathing apparatus with full facepiece and operated in a pressure-demand or other positive pressure mode.

ESCAPE: Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister. / Any appropriate escape-type self-contained breathing apparatus.

FIRST AID SOURCE: NIOSH

EYE: irr immed

SKIN: soap wash promptly

INHALATION: art resp

INGESTION: ipecac, vomit

FIRST AID SOURCE: DOT Emergency Response Guide 1990.

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes. Speed in removing material from skin is of extreme importance. Removal of solidified molten material from skin requires medical assistance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

----- INITIAL INCIDENT RESPONSE -----

US Department of Transportation Guide to Hazardous Materials Transport Information - Publication DOT 5800.5 (1990).

DOT SHIPPING NAME: TETRACHLOROETHANE

DOT ID NUMBER: UN1702

ERG93

GUIDE 55

POTENTIAL HAZARDS

***HEALTH HAZARDS**

Poisonous; may be fatal if inhaled, swallowed or absorbed through skin. Contact may cause burns to skin and eyes.

Runoff from fire control or dilution water may give off poisonous gases and cause water pollution.

Fire may produce irritating or poisonous gases.

***FIRE OR EXPLOSION**

Some of these materials may burn, but none of them ignites readily. Container may explode violently in heat of fire. Material may be transported in a molten form.

EMERGENCY ACTION

Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind, out of low areas, and ventilate closed spaces before entering. Positive pressure self-contained breathing apparatus (SCBA) and chemical protective clothing which is specifically recommended by the shipper or manufacturer may be worn. It may provide little or no thermal protection.

*Structural firefighters' protective clothing is not effective for these materials. See the Table of Initial Isolation and Protective Action Distances. If you find the ID Number and the name of the material there, begin protective action. Remove and isolate contaminated clothing at the site. CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, CALL CHEMTREC AT 1-800-424-9300.

***FIRE**

Small Fires: Dry chemical, water spray or regular foam.

Large Fires: Water spray, fog or regular foam.

Move container from fire area if you can do it without risk.

Fight fire from maximum distance. Stay away from ends of tanks.

Dike fire control water for later disposal; do not scatter the material.

***SPILL OR LEAK**

Do not touch or walk through spilled material; stop leak if you can do it without risk. Fully-encapsulating, vapor-protective clothing should be worn for spills and leaks with no fire. Use water spray to reduce vapors.

Small Spills: Take up with sand or other noncombustible absorbent material and place into containers for later disposal. Small Dry Spills: With clean shovel place material into clean, dry container and cover loosely; move containers from spill area.

Large Spills: Dike far ahead of liquid spill for later disposal.

***FIRST AID**

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen. In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes. Speed in removing material from skin is of extreme importance. Removal of solidified molten material from skin requires medical assistance. Remove and isolate contaminated clothing and shoes at the site. Keep victim quiet and maintain normal body temperature. Effects may be delayed; keep victim under observation.

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forms.

100 % ODOR DETECTION:

No data

----- REGULATIONS -----

DOT hazard class: 3 FLAMMABLE LIQUID
DOT guide: 27
Identification number: UN1114
DOT shipping name: Benzene
Packing group: II
Label(s) required: FLAMMABLE LIQUID
Special provisions: T8
Packaging exceptions: 173.150
Non bulk packaging: 173.202
Bulk packaging: 173.242
Quantity limitations-
Passenger air/rail: 5 L
Cargo aircraft only: 60 L
Vessel stowage: B
Other stowage provisions: 40

STCC NUMBER: 4908110

CLEAN WATER ACT Sect.307:Yes

CLEAN WATER ACT Sect.311:Yes

National Primary Drinking Water Regulations

Maximum Contaminant Levels (MCL): 0.005 mg/L» (01/09/89)

Maximum Contaminant Level Goals (MCLG): 0 mg/L» (01/09/89)

CLEAN AIR ACT: CAA '90 Listed and CAA '77 Sect 109

HAZARDOUS WASTE NUMBER: U019,D018,D001

CERCLA REF: Y

RQ DESIGNATION: A 10 pounds (4.54 kg) CERCLA

SARA TPQ VALUE: Not listed

SARA Sect. 312

categories:

Acute toxicity: Irritant

Acute toxicity: adverse effect to target organs.

Chronic toxicity: carcinogen

Chronic toxicity: mutagen.

Chronic toxicity: reproductive toxin.

Fire hazard: flammable.

LISTED IN SARA Sect 313: Yes

de minimus CONCENTRATION: 0.1 percent

UNITED STATES POSTAL SERVICE MAILABILITY:

Hazard class: Not given

Mailability: Nonmailable

Max per parcel: 0

NFPA CODES:

HEALTH HAZARD (BLUE): (2) Hazardous to health. Area may be entered with self-contained breathing apparatus.

FLAMMABILITY (RED) : (3) This material can be ignited under almost all temperature conditions.

REACTIVITY (YELLOW): (0) Stable even under fire conditions.

SPECIAL

: Unspecified

----- TOXICITY DATA -----

SHORT TERM TOXICITY: INHALATION: benzene may produce both nerve and blood effects. irritation of the nose, throat and lungs may occur (3,000 ppm may be tolerated for only 30 to 60 minutes). lung congestion may occur. nerve effects may include an exaggerated feeling of well-being, excitement, headache, dizziness and slurred speech. at high levels, slowed breathing and death may result. death has occurred at 20,000 ppm for 5 to 10 minutes, or 7,500 ppm for 30 minutes. SKIN: irritation may occur, with redness and blistering if not promptly removed. benzene is poorly absorbed. whole body exposure for 30 minutes has been reported with no health effects. Eyes: may cause severe irritation. INGESTION: may cause irritation of mouth, throat and stomach. symptoms are similar to those listed under inhalation. one tablespoon may cause collapse, bronchitis, pneumonia and death. (NYDH)

LONG TERM TOXICITY: may cause loss of appetite, nausea, weight loss, fatigue, muscle weakness, headache, dizziness, nervousness and irritability. mild anemia has been reported from exposures of 25 ppm for several years and 100 ppm for 3 months. at levels between 100 and 200 ppm for periods of 6 months, or more, severe irreversible blood changes and damage to liver and heart may occur. temporary partial paralysis has been reported. (NYDH)

TARGET ORGANS: blood, CNS, skin, bone marrow, eyes, resp sys

SYMPTOMS: Dizziness, excitation, pallor, followed by flushing, weakness, headache, breathlessness, chest constriction. Coma and possible death. Source: CHRIS

CONC IDLH: 3000ppm

NIOSH REL: Potential occupational carcinogen 0.1 ppm Time weighted averages for 8-hour exposure 0.32 mg/M3 Time weighted averages for 8-hour exposure 1 ppm Ceiling exposures which shall at no time be exceeded 3.2 mg/M3 Ceiling exposures which shall at no time be exceeded

ACGIH TLV: TLV = 10ppm Suspected human carcinogen (A2)

ACGIH STEL: Suspected human carcinogen (A2)

OSHA PEL: Final Rule Limits:
TWA = 1 ppm
STEL = 5 ppm
CONSULT 29CFR 1910.1028

MAK INFORMATION: Danger of cutaneous absorption
Carcinogenic working material without MAK
Capable of inducing malignant tumors as shown by
experience with humans.

CARCINOGEN?: Y STATUS: See below
REFERENCES:

HUMAN SUSPECTED IARC** 7,203,74
HUMAN SUSPECTED IARC** 28,151,82
ANIMAL SUSPECTED IARC** 28,151,82
ANIMAL SUSPECTED IARC** 29,93,82
HUMAN POSITIVE IARC** 29,93,82
ANIMAL INDEFINITE IARC** 7,203,74

CARCINOGEN LISTS:

IARC: Carcinogen as defined by
IARC as carcinogenic to humans,
with sufficient epidemiological
evidence.
MAK: Capable of inducing malignant
tumors as shown by experience in
humans.
NIOSH: Carcinogen defined by NIOSH
with no further categorization.
NTP: Carcinogen defined by NTP as
known to be carcinogenic, with
evidence from human studies.
ACGIH: Carcinogen defined by ACGIH
TLV Committee as a suspected
carcinogen, based on either
limited epidemiological evidence or
demonstration of carcinogenicity
in experimental animals.
OSHA: Cancer hazard

HUMAN TOXICITY DATA: (Source: NIOSH RTECS)

* ihl-hmn LCLo:2 pph/5M TABIA2 3,231,33
* orl-man LDLo:50 mg/kg YAKUD5 22,883,80
* ihl-hmn LCLo:2000 ppm/5M YAKUD5 22,883,80
ihl-man TCLo:150 ppm/1Y-I BLUTA9 28,293,74
BLOOD
Other changes
NUTRITIONAL AND GROSS METABOLIC
Changes in:
Body temperature increase
ihl-hmn TCLo:100 ppm INMEAF 17,199,48
BEHAVIORAL
Somnolence (general depressed activity)
GASTROINTESTINAL
Nausea or vomiting
SKIN AND APPENDAGES

Skin - after systemic exposure
Dermatitis, other

ihl-hmn LCLo:65 mg/m3/5Y ARGEAR 44,145,74
BLOOD
Other changes

LD50 value: orl-rat LD50:930 mg/ kg

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)

orl-rat LD50:930 mg/kg
ihl-rat LC50:10000 ppm/7H
ipr-rat LD50:2890 ug/kg
orl-mus LD50:4700 mg/kg
ihl-mus LC50:9980 ppm
ipr-mus LD50:340 mg/kg
orl-dog LDLo:2 gm/kg
ihl-dog LCLo:146000 mg/m3
ihl-cat LCLo:170000 mg/m3
ihl-rbt LCLo:45000 ppm/30M
ivn-rbt LDLo:88 mg/kg
ipr-gpg LDLo:527 mg/kg
scu-frg LDLo:1400 mg/kg
ihl-mam LCLo:20000 ppm/5M
ipr-mam LDLo:1500 mg/kg

IRRITATION DATA: (Source: NIOSH RTECS 1992)

Reproductive toxicity (1992 RTECS):

This chemical is a mammalian reproductive toxin.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

ihl-rat TCLo:670 mg/m3/24H (15D pre/1-22D preg) HYSAAV
33(1-3),327,68

EFFECTS ON FERTILITY

Female fertility index

ihl-rat TCLo:56600 ug/m3/24H (1-22D preg) HYSAAV
33(7-9),112,68

EFFECTS ON NEWBORN

ihl-rat TCLo:50 ppm/24H (7-14D preg) JHEMA2 24,363,80
EFFECTS ON EMBRYO OR FETUS

Extra embryonic features(e.g.,placenta,umbilical
cord)

EFFECTS ON EMBRYO OR FETUS

Fetotoxicity(except death,e.g.,stunted fetus)

ihl-rat TCLo:150 ppm/24H (7-14D preg) JHEMA2 24,363,80
EFFECTS ON FERTILITY

Post-implantation mortality

SPECIFIC DEVELOPMENTAL ABNORMALITIES

Musculoskeletal system

- orl-mus TDLo:9 gm/kg (6-15D preg) TJADAB 19,41A,79
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
- orl-mus TDLo:12 gm/kg (6-15D preg) TJADAB 19,41A,79
EFFECTS ON FERTILITY
Post-implantation mortality
- orl-mus TDLo:6500 mg/kg (8-12D preg) TCMUD8 6,361,86
EFFECTS ON NEWBORN
Growth statistics(e.g.,reduced weight gain)
- ihl-mus TCLo:500 ppm/7H (6-15D preg) AIHAAP 40,993,79
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system
- ihl-mus TCLo:500 mg/m3/12H (6-15D preg) ATSUDG 8,425,85
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system
- ihl-mus TCLo:5 ppm (6-15D preg) TXCYAC 42,171,86
EFFECTS ON EMBRYO OR FETUS
Cytological changes(including somatic cell genetic material)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Blood and lymphatic systems(including spleen and marrow)
- ihl-mus TCLo:20 ppm/6H (6-15D preg) FAATDF 10,224,88
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Blood and lymphatic systems(including spleen and marrow)
- ipr-mus TDLo:5 mg/kg (1D male) TPKVAL 15,30,79
EFFECTS ON FERTILITY
Pre-implantation mortality
EFFECTS ON EMBRYO OR FETUS
Fetal death
- scu-mus TDLo:1100 mg/kg (12D preg) TOXID9 1,125,81
EFFECTS ON EMBRYO OR FETUS
Other effects on embryo or fetus
- scu-mus TDLo:7030 mg/kg (12-13D preg) SEIJBO 15,47,75
EFFECTS ON EMBRYO OR FETUS
Extra embryonic features(e.g.,placenta,umbilical cord)
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)

SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

ivn-mus TDLo:13200 ug/kg (13-16D preg) ICHUDW
4(6),24,82

EFFECTS ON EMBRYO OR FETUS
Cytological changes(including somatic cell genetic
material)

par-mus TDLo:4 gm/kg (12D preg) NEZAAQ 25,438,70
EFFECTS ON NEWBORN

Weaning or lactation index(#alive at weaning per #
alive at day 4)

ihl-rbt TCLo:1 gm/m3/24H (7-20D preg) ATSUDG 8,425,85
EFFECTS ON FERTILITY
Post-implantation mortality
EFFECTS ON FERTILITY
Abortion
EFFECTS ON EMBRYO OR FETUS
Fetal death

NO SIGNIFICANT

RISK LEVEL(Ca P65): 20 micrograms/day

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED

FROM THE CHRIS MANUAL:
hydrocarbon vapor canister, supplied air or hose mask;
hydrocarbon-insoluble rubber or plastic gloves; chemical goggles or face
splash shield; hydrocarbon-insoluble apron such as neoprene.

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS:

- ** WEAR APPROPRIATE EQUIPMENT TO PREVENT:
Repeated or prolonged skin contact.
- ** WEAR EYE PROTECTION TO PREVENT:
Reasonable probability of eye contact.
- ** EXPOSED PERSONNEL SHOULD WASH:
Promptly wash with soap when skin becomes contaminated.
- ** REMOVE CLOTHING:
Immediately remove any clothing that becomes wet to avoid any flammability
- ** REFERENCE: NIOSH

RECOMMENDED RESPIRATION PROTECTION Source: NIOSH POCKET GUIDE (85-114)
OSHA (BENZENE)

Less than or equal to 10 ppm: Half-mask air-purifying respirator with
organic vapor cartridge.

Less than or equal to 50 ppm: Full facepiece respirator with organic
vapor cartridges. / Full facepiece gas mask with chin style canister.

Less than or equal to 100 ppm: Full facepiece powered air-purifying respirator with organic vapor canister.

Less than or equal to 1000 ppm: Supplied air respirator with full facepiece in positive-pressure mode.

Greater than 1000 ppm or Unknown concentration: (1) Self-contained breathing apparatus with full face-piece in positive pressure mode. (2) Full facepiece positive-pressure supplied-air respirator with auxiliary self-contained air supply.

Escape : (1) Any organic vapor gas mask; or (2) Any self-contained breathing apparatus with full facepiece.

Firefighting : Any full facepiece self-contained breathing apparatus operated in positive pressure mode.

FIRST AID SOURCE: NIOSHP

EYE: irr immed

SKIN: soap wash promptly

INHALATION: art resp

INGESTION: no vomit

FIRST AID SOURCE: CHRIS Manual 1991

SKIN: flush with water followed by soap and water; remove contaminated clothing and wash skin.

EYES: flush with plenty of water until irritation subsides.

INHALATION: remove from exposure immediately. Call a physician. IF breathing is irregular or stopped, start resuscitation, administer oxygen.

FIRST AID SOURCE: DOT Emergency Response Guide 1990.

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen. In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water. Remove and isolate contaminated clothing and shoes at the site.

----- INITIAL INCIDENT RESPONSE -----

FIRE EXTINGUISHMENT: Dry chemical, foam, or carbon dioxide. Note: Water may be ineffective CHRIS91

US Department of Transportation Guide to Hazardous Materials Transport Information - Publication DOT 5800.5 (1990).

DOT SHIPPING NAME: Benzene

DOT ID NUMBER: UN1114

ERG90

GUIDE 27

* POTENTIAL HAZARDS *

*FIRE OR EXPLOSION

Flammable/combustible material; may be ignited by heat, sparks or flames.

Vapors may travel to a source of ignition and flash back.

Container may explode in heat of fire.

Vapor explosion hazard indoors, outdoors or in sewers.

Runoff to sewer may create fire or explosion hazard.

*HEALTH HAZARDS

May be poisonous if inhaled or absorbed through skin.
Vapors may cause dizziness or suffocation.
Contact may irritate or burn skin and eyes.
Fire may produce irritating or poisonous gases.
Runoff from fire control or dilution water may cause pollution.

* EMERGENCY ACTION *

Keep unnecessary people away; isolate hazard area and deny entry.
Stay upwind; keep out of low areas.
Positive pressure self-contained breathing apparatus (SCBA) and structural firefighters' protective clothing will provide limited protection.
Isolate for 1/2 mile in all direction if tank, rail car or tank truck is involved in fire.
CALL CHEMTREC AT 1-800-424-9300 FOR EMERGENCY ASSISTANCE. If water pollution occurs, notify the appropriate authorities.

*FIRE

Small Fires: Dry chemical, CO₂, water spray or regular foam.
Large Fires: Water spray, fog or regular foam.
Move container from fire area if you can do it without risk.
Apply cooling water to sides of containers that are exposed to flames until well after fire is out. Stay away from ends of tanks.
For massive fire in cargo area; use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn.
Withdraw immediately in case of rising sound of venting safety device or any discoloration of tank due to fire.

*SPILL OR LEAK

Shut off ignition sources; no flares, smoking or flames in hazard area.
Stop leak if you can do it without risk.
Water spray may reduce vapor; but it may not prevent ignition in closed spaces.
Small Spills: Take up with sand or other noncombustible absorbent material and place into containers for later disposal.
Large Spills: Dike far ahead of liquid spill for later disposal.

*FIRST AID

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen.
In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water.
Remove and isolate contaminated clothing and shoes at the site.

DISCLAIMER: The data shown above on this chemical represents a best effort of the part of the compilers of the CHEMTOX database to obtain useful, accurate, and factual data. The use of these data shall be in accordance with the guidelines and limitations of the user's CHEMTOX license agreement. The COMPILERS of the CHEMTOX database shall not be held liable for inaccuracies or omissions within this database, or in any of its printed or displayed output forms.

CHEMTOX DATA

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----- IDENTIFIERS -----

CHEMTOX RECORD 398 LAST UPDATE OF THIS RECORD: 12/03/9

NAME: TOLUENE

SYNONYMS: TOLUOL; PHENYL METHANE; METHYL BENZENE; BENZENE, METHYL-

CAS: 108-88-3 RTECS: XS5250000

FORMULA: C7H8 MOL WT: 92

WLN: 1R

CHEMICAL CLASS: Aromatic hydrocarbon

See other identifiers listed below under Regulations.

----- PROPERTIES -----

PHYSICAL DESCRIPTION: colorless watery liquid with a pleasant odor

BOILING POINT:	383.6 K	110.4 C	230.8 F
MELTING POINT:	178.00 K	-95.2 C	-139.3 F
FLASH POINT:	277.6 K	4.4 C	40 F
AUTO IGNITION:	809 K	535.8 C	996.5 F
CRITICAL TEMP:	591.8 K	318.65 C	605.57 F
CRITICAL PRESS:	4.108 kN/M2	40.5 atm	595 psia
HEAT OF VAP:	155 Btu/lb	86.08 cal/g	3.601x E5 J/kg
HEAT OF COMB:	-17430 Btu/lb	-9690 cal/g	-405x E5 J/kg
VAPOR PRESSURE:	36.7 mm @ 30 C		
VL:	7.1 %		
LL:	1.3 %		
IONIZATION POTENTIAL (eV):	8.82		
VAPOR DENSITY:	3.14 (air=1)		
EVAPORATION RATE:	2.00 (n-BUTYL ACETATE=1)		
SPECIFIC GRAVITY:	0.867 @ 20 C		
DENSITY:	0.867		
WATER SOLUBILITY:	0.05%		
INCOMPATIBILITIES:	strong ox		

REACTIVITY WITH WATER: No data on water reactivity

REACTIVITY WITH COMMON MATERIALS: No data

STABILITY DURING TRANSPORT: No Data

NEUTRALIZING AGENTS: No data

POLYMERIZATION POSSIBILITIES: No data

TOXIC FIRE GASES: None reported other than possible unburned vapors

ODOR DETECTED AT (ppm): 40 PPM

ODOR DESCRIPTION: STRONG, PLEASANT Source: NYDH

100 % ODOR DETECTION: No data

----- REGULATIONS -----

DOT hazard class: 3 FLAMMABLE LIQUID

DOT guide: 27

Identification number: UN1294

DOT shipping name: Toluene
Packing group: II
Label(s) required: FLAMMABLE LIQUID
Special provisions: T1
Packaging exceptions: 173.150
Non bulk packaging: 173.202
Bulk packaging: 173.242
Quantity limitations-
Passenger air/rail: 5 L
Cargo aircraft only: 60 L
Vessel stowage: B
Other stowage provisions:

STCC NUMBER: 4909305

CLEAN WATER ACT Sect.307:Yes
CLEAN WATER ACT Sect.311:Yes
National Primary Drinking Water Regulations
Maximum Contaminant Levels (MCL): 1 mg/L»(07/30/92)
Maximum Contaminant Level Goals (MCLG): 1 mg/L»(07/30/92)
CLEAN AIR ACT: CAA '90 Listed
EPA WASTE NUMBER: U220,D001
CERCLA REF: Not listed
RQ DESIGNATION: C 1000 pounds (454 kg) CERCLA
SARA TPQ VALUE: Not listed
SARA Sect. 312
categories:

Acute toxicity: Irritant
Acute toxicity: adverse effect to target organs.
Chronic toxicity: adverse effect to target organ
after long period of exposure.
Chronic toxicity: mutagen.
Chronic toxicity: reproductive toxin.

Fire hazard: flammable.

LISTED IN SARA Sect 313: Yes
de minimus CONCENTRATION: 1.0 percent

UNITED STATES POSTAL SERVICE MAILABILITY:
Hazard class: Flammable liquid - Mailable as ORM-D
Mailability: Domestic surface mail only
Max per parcel: 1 QT METAL; 1 PT OTHER

NFPA CODES:
HEALTH HAZARD (BLUE): (2) Hazardous to health. Area may be entered with
self-contained breathing apparatus.
FLAMMABILITY (RED) : (3) This material can be ignited under almost all
temperature conditions.
REACTIVITY (YELLOW): (0) Stable even under fire conditions.
SPECIAL : -Unspecified -

----- TOXICITY DATA -----

SHORT TERM TOXICITY: INHALATION: 100 ppm exposure can cause dizziness, drowsiness and hallucinations. 100-200 ppm can cause depression. 200-500 ppm can cause headaches, nausea, loss of appetite, loss of energy, loss of coordination and coma. in addition to the above, death has resulted from exposure to 10,000 ppm for an unknown time. SKIN: can cause dryness and irritation. absorption may cause or increase the severity of symptoms listed above. Eyes: can cause irritation at 300 ppm. INGESTION: can cause a burning sensation in the mouth and stomach, upper abdominal pain, cough, hoarseness, headache, nausea, loss of appetite, loss of energy, loss of coordination and coma. (NYDH)

LONG TERM TOXICITY: levels below 200 ppm may produce headache, tiredness and nausea. from 200 to 750 ppm symptoms may include insomnia, irritability, dizziness, some loss of memory, loss of appetite, a feeling of drunkenness and disturbed menstruation. levels up to 1,500 ppm may cause heart palpitations and loss of coordination. blood effects and anemia have been reported but are probably due to contamination by benzene. most of these effects are believed to go away when exposure stops. (NYDH)

TARGET ORGANS: CNS, liver, kidneys, skin, eyes

SYMPTOMS: Vapors irritate eyes and upper respiratory tract; cause dizziness, headache, anesthesia, respiratory arrest. Liquid irritates eyes and causes drying of skin. If aspirated, causes coughing, gagging, distress, and rapidly developing pulmonary edema. If ingested causes vomiting, griping, diarrhea, depressed respiration. Source: CHRIS

CONC IDLH: 2000ppm

NIOSH REL: 100 ppm Time weighted averages for 8-hour exposure
375 mg/M3 Time weighted averages for 8-hour exposure
200 ppm Ceiling exposures which shall at no time be exceeded(10-MIN)
750 mg/M3 Ceiling exposures which shall at no time be exceeded(10-MIN)

ACGIH TLV: TLV = 50ppm(188 mg/M3) Skin
ACGIH STEL: Not listed

OSHA PEL: Transitional Limits:
PEL = 200 PPM; CEILING = 300 PPM; MAXIMUM PEAK ABOVE CEIL
Final Rule Limits:
TWA = 100 ppm (375 mg/M3)
STEL = 150 ppm(560 mg/M3)

*** INFORMATION: 100 ppm
380 mg/M3

Substance with systemic effects, onset of effect less than or equal to 2 hrs: Peak = 5xMAK for 30 minutes, 2 times per shift of 8 hours.

Risk of damage to the developing embryo or fetus must be considered probable. Damage cannot be excluded even when the MAK values are adhered to.

CARCINOGEN?: N STATUS: See below

CARCINOGEN LISTS:

IARC: Not listed
MAK: Not listed
NIOSH: Not listed
NTP: Not listed
ACGIH: Not listed
OSHA: Not listed

HUMAN TOXICITY DATA: (Source: NIOSH RTECS)

* orl-hmn LDLo:50 mg/kg YAKUD5 22,883,80

ihl-hmn TCLo:200 ppm JAMAAP 123,1106,43

BRAIN AND COVERINGS

Recordings from specific areas of CNS

BEHAVIORAL

Antipsychotic

BLOOD

Changes in bone marrow not included above

LD50 value: orl-rat LD50:636 mg/ kg

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)

orl-rat LD50:636 mg/kg
ihl-rat LC50:>26700 ppm/1H
ipr-rat LD50:1332 mg/kg
ivn-rat LD50:1960 mg/kg
unr-rat LD50:6900 mg/kg
ihl-mus LC50:400 ppm/24H
ipr-mus LD50:59 mg/kg
scu-mus LD50:2250 mg/kg
unr-mus LD50:2000 mg/kg
ihl-rbt LCLo:55000 ppm/40M
skn-rbt LD50:12124 mg/kg
ivn-rbt LDLo:130 mg/kg
ihl-gpg LCLo:1600 ppm
ipr-gpg LD50:500 mg/kg
scu-frg LDLo:920 mg/kg
ipr-mam LDLo:1750 mg/kg

IRRITATION DATA: (Source: NIOSH RTECS 1992)

Reproductive toxicity (1992 RTECS):

This chemical is a mammalian reproductive toxin.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

ihl-rat TCLO:1500 mg/m³/24H (1-8D preg) TXCYAC 11,55,78
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

ihl-rat TCLO:1000 mg/m³/24H (7-14D preg) FMORAO
28,286,80
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

ihl-rat TCLO:100 ppm (51W male) SAIGBL 13,501,71
PATERNAL EFFECTS
Testes,epididymis,sperm duct

orl-mus TDLo:9 gm/kg (6-15D preg) TJADAB 19,41A,79
EFFECTS ON EMBRYO OR FETUS
Fetal death

orl-mus TDLo:15 gm/kg (6-15D preg) TJADAB 19,41A,79
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)

orl-mus TDLo:30 gm/kg (6-15D preg) TJADAB 19,41A,79
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Craniofacial(including nose and tongue)

ihl-mus TCLO:500 mg/m³/24H (6-13D preg) TXCYAC 11,55,78
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)

ihl-mus TCLO:1000 ppm/6H (2-17D preg) TJEMDR 7,265,82
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

ihl-mus TCLO:400 ppm/7H (7-16D preg) FAATDF 6,145,86
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system
EFFECTS ON NEWBORN

ihl-mus TCLO:200 ppm/7H (7-16D preg) FAATDF 6,145,86
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Urogenital system

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED
FROM THE CHRIS MANUAL:

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS:

WEAR APPROPRIATE EQUIPMENT TO PREVENT:

Repeated or prolonged skin contact.

**** WEAR EYE PROTECTION TO PREVENT:**

Reasonable probability of eye contact.

**** EXPOSED PERSONNEL SHOULD WASH:**

Promptly when skin becomes wet.

**** REMOVE CLOTHING:**

Immediately remove any clothing that becomes wet to avoid any flammability.

**** REFERENCE: NIOSH**

RECOMMENDED RESPIRATION PROTECTION Source: NIOSH POCKET GUIDE (85-114)
NIOSH (TOLUENE)

1000 ppm: Any chemical cartridge respirator with organic vapor cartridge(s). * Substance reported to cause eye irritation or damage may require eye protection. / Any supplied-air respirator. * Substance reported to cause eye irritation or damage may require eye protection. / Any powered air-purifying respirator with organic vapor cartridge(s). * Substance reported to cause eye irritation or damage may require eye protection. / Any self-contained breathing apparatus. * Substance reported to cause eye irritation or damage may require eye protection.

2000 ppm: Any supplied-air respirator operated in a continuous flow mode. * Substance reported to cause eye irritation or damage may require eye protection. / Any self-contained breathing apparatus with a full facepiece. / Any supplied-air respirator with a full facepiece. / Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister.

EMERGENCY OR PLANNED ENTRY IN UNKNOWN CONCENTRATIONS OR IDLH CONDITIONS. Any self-contained breathing apparatus with full facepiece and operated in a pressure-demand or other positive pressure mode. / Any supplied-air respirator with a full facepiece and operated in 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 or front- or back-mounted organic vapor canister. / Any appropriate escape-type self-contained breathing apparatus.

FIRST AID SOURCE: NIOSH

EYE: irr immed

SKIN: soap wash promptly

INHALATION: art resp

INGESTION: no vomit

FIRST AID SOURCE: CHRIS Manual 1991

INHALATION: remove to fresh air, give artificial respiration and oxygen if needed; call a doctor.

INGESTION: do NOT induce vomiting; call a doctor.

EYES: flush with water for at least 15 min.

SKIN: wipe off, wash with soap and water.

FIRST AID SOURCE: DOT Emergency Response Guide 1990.

Move victim to fresh air and call emergency medical care; if not

breathing, give artificial respiration; if breathing is difficult, give oxygen. In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water. Move and isolate contaminated clothing and shoes at the site.

----- INITIAL INCIDENT RESPONSE -----

FIRE EXTINGUISHMENT: Carbon dioxide or dry chemical for small fires, ordinary foam for large fires. Note: Water may be ineffective CHRIS91

US Department of Transportation Guide to Hazardous Materials Transport Information - Publication DOT 5800.5 (1990).

DOT SHIPPING NAME: Toluene

DOT ID NUMBER: UN1294

ERG90

GUIDE 27

* POTENTIAL HAZARDS *

*FIRE OR EXPLOSION

Flammable/combustible material; may be ignited by heat, sparks or flames.

Vapors may travel to a source of ignition and flash back.

Container may explode in heat of fire.

Vapor explosion hazard indoors, outdoors or in sewers.

Runoff to sewer may create fire or explosion hazard.

*HEALTH HAZARDS

May be poisonous if inhaled or absorbed through skin.

Vapors may cause dizziness or suffocation.

Contact may irritate or burn skin and eyes.

Fire may produce irritating or poisonous gases.

Runoff from fire control or dilution water may cause pollution.

* EMERGENCY ACTION *

Keep unnecessary people away; isolate hazard area and deny entry.

Stay upwind; keep out of low areas.

Positive pressure self-contained breathing apparatus (SCBA) and structural firefighters' protective clothing will provide limited protection.

Isolate for 1/2 mile in all direction if tank, rail car or tank truck is involved in fire.

CALL CHEMTREC AT 1-800-424-9300 FOR EMERGENCY ASSISTANCE. If water pollution occurs, notify the appropriate authorities.

*FIRE

Small Fires: Dry chemical, CO2, water spray or regular foam.

Large Fires: Water spray, fog or regular foam.

Move container from fire area if you can do it without risk.

Apply cooling water to sides of containers that are exposed to flames until well after fire is out. Stay away from ends of tanks.

For massive-fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Withdraw immediately in case of rising sound of venting safety device or any discoloration of tank due to fire.

*SPILL OR LEAK

Shut off ignition sources; no flares, smoking or flames in hazard area.

Stop leak if you can do it without risk.

Water spray may reduce vapor; but it may not prevent ignition in closed spaces.

Small Spills: Take up with sand or other noncombustible absorbent material and place into containers for later disposal.

Large Spills: Dike far ahead of liquid spill for later disposal.

*FIRST AID

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen.

In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water.

Remove and isolate contaminated clothing and shoes at the site.

DISCLAIMER: The data shown above on this chemical represents a best effort the part of the compilers of the CHEMTOX database to obtain useful, accurate and factual data. The use of these data shall be in accordance with the guidelines and limitations of the user's CHEMTOX license agreement. The COMPILERS of the CHEMTOX database shall not be held liable for inaccuracies or omissions within this database, or in any of its printed or displayed out forms.

DOT hazard class: 3 FLAMMABLE LIQUID
DOT guide: 26
Identification number: UN1175
DOT shipping name: Ethylbenzene
(after shipping description):
Packing group: II
Label(s) required: FLAMMABLE LIQUID
Special provisions: T1
Packaging exceptions: 173.150
Non bulk packaging: 173.202
Bulk packaging: 173.242
Quantity limitations-
Passenger air/rail: 5 L
Cargo aircraft only: 60 L
Vessel stowage: B
Other stowage provisions:

STCC NUMBER: 4909163

CLEAN WATER ACT Sect.307:Yes

CLEAN WATER ACT Sect.311:Yes

National Primary Drinking Water Regulations

Maximum Contaminant Levels (MCL): 0.7 mg/L (07/30/92)

Maximum Contaminant Level Goals (MCLG): 0.7 mg/L (07/30/92)

CLEAN AIR ACT: CAA '90 Listed

EPA WASTE NUMBER: D001

CERCLA REF: Y

DESIGNATION: C 1000 pounds (454 kg) CERCLA

RA TPQ VALUE: Not listed

SARA Sect. 312
categories:

Acute toxicity: Irritant

Acute toxicity: adverse effect to target organs.

Chronic toxicity: mutagen.

Chronic toxicity: reproductive toxin.

Fire hazard: flammable.

LISTED IN SARA Sect 313: Yes

de minimus CONCENTRATION: 1.0 percent

UNITED STATES POSTAL SERVICE MAILABILITY:

Hazard class: Flammable liquid - Mailable as ORM-D

Mailability: Domestic surface mail only

Max per parcel: 1 QT METAL; 1 PT OTHER

NFPA CODES:

HEALTH HAZARD (BLUE): (2) Hazardous to health. Area may be entered with self-contained breathing apparatus.

FLAMMABILITY (RED) : (3) This material can be ignited under almost all temperature conditions.

REACTIVITY (YELLOW): (0) Stable even under fire conditions.

SPECIAL : Unspecified

----- SUMMARY OF REGULATORY LISTS THIS SUBSTANCE APPEARS ON -----

ACGIH TLV list "Threshold Limit Values for 1992-1993"
California Assembly Bill 1803 Well Monitoring Chemicals.
Canadian Domestic Substances List
Canadian Ingredient Disclosure List. 20/01/88 Canada Gazette part II, Vol 122
Clean Air Act Section 111 List.
Clean Air Act of November 15, 1990. List of pollutants.
Clean Water Act Section 307 Priority Pollutants
Clean Water Act Section 311 Hazardous Chemicals List.
DOT Hazardous Materials Table. 49 CFR 172.101
EPA Carcinogen Assessment Group List
EPA List of VOC chemicals from 40 CFR 60.489
EPA TSCA 8(a) Preliminary Assessment Information Rule - effective 11/19/82
EPA TSCA 8(d) Health and Safety Data Rule - effective date 06/19/87
EPA TSCA Chemical Inventory List 1986
EPA TSCA Chemical Inventory List 1989
EPA TSCA Chemical Inventory List 1990
EPA TSCA Chemical Inventory List 1992
EPA TSCA Test Submission (TSCATS) Database - April 1990
EPA TSCA Test Submission (TSCATS) Database - September 1989
ETHYL BENZENE [100-41-4]
Massachusetts Substance List.
New Jersey DEQ100 list for release reporting.
New Jersey Right To Know Substance List. (December 1987)
OSHA Air Contaminant (Table Z-1-A). 54 FR 4332, Jan. 19, 1989 and revised.
HA Process Safety Rule chemical with a TQ. Effective May 26, 1992
Pennsylvania Hazardous Substance List
RCRA Hazardous Constituents for Ground Water Monitoring. Ap'dx IX to 40 CFR 26
RCRA Hazardous Waste
SARA Section 313 Toxic Chemicals List
Superfund/CERCLA RQ list. Table 302.4 in 54 FR 50968 (December 11, 1989)
Wisconsin Air Toxics Control Regulation NR-445 (December 1988)

----- TOXICITY DATA -----

SHORT TERM TOXICITY: INHALATION: 200 ppm for 30 minutes can cause irritation of the nose and throat, dizziness, difficult breathing and depression. very high levels can cause unconsciousness. SKIN: can cause irritation, inflammation, blisters and burns. Eyes: 200 ppm can cause irritation. higher levels can cause burning, tearing and injury. INGESTION: can cause headache, sleepiness and coma. (NYDH)

LONG TERM TOXICITY: may cause skin rash and irritation of eyes, nose and throat. (NYDH)

TARGET ORGANS: eyes, upper resp sys, skin, CNS

SYMPTOMS: Inhalation may cause irritation of nose, dizziness, depression. Moderate irritation of eye with corneal injury possible. Irritates skin and may cause blisters. Source: CHRIS

CONC IDLH: 2000PPM

NIOSH REL:

ACGIH TLV: TLV = 100ppm(435 mg/M3)
ACGIH STEL: STEL = 125 ppm(545 mg/M3)

OSHA PEL: Transitional Limits:
PEL = 100 ppm(435mg/M3)
Final Rule Limits:
TWA = 100 ppm (435 mg/M3)
STEL = 125 ppm(545 mg/M3)

MAK INFORMATION: 100 ppm
440 mg/M3
Local irritant: Peak = 2xMAK for 5 minutes, 8 times per shift.
Danger of cutaneous absorption

CARCINOGEN?: N STATUS: See below

CARCINOGEN LISTS:

IARC: Not listed
MAK: Not listed
NIOSH: Not listed
NTP: Not listed
ACGIH: Not listed
OSHA: Not listed

HUMAN TOXICITY DATA: (Source: NIOSH RTECS)
ihl-hmn TCLO:100 ppm/8H AIHAAP 31,206,70
SENSE ORGANS
Eye
Other
BEHAVIORAL
Sleep
LUNGS, THORAX, OR RESPIRATION
Other changes

LD50 value: orl-rat LD50:3500 mg/ kg

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)

- orl-rat LD50:3500 mg/kg
ihl-rat LCLO:4000 ppm/4H
ihl-mus LDLo:50 gm/m3/2H
ipr-mus LD50:2272 mg/kg

skn-rbt LD50:17800 mg/kg
ihl-gpg LCLo:10000 ppm

RITATION DATA: (Source: NIOSH RTECS 1992)

skn-rbt 15 mg/24H open MLD
eye-rbt 100 mg

Reproductive toxicity (1992 RTECS):

This chemical is a mammalian reproductive toxin.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

ihl-rat TCLo:97 ppm/7H (15D pre) NTIS** PB83-208074
EFFECTS ON FERTILITY
Female fertility index

ihl-rat TCLo:985 ppm/7H (1-19D preg) NTIS** PB83-208074
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)

ihl-rat TCLo:96 ppm/7H (1-19D preg) NTIS** PB83-208074
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

ihl-rat TCLo:600 mg/m3/24H (7-15D preg) ATSUDG 8,425,85
EFFECTS ON FERTILITY
Post-implantation mortality
EFFECTS ON EMBRYO OR FETUS
Fetal death
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

ihl-rat TCLo:2400 mg/m3/24H (7-15D preg) ATSUDG
8,425,85
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)

ihl-rbt TCLo:99 ppm/7H (1-18D preg) NTIS** PB83-208074
EFFECTS ON FERTILITY
Litter size(# fetuses per litter;measured before
birth)

ihl-rbt TCLo:500 mg/m3/24H (7-20D preg) ATSUDG 8,425,85
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)

California Prop 65: Not listed

----- EPA's IRIS DATA SUMMARY -----
Ethylbenzene; CASRN 100-41-4 (04/01/92)

_II. CARCINOGENICITY ASSESSMENT FOR LIFETIME EXPOSURE

Substance Name -- Ethylbenzene

Section II provides information on three aspects of the carcinogenic risk assessment for the agent in question; the U.S. EPA classification, and quantitative estimates of risk from oral exposure and from inhalation exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in three ways. The slope factor is the result of application of a low-dose extrapolation procedure and is presented as the risk per (mg/kg)/day. The unit risk is the quantitative estimate in terms of either risk per ug/L drinking water or risk per ug/cu.m air breathed. The third form in which risk is presented is a drinking water or air concentration providing cancer risks of 1 in 10,000, 1 in 100,000 or 1 in 1,000,000. Background Document 2 (Service Code 5) provides details on the rationale and methods used to derive the carcinogenicity values found in IRIS. Users are referred to Section I for information on long-term toxic effects other than carcinogenicity.

___ II.A. EVIDENCE FOR CLASSIFICATION AS TO HUMAN CARCINOGENICITY

___ II.A.1. WEIGHT-OF-EVIDENCE CLASSIFICATION

Classification -- D; not classifiable as to human carcinogenicity.

Basis -- nonclassifiable due to lack of animal bioassays and human studies.

___ II.A.2. HUMAN CARCINOGENICITY DATA

None.

___ II.A.3. ANIMAL CARCINOGENICITY DATA

None. NTP has plans to initiate bioassay. Metabolism and excretion studies at 3.5, 35 and 350 mg/kg are to be conducted as well.

___ II.A.4. SUPPORTING DATA FOR CARCINOGENICITY

The metabolic pathways for humans and rodents are different (Engstrom et al., 1984). Major metabolites in humans, mandelic acid and phenylglyoxylic acid, are minor metabolites in rats and rabbits (Kiese and Lenk, 1974). The major animal metabolites were not detected in the urine of exposed workers (Engstrom et al., 1984).

Ethylbenzene at 0.4 mg/plate was not mutagenic for Salmonella strains

TA98, TA1535, TA1537 and TA1538 with or without Aroclor 1254 induced rat liver homogenates (S9) (Nestmann et al., 1980). Ethylbenzene was shown to increase the mean number of sister chromatid exchanges in human whole blood lymphocyte culture at the highest dose examined without any metabolic activation system (Norppa and Vainio, 1983).

Dean et al. (1985) used a battery of short-term tests including bacterial mutation assays, mitotic gene conversion in *Saccharomyces cerevisiae* JD1 in the presence and absence of S9 and chromosomal damage in a cultured rat liver cell line. Ethylbenzene was not mutagenic in the range of concentrations tested (0.2, 2, 20, 50 and 200 ug/plate) for *S. typhimurium* TA98, TA100, TA1535, TA1537 and TA1538 or for *Escherichia coli* WP2 and WP2uvrA. Ethylbenzene also showed no response in the *S. cerevisiae* JD1 gene conversion assay. In contrast, ethylbenzene hydroperoxide showed positive responses with *E. coli* WP2 at 200 ug/plate in the presence of S9 and an equally significant response with the gene conversion system of yeast.

__II.B. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM ORAL EXPOSURE

Not available.

__II.C. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM INHALATION EXPOSURE

Not available.

__II.D. EPA DOCUMENTATION, REVIEW, AND CONTACTS (CARCINOGENICITY ASSESSMENT)

__II.D.1. EPA DOCUMENTATION

U.S. EPA. 1980. Ambient Water Quality Criteria Document for Ethylbenzene. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Water Regulations and Standards, Washington, DC. EPA 440/5-80-048. NTIS PB 81-117590.

U.S. EPA. 1984. Health Effects Assessment for Ethylbenzene. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Emergency and Remedial

Response, Washington, DC. EPA/540/1-86/008.

" S. EPA. 1987. Drinking Water Criteria Document for Ethylbenzene. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Drinking Water, Washington, DC.

___ II.D.2. REVIEW (CARCINOGENICITY ASSESSMENT)

The Ambient Water Quality Criteria Document and the Health Assessment Document have received Agency and external review. The Drinking Water Criteria Document has been extensively reviewed.

Agency Work Group Review: 10/07/87

Verification Date: 10/07/87

___ II.D.3. U.S. EPA CONTACTS (CARCINOGENICITY ASSESSMENT)

Arthur S. Chiu / ORD -- (202)260-6764 / FTS 260-6764

Lynn Papa / ORD -- (513)569-7523 / FTS 684-7523

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED
FROM THE CHRIS MANUAL:
self-contained breathing apparatus; safety goggles.

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS:

- ** WEAR APPROPRIATE EQUIPMENT TO PREVENT:
Repeated or prolonged skin contact.
- ** WEAR EYE PROTECTION TO PREVENT:
Reasonable probability of eye contact.
- ** EXPOSED PERSONNEL SHOULD WASH:
Promptly when skin becomes contaminated.
- ** REMOVE CLOTHING:
Immediately remove any clothing that becomes wet to avoid any flammability.
- ** REFERENCE: NIOSH

RECOMMENDED RESPIRATION PROTECTION Source: NIOSH POCKET GUIDE (85-114)
OSHA (ETHYL BENZENE)

1000 ppm: Any powered air-purifying respirator with organic vapor cartridge(s). * Substance reported to cause eye irritation or damage may require eye protection. / Any supplied-air respirator. * Substance reported to cause eye irritation or damage may require eye protection. / Any self-contained breathing apparatus. * Substance reported to cause eye irritation or damage may require eye protection. / Any chemical cartridge respirator with organic vapor cartridge(s). * Substance reported to cause eye irritation or damage may require eye protection.

2000 ppm: Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister. / Any supplied-air respirator with a full facepiece. / Any self-contained breathing apparatus with a full facepiece.

EMERGENCY OR PLANNED ENTRY IN UNKNOWN CONCENTRATIONS OR IDLH CONDITIONS.: Any self-contained breathing apparatus with full facepiece and operated in a pressure-demand or other positive pressure mode. / Any supplied-air respirator with a full facepiece and operated in 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 or front- or back-mounted organic vapor canister. / Any appropriate escape-type self-contained breathing apparatus.

FIRST AID SOURCE: CHRIS Manual 1991

INHALATION: if ill effects occur, remove victim to fresh air, keep him warm and quiet, and get medical help promptly; if breathing stops, give artificial respiration.

INGESTION: induce vomiting only upon physician's approval; material ingested may cause chemical pneumonitis.

IN AND

EYES: promptly flush with plenty of water (15 min. for eyes) and get medical attention; remove and wash contaminated clothing before reuse.

FIRST AID SOURCE: DOT Emergency Response Guide 1990.

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen. In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water. Remove and isolate contaminated clothing and shoes at the site.

----- INITIAL INCIDENT RESPONSE -----

FIRE EXTINGUISHMENT: Foam (most effective), water fog, carbon dioxide or dry chemical. CHRIS91

US Department of Transportation Guide to Hazardous Materials Transport Information - Publication DOT 5800.5 (1990).

DOT SHIPPING NAME: Ethylbenzene

DOT ID NUMBER: UN1175

ERG93

GUIDE 26

POTENTIAL HAZARDS

*FIRE OR EXPLOSION

Flammable/combustible material; may be ignited by heat, sparks or flames.
Vapors may travel to a source of ignition and flash back.
Container may explode in heat of fire.

Major explosion hazard indoors, outdoors or in sewers.
Runoff to sewer may create fire or explosion hazard.

***HEALTH HAZARDS**

May be poisonous if inhaled or absorbed through skin.

Vapors may cause dizziness or suffocation.

Contact may irritate or burn skin and eyes.

Fire may produce irritating or poisonous gases.

Runoff from fire control or dilution water may give off poisonous gases and ca

EMERGENCY ACTION

Keep unnecessary people away; isolate hazard area and deny entry.

Stay upwind; keep out of low areas.

Positive pressure self-contained breathing apparatus (SCBA) and structural fire

*Isolate for 1/2 mile in all directions if tank, rail car or tank truck is involved.

CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping

If water pollution occurs, notify the appropriate authorities.

***FIRE**

Small Fires: Dry chemical, CO₂, water spray or alcohol-resistant foam.

Do not use dry chemical extinguishers to control fires involving nitromethane

Large Fires: Water spray, fog or alcohol-resistant foam.

Move container from fire area if you can do it without risk.

Apply cooling water to sides of containers that are exposed to flames until well

For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if

Withdraw immediately in case of rising sound from venting safety device or any

***SPILL OR LEAK**

Shut off ignition sources; no flares, smoking or flames in hazard area.

Stop leak if you can do it without risk.

Water spray may reduce vapor; but it may not prevent ignition in closed spaces.

Small Spills: Take up with sand or other noncombustible absorbent material and

Large Spills: Dike far ahead of liquid spill for later disposal.

***FIRST AID**

Move victim to fresh air and call emergency medical care; if not breathing, give

In case of contact with material, immediately flush eyes with running water for

Remove and isolate contaminated clothing and shoes at the site.

DISCLAIMER: The data shown above on this chemical represents a best effort of the part of the compilers of the CHEMTOX database to obtain useful, accurate, and factual data. The use of these data shall be in accordance with the guidelines and limitations of the user's CHEMTOX license agreement. The COMPILERS of the CHEMTOX database shall not be held liable for inaccuracies or omissions within this database, or in any of its printed or displayed output forms.

CHEMTOX DATA

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----- IDENTIFIERS -----

CHEMTOX RECORD 421 LAST UPDATE OF THIS RECORD: 12/03/90
 NAME: XYLENE
 SYNONYMS: XYLENE (XYLOL); XYLOL; METHYL TOLUENE; BENZENE, DIMETHYL-;
 DIMETHYLBENZENE; NCI-C55232; VIOLET 3; XYLOL (DOT); SOCIAL
 AQUATIC SOLVENT 3501
 CAS: 1330-20-7 RTECS: ZE2100000
 FORMULA: C8H10 MOL WT: 106.18
 WLN: 1R X1
 CHEMICAL CLASS: Aromatic hydrocarbon

See other identifiers listed below under Regulations.

----- PROPERTIES -----

PHYSICAL DESCRIPTION: colorless liquid with aromatic odor
 BOILING POINT: 412 K 138.8 C 281.9 F
 MELTING POINT: 247 K -26.2 C -15.1 F
 FLASH POINT: 300.35-305.35 27.2-32.2 C 80.9-89.9 F
 AUTO IGNITION: NA
 VAPOR PRESSURE: 6.7 mm @ 21 C
 UEL: 7 %
 LEL: 1 %
 IONIZATION POTENTIAL (eV): 8.56
 VAPOR DENSITY: 3.7 (air=1)
 EVAPORATION RATE: 0.77 (n-BUTYL ACETATE=1)
 SPECIFIC GRAVITY: 0.861 20C
 DENSITY: 0.861 g/cc or 8.0073 lb/gal
 WATER SOLUBILITY: VERY SL SOL
 INCOMPATIBILITIES: strong oxidizers

REACTIVITY WITH WATER: No data on water reactivity
 REACTIVITY WITH COMMON MATERIALS: No data
 STABILITY DURING TRANSPORT: No Data
 NEUTRALIZING AGENTS: No data
 POLYMERIZATION POSSIBILITIES: No data

TOXIC FIRE GASES: None reported other than possible unburned vapors
 ODOR DETECTED AT (ppm): 0.05
 ODOR DESCRIPTION: LIKE BENZENE; CHARACTERISTIC AROMATIC
 Source: CHRIS
 100 % ODOR DETECTION: 0.4-20 ppm

----- REGULATIONS -----

DOT hazard class: 3 FLAMMABLE LIQUID
 DOT guide: 27
 Identification number: UN1307
 Shipping name: XYLENES

Packing group: II
Label(s) required: FLAMMABLE LIQUID
Special provisions: T1
Packaging exceptions: 173.150
Non bulk packaging: 173.202
Bulk packaging: 173.242
Quantity limitations-
Passenger air/rail: 5 L
Cargo aircraft only: 60 L
Vessel stowage: B
Other stowage provisions:

STCC NUMBER: 4909350, 4909351

CLEAN WATER ACT Sect.307:No
CLEAN WATER ACT Sect.311:Yes
National Primary Drinking Water Regulations
Maximum Contaminant Levels (MCL): 10 mg/L» (07/30/92)
Maximum Contaminant Level Goals (MCLG): 10 mg/L» (07/30/92)
CLEAN AIR ACT: CAA '90 Listed
EPA WASTE NUMBER: U239,D001
CERCLA REF: Not listed
RQ DESIGNATION: C 1000 pounds (454 kg) CERCLA
SARA TPQ VALUE: Not listed
SARA Sect. 312
categories:

Acute toxicity: Irritant
Acute toxicity: adverse effect to target organs.
Chronic toxicity: adverse effect to target organ
after long period of exposure.
Chronic toxicity: reproductive toxin.
Fire hazard: flammable.

LISTED IN SARA Sect 313: Yes
Minimum CONCENTRATION: 1.0 percent

UNITED STATES POSTAL SERVICE MAILABILITY:
Hazard class: Not given
Mailability: Nonmailable
Max per parcel: 0

NFPA CODES:
HEALTH HAZARD (BLUE): (2) Hazardous to health. Area may be entered with
self-contained breathing apparatus.
FLAMMABILITY (RED) : (3) This material can be ignited under almost all
temperature conditions.
REACTIVITY (YELLOW): (0) Stable even under fire conditions.
SPECIAL : Unspecified

----- TOXICITY DATA -----

SHORT TERM TOXICITY: Unknown

LONG TERM TOXICITY: unknown

TARGET ORGANS: CNS, eyes, gi tract, blood, liver, kidneys, skin

SYMPTOMS: DIZZ, EXCITEMENT, DROW, INCO, STAGGERING GAIT, IRRIT EYES, NOSE, THROAT, CORNEAL VACUOLIZATION, ANOREXIA, NAU, VOMIT, ABDOM PAIN; DERM Source: CHRIS

CONC IDLH: 1000ppm

NIOSH REL: 100 ppm Time weighted averages for 8-hour exposure
434 mg/M3 Time weighted averages for 8-hour exposure
200 ppm Ceiling exposures which shall at no time be exceeded(10-MIN) 868 mg/M3 Ceiling exposures which shall at no time be exceeded(10-MIN)

ACGIH TLV: TLV = 100ppm(435 mg/M3)
ACGIH STEL: STEL = 150 ppm(655 mg/M3)

OSHA PEL: Transitional Limits:
PEL = 100 ppm(435mg/M3)
Final Rule Limits:
TWA = 100 ppm (435 mg/M3)
STEL = 150 ppm(655 mg/M3)

MAK INFORMATION: 100 ppm
440 mg/M3
Substance with systemic effects, onset of effect less than or equal to 2 hrs: Peak = 2xMAK for 30 minutes, 4 times per shift of 8 hours.

CARCINOGEN?: N STATUS: See below

CARCINOGEN LISTS:
IARC: Not listed
MAK: Not listed
NIOSH: Not listed
NTP: Not listed
ACGIH: Not listed
OSHA: Not listed

HUMAN TOXICITY DATA: (Source: NIOSH RTECS)
* orl-hmn LDLo:50 mg/kg YAKUD5 22,883,80
ihl-man LCLo:10000 ppm/6H BMJOAE 3,442,70

LD50 value: orl-rat LD50:4300 mg/ kg

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)
orl-rat LD50:4300 mg/kg
ihl-rat LC50:5000 ppm/4H
ipr-rat LD50:2459 mg/kg
scu-rat LD50:1700 mg/kg
ipr-mus LD50:1548 mg/kg

ivn-rbt LDLo:129 mg/kg
ihl-gpg LCLo:450 ppm
ipr-gpg LDLo:2000 mg/kg
ipr-mam LDLo:2 gm/kg

IRRITATION DATA: (Source: NIOSH RTECS 1992)

Reproductive toxicity (1992 RTECS):

This chemical is a mammalian reproductive toxin.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

ihl-rat TCLo:250 mg/m³/24H (7-15D preg) ATSUDG 8,425,85
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

ihl-rat TCLo:50 mg/m³/6H (1-21D preg) JHEMA2 27,337,83
EFFECTS ON FERTILITY
Post-implantation mortality
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Craniofacial(including nose and tongue)

ihl-rat TCLo:50 mg/m³/6H (1-21D preg) JHEMA2 27,337,83
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Other developmental abnormalities
EFFECTS ON NEWBORN
Growth statistics(e.g.,reduced weight gain)

ihl-rat TCLo:600 mg/m³/24H (7-15D preg) PCBRD2
163B,295,85
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

orl-mus TDLo:20600 ug/kg (6-15D preg) JTEHD6 9,97,82
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Craniofacial(including nose and tongue)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

orl-mus TDLo:31 mg/kg (6-15D preg) JTEHD6 9,97,82
EFFECTS ON FERTILITY
Post-implantation mortality

ihl-mus TCLo:4000 ppm/6H (6-12D preg) TJADAB 28,22A,83
EFFECTS ON NEWBORN
Growth statistics(e.g.,reduced weight gain)
EFFECTS ON NEWBORN

Physical

ihl-mus TCLO:2000 ppm/6H (6-12D preg) TJADAB 28,22A,83
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)

ihl-mus TCLO:1 gm/m3/12H (6-15D preg) ATSUDG 8,425,85
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

ihl-rbt TCLO:500 mg/m3/24H (7-20D preg) ATSUDG 8,425,85
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED
FROM THE CHRIS MANUAL:

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS:

- ** WEAR APPROPRIATE EQUIPMENT TO PREVENT:
Repeated or prolonged skin contact.
- ** WEAR EYE PROTECTION TO PREVENT:
Reasonable probability of eye contact.
- ** EXPOSED PERSONNEL SHOULD WASH:
Promptly when skin becomes contaminated.
- ** REMOVE CLOTHING:
Immediately remove any clothing that becomes wet to avoid any flammabil.
- ** REFERENCE: NIOSH

RECOMMENDED RESPIRATION PROTECTION Source: NIOSH POCKET GUIDE (85-114)
NIOSH (XYLENE)

1000 ppm: Any chemical cartridge respirator with organic vapor cartridge(s). * Substance reported to cause eye irritation or damage may require eye protection. / Any powered air-purifying respirator with organic vapor cartridge(s). * Substance reported to cause eye irritation or damage may require eye protection. / Any supplied-air respirator. * Substance reported to cause eye irritation or damage may require eye protection. / Any self-contained breathing apparatus. * Substance reported to cause eye irritation or damage may require eye protection.
EMERGENCY OR PLANNED ENTRY IN UNKNOWN CONCENTRATIONS OR IDLH CONDITIONS.: Any self-contained breathing apparatus with full facepiece and operated in a pressure-demand or other positive pressure mode. / Any supplied-air respirator with a full facepiece and operated in 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 or front- or back-mounted organic vapor canister. / Any appropriate escape-type self-contained breathing apparatus.

FIRST AID SOURCE: NIOSH
EYE: irr immed
SKIN: soap wash promptly
INHALATION: art resp
INGESTION: no vomit

FIRST AID SOURCE: DOT Emergency Response Guide 1990.
Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen. In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water. Remove and isolate contaminated clothing and shoes at the site.

----- INITIAL INCIDENT RESPONSE -----

US Department of Transportation Guide to Hazardous Materials Transport Information - Publication DOT 5800.5 (1990).

DOT SHIPPING NAME: XYLENES
DOT ID NUMBER: UN1307

ERG90

GUIDE 27

* POTENTIAL HAZARDS *

*FIRE OR EXPLOSION

Flammable/combustible material; may be ignited by heat, sparks or flames.

Vapors may travel to a source of ignition and flash back.

Container may explode in heat of fire.

Vapor explosion hazard indoors, outdoors or in sewers.

Runoff to sewer may create fire or explosion hazard.

*HEALTH HAZARDS

May be poisonous if inhaled or absorbed through skin.

Vapors may cause dizziness or suffocation.

Contact may irritate or burn skin and eyes.

Fire may produce irritating or poisonous gases.

Runoff from fire control or dilution water may cause pollution.

* EMERGENCY ACTION *

Keep unnecessary people away; isolate hazard area and deny entry.

Stay upwind; keep out of low areas.

Positive pressure self-contained breathing apparatus (SCBA) and structural firefighters' protective clothing will provide limited protection.

Isolate for 1/2 mile in all direction if tank, rail car or tank truck is involved in fire.

CALL CHEMTREC AT 1-800-424-9300 FOR EMERGENCY ASSISTANCE. If water pollution occurs, notify the appropriate authorities.

*FIRE

Small Fires: Dry chemical, CO2, water spray or regular foam.

Large Fires: Water spray, fog or regular foam.

Move container from fire area if you can do it without risk.

Apply cooling water to sides of containers that are exposed to flames until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Withdraw immediately in case of rising sound of venting safety device or any discoloration of tank due to fire.

***SPILL OR LEAK**

Shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do it without risk.

Water spray may reduce vapor; but it may not prevent ignition in closed spaces.

Small Spills: Take up with sand or other noncombustible absorbent material and place into containers for later disposal.

Large Spills: Dike far ahead of liquid spill for later disposal.

***FIRST AID**

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen.

In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water.

Remove and isolate contaminated clothing and shoes at the site.

DISCLAIMER: The data shown above on this chemical represents a best effort by the part of the compilers of the CHEMTOX database to obtain useful, accurate, and factual data. The use of these data shall be in accordance with the guidelines and limitations of the user's CHEMTOX license agreement. The COMPILERS of the CHEMTOX database shall not be held liable for inaccuracies or omissions within this database, or in any of its printed or displayed output forms.

ATTACHMENT B

DIRECTIONS TO EMERGENCY MEDICAL FACILITIES

INSERT MAP TO HOSPITAL

ATTACHMENT C

HEALTH AND SAFETY PLAN FORMS

PLAN ACCEPTANCE FORM

PROJECT HEALTH AND SAFETY PLAN

INSTRUCTIONS: This form is to be completed by each person working on the project site and returned to: EnSafe/Allen & Hoshall, Memphis, Tennessee.

Job No: 2151-016

Contract No: N62467-89-D-0318

Project: SWMUs 4, 6, 10, 31, 38 — Miscellaneous Drainage Ditch Areas

I have read and understand the contents of the above plan and agree to perform my work in accordance with it.

Signed

Print Name

Company

Date

PLAN FEEDBACK FORM

Problems with plan requirements:

Unexpected situations encountered:

Recommendations for revisions:

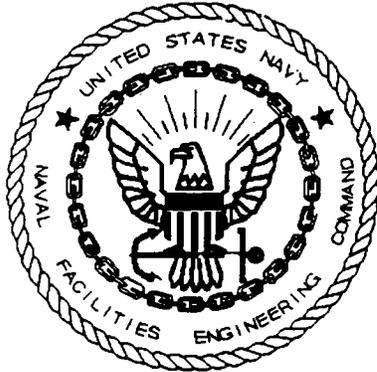
ACCIDENT REPORT FORM

SUPERVISOR'S REPORT OF ACCIDENT		DO NOT USE FOR MOTOR VEHICLE OR AIRCRAFT ACCIDENTS	
TO		FROM	
		TELEPHONE (Include area code)	
NAME OF INJURED OR ILL WORKER AND COMPANY			
WORKER'S SOCIAL SECURITY NUMBER			
DATE OF ACCIDENT	TIME OF ACCIDENT	EXACT LOCATION OF ACCIDENT	
NARRATIVE DESCRIPTION OF ACCIDENT			
NATURE OF ILLNESS OR INJURY AND PART OF BODY INVOLVED		LOST TIME YES <input type="checkbox"/> NO <input type="checkbox"/>	
PROBABLE DISABILITY (Check one)			
FATAL <input type="checkbox"/> LOST WORK DAY WITH ___ DAYS AWAY FROM WORK LOST WORK DAY WITH ___ DAYS OF RESTRICTED ACTIVITY NO LOST WORK DAY <input type="checkbox"/> FIRST-AID ONLY <input type="checkbox"/>			
CORRECTIVE ACTION RECOMMENDED (By whom and by when)			
NAME OF SUPERVISOR		TITLE	
SIGNATURE		DATE	

**RFI WORK PLAN
NAS MEMPHIS**

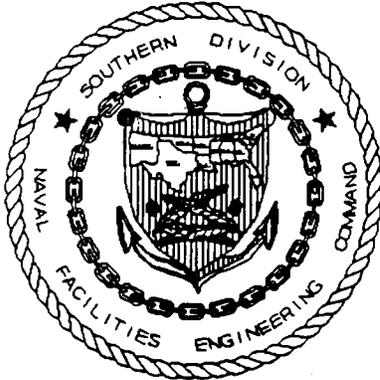
**SITE INVESTIGATION PLAN
SWMU 40 — SALVAGE YARD NO. 1**

**CTO-094
Contract No. N62467-89-D-0318**



Prepared for:

**Department of the Navy
Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina**



Prepared by:

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5720 Summer Trees Drive, Suite 8
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(901) 383-9115**

March 15, 1995

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Appendix E	Site-Specific Health and Safety Plan

1.0 INTRODUCTION

As part of the U.S. Navy Comprehensive Long Term Environmental Action Navy (CLEAN) Program, the following Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Site Investigation Plan (SIP) has been prepared for SWMU 40, the Salvage Yard No. 1, located at Naval Air Station (NAS) Memphis, Millington, Tennessee. The primary reference for this SIP is the *Comprehensive RFI Work Plan* (E/A&H, 1994).

2.0 ENVIRONMENTAL SETTING

SWMU 40 consists of two formerly fenced-in, open storage areas designated as Areas N-813 and N-1666. SWMU 40 is located in the southern portion of NAS Memphis Northside, southwest of Building N-1694 (Hazardous Waste Storage Facility) and east of the Carrier Deck Fire Training Area (Figure 1). The yard was used from 1945 until 1989 and, based on historical information, was not used for burying waste. Area N-813 (unpaved) was formerly used to store scrap airplane parts, anchor chains, and other equipment. Area N-1666 (paved) was used for long-term, personally owned vehicle parking and storage. The asphalt surface is low-quality paving consisting primarily of asphalt tailings generated from resurfacing runways. In 1988 and 1989, this area was converted into an asphalt parking area for mobile trailers and used for electronic communications training. The parking area has changed location and now consists of a fenced, concrete parking area in the southeastern portion of the site.

According to NAS Memphis Department of Public Works records, a service station also formerly occupied part of the site. Maps dating back to 1947 show a service station in the northern portion of the site. The service station reportedly consisted of a fuel island and two underground storage tanks. The building and all surface features have been removed, however, the tanks are believed to be in place.

2.1 Topography and Drainage

The SWMU 40 area has been disturbed by past activities but is generally level. A shallow drainage ditch that follows Dakar Street along the northern border of the site drains southwest. Surface drainage across the site is in a southwesterly direction toward SWMU 4, a tributary to SWMU 38, which discharges to North Fork Creek near the southwestern corner of the NAS Northside.

2.2 Geologic and Hydrogeologic Information

The general regional and local hydrogeology of NAS Memphis area are described in Sections 2.11 and 2.12 of the *Comprehensive RFI Work Plan*.

Stratigraphy

Shallow subsurface soil information was collected during previous investigations while implementing the Interim Measures (IM) (SOUTHNAVFACENCOM, E/A&H, 1993) and underground storage tank (UST) investigations at SWMU 5 (Aircraft Fire Fighting Training Facility) (E/A&H, 1992). The studies indicate the presence of low- to very low-permeability silts with varying amounts of clay to a depth of approximately 20 feet below land surface (bls) underlain by a silt unit. SWMU 5 is approximately 1,500 feet southwest of SWMU 40. Laboratory-measured vertical hydraulic conductivities for the clayey silt unit range from 10^{-8} to 10^{-7} centimeters per second (cm/sec) (E/A&H, 1992); no conductivity data are available for the underlying silt unit. Permeability data collected during an UST investigation at Building N-126 (E/A&H, 1993), approximately 1,000 feet northeast of the site, indicated an average hydraulic conductivity value of 4.5×10^{-7} cm/sec at a depth interval of 11 to 13 feet. Boring logs from the UST investigation at SWMU 5 are provided in Appendix A of this document.

Stratigraphic Test Borings

The USGS drilled stratigraphic test hole 4 to a total depth of 220 feet at a location approximately 500 feet south of the main runway and about 1,000 feet north of SWMU 40 (Figure 1). The test hole originally was to be advanced approximately 15 feet into the Cook Mountain Formation (the clay unit separating the Memphis Sand from the overlying Cockfield Formation and shallower units). However, due to the unanticipated thinness of the Cockfield Formation, this borehole was advanced approximately 50 feet into the Memphis Sand. This test hole was visually logged by a field geologist during drilling and geophysically logged following completion. Lithologies encountered in the test hole are as follows:

- Loess:** Approximately 40 feet of wind-blown silt deposits consisting of silt and minor clay.
- Fluvial Deposits:** Approximately 30 feet of fluvial deposits consisting of sand and gravel.
- Cockfield Formation:** Approximately 30 feet of alternating sand, clay, and some lignite.
- Cook Mountain Formation:** The Cook Mountain, characterized as a grey to blue-grey dense clay approximately 44 feet thick, is defined as the upper confining unit between the surficial aquifer(s) and the Memphis aquifer.

Shallow Groundwater

No groundwater monitoring wells exist at SWMU 40. Monitoring wells do exist at SWMU 5 (near SWMU 4) and Building N-126 (near SWMU 31). During the UST investigations at both

Building N-126 and SWMU 5, a saturated zone was encountered at approximately 15 to 20 feet bls. Based on topography, the information contained in the conceptual model of the NAS Memphis hydrogeology (Section 2.12 of the *Comprehensive RFI Work Plan*), and recent data collected during investigations at Assembly A SWMUs, groundwater flows locally toward the southwest.

2.3 Climatological Data

Regional climatological data are provided in Section 2.8 of the *Comprehensive RFI Work Plan*.

3.0 SOURCE CHARACTERIZATION

Prior to the RCRA Facility Assessment (RFA) performed in August 1990, SWMU 40 was investigated in August of 1988 in anticipation of a Military Construction (MILCON) project. Part of the MILCON project consisted of constructing the Carrier Deck Fire Training Area next to SWMU 40. Although scheduled to be investigated during the RFI, the MILCON project created a need for an expedited investigation while awaiting official approval of the RFI work plan.

During the 1988 investigation, soil samples were collected from three locations and two depth intervals (0 to 1-foot and 1 to 3-feet bls) at SWMU 40. The samples collected from the 0 to 1-foot interval indicated the presence of total petroleum hydrocarbons (TPH) and reportedly contained asphalt fragments. No TPH were detected in soil samples from the 1 to 3-foot interval. The parking area, where vehicles and equipment have historically been stored, is paved with asphalt.

During a 1990 visual site inspection, the foundation and fuel islands of a former service station were identified on the northeast portion of SWMU 40 (Figure 1). According to a 1947 map of the area obtained from NAS Memphis Public Works, the service station area contained one

2,000-gallon tank and one 1,000-gallon tank (Figure 2). Based on preliminary geophysical data, it is believed that the tanks were underground storage tanks, and have not been removed.

Reference materials will be used to determine the physical, chemical, and migration/dispersal characteristics of any contaminants identified during the RFI as exceeding the appropriate action levels. The procedures and references used to determine these characteristics will be documented in the RFI report.

4.0 CHARACTERIZATION OF RELEASES OF HAZARDOUS CONSTITUENTS

4.1 Previous Investigations

The following paragraphs summarize the previous investigations performed at or near SWMU 40.

Sampling Report - Southern Division Naval Facilities Engineering Command - (1988)

Before beginning construction of the Carrier Deck Fire Training Area next to SWMU 40, SOUTHNAVFACENGCOM investigated the SWMU 40 area. According to the sampling report, a visual inspection identified "wide-spread discoloration of surface soils." Soil samples were collected from three locations at two depths: 0 to 1-foot and 1 to 3-feet bls. The samples collected from the 0 to 1-foot interval were analyzed for TPH and Total Lead. Samples collected from the 1 to 3-foot interval were analyzed for TPH, lead, EP Toxicity, benzene, toluene, ethylbenzene, and xylenes (BTEX), and Aroclors (polychlorinated biphenyls, or PCBs). Table 1 and Appendix B provide the analytical data and information generated from this investigation.

Table 1 Soil Analytical Data — Sampling Report (1988) Salvage Yard No. 1 (ppm)						
	SY1 0-1 ft.	SY2 0-1 ft.	SY3 0-1 ft.	SY1 1-3 ft.	SY2 1-3 ft.	SY3 1-3 ft.
Total Petroleum Hydrocarbons	1100	1850	839	< 1	< 1	< 1
Total Lead	70.3	15.7	17.9	7.49	6.79	10.0
Lead (EP Toxicity)	NA	NA	NA	< 1	< 1	< 1
Benzene	NA	NA	NA	< 10 ppb	< 10 ppb	< 10 ppb
Ethylbenzene	NA	NA	NA	< 10 ppb	< 10 ppb	< 10 ppb
Toluene	NA	NA	NA	< 10 ppb	< 10 ppb	< 10 ppb
Xylenes	NA	NA	NA	< 10 ppb	< 10 ppb	< 10 ppb
Aroclor (all)	NA	NA	NA	< 1	< 1	< 1

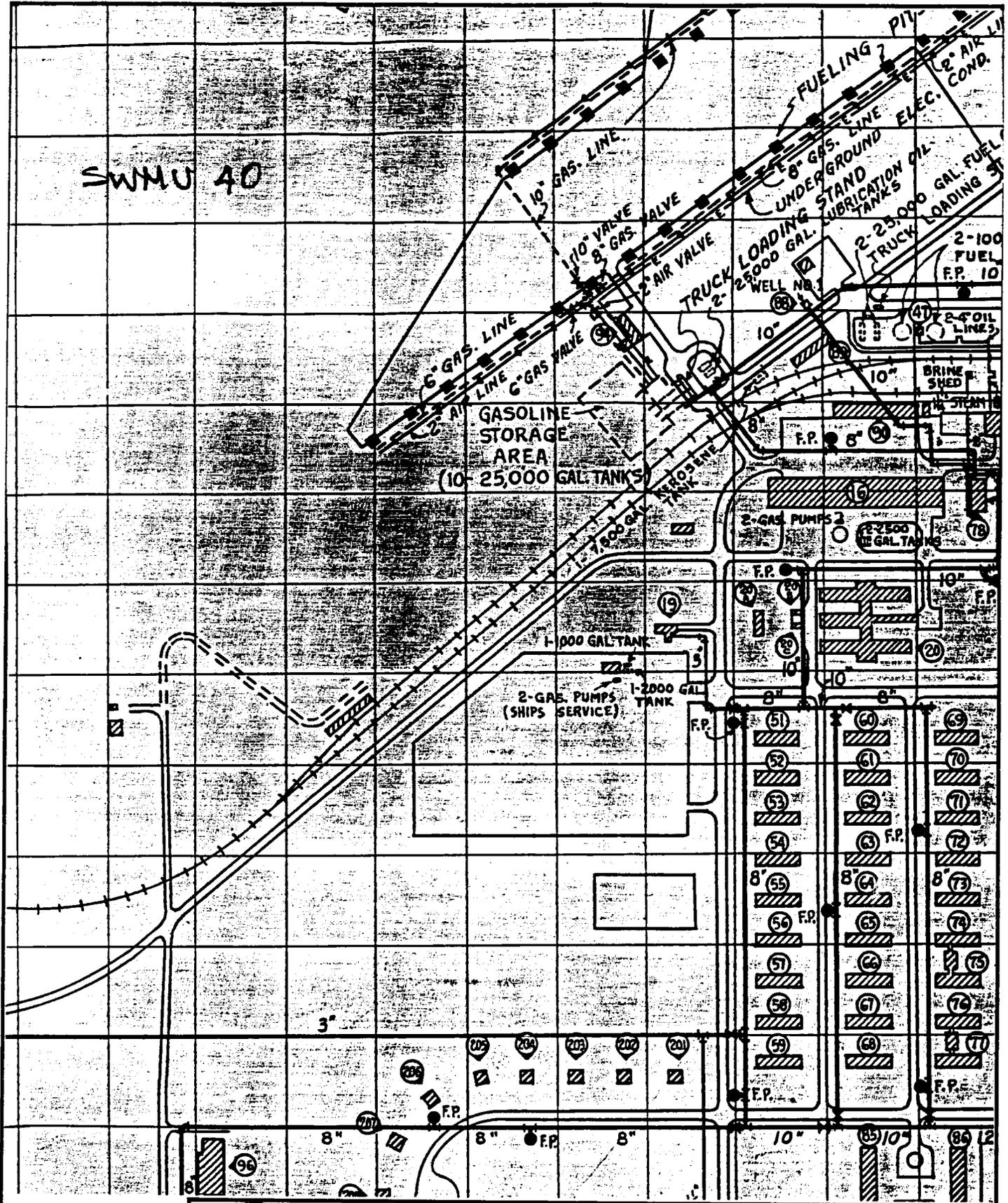
Note:

NA — Not Analyzed

Potential sources of the elevated TPH concentrations in the 0 to 1-foot interval samples may be the asphalt paving, the presence of asphalt in the samples collected, or leakage from vehicles and equipment formerly stored in the area. With one exception, lead concentrations in soil samples from the 0 to 1-foot interval slightly exceeded the background lead concentration (12.3 ppm) established during the 1988 investigation. Soil samples from the 1 to 3-foot interval were below the background lead concentration.

Geophysical Survey — EnSafe/Allen and Hoshall (1994)

A geophysical survey was performed by E/A&H in December 1994. The service station location was confirmed using both engineering drawings and preliminary geophysical data generated using frequency-domain electromagnetic instrumentation (EM-31). The EM-31 data identified two anomalies consistent with areas within the service station boundaries. The



RFI WORKPLAN
 NAS MEMPHIS
 MILLINGTON, TENNESSEE

FIGURE 2
 1947 BASE MAP
 NAS MEMPHIS

*RFI Work Plan
NAS Memphis
Site Investigation Plan — SWMU 40
Revision 1
March 15, 1995*

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conductivity portion of the survey identified an area of disturbed soil. The shape of this particular anomaly is similar to one which would be produced by a trench which has been backfilled with a more conductive material, such as clay. The anomaly produced during the in-phase parameter of the survey (metal detection) is similar to that produced by a large metallic tank or tanks. The data generated during this investigation is included as Appendix C.

4.2 Data Gaps

The sampling activities associated with the MILCON project (SOUTHNAVFACENCOM, 1988) addressed surficial soil and shallow subsurface soil at SWMU 40 to a limited extent. The following data gaps which were not addressed in the previous investigations, will be the focus of this investigation.

- Extent of surface-soil contamination.
- The potential for subsurface-soil contamination in the loess.
- The potential for groundwater contamination in the loess and fluvial deposits.
- The status and/or impact of the underground storage tanks associated with the former service station.

4.3 Objectives and Proposed Field Investigation

The objectives of the proposed field investigation are to further define the location and boundaries of the salvage yard and the reported service station, fill the identified data gaps, and delineate the horizontal and vertical extent of any soil and/or groundwater contamination at SWMU 40. The field sampling investigation will consist of two phases in which soil and

groundwater samples will be collected as outlined in the following sections. All sample collection and processing will adhere to Section 4 of the *Comprehensive RFI Work Plan*.

The first phase will consist of a soil and groundwater volatiles screening investigation that will be conducted using Direct Push Technology (DPT), as well as hand auger and/or Geoprobe-type (or equivalent) samples. It is anticipated that the DPT equipment will be able to penetrate to the top of the fluvial deposits (approximately 40 ft bls).

Results of the DPT investigation will be used to plan the placement of soil borings and monitoring wells to be installed during the second phase of the investigation, if necessary. Unless the analytical data from the DPT-phase of the investigation suggests the presence of solvent-type volatile contaminants, the second phase of the investigation will focus on delineating the horizontal and vertical extent of petroleum-related contaminants in the loess through installing and sampling soil borings and monitoring wells.

Contaminant concentrations identified in soil and groundwater at SWMU 40 will be compared to background soil and water concentrations from background monitoring wells to be installed across the base, and from background monitoring wells installed at other SWMUs during all phases of the RFI. These comparisons will determine whether measured values occur naturally or indicate contamination. To collect data for comparison, background samples will be analyzed for full scan analysis (FSA) using the following methods:

- Volatile Organic Compounds (VOCs) (USEPA Method 8240)
- Semivolatile Organic Compounds (SVOCs) (USEPA Method 8270)
- Gasoline Range Organics (GRO) (TN Modified 8015/GRO)
- Diesel Range Organics (DRO) (TN Modified 8015/DRO)
- Total Petroleum Hydrocarbons (TPH) (USEPA Method 418.1)

- Chlorinated Pesticides/PCBs (USEPA Method 8080)
- Organophosphorus Pesticides (USEPA Method 8140)
- Chlorinated Herbicides (USEPA Method 8150)
- RCRA Part 264, Appendix IX Total Metals (USEPA Method 6010/7000 series)
- Total Cyanide (USEPA Method 9010)

Table 2 provides a summary of the analytical suite for samples collected during each phase the investigation.

4.3.1 DPT Phase

As stated in Section 4.1, soil contamination at SWMU 40 was addressed on a limited basis in previous investigations. This proposed soil and groundwater investigation will initially consist of DPT sampling (Section 4.4.4.3 of the *Comprehensive RFI Work Plan*) to collect soil and groundwater samples for field analysis. A total of 14 initial sampling locations have been selected and are shown in Figure 3. The boundary of the salvage yard area shown on Figure 3 has been estimated from previous investigations, various aerial photographs, and engineering plans obtained from the NAS Memphis Public Works Office.

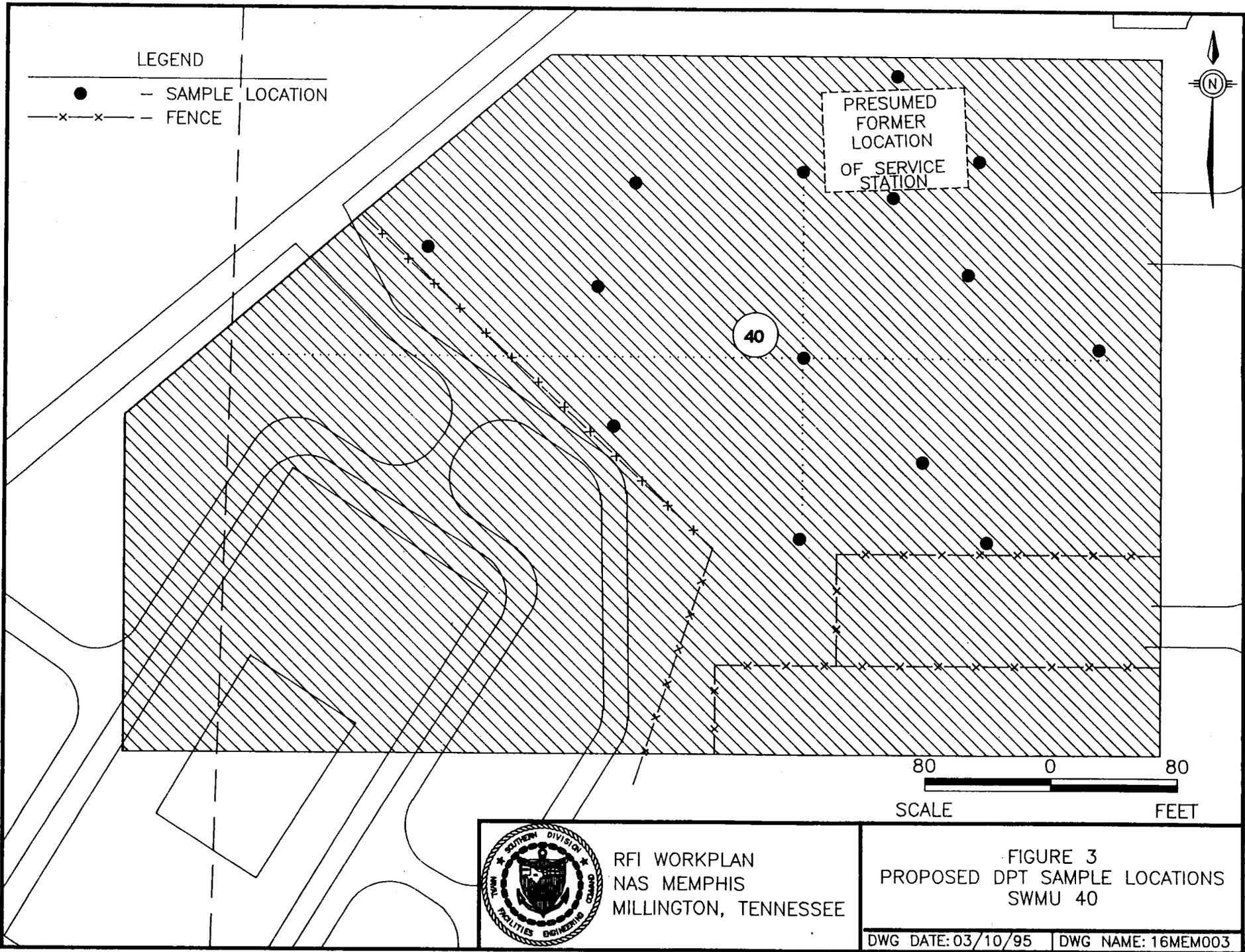
At least three soil and/or groundwater samples will be collected from each sampling point. One soil sample will be collected from the shallow interval (1 to 3 feet). Shallow soil samples may be collected using DPT, a hand auger, or a Geoprobe-type (or equivalent) sampler. A soil sample will also be collected just above the soil/water interface in the loess (expected to be between 10 and 15 feet bls). A groundwater sample will be collected from the loess, if possible. A groundwater sample will also be collected from the upper part of the fluvial deposits. Field personnel may deviate from this strategy if field conditions or data (i.e., piezocone or gas chromatograph) suggest that additional or different intervals may be successfully sampled or

Table 2 Analytical Parameters — SWMU 40			
Phase	Interval	Media	Analytical Parameters
DPT	—	Soil	VOCs ⁽¹⁾
DPT	—	Water	VOCs
Soil Boring	Surficial	Soil	TPH-GRO/BTEX ⁽²⁾ , TPH-DRO ⁽³⁾ , Pesticides/PCBs ⁽⁴⁾ , Herbicides ⁽⁵⁾ , Metals ⁽⁶⁾
Soil Boring	Intermediate	Soil	TPH-GRO/BTEX, TPH-DRO, Metals
Soil Boring	Soil/Water Interface	Soil	TPH-GRO/BTEX, TPH-DRO, Metals
Monitoring Well	Shallow ⁽⁷⁾	Water	TPH-GRO/BTEX, TPH-DRO, Pesticides/PCBs, Herbicides, Metals

NOTES:

- (1) Volatile organic compounds (VOCs) will be analyzed using EPA Method 8021.
- (2) Total petroleum hydrocarbons - gasoline range organics (TPH-GRO) and benzene, toluene, ethylbenzene, and xylenes (BTEX) will be analyzed using the Tennessee Modified 8015 and Tennessee GRO 8020 Methods, respectively.
- (3) Total petroleum hydrocarbons - diesel range organics (TPH-DRO) will be analyzed using the Tennessee Modified 8015 Method.
- (4) Chlorinated pesticides/polychlorinated biphenyls (Pesticides/PCBs) will be analyzed using Method 8080. Organophosphorus pesticides will be analyzed using Method 8140.
- (5) Chlorinated herbicides (Herbicides) will be analyzed using Method 8150.
- (6) RCRA Part 264, Appendix IX Total Metals (Metals) will be analyzed using Method 6010/7000 series.
- (7) Shallow (loess) monitoring wells only.

yield more useful information. The investigatory area may then be expanded or concentrated, based on the results of the initial data. Deviations from proposed sampling rationale will be recorded in the field log book.



LEGEND

- - SAMPLE LOCATION
- x-x- FENCE

PRESUMED
FORMER
LOCATION
OF SERVICE
STATION

40

80 0 80
SCALE FEET



RFI WORKPLAN
NAS MEMPHIS
MILLINGTON, TENNESSEE

FIGURE 3
PROPOSED DPT SAMPLE LOCATIONS
SWMU 40

DWG DATE: 03/10/95 | DWG NAME: 16MEM003

RFI Work Plan
NAS Memphis
Site Investigation Plan — SWMU 40
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March 15, 1995

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Analysis of these samples for VOCs will be performed in the field using a portable gas chromatograph. At least 25 percent of the samples collected will be split for offsite laboratory analysis for confirmatory purposes. Split samples submitted to the offsite laboratory will be analyzed for VOCs using USEPA Method 8240. Split sample selection will be determined in the field. Table 2, above, shows the analytical test method which will be used for each sample.

4.3.2 Soil Boring/Monitoring Well Phase

Soil boring and monitoring well placement and depth will be determined using data from the DPT phase of this investigation. Unless analytical data from the DPT-phase of the investigation suggests the presence of solvent-type contaminants, the remainder of the investigation will focus on the loess and petroleum-related constituents (e.g., BTEX, TPH, Metals). Both soil and groundwater samples will be collected during the soil boring/monitoring well phase.

As shown on Table 2, three intervals will be sampled during soil boring advancement. Soil samples will be collected from the surface (0 to 12 inches), from an intermediate interval between the surface and the first water encountered, and from just above the soil/water interface. The intermediate soil sample interval will be selected based on PID readings, as described in Section 4.4.4 of the *Comprehensive RFI Work Plan*. Field personnel may deviate from this rationale should field conditions or DPT screening data suggest that changing the sampling interval would yield more useful results. Samples from the borings will be submitted to an offsite laboratory for analysis for the parameters presented in Table 2. As noted in Table 2, all soil and groundwater samples will be analyzed for the same parameters, except for surficial soil and shallow (loess) groundwater samples. Due to the confirmed presence of pesticides at SWMU 5 (located approximately 1500 feet southwest of the site), the surface (0 to 1-foot) soil interval and the shallow groundwater from the loess will be investigated to determine if pesticides/PCBs or herbicides are present at SWMU 40.

Hollow-stem auger techniques are planned for borings/wells installed in the loess. No borings/wells are scheduled to be installed below the loess at SWMU 40 unless solvents are detected during the DPT survey. Soil samples will be collected during monitoring well installation in accordance with the procedures outlined in Section 4.4 of the *Comprehensive RFI Work Plan*.

All wells installed will be constructed of 2-inch PVC using the hollow-stem auger drilling techniques described in Section 4.5 of the *Comprehensive RFI Work Plan*. The wells will consist of a 10-foot screen, positioned three feet above and seven feet below the soil/water interface. PVC well construction justification information is provided in Appendix D of this document, including these publications supporting the use of this material. These are *Influence of Casing Materials on Trace-Level Chemicals in Well Water* (Parker, 1990), *Leaching of Metal Pollutants from Four Well Casings Used for Groundwater Monitoring* (Hewitt, 1989), and *Dynamic Study of Common Well Screen Materials* (Hewitt, 1994).

4.4 Expansion of Investigation

If laboratory data indicate the presence of soil contamination in the proposed sample locations, additional sampling points may be required to fully define the nature and extent of soil contamination, particularly in the determined downgradient groundwater flow direction. Deviations from proposed sampling rationale will be recorded in the field log book. If physical evidence of contamination (i.e., visual and olfactory observations and elevated organic vapor field screening readings) is observed below the first-encountered groundwater in any sampling point, a soil sample may be collected; otherwise, no soil samples will be collected from below the water level for laboratory analysis.

If contamination is detected in any new well, the investigation may enter a second phase which could include expansion vertically (e.g., install monitoring wells in the fluvial deposits) and

laterally to further delineate the nature and extent of contamination. Measured contaminant concentrations coupled with groundwater flow directions and characteristics will be utilized to determine placement of additional monitoring wells. The groundwater investigation will proceed until such time that the nature and extent of contamination has been adequately defined and/or modeling results indicate that downgradient concentrations are below action levels at potential receptor sites.

4.5 Design Parameters

If necessary, soil and groundwater samples will be collected and analyzed for engineering design parameters to plan for soil and/or groundwater remediation, in accordance with Section 4.4.5 of the *Comprehensive RFI Work Plan*. A soil sample will be collected from below the saturated zone to be analyzed for total phosphorus, nitrate-N, total Kjeldahl nitrogen (TKN), heterotrophic plate count, total organic carbon (TOC), and cation exchange capacity (CEC). At least one Shelby tube sample will be collected (Section 4.4.5 of the *Comprehensive RFI Work Plan*) and analyzed for hydraulic conductivity, porosity, bulk density, particle size, percent moisture, and specific gravity.

A groundwater sample will be collected from one well completed in each stratigraphic unit and analyzed to obtain data for potential remedial design. The groundwater samples will be analyzed for 5-day biochemical oxygen demand (BOD₅), chemical oxygen demand (COD), hardness, total suspended solids (TSS), total dissolved solids (TDS), alkalinity, total phosphorus, nitrate-N, total Kjeldahl Nitrogen (TKN), sulfates, heterotrophic plate count, iron, turbidity, and manganese.

4.6 Hydrologic Characterization

Aquifer tests (pump test, specific capacity tests, and/or slug tests) will be conducted on select monitoring wells only if groundwater contamination requiring remediation is identified. Aquifer tests are described in Section 4.9.4 of the *Comprehensive RFI Work Plan*.

4.7 Analytical Requirements

Proposed sampling and analytical requirements for SWMU 40 are summarized in Table 3. Soil and groundwater samples sent to the offsite laboratory will be analyzed for the parameters listed in Tables 2 and 3. Level III Data Quality Objectives (DQO) will be used for 95 percent of the samples and DQO Level IV for the remaining 5 percent. A detailed list of the analytical parameters shown in Table 2 is provided in Appendix D of the *Comprehensive RFI Work Plan*. Field sampling personnel will determine which samples will receive a Level IV DQO.

Field measurements at SWMU 40 will be conducted in accordance with Section 4.10.1 of the *Comprehensive RFI Work Plan*. Field measurements will include pH, temperature, specific conductivity, dissolved oxygen, redox potential, and groundwater level for monitoring wells, and organic vapor detection for soil samples and boreholes. Soil and groundwater samples collected during the DPT survey will be analyzed in the field with a portable GC at Level II DQO.

4.8 Sample and Data Management

Sample management procedures will adhere to Sections 4.12 and 5.0 of the *Comprehensive RFI Work Plan*.

4.9 Sample Custody

Sample custody will be maintained in accordance with Section 4.12.5 of the *Comprehensive RFI Work Plan*.

4.10 Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) procedures will adhere to Section 4.14 of the *Comprehensive RFI Work Plan*.

Table 3 Estimated Sampling and Analytical Requirements — SWMU 40			
Method	Sample Matrix/Type	Number of Samples	Analysis ⁽¹⁾
DPT	Physical	5 Piezocone	-
	Soil	50 Geocone	VOCs
	Groundwater	50 Hydrocone	VOCs
Monitoring Well	Groundwater	6 (Loess)	TPH-GRO/BTEX, TPH-DRO, Pesticides/PCBs, Metals
		1 (Loess)	DPW ⁽²⁾
Boring	Soil	18 (3 per well)	TPH-GRO/BTEX, TPH-DRO, Pesticides/PCBs, Herbicides, Metals — surficial interval; TPH-GRO/BTEX, TPH-DRO, and Metals — intermediate interval and soil/water interface
		4 Soil Borings (3 per boring)	TPH-GRO/BTEX, TPH-DRO, Pesticides/PCBs, Herbicides, Metals — surficial interval; TPH-GRO/BTEX, TPH-DRO, and Metals — intermediate interval and soil/water interface
	Soil	1 (loess)	DPS ⁽³⁾
	Soil	1 (loess)	ST

NOTES:

- (1) Analytical test methods are presented in the footnotes of Table 2.
- (2) DPW (Design Parameters Water) = 5-day biochemical oxygen demand (BOD₅), chemical oxygen demand (COD), hardness, total suspended solids (TSS), total dissolved solids (TDS), alkalinity, total phosphorus, nitrate-N, TKN, sulfates, heterotrophic plate count, turbidity, iron, and manganese.
- (3) DPS (Design Parameters Soil) = Total phosphorus, nitrate-N, total Kjeldahl nitrogen (TKN), heterotrophic plate count, total organic carbon (TOC), cation exchange capacity.
- (4) ST (Shelby Tube) = Hydraulic conductivity, porosity, bulk density, particle size, percent moisture, and specific gravity.

4.11 Decontamination Procedures

Decontamination procedures will adhere to Section 4.11 of the *Comprehensive RFI Work Plan*.

4.12 Investigation-Derived Waste

Investigation-derived waste (IDW) will be handled in accordance with Section 4.13 of the *Comprehensive RFI Work Plan*.

5.0 POTENTIAL RECEPTORS

SWMU 40 is approximately 2,500 feet northeast of the nearest offsite residential housing on Navy Road. Runoff from the SWMU discharges into North Fork Creek (which may serve as a water and food source for various animals) via SWMU 4. The nearest base office personnel are located adjacent to the site at Building N-1694 (Hazardous Waste Storage Facility). SWMU 40 is related to drainage ways which are located in populated areas of the base; therefore, the potential exists for contact by base personnel. Off base, the potential exists for contact by the general public due to unrestricted access to the drainage ways. According to base personnel, no fishing or swimming occurs in North Fork Creek or Big Creek, but children may play near these drainage ways.

Other potential receptors include two production wells (Production Well 1 and Production Well 2). Production Well 1 is approximately 1,500 feet northeast of SWMU 40. Production Well 2 is approximately 2,500 feet northeast of SWMU 40. However, these wells are screened in the Memphis Sand with the Cook Mountain confining unit above the screened intervals. A more detailed analysis of potential receptors will be conducted and presented in the RFI report if contamination is found at SWMU 40.

6.0 QUALITY ASSURANCE PLAN

The Quality Assurance Plan (QAP) presented in Section 4.14 of the *Comprehensive RFI Work Plan* will be followed throughout the RFI at SWMU 40.

7.0 DATA MANAGEMENT PLAN

The Data Management Plan (DMP) presented in Section 5 of the *Comprehensive RFI Work Plan* will be followed during the RFI for SWMU 40.

8.0 SITE-SPECIFIC HEALTH AND SAFETY PLAN

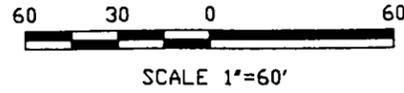
The Site-specific Health and Safety Plan for SWMU 40 is included in Appendix E of this document. The Comprehensive Health and Safety Plan is included in Section 7 of the *Comprehensive RFI Work Plan*.

9.0 REFERENCES

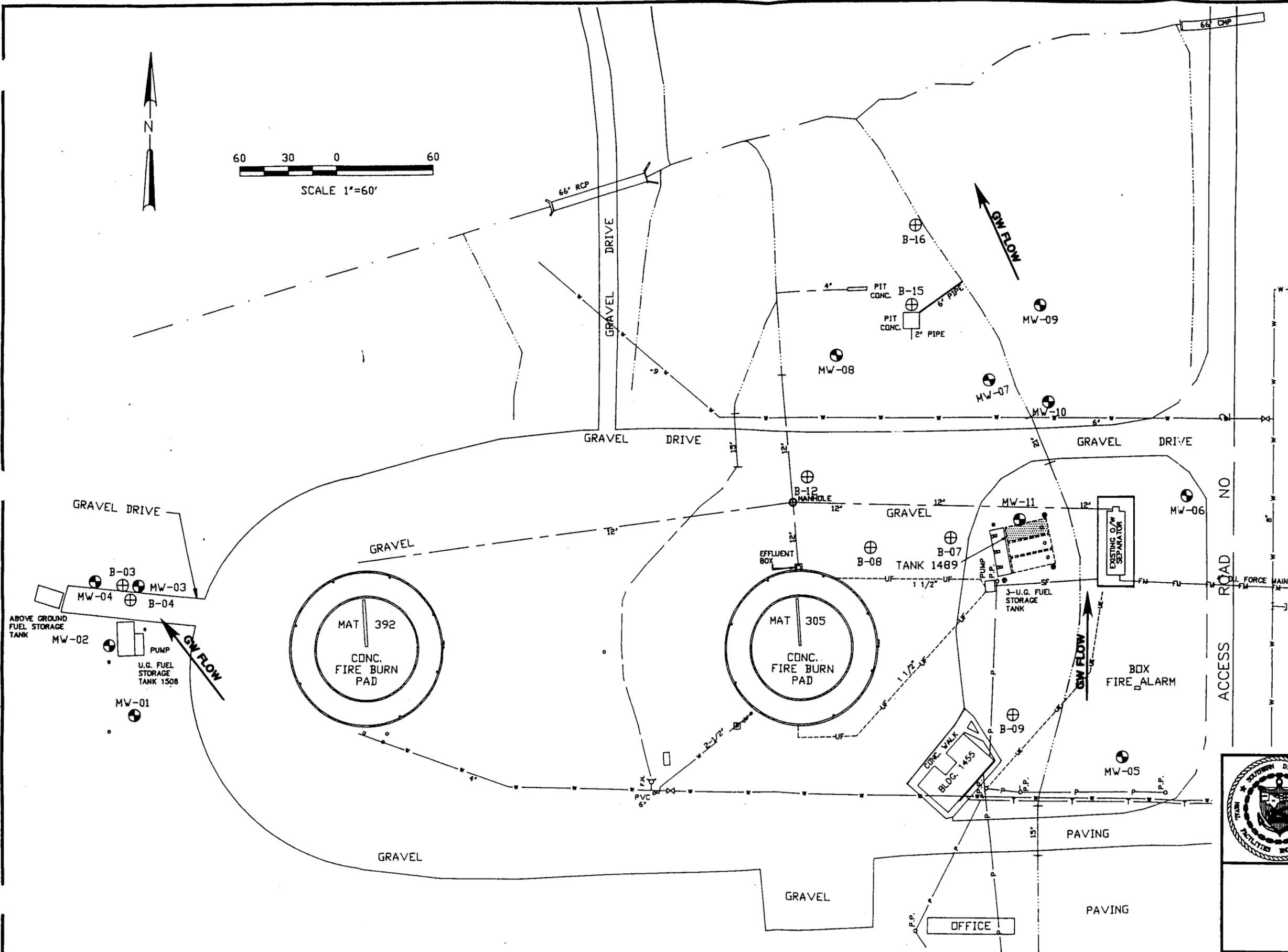
- EnSafe/Allen & Hoshall (October 1992). *Environmental Assessment Report, Tank Systems 1489 and 1508, Aircraft Fire Fighting Training Facility, Naval Air Station Memphis, Millington, Tennessee*. E/A&H: Memphis, Tennessee.
- EnSafe/Allen & Hoshall (1993). *Final EAR - Building N-126 USTs; Facility I.D. 0-791709, Naval Air Station Memphis*. E/A&H: Memphis, Tennessee.
- EnSafe/Allen & Hoshall (October 1994). *Comprehensive RFI Work Plan for Naval Air Station Memphis*. E/A&H: Memphis, Tennessee.
- ERC/EDGE (September 1990). *RCRA Facility Assessment (RFA), NAS Memphis*. ERC/EDGE: Nashville, Tennessee.
- Geraghty and Miller (November 1985). *NACIP Program Confirmation Study, Verification Phase (CS/VP), NAS-Memphis*. Geraghty and Miller: Tampa, Florida.
- Southern Division and EnSafe/Allen & Hoshall (February 1993). *NAS Memphis Technical Memorandum SWMUs 4 and 5. Subject: NAS Memphis RFI — Interim Measures Field and Analytical Summary*. SOUTHNAVFACENGCOM and E/A&H: Memphis, Tennessee.
- Southern Division Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) (August 1988). *Sampling Report (SWMUs 3, 4, and 40), NAS Memphis*. SOUTHNAVFACENGCOM: Charleston, SC.

Appendix A

Miscellaneous Boring Logs



- LEGEND**
- x — CHAIN LINK FENCE
 - P — POWER UTILITY
 - T — TELEPHONE UTILITY
 - - - UT - - - UNDERGROUND TELEPHONE
 - - - UE - - - UNDERGROUND ELECTRICAL
 - - - UF - - - UNDERGROUND FUEL
 - - - SF - - - SALVAGED FUEL
 - - - FM - - - FORCE MAIN
 - - - W - - - FRESH WATER LINE
 - — — CULVERT
 - - - - - DITCH LINE
 - - - - - STREAM LINE
 - o POLE
 - ⊗ FIRE HYDRANT
 - MANHOLE
 - PRE-EXISTING DETECTION WELL
 - ⊕ MONITORING WELL
 - ⊕ BORING



UST INVESTIGATION
 AFTTF USTS
 NAS MEMPHIS
 MILLINGTON, TENNESSEE

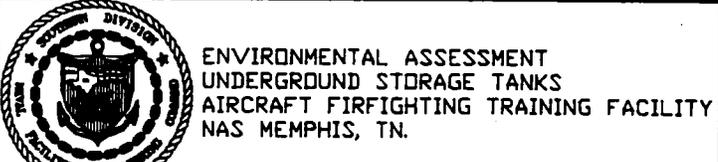
FIGURE B-2
 SITE MAP

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW01 1/2	0			0-0.5 LIGHT BROWN SAND AND SILT WITH ORGANICS AND ROOTS.	
0.5-2	MW01 1/2	2			DARK BROWN SILT AND CLAY WITH LAYERED TEXTURE. TIGHT, DRY.	
2-4	MW01 1/2	4			MOTTLED BROWN, LIGHT-BROWN, ORANGE-BROWN SILT AND CLAY WITH DARK ORGANIC SPECKS. TIGHT, DRY.	
4-12	MW01 1/2	4			MOTTLED CLAY, SOME SILT BECOMING LIGHT GRAY/BROWN. TIGHT, MOIST.	
5	MW01 1/2	6				
8	MW01 1/3	8		GRD, BTX		
10	MW01 1/3	10		● WATER AT 10-12 FT.		
12	MW01 1/3	12			12-18 HOMOGENOUS GRAY SILT. FIRM TO SOFT, WET	
14	MW01 1/5	14				
16	MW01 1/3	16				
18-18.5					NO SAMPLE END OF BORING AT 18.5 FT.	

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW STEM AUGERS
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER

DATE OF COMPLETION: 06/22/92



BORING B-01
MW-01

DATE: 08/08/92

DWG NAME: 026MW-01

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW02 1	11			0-0.5 LIGHT BROWN SAND AND SILT WITH ORGANICS AND ROOTS.	
0.5-2	MW02 28	25			MOTTLED BROWN, ORANGE-BROWN SILT AND CLAY. TIGHT, DRY.	
2-5	MW02 100	200			MOTTLED BROWN, ORANGE-BROWN, GREEN-GRAY SILT AND CLAY WITH FEW BLACK ORGANIC SPECKS. TIGHT, MOIST, WITH HYDROCARBON ODOR.	
5-11.5	MW02 100	NH*		K, GRD, BTX, RFI, SCAN	DARK GRAY HYDROCARBON-STAINED SILT AND CLAY. TIGHT, SOFT, WET TO MOIST. STRONG HYDROCARBON ODOR. ● WATER AT 11.5 FT.	
11.5-12	MW02 200	200			BROWN SAND, SOME GRAVEL AND SILT. WET, LOOSE, NO APPARENT ODOR.	
12-12.5	MW02 10	14			GRAY, BROWN, ORANGE-BROWN SILT AND CLAY TIGHT, MOIST TO WET.	
12.5-18	MW02 20	11			HOMOGENOUS GRAY SILT. FIRM, WET. -WITH A GRAVEL ISOLATE AT 15 FT.	
18-18.5					NO SAMPLE END OF BORING AT 18.5 FT.	
					* NH-NO 15 MINUTE HEADSPACE ANALYSIS.	

DRILLER:

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.
SHELBY TUBE FOR PERMEABILITY SAMPLES.

DATE OF COMPLETION: 06/22/92 MONITORING WELL
06/27/92 SHELBY TUBE



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-02
MW-02

DATE: 08/08/92

DWG NAME: 026MW-02

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN)	LABORATORY ANALYSIS	
		B03 0	5/5		0-17 BROWN SAND,SILT AND ORGANICS,SOME GRAVEL 17-4 BROWN TO DARK BROWN SILT,LITTLE CLAY. TIGHT,DRY.
		B03 2	10/4		
		B03 4	5/4		4-6 MOTTLED LIGHT-BROWN,GRAY,ORANGE-BROWN SILT AND CLAY,WITH SOME BLACK ORGANIC SPECKS. LOOSE,WET.
5		B03 6	2/5		6-6.5 ORANGE-BROWN SILT AND GRAVEL. LOOSE,WET. 6.5-8 MOTTLED LIGHT-BROWN,GRAY,ORANGE-BROWN SILT AND CLAY,WITH SOME BLACK ORGANIC SPECKS.
		B03 8	2/4	GRD, BTX	8-12 GRADING TO MOTTLED GRAY,ORANGE-BROWN SILT WITH SOME BLACK ORGANIC SPECKS.
10		B03 10	2/4		● WATER AT 10 FT.
					END OF BORING AT 12 FT.
15					
20					
25					
30					

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/22/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-03

DATE: 07/28/92

DWG NAME: 026B-03

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	
					GRAVEL ROAD BEDDING.
	B04	0/1			2-4 BROWN SILT, WITH MINOR BLACK ORGANIC SPECKS. TIGHT, DRY.
	2				
	B04	0/1			4-6 BROWN SILT AND CLAY, WITH MINOR BLACK ORGANIC SPECKS. TIGHT, DRY.
	4				
5	B04	0/4			6-7 LIGHT GRAY SILT AND CLAY, MOTTLED WITH ORANGE - BROWN PATCHES. TIGHT, DRY.
	6				
	B04	6/40		GRD, BTX	7-10 DARK GRAY CLAY, MOTTLED WITH ORANGE - BROWN PATCHES. TIGHT, DRY TO MOIST. - WITH HYDROCARBON ODDOR AT 8-10 FT.
	8				
10	B04	5/5		GRD, BTX	10-11 DARK GRAY SILT AND CLAY, MOTTLED WITH ORANGE - BROWN PATCHES. TIGHT, MOIST, WITH HYDROCARBON ODDOR.
	10				
	B04	2/4		GRD, BTX	11-16 LIGHT GRAY SILT AND CLAY, MOTTLED WITH ORANGE - BROWN PATCHES. TIGHT, MOIST TO WET NO APPARENT ODDOR.
	12				
15	B04	2/3			● WATER AT 14 FT.
	14				
	B04	1/2			16-19.5 MOTTLED GRAY, BROWN, ORANGE - BROWN SILT, SOME CLAY. TIGHT, WET.
	16				
	B04	3/2			19.5-20 GRAY UNIFORM SILT. FIRM, WET.
	18				END OF BORING AT 20 FT.
20					
25					
30					

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC. 4161 RIDGEMOOR AVENUE MEMPHIS, TN. 38118	DRILLING AND SAMPLING METHOD: 3.25-INCH ID HOLLOW-STEM AUGERS. 2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.
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DATE OF COMPLETION: 06/22/92	
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 ENVIRONMENTAL ASSESSMENT UNDERGROUND STORAGE TANKS AIRCRAFT FIREFIGHTING TRAINING FACILITY NAS MEMPHIS, TN.	<h2 style="margin: 0;">BORING B-04</h2>
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DATE: 07/28/92	DWG NAME: 026B-04
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DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW03 3/2	0			0-1 BROWN SAND,SILT AND ORGANICS,SOME GRAVEL. LOOSE,DRY.	<p>CEMENT-BENTONITE GROUT</p> <p>2" DIAMETER SCHEDULE 40 PVC RISER</p> <p>BENTONITE SEAL FROM 5 TO 7 FT.</p> <p>10-20 SAND FROM 7 TO 19.5 FT.</p> <p>10' LONG 0.010 SLOT SCHEDULE 40 PVC SCREEN FROM 9 TO 19 FT.</p> <p>10.5 IN. DIAMETER BOREHOLE</p>
2	MW03 2/2	2			1-4 BROWN, ORANGE-BROWN SILT,SOME GRAVEL AND CLAY,BECOMING (AT 4 FT.) MOTTLED BROWN, ORANGE-BROWN SILT,LITTLE CLAY.	
4	MW03 1/2	4			4-7 GRAY-BROWN SILT,LITTLE CLAY,BECOMING (AT 4.5 FT.) GRAY SILT AND CLAY WITH ORANGE-BROWN MOTTLING AND BLACK ORGANIC SPECKS.	
6	MW03 1/2	6			7-10 GRADING TO DARK-GRAY CLAY, LITTLE SILT, WITH ORANGE-BROWN MOTTLES AND BLACK ORGANIC SPECKS. VERY TIGHT,MOIST.	
8	MW03 1/2	8			10-12 LIGHT GRAY SILT AND CLAY WITH ORANGE-BROWN MOTTLES AND BLACK ORGANIC SPECKS. TIGHT,MOIST TO WET.	
10	MW03 1/2	10	GRD, BTX		● WATER AT 12 FT.	
12	MW03 1/2	12			12-17 MOTTLED GRAY,BROWN,ORANGE-BROWN SILT AND CLAY,WITH BLACK ORGANIC SPECKS. SOFT,WET.	
14	MW03 1/3	14				
16	MW03 1/4	16			17- 19 BECOMING MOTTLED LIGHT-GRAY, ORANGE-BROWN SILT,WITH SCATTERED BLACK ORGANIC SPECKS.	
19.5					19-19.5 NO SAMPLE END OF BORING AT 19.5 FT.	

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/23/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

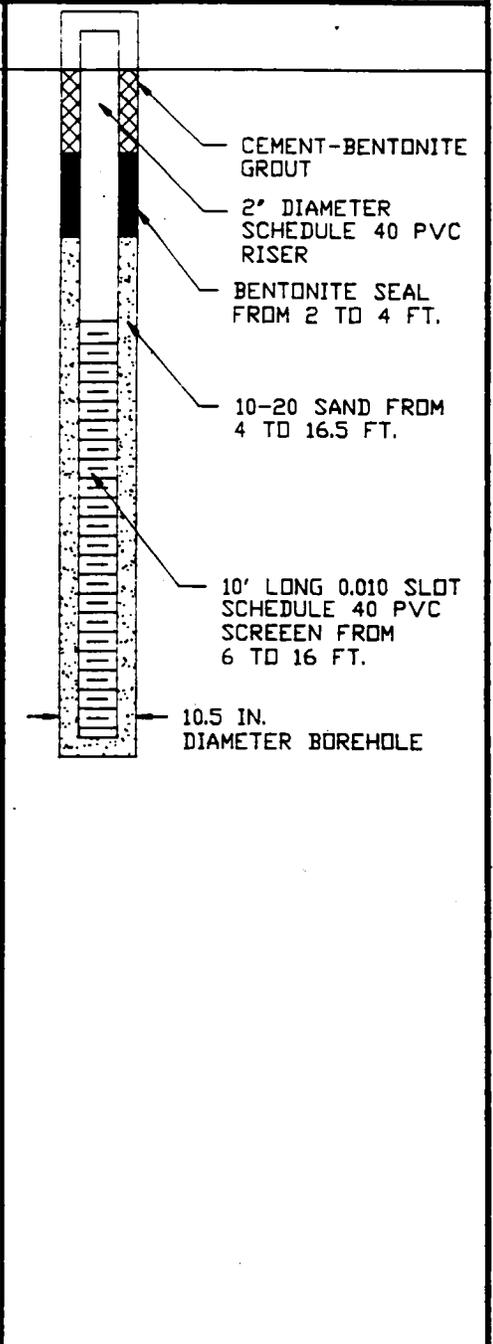
BORING B-05
MW-03

DATE:08/08/92

DWG NAME:026MW-03

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
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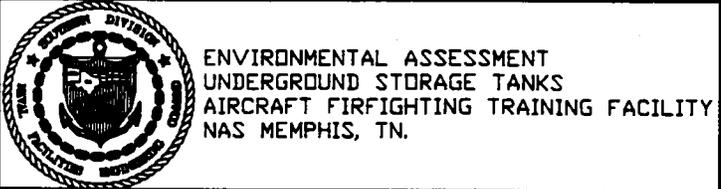
0	MW04	3/3			0-2 BROWN SAND, SILT AND ORGANICS; BECOMING (AT 1 FT.) BROWN, ORANGE SAND AND SILT, SOME GRAVEL. LOOSE TO TIGHT, DRY TO MOIST.
2	MW04	2/4			2-4 LAYERED BROWN, LIGHT-BROWN SILT, SOME CLAY, WITH MINOR ORANGE-BROWN MOTTLES AND BLACK ORGANIC SPECKS; BECOMING (AT 3 FT.) LIGHT-BROWN, ORANGE-BROWN SILT AND CLAY. TIGHT, MOIST.
4	MW04	2/4			4-6 BECOMING LIGHT-BROWN TO GRAY CLAY, WITH ORANGE-BROWN MOTTLED ZONES AND BLACK TO BROWN-DARK RED ORGANIC SPECKS.
6	MW04	2/3			6-10 BECOMING LIGHT BROWN TO GRAY SILT AND CLAY, WITH ORANGE-BROWN MOTTLING AND DARK BROWN TO DARK RED ORGANIC NODULES.
8	MW04	1/3	GRD, BTX		● WATER AT 10 FT.
10	MW04	1/2			10-15.5 BECOMING GRAY SILT, SOME CLAY, WITH ORANGE-BROWN MOTTLING AND DARK BROWN TO DARK RED ORGANIC NODULES. TIGHT, WET.
12	MW04	1/3			15.5-16.5 BECOMING MOTTLED GRAY AND ORANGE-BROWN SILT AND CLAY. TIGHT, WET.
14	MW04	1/3			16-16.5 NO SAMPLE END OF BORING AT 16.5 FT.



DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/23/92



BORING B-06
MW-04

DATE: 08/08/92

DWG NAME: 026MW-04

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	
		B07 0	1000 700		0-0.5 BROWN AND GRAY-BLACK SILT AND ASH, LITTLE SAND. LOOSE, DRY, HYDROCARBON ODOR.
		B07 2	1000 1000	RFI- SCAN,	0.5-3.5 BROWN TO GRAY-BROWN SILT, SOME CLAY, ORGANICS AND ROOTS; BECOMING (AT 2 FT.) MOTTLED GRAY-BROWN, ORANGE-BROWN SILT, SOME CLAY WITH BLACK TO DARK-RED ORGANIC SPECKS AND SOME ROOTS. TIGHT, DRY, HYDROCARBON ODOR.
		B07 4	900 900	GRD, BTX	
5		B07 6	700 900		3.5-11 DARK GRAY-BROWN TO GRAY-GREEN-BROWN, HYDROCARBON STAINED SILT AND CLAY, WITH GRAY MOTTLED PATCHES. TIGHT, MOIST TO WET, HYDROCARBON ODOR.
		B07 8	300 NH*	GRD, BTX	
10		B07 10	5 10		● WATER AT 10 FT.
		B07 12	3 7		11-16 GRAY, DARK-GRAY SILT. FIRM, WET.
		B07 14	2 5		
15		B07 16			END OF BORING AT 16 FT.
		B07 18			
20					
25					
30					

* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/23/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-07

DATE: 07/28/92

DWG NAME: 026B-07

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	
		B08 0	20 30		0-0.5 COMPACTED SAND AND GRAVEL OVERLYING 1/2" THICK LAYER OF ASH.
		B08 2	4 25		0.5-2 BROWN SILT AND CLAY. COMPACT, DRY TO MOIST. 2-5 MOTTLED BROWN, ORANGE-BROWN SILT, SOME CLAY, WITH DARK-BROWN, DARK-RED ORGANIC NODULES.
5		B08 4	1000 1000	RFI-SCAN,	5-11 DARK GREEN-GRAY, HYDROCARBON STAINED SILT AND CLAY, WITH FAINT LIGHT-GRAY AND ORANGE-BROWN MOTTLING. TIGHT, MOIST, CHEMICAL ODOR.
		B08 6	200 200	GRD, BTX	
		B08 8	600 800		
10		B08 10	600 NH*	GRD, BTX, VOC	● WATER AT 11 FT. 11-12 GRAY, DARK-GRAY SILT. WET. END OF BORING AT 12 FT.
15					
20					
25					
30					

* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC. 4161 RIDGEMOOR AVENUE MEMPHIS, TN. 38118	DRILLING AND SAMPLING METHOD: 3.25-INCH ID HOLLOW-STEM AUGERS. 2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.
DATE OF COMPLETION: 06/23/92	
 ENVIRONMENTAL ASSESSMENT UNDERGROUND STORAGE TANKS AIRCRAFT FIRFIGHTING TRAINING FACILITY NAS MEMPHIS, TN.	BORING B-08
DATE: 07/28/92	DWG NAME: 026B-08

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	
0	B09 0	40 30			0-1 BROWN SILT AND ORGANICS, SOME GRAVEL, LITTLE SAND; BECOMING (AT 1 FT.) MOTTLED BROWN, ORANGE-BROWN SILT, SOME ORGANICS.
2	B09 2	20 55			2-4 DARK GRAY CLAY WITH SUBDUED ORANGE-BROWN, LIGHT-GRAY MOTTLING. TIGHT, MOIST.
5	B09 4	600 1100		RFI-SCAN, GRD, BTX	4-7 DARK GRAY CLAY, SOME SILT. TIGHT, MOIST, CHEMICAL QDDR.
6	B09 6	500 600			7-12 BECOMING MOTTLED LIGHT-GRAY AND ORANGE-BROWN SILT, SOME CLAY, WITH SCATTERED BLACK ORGANIC SPECKS. TIGHT, MOIST TO WET.
8	B09 8	20 20			
10	B09 10	6 2		GRD, BTX	<p>● WATER AT 11 FT.</p> <p>END OF BORING AT 12 FT.</p>
15					
20					
25					
30					

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/24/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIREFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

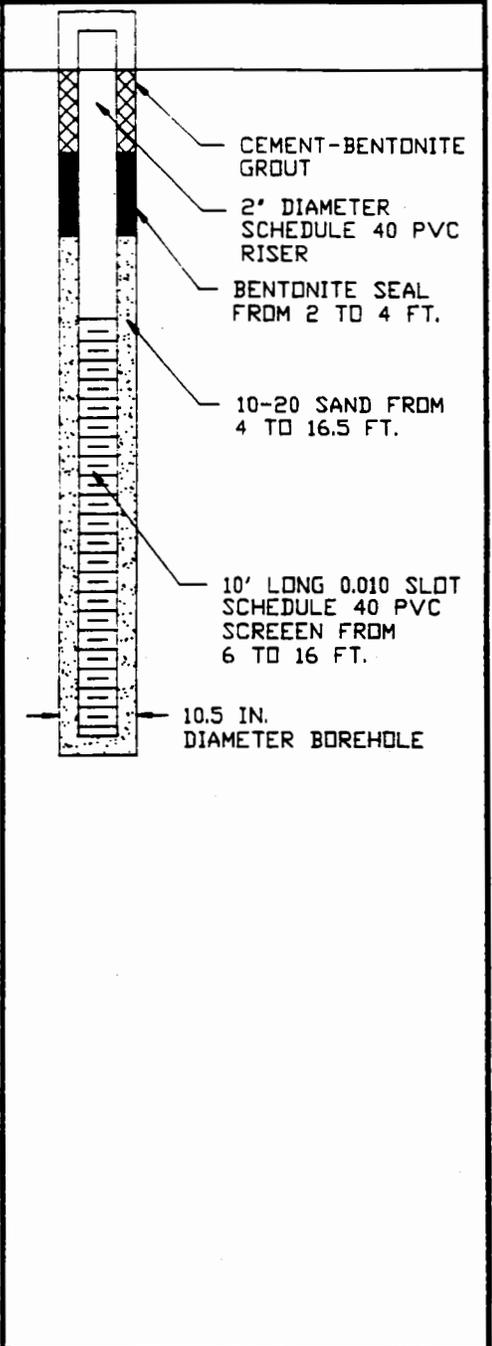
BORING B-09

DATE: 07/28/92

DWG NAME: 026B-09

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
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0	MW05 1/4				0-2 DARK BROWN SILT AND ORGANICS. 2-6 DARK BROWN CLAY, WITH INTERSPERSED ORANGE-BROWN NODULES. VERY TIGHT TO MOIST.	
2	MW05 2/2					
4	MW05 1/3					
6	MW05 1/2				6-13 BECOMING MOTTLED BROWN-GRAY, ORANGE-BROWN SILT AND CLAY. TIGHT, MOIST TO WET.	
8	MW05 1/2			RFI-SCAN, BTX, GRD, BTX		
10	MW05 1/10			NH*	● WATER AT 10 FT.	
12	MW05 0/2				13-14.5 BECOMING DARK BROWN CLAY, LITTLE SILT, BECOMING DARK BROWN TO BLACK CLAY WITH ROOTS AND ORGANICS. VERY TIGHT.	
14	MW05 1/1				14.5-16.5 NO SAMPLE END OF BORING AT 16.5 FT.	

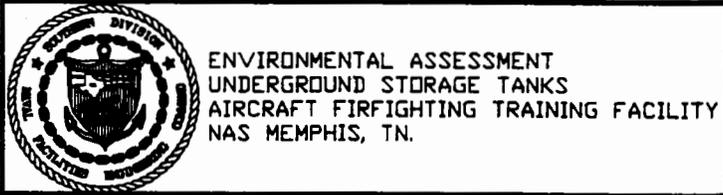


* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/24/92



BORING B-10
MW-05

DATE: 08/08/92

DWG NAME: 026MW-05

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW06 1/3	0			0-2 BROWN SILT AND SAND, SOME GRAVEL AND ORGANICS. LOOSE, DRY.	<p>CEMENT-BENTONITE GROUT</p> <p>2" DIAMETER SCHEDULE 40 PVC RISER</p> <p>BENTONITE SEAL FROM 8 TO 10 FT.</p> <p>10-20 SAND FROM 10 TO 21.5 FT.</p> <p>10' LONG 0.010 SLOT SCHEDULE 40 PVC SCREEN FROM 11 TO 21 FT.</p> <p>10.5 IN. DIAMETER BOREHOLE</p>
2	MW06 1/5	2			2-3.5 BROWN-GRAY SILT AND CLAY, SOME ORGANICS AND ROOTS. TIGHT, MOIST.	
4	MW06 200	4	400		3.5-7.5 BECOMING DARK GRAY, BLACK CLAY. PLIABLE TO HARD, MOIST TO WET TO MOIST. HYDROCARBON ODOR.	
6	MW06 1500	6	NH*	RFI-SCAN, GRD, BTX	7.5-10.5 BECOMING DULL GREEN-GRAY, HYDROCARBON STAINED SILT AND CLAY WITH ORANGE-BROWN MOTTLING AND MINOR DARK BROWN-RED NODULES.	
8	MW06 400	8	500		10.5-11 DARK BROWN-GRAY CLAY, LITTLE SILT. PLIABLE, MOIST.	
10	MW06 3/7	10		GRD, BTX	11-20 MOTTLED LIGHT-BROWN-GRAY AND ORANGE-BROWN SILT, SOME CLAY, WITH BLACK ORGANIC PATCHES. WET.	
12	MW06 3/1	12			● WATER AT 12 FT.	
14	MW06 1/1	14				
16	MW06 0/2	16				
18	MW06 1/1	18				
20					20-21.5 NO SAMPLE. END OF BORING AT 21.5 FT.	
25						
30						

* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS,
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/24/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-11
MW-06

DATE: 07/29/92

DWG NAME: 026MW-06

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	
	B12 0	50 NH*			0-1 TAN-BROWN SAND AND GRAVEL. LOOSE, DRY.
	B12 2	200 NH*			1-2 DARK GREEN-GRAY SILT AND ASH, WITH A PIECE OF BLACK RUBBER-TAR-LIKE MATERIAL. TIGHT, DRY.
5	B12 4	500 650	GRD, BTX		2-11 DARK GRAY-GREEN SILT AND CLAY, WITH SUBDUED LIGHT-GRAY AND ORANGE-BROWN MOTTLING. HYDROCARBON STAINED. TIGHT, MOIST.
	B12 6	300 700			
	B12 8	500 850			
10	B12 10	500 750	GRD, BTX		● WATER AT 11 FT. 11-12 DARK GRAY-GREEN SILT END OF BORING AT 12 FT.
15					
20					
25					
30					

* NH-ND 15 MINUTE HEADSPACE ANALYSIS.

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/24/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIREFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-12

DATE: 07/28/92

DWG NAME: 026B-12

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW07 2/2				0-1 BROWN SILT AND ORGANICS, SOME CLAY AND ROOTS.	<p>CEMENT-BENTONITE GROUT</p> <p>2" DIAMETER SCHEDULE 40 PVC RISER</p> <p>BENTONITE SEAL FROM 2 TO 4 FT.</p> <p>10-20 SAND FROM 4 TO 16.5 FT.</p> <p>10' LONG 0.010 SLOT SCHEDULE 40 PVC SCREEN FROM 6 TO 16 FT.</p> <p>10.5 IN. DIAMETER BOREHOLE</p>
1-3					1-3 DARK BROWN SILT AND CLAY WITH FAINT GRAY AND ORANGE-BROWN MOTTLING, AND BLACK ORGANIC SPECKS TO RUST-BROWN NODULES. TIGHT, MOIST.	
2	MW07 200	700				
3-6					3-6 BECOMING GRAY-GREEN HYDROCARBON STAINED CLAY, WITH SUBDUED ORANGE-BROWN MOTTLING AND RUST-BROWN NODULES. VERY TIGHT, MOIST, HYDROCARBON ODDR.	
4	MW07 250	850		GRD, BTX		
5						
6-9.5					6-9.5 BECOMING DARK GREEN-GRAY SILT AND CLAY. TIGHT, MOIST.	
6	MW07 50	400		GRD, BTX		
9.5					9.5 BECOMING DARK BROWN CLAY. WET, VERY PLIABLE. ● WATER AT 9.5 FT.	
8	MW07 1/5			GRD, BTX		
10-16					10-16 MOTTLED LIGHT-BROWN, GRAY, ORANGE-BROWN SILT, WITH DARK-BROWN, RED-BLACK NODULES. FIRM, WET.	
10	MW07 2/5	10				
12	MW07 2/2					
14	MW07 1/2					
16-16.5					16-16.5 NO SAMPLE. END OF BORING AT 16.5 FT.	

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/25/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIREFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-13
MW-07

DATE: 08/08/92

DWG NAME: 026MW-07

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW08 1/0				0-0.5 BROWN SILT, ORGANICS AND ROOTS 0.5-2 MOTTLED LIGHT-BROWN-GRAY, ORANGE-BROWN SILT, SOME CLAY AND ROOTS. DRY.	<p>CEMENT-BENTONITE GROUT</p> <p>2" DIAMETER SCHEDULE 40 PVC RISER</p> <p>BENTONITE SEAL FROM 2 TO 4 FT.</p> <p>10-20 SAND FROM 4 TO 16.5 FT.</p> <p>10' LONG 0.010 SLOT SCHEDULE 40 PVC SCREEN FROM 6 TO 16 FT.</p> <p>10.5 IN. DIAMETER BOREHOLE</p>
2	MW08 1000 2 1100			GRD, BTX	2-10 DARK GREEN-GRAY SILT AND CLAY. HYDROCARBON-STAINED. TIGHT, MOIST TO WET. UNIDENTIFIED ODOR.	
4	MW08 1000 4 1100			VOC		
5	MW08 500 6 700					
8	MW08 10/8 8			GRD, BTX		
10	MW08 7/0 10				● WATER AT 9-10 FT. 10-13 BECOMING MOTTLED GRAY, ORANGE-BROWN SILT. FIRM, WET. 13 THIN HORIZON (3") OF BLACK SILT. PASTE-LIKE, WET.	
12	MW08 200 12 20			VOC	13-15 MOTTLED GRAY, ORANGE-BROWN SILT, BECOMING RED-BROWN SILT WITH MINOR ORANGE-BROWN STREAKS.	
14	MW08 3/16 14				15-16 UNIFORM GRAY SILT. 16-16.5 NO SAMPLE. END OF BORING AT 16.5 FT.	
15						
20						
25						
30						

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC. 4161 RIDGEMOOR AVENUE MEMPHIS, TN. 38118	DRILLING AND SAMPLING METHOD: 6.25-INCH ID HOLLOW-STEM AUGERS. 2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.
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DATE OF COMPLETION: 06/25/92

<p>ENVIRONMENTAL ASSESSMENT UNDERGROUND STORAGE TANKS AIRCRAFT FIREFIGHTING TRAINING FACILITY NAS MEMPHIS, TN.</p>	<p>BORING B-14 MW-08</p>
	<p>DATE: 08/08/92</p> <p>DWG NAME: 026MW-08</p>

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN)	LABORATORY ANALYSIS	DESCRIPTION
	B15 0	14 200			0-1? BROWN SILT AND ORGANICS. 1-7 DARK BROWN-BLACK SILT AND CLAY, HYDROCARBON STAINED. TIGHT, HARD.
	B15 2	1000 1100		RFI-SCAN, GRD, BTX	
5	B15 4	800 1100			
	B15 6	700 100			7-8 BECOMING GREEN-GRAY SILT, POSSIBLY HYDRO-CARBON STAINED. FIRM, MOIST.
	B15 8	10 10		GRD, BTX	8-11 BECOMING MOTTLED GRAY, ORANGE-BROWN SILT AND CLAY. FIRM, MOIST.
10	B15 10	3 4		GRD, BTX	● WATER AT 11 FT. 11-11.5 DARK BROWN CLAY, SOME SILT. 11.5-12 GREEN-GRAY SILT AND CLAY. END OF BORING AT 12 FT.
15					
20					
25					
30					

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/25/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

BORING B-15

DATE: 07/28/92

DWG NAME: 026B-15

DESCRIPTION OF SUBSURFACE MATERIALS

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	
		B16 0	1/1		0-1 BROWN, ORANGE-BROWN SILT, ORGANICS AND ROOTS.
		B16 2	1/0		1-4 DARK BROWN ORGANIC-RICH SILT AND CLAY; BECOMING (AT 2 FT.) DARK BROWN-BLACK ORGANIC-RICH CLAY. TIGHT TO VERY TIGHT, DRY.
5		B16 4	1/1		4-6 BECOMING MOTTLED GRAY-GREEN, GRAY-BROWN, DARK-BROWN SILT AND CLAY.
		B16 6	1/2		6-7.5 BECOMING GREEN-GRAY SILT, LITTLE CLAY. FIRM, WET.
		B16 8	1/1		7.5-10 BECOMING LIGHT-BROWN, GRAY-BROWN SILT AND CLAY. TIGHT, MOIST.
10		B16 10	1/1	GRD, BTX	10-12 BECOMING MOTTLED GRAY, ORANGE-BROWN SILT, SOME CLAY. TIGHT, MOIST. ● WATER AT 11 FT. END OF BORING AT 12 FT.
15					
20					
25					
30					

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
3.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/25/92



ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIREFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

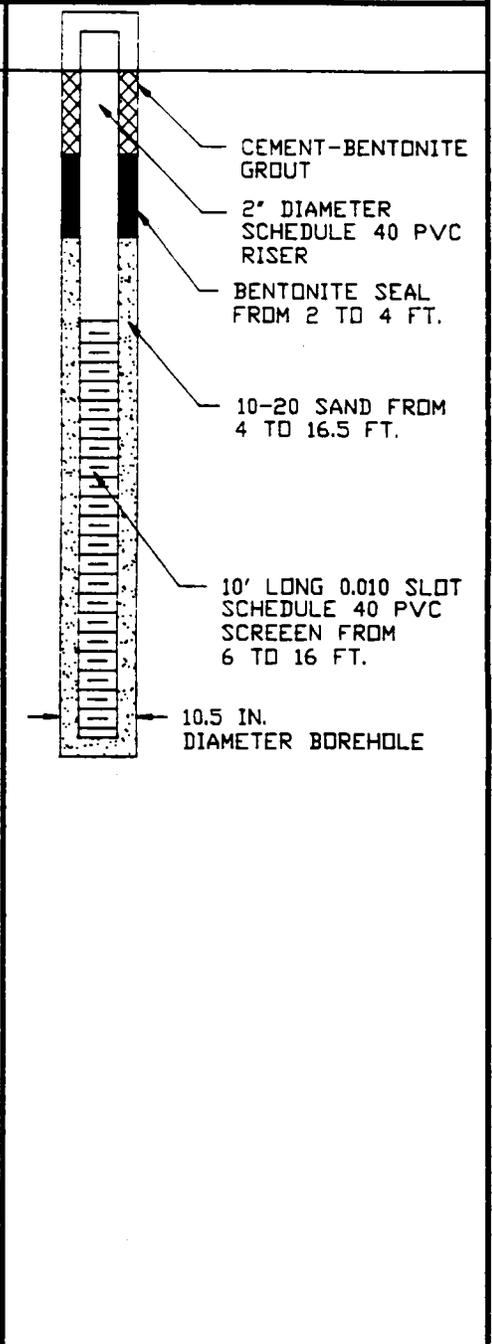
BORING B-16

DATE: 07/28/92

DWG NAME: 026B-16

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
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0	MW09 0/0	0			0-1.5 BROWN SILT,CLAY,ORGANICS AND ROOTS; BECOMING MOTTLED BROWN,ORANGE-BROWN SILT, CLAY AND ROOTS.
2	MW09 0/0	2			1.5-4 BECOMING DARK BROWN CLAY,TURNING DARK BROWN-BLACK ORGANIC-RICH CLAY WITH SOME ROOTS,TIGHT,MOIST.
4	MW09 0/0	4			4-6 BECOMING GRAY SILT AND CLAY WITH FAINT ORANGE-BROWN INTERBEDS. TIGHT,MOIST.
6	MW09 0/0	6			6-10 MOTTLED GRAY-BROWN,BLUE-GRAY SILT AND CLAY. BECOMING (AT 8 FT.) MOTTLED LIGHT-BROWN AND BLUE-GRAY. TIGHT,MOIST.
8	MW09 0/0	8		GRD, BTX	
10	MW09 0/0	10			● WATER AT 9.5 FT. 10-12 GRAY-BROWN SILT.
12	MW09 0/0	12			12-16 MOTTLED GRAY,ORANGE-BROWN SILT,WITH MINDR BLACK TO DARK-RED NODULES OR PATCHES. FIRM,WET.
14	MW09 0/0	14			16-16.5 NO SAMPLE END OF BORING AT 16.5 FT.



DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/26/92

ENVIRONMENTAL ASSESSMENT
UNDERGROUND STORAGE TANKS
AIRCRAFT FIRFIGHTING TRAINING FACILITY
NAS MEMPHIS, TN.

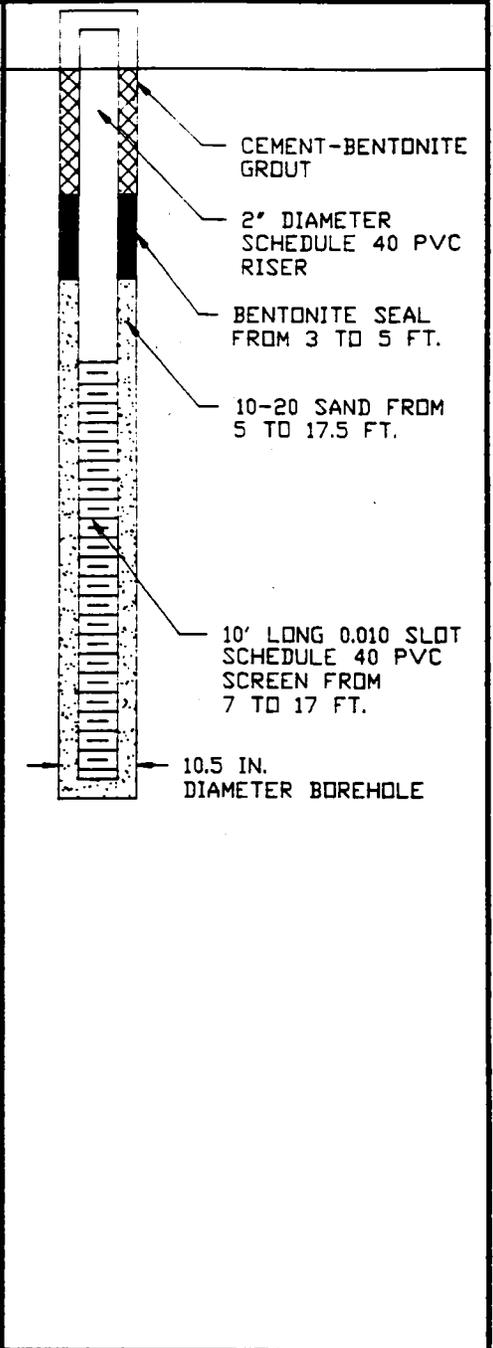
BORING B-17
MW-09

DATE: 08/08/92

DWG NAME: 026MW-09

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN.)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
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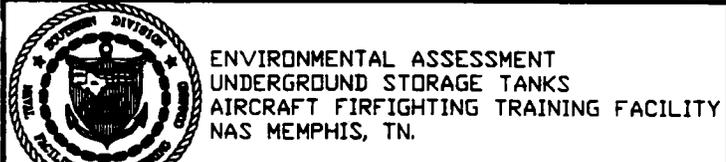
	MW10	0/0			0-0.5 BROWN SILT,CLAY AND ORGANICS
		0			0.5-2 MOTTLED BROWN,GRAY-BROWN,ORANGE-BROWN SILT AND CLAY WITH MINOR BLACK ORGANIC NODULES. FIRM,MOIST.
	MW10	12/600	GRD, BTX		2-4 BECOMING DARK GRAY CLAY. TIGHT,MOIST, HYDROCARBON ODDR.
		2			
	MW10	14/600			4-6 BECOMING DARK-GREEN-GRAY,HYDROCARBON STAINED SILT AND CLAY. TIGHT,MOIST,HYDROCARBON ODDR.
		4			
5	MW10	1/5	GRD, BTX		6-8 GREEN-GRAY SILT AND CLAY.
		6			
	MW10	1/0			8-10 MOTTLED GREEN-GRAY ORANGE-BROWN SILT AND CLAY.
		8			
10	MW10	1/0	GRD, BTX		10-12 BECOMING GREEN-GRAY SILT. FIRM,MOIST.
		10			
	MW10	1/1			● WATER AT 12 FT.
		12			12-16 MOTTLED GRAY-BROWN,ORANGE-BROWN SILT WITH BLACK TO RED NODULES OR PATCHES FIRM,WET.
	MW10	1/1			
		14			
15					16-17.5 NO SAMPLE.
					END OF BORING AT 17.5 FT.



DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC.
4161 RIDGEMOOR AVENUE
MEMPHIS, TN. 38118

DRILLING AND SAMPLING METHOD:
6.25-INCH ID HOLLOW-STEM AUGERS.
2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.

DATE OF COMPLETION: 06/26/92



BORING B-18
MW-10

DATE: 07/29/92

DWG NAME: 026MW-10

DEPTH (FEET)	SAMPLE INTERVAL	SAMPLE NUMBER	PID (PPM) (INITIAL/15 MIN)	LABORATORY ANALYSIS	DESCRIPTION OF SUBSURFACE MATERIALS	WELL CONSTRUCTION DETAILS
0	MW11 13 0 10				0-1 SILT AND ORGANICS, SOME CLAY.	<p>CEMENT-BENTONITE GROUT</p> <p>2" DIAMETER SCHEDULE 40 PVC RISER</p> <p>BENTONITE SEAL FROM 2 TO 4 FT.</p> <p>10-20 SAND FROM 4 TO 16.5 FT.</p> <p>10' LONG 0.010 SLOT SCHEDULE 40 PVC SCREEN FROM 6 TO 16 FT.</p> <p>10.5 IN. DIAMETER BOREHOLE</p>
2	MW11 300 2 500				1-2 INTERLAYERED BROWN, GRAY-BROWN, ORANGE-BROWN SILT AND CLAY, MINOR GRAVEL. TIGHT, MOIST.	
4	MW11 1300 4 NH*				2-9 BECOMING DARK GREEN-GRAY, HYDROCARBON-STAINED SILT AND CLAY. TIGHT, MOIST, HYDROCARBON ODOR.	
5				K GRD, BTX, RFI-SCAN	● PERCHED WATER AT 7 FT. -WITH FAINT GRAY, ORANGE-BROWN MOTTLING FROM 7 TO 10 FT.	
6	MW11 500 6 1100				9-11 MOTTLED GRAY, ORANGE-BROWN SILT. FIRM, MOIST.	
8	MW11 150 8 300				11 THIN (3' THICK) HORIZON OF ORANGE-BROWN SILT AND CLAY. EXTREMELY TIGHT AND COMPACT, DRY.	
10	MW11 20 10 80			K, GRD, BTX	● WATER AT ~ 11.5 FT.	
12	MW11 1 12 1				11-16 GRAY UNIFORM SILT. FIRM, WET.	
14	MW11 0 14 0				16-16.5 NO SAMPLE. END OF BORING AT 16.5 FT.	
15						
20						
25						
30						

* NH-NO 15 MINUTE HEADSPACE ANALYSIS.

DRILLER: PROFESSIONAL SERVICE INDUSTRIES, INC. 4161 RIDGEMOOR AVENUE MEMPHIS, TN. 38118	DRILLING AND SAMPLING METHOD: 6.25-INCH ID HOLLOW-STEM AUGERS. 2 FT. LONG, 2 IN. OD SPLIT BARREL SAMPLER.
DATE OF COMPLETION: 06/26/92-MONITORING WELL 06/27/92-SHELBY TUBE	
<p>ENVIRONMENTAL ASSESSMENT UNDERGROUND STORAGE TANKS AIRCRAFT FIRFIGHTING TRAINING FACILITY NAS MEMPHIS, TN.</p>	BORING B-19 MW-11
	DATE: 08/08/92

Appendix B

1988 Sampling Report Information

Currently there is not a facility of this type for a Navy aircraft crash and salvage crew to train under live fire conditions. This project was developed from the findings of the investigation into the problems associated with extinguishing the catastrophic fire onboard the USS NIMITZ. Investigators discovered that the current level of training for aircraft crash crews was inadequate because no facilities exist where an aircraft crash crew can receive live fire training. This project will enable a team to receive live firefighting training with the unique hazards associated with shipboard aircraft firefighting. This team training will develop confidence in the crew's ability to extinguish large, complex shipboard aircraft deck fires, thus potentially saving thousands of lives aboard our ships.

3.0 SAMPLING RATIONALE

"The sampling target for site 1 was to sample soils surrounding the storm sewer at all defective joints. An internal inspection of the sewer was performed by Industrial Clean-up Inc. (ICI) and all suspect joints were marked and recorded (Table 1). Photographs of the joints are located in Appendix A. All joint locations were then transposed to the ground surface measured from the outfall. Sampling was performed by drilling to depths of 0-1 feet, 1-3 feet, and 3-5 feet. Two additional borings were taken at the 0-1 foot depth interval from the storm sewer system. All of the 0-1 foot samples were analyzed for EPA Toxicity Metals (EPA METHOD SW-846) and Total Cyanide." 1

"Site 2, the salvage yard, was visually inspected and monitored using a hNu photoionization detector. The visual inspection of the property indicated widespread discoloration of surface soils on the site. Consequently, three composite samples were collected from areas that showed staining or discoloration on the surface. An organic vapor background concentration of 0.1 ppm was established using the hNu and at sampling location SY1 there was a slight deflection to 0.3ppm. Sample locations SY2 and SY3 were determined by staining only. Composite samples were collected at each of these locations from depths of 0-1 feet, 1-3 feet, and 3-5 feet below the surface. Samples collected from the 0-1, and 1-3 foot level were analyzed for Total Petroleum Hydrocarbons and Total Lead." 1 Samples collected from the 1-3 foot level were also analyzed for EPA Toxicity Lead and BTX.

During the field investigation site 2 was found to be covered with a good growth of grass. The grass had to be cut so that the salvage yard could be visually inspected. Asphalt was detected at the surface of the salvage yard and appeared to be fine millings. The boring logs are provided in appendix C.

"The sampling target for site 3 was the joint nearest the storm sewer manhole as shown on the attached location map (Figure 1). A composite sample was taken from a boring at depths 0-1 foot, 1-3 feet, and 3-5 feet below the pipe's invert. The storm sewer samples (from the 0-1 feet below the invert) were also analyzed for EPA Toxicity Metals and Total Cyanide." 1

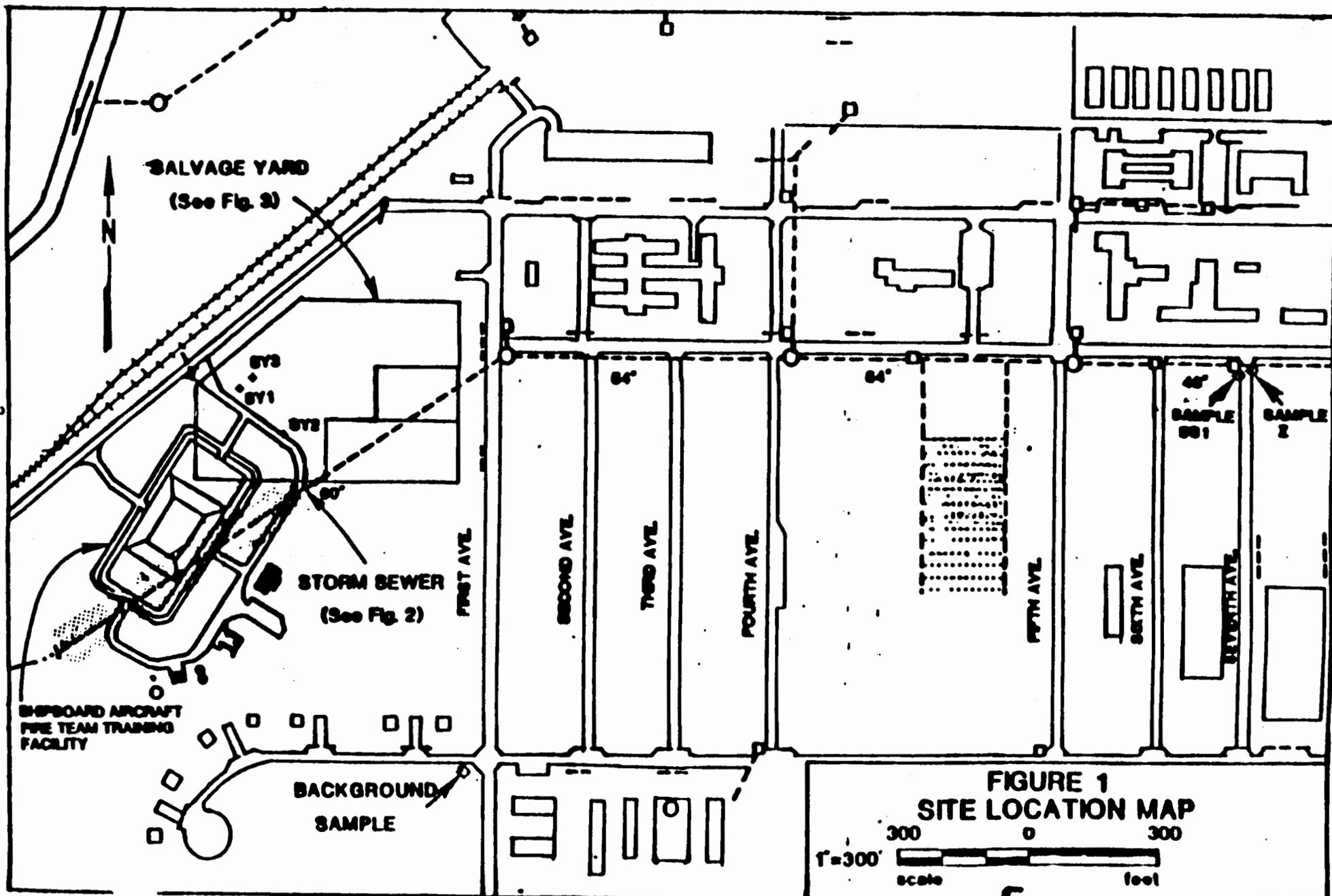


Table 4
Data Summary for Salvage Yard
And Related Background Tests

Sample Number	Total Petroleum Hydrocarbons (ppm)	Total Lead

SY1 0-1'	1100	70.3
SY2 0-1'	1850	15.7
SY3 0-1'	839	17.9
SY1 1-3'	<1	7.49
SY2 1-3'	<1	6.79
SY3 1-3'	<1	10.0
BKG2 1-3'	389	12.3
BKG 7-8'	<1	4.65
BKG 8-10'	9	5.20
BKG 10-12'	<1	4.80

GENERAL ENGINEERING LABORATORIES

Environmental Engineering and Analytical Services

Molly F. Grana
President

George C. Grana, P.E., Ph.D.
Vice President
SC Registration No. 9103

Laboratory Certifications
FL E071566
NC
SC
VA
NACIP

CERTIFICATE OF ANALYSIS

Client: ENVIRONMENTAL & SAFETY DESIGNS, INC
P.O. BOX 341315
MEMPHIS, TN 38184
Contact: MR. J. SPEAKMAN, PHD, PE

Date: 08/09/88

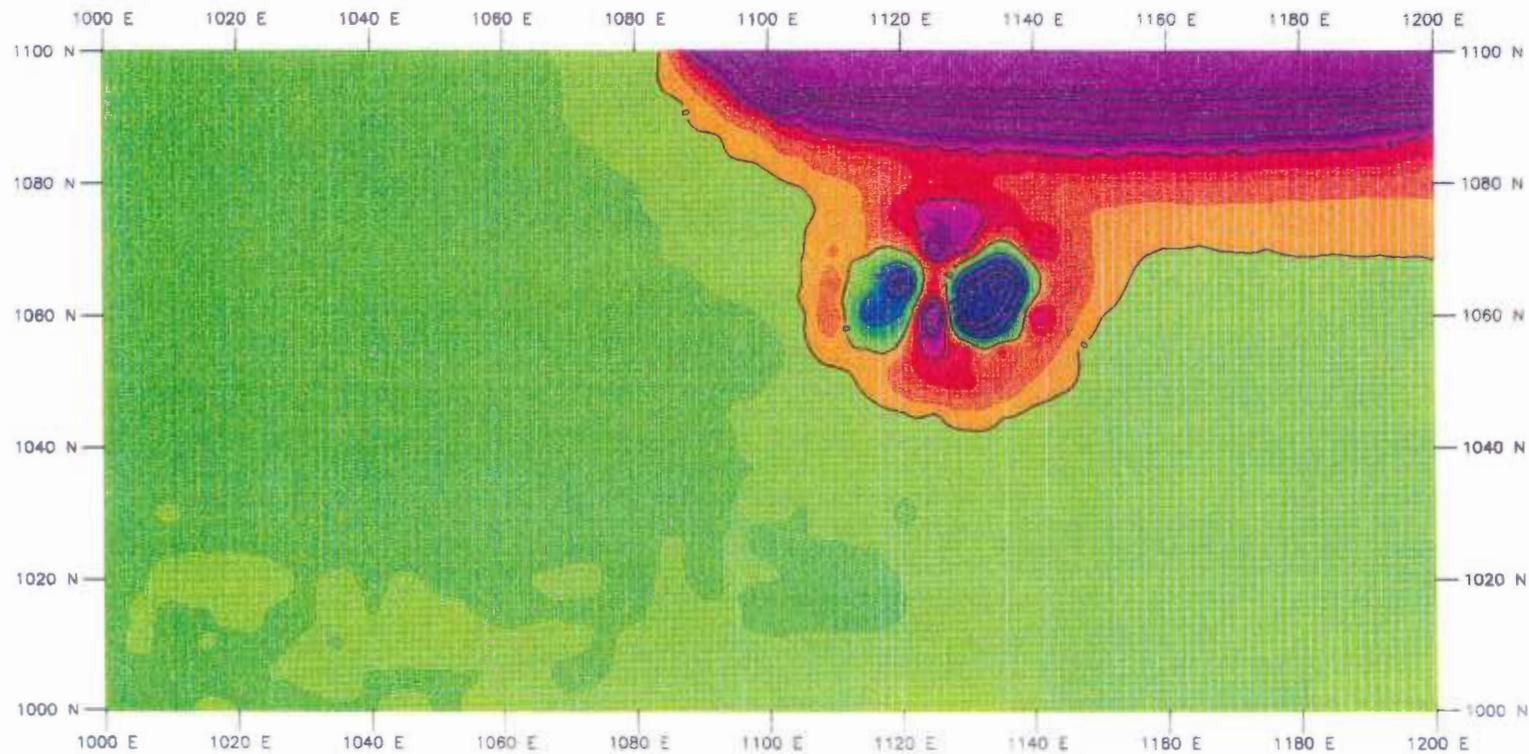
Released by: *Alan M. Crave*
ALLAN M. CRAVE
Page No. 1 1

cc/fc: ENSA/ENSAJ

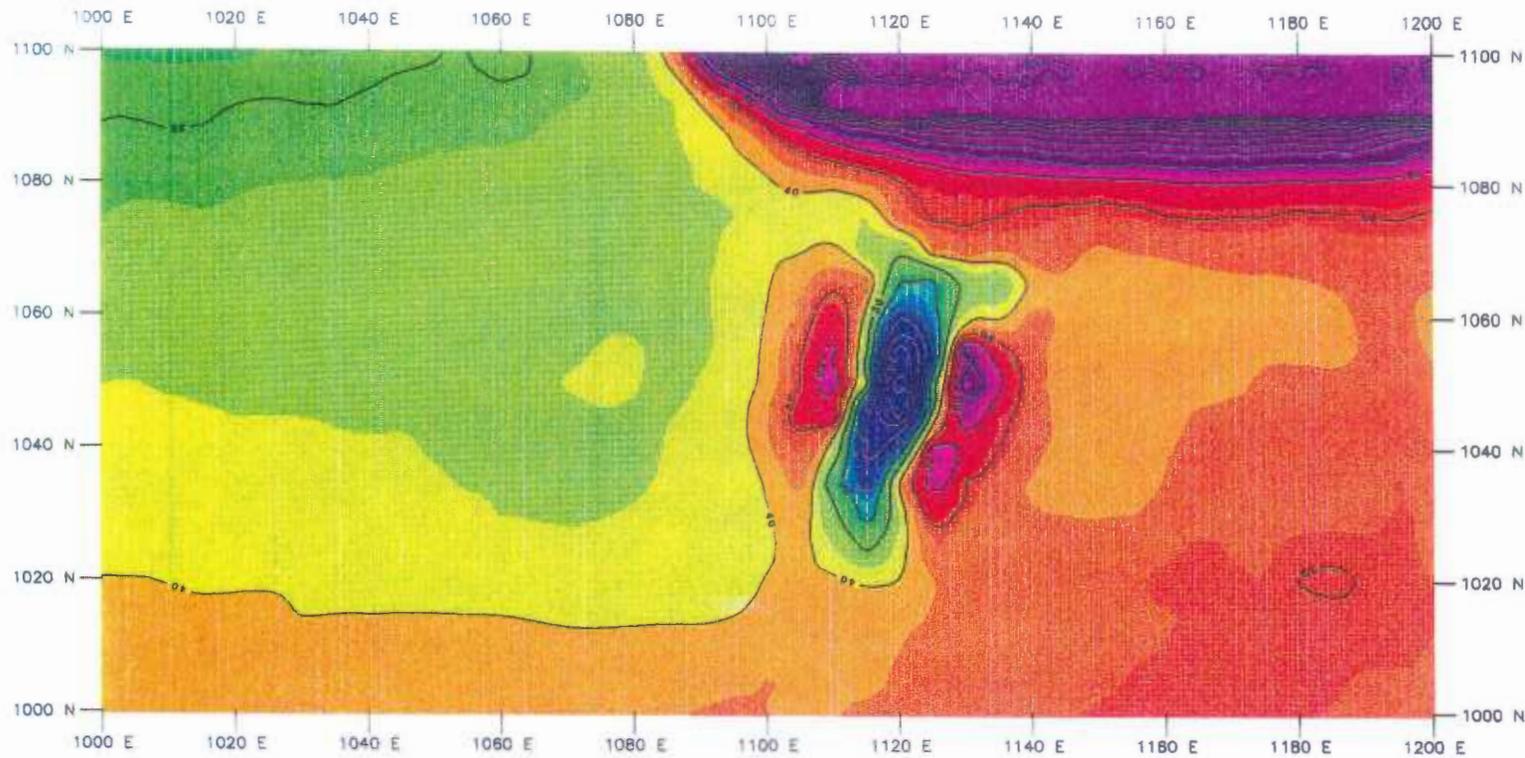
Sample ID	SY1 1-3'	SY2 1-3'	SY3 1-3'
Lab ID	88070677	88070678	88070679
Sample Type	15	15	15
Date Received	07/18/88	07/18/88	07/18/88
Parameter Collected by	ENSA	ENSA	ENSA

TOTAL HYDROCARBONS	<1 ppm	<1 ppm	<1 ppm
LEAD	7.49 ppm	6.79 ppm	10.0 ppm
ACID DIGESTION	YES	YES	YES
LEAD	<1.00 ppm	<1.00 ppm	<1.00 ppm
EP TOX EXTRACTION-SOLID	YES	YES	YES
BENZENE	<5 ppb	<5 ppb	<5 ppb
ETHYLBENZENE	<10 ppb	<10 ppb	<10 ppb
TOLUENE	<10 ppb	<10 ppb	<10 ppb
XYLENE	<10 ppb	<10 ppb	<10 ppb
AROCLOR 1016	<1 ppm	<1 ppm	<1 ppm
AROCLOR 1221	<1 ppm	<1 ppm	<1 ppm
AROCLOR 1232	<1 ppm	<1 ppm	<1 ppm
AROCLOR 1242	<1 ppm	<1 ppm	<1 ppm
AROCLOR 1248	<1 ppm	<1 ppm	<1 ppm
AROCLOR 1254	<1 ppm	<1 ppm	<1 ppm
AROCLOR 1260	<1 ppm	<1 ppm	<1 ppm
AROCLOR 1262	<1 ppm	<1 ppm	<1 ppm
SAMPLE PREP - PCB'S	YES	YES	YES

Appendix C
Geophysical Data



IN-PHASE, SWMU 40
NAS Memphis
1994 Geophysics Investigation
ENSAFE/ALLEN & HOSHAL



CONDUCTIVITY, SWMU 40
NAS Memphis
1994 Geophysics Investigation
ENSAF/ALLEN & HOSHALL

Appendix D

PVC Well Construction Justification

**JUSTIFICATION FOR THE USE OF PVC WELL MATERIALS AT
SWMU 40 (SALVAGE YARD NO. 1)
NAS MEMPHIS, MILLINGTON, TENNESSEE**

Southern Division Naval Facilities Engineering Command (SOUTHNAVFACENGCOCM) is committed to using only the most reliable methods to obtain the data used in its investigations. Therefore, SOUTHNAVFACENGCOCM recommends the use of well casings made of Polyvinyl Chloride (PVC) material for monitoring wells installed at several Solid Waste Management Units (SWMUs) at NAS Memphis. After reviewing the literature, SOUTHNAVFACENGCOCM has concluded that PVC is a superior well casing material when monitoring a plume consisting of both metals and organics. Attached are two recent publications supportive of SOUTHNAVFACENGCOCM's position: "Influence of Casing Materials on Trace-Level Chemicals in Well Water" (Parker, 1990) and "Leaching of Metal Pollutants from Four Well Casing Used for Groundwater Monitoring" (Hewitt, 1989). Also attached is the National Sanitation Foundations "Standard 14 - Plastics Piping Components and Related Materials" which contains the specifications and performance evaluations of the proposed well construction material (Attachment A).

SOUTHNAVFACENGCOCM request that U.S. EPA consider the following information as required in the "Alternate Well Casing Justification" form.

1. The Data Quality Objectives (DQO) for the samples to be collected from wells with PVC casing per EPA/540/G-87/003., Data Quality Objectives for Remedial Response Activities.

Response: The DQO's for the RFI at NAS Memphis are to provide information of sufficient quality to support risk assesment and to characterize all active and inactive SWMUs at NAS Memphis. The quality assurance (QA) and quality control (QC) procedures are specified in the Comprehensive RFI Work Plan. Sample collection and accompanying QA/QC procedures are designed to meet Level III and Level IV DQOs.

2. The anticipated compounds and their concentrations.

Response: PVC should not interfere with the anticipated compounds and their concentration range. (See Attachment B analytical data for contaminant concentrations identified in soil at SWMU 40)

3. The anticipated residence time of the sample in the well and the aquifers productivity.

Response: Each well will be purged immediately prior to the collection of the sample. The anticipated residence time of the water after purging and prior to sampling is approximately 20 minutes. Permeability data from the shallow aquifer from various locations throughout NAS Memphis range from 3.8×10^{-8} cm/second to 7.6×10^{-5} cm/second and an average hydraulic conductivity ranging from 0.102 ft./day to 0.234 ft./day.

4. The reason for not using a hybrid well of PVC casings and stainless steel screen.

Response: SOUTHNAVFACENGCOCM feels that PVC is the preferred material when sampling mixed waste plumes. Stainless steel may absorb or adsorb heavy metals such as lead, chromium, and arsenic. Also, the cutting oils used in the manufacturing of stainless steel riser and screen are difficult to remove. These oils, if not completely removed by the decontamination process, may contaminate the well. Hybrid wells introduce additional problems. For instance, the junction is usually a weak point subject to breakage or is a place for down-hole equipment to become ensnared.

5. Literature on adsorption/desorption characteristics of the compounds and elements of interest for the type of PVC to be used.

Response: Two reprints are attached that evaluate the sorptive characteristics of stainless steel and PVC.

6. If an anticipated increase in the thickness of the monitor well wall would require an increase in annular space.

Response: No change in the annular space is required.

7. The type of PVC to be used and if available the manufacturer's specifications, and an assurance that the PVC to be used does not leach, mask, react, or otherwise interfere with the contaminants being monitored within the limits of the DQO(s).

Response: The PVC will to be used in the well construction will meet National Sanitation Foundation (NSF) Standard 14. Attached is a reprint of the NSF Standard 14 for Plastic Piping System Components and Related Materials with performance requirements of the PVC in question. In addition to NSF Standard 14 PVC, a high solids bentonite grout will be used in place of a cement/bentonite grout.

ATTACHMENT A

"Influence of Casing Materials on Trace-Level Chemicals in Well Water" (Parker, 1990)

**"Leaching of Metal Pollutants from Four Well Casing Used for Groundwater Monitoring"
(Hewitt, 1989).**

**National Sanitation Foundations "Standard 14 - Plastics Piping Components and Related
Materials"**

Dynamic Study of Common Well Screen Materials

by Alan D. Hewitt

Abstract

Experiments simulating the dynamics of compliance sampling via a monitoring well were performed to assess the effects of common well screen materials (rigid polyvinyl chloride, polytetrafluoroethylene, stainless steel 304, and stainless steel 316) on several metals and trichloroethylene (TCE) in ground water. This was achieved by using a continuous flow-through chamber system capable of exposing monitoring well screens to ground water for periods ranging from 0.25 to 8 hours. The findings of this study are more representative than static laboratory experiments for assessing the potential effects well casing materials have on ground water samples. Under dynamic flow conditions stainless steel 304 and 316 screens were found to influence solution concentrations of Pb, Cd, Cr, Ni, and Fe, while ground water TCE concentrations were not affected by any of the materials tested.

Introduction

Recent regulatory guidance (U.S. EPA 1992) has recommended that well casing material selection consider the data quality objectives of the site investigation and the site characteristics. This change was made in part because studies have shown that all of the commonly used casing materials (rigid polyvinyl chloride [PVC], polytetrafluoroethylene [PTFE], stainless steel 304 [SS 304], and stainless steel 316 [SS 316]) can potentially influence the chemical composition of different analytes in ground water. Static laboratory studies have found that several metals are leached from and/or sorbed by stainless steel casings (Hewitt 1989a, 1989b; Parker et al. 1990; Hewitt 1992), and PTFE and PVC casings sorb halogenated organic compounds (Reynolds and Gillham 1986; Gillham and O'Hannesin 1988; Parker et al. 1990; Reynolds et al. 1990). These laboratory-based experiments are a logical first step in material testing because experimental parameters could be managed cost-effectively. However, the inability to simulate environmental conditions has limited their findings to just the identification of potential problems. Conversely, tests performed using full-scale field designs are costly and often are unable to establish small changes with any degree of certainty because spatial, sampling, and material variables are not readily managed (Houghton and Berger 1984; Barcelona and Helfrich 1986).

Screened sections of ground water monitoring wells are posi-

tioned in saturated soils where the interstitial waters exhibit a directional velocity. Moreover, currently practiced field sampling protocol requires wells to be purged of multiple well volumes of water (often five) prior to sampling. The water within the screened section of a well, taken as a representative sample of an aquifer, is a product of the dynamic flow created by these two processes. For these reasons the period of contact between the water that is sampled and the well casing material typically ranges from less than an hour to several hours. Maintaining the in situ chemistry is another concern, since ground water is prone to redox shifts and oxygenation transformations soon after being transferred to the surface. The period that ground water is exposed to well casing materials and issues concerned with the in situ chemistry of ground water are both valid criticisms of most laboratory studies (Nielsen 1988).

In this study, we attempt to simulate characteristic exposure periods of monitoring well screens to ground water without altering the in situ solution chemistry. The water for this study was drawn from an aquifer 24 m (80 feet) below the surface via a production well. This ground water is contaminated with trichloroethylene (0.5 to 2 mg TCE/L) and contains moderate concentrations of total iron (200 $\mu\text{g Fe/L}$). These constituents are easily lost from solution when care is not taken to avoid atmospheric exposure. By positioning a closed system chamber apparatus next to a wellhead (less than 1 m) and drawing from the well main, experiments were

performed that allowed the ground water to flow continuously while avoiding atmospheric exposure. The results from these dynamic flow experiments will better assess the potential effects well casing materials can have on selected metals and TCE in ground water samples. All three experiments were performed, one assessed if virgin materials can affect solution concentrations of metals and TCE over a range of dynamic conditions, and two others assessed if the degree of surface oxidation on stainless screens enhances the potential for metal concentrations to be altered in ground water samples.

Materials and Methods

The experimental design required collecting replicate samples for the analysis of several metals and TCE independent of variables such as analyte spatial and temporal variability. This was achieved by individually housing four common well screen materials (PVC, PTFE, SS 304, SS 316) in separate chambers, through which a regulated flow of ground water was simultaneously passed. In all, the experimental apparatus consisted of a series of five test chambers, four containing well screens and one with no screen to serve as the control (Figure 1).

Chamber Apparatus

First, 60-cm (2-foot) sections of 5-cm-I.D. (2-inch-I.D.) well screens of PVC, PTFE, SS 316, and SS 304

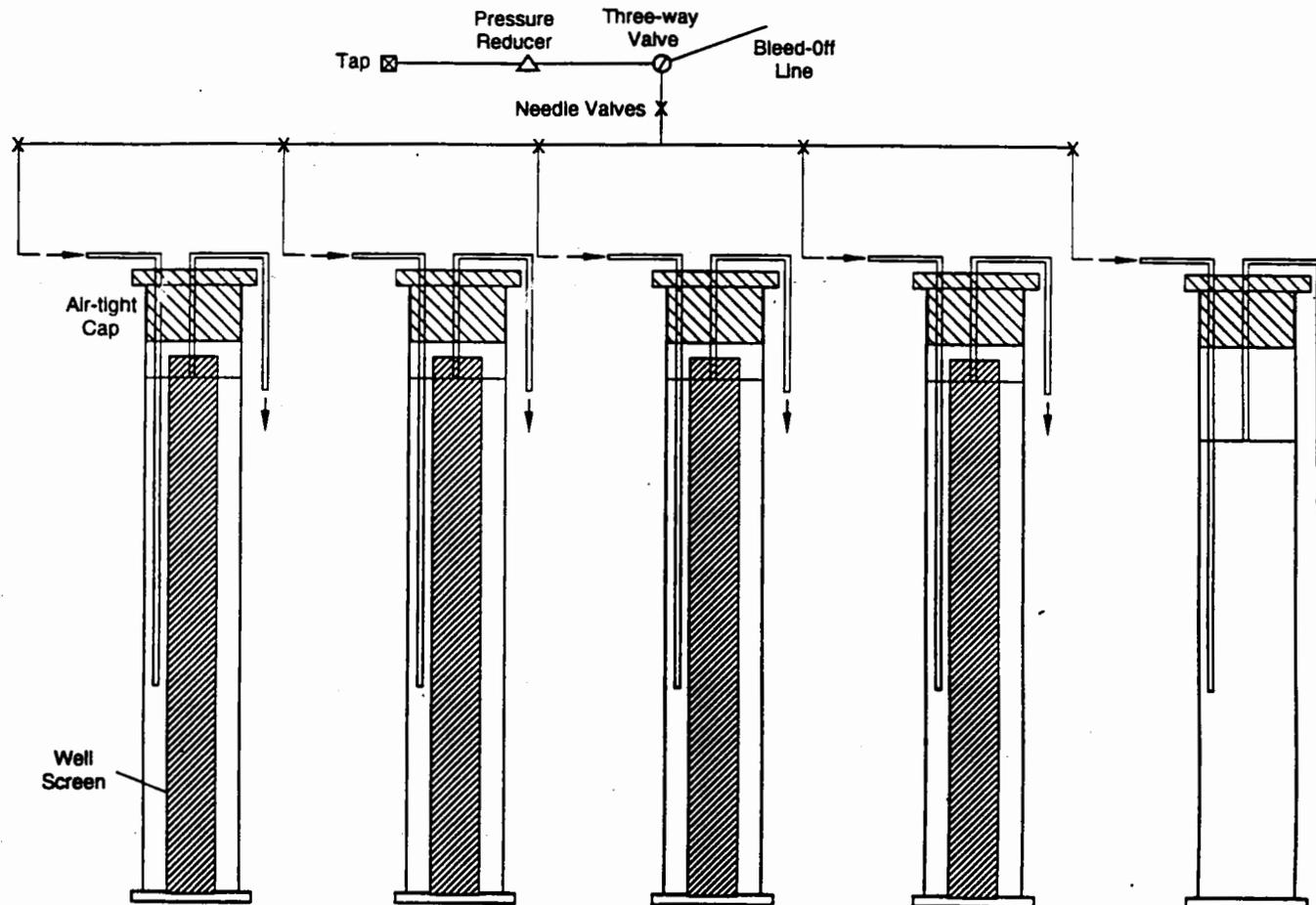


Figure 1. Dynamic flow-through chamber apparatus.

were cut to 44-cm (17-inch) lengths for use in the ground water flow chambers. The well screens were then rinsed several times with Type 1 water (Milli Q Millipore Corp.) and dried in a class 100 cleanroom. The slit openings were 0.025 cm (0.010 inches) for the stainless steel and PVC screens and about 0.046 cm (0.018 inches) for the PTFE.

Airtight flow chambers were made by capping commercially available 2-L graduated glass cylinders (Figure 1). The chamber inlet was positioned 28 cm below the cap, adjacent to the cylinder wall (exterior to the well screen), and the outlet was 3 cm below the cap, centered inside the screen's axial void. The control chamber was slightly different (Figure 1) to account for the water displaced by the screen, so as to maintain a constant water volume of approximately 1750 mL in each chamber.

Water flow to the chambers was regulated by a series of valves and a manifold made of Tygon, polypropylene, and Teflon® tubing (Figure 1). Between the inlet valve of each chamber and the sample collection point, glass tubing connected by short sections of Tygon tubing and the glass walls of the graduated cylinder were the only materials other than the well screens to contact the ground water. The ground water was supplied from a production well flowing at 1900 L/min. A regulated flow of 600 mL/min was tapped off the well main in order to supply the chamber manifold and allow for ground water samples to be taken from a bleed-off line (background samples). A more complete description of the design and operation of this chamber apparatus can be found elsewhere (Hewitt 1993).

Test Design and Sampling

All experiments were performed so that the initial and often the subsequent ground water samples would be collected from all five chambers after passage of five chamber volumes (Table 1). Three separate experiments were performed differing in sampling formats and well casing conditions. The first experiment used virgin well casing materials; the ground water flow rates were varied in a sequence from fast to slow to create residence times of one-quarter, one-half, one, two, four, and eight hours between the sampling events. The second and third experiments were performed 75 and 130 days after the first experiment, respectively, and used a constant flow rate (residence time one-half hour). For the second experiment samples were collected after 5, 10, and 15 chamber volume flushes. Samples were collected after 5, 6, 7, 8, 9, and 10 chamber flushes for the third experiment. Between experiments the well casings were exposed to stagnant ground water and surface oxidation developed on the two stainless steel well screens.

On day one (Table 1) of the first experiment, the three shortest residence times (one-quarter, one-half, and one hour) were performed under constant supervision without interruptions to flow. However, the water distribution manifold system failed to maintain constant and equal flow through all of the chambers when unattended, resulting in interruptions (overnight) between

	Residence Time (hours)	Flow Rate (mL/min)	Samples
I. 1st Experiment*			
Day 1 (8/3/92)			
1st	0.25	113	Metals/TCE
2nd	0.50	56	Metals/TCE
3rd	1.0	28	Metals/TCE
Day 2 (8/4/92)			
4th	2.0	14	Metals/TCE
Day 3 (8/5/92)			
5th	4.0	7.0	Metals/TCE
Day 4 (8/6/92)			
6th	8.0	3.5	Metals/TCE
II. 2nd Experiment**			
Day 5 (10/23/92)			
7-9th	0.50	56	Metals
III. 3rd Experiment †			
Day 6 (12/21/92)			
10-15th	0.50	56	Metals

* Sampling performed after at least 5 chamber volume flushes.

** Sampling performed after 5, 10, and 15 chamber volume flushes.

† Sampling performed after 5, 6, 7, 8, 9, and 10 chamber volume flushes.

each of the three successive days used for two-, four-, and eight-hour residence time tests. For the two-hour residence time test, the proper flow was established early in the morning and samples were collected 10 hours later. For the two longest residence times, flow was increased to 113 mL/min (residence time of one-quarter hour) early in the morning to allow four volume exchanges to pass quickly prior to setting the proper rate for a final volume flush prior to sampling.

The second and third experiments were performed on a single day with no interruptions to constant and equal flow. For the second experiment there was no change to the chamber apparatus; however, during the third experiment aqueous concentrations Pb^{2+} and Cd^{2+} were added to the ground water with a syringe pump. The rate of introduction was set to create concentrations of approximately 28 $\mu g Pb/L$ and 1.1 $\mu g Cd/L$, respectively. To ensure proper analyte mixing, a coil of Tygon tubing was added to the chamber manifold. Samples were collected after 5, 6, 7, 8, 9, and 10 chamber flushes; the syringe pump was activated after the first sample collection and turned off after the third (first = five, and third = seven chamber flushes, respectively).

Samples were collected for the analysis of both TCE and metals during the first experiment (residence time study/virgin casings), and for only metals during the second and third experiments (Table 1). Sampling events consisted of rapidly collecting triplicate samples for TCE and/or just metals from each of the chamber outlets and a single background sample (TCE/metals) from the bleed-off line. In addition, water quality samples for conductivity and pH (and dissolved oxygen

for the second experiment) were collected during the first sampling event of each day.

Ground water samples taken for the analysis of TCE were obtained in either 40- or 3.5-mL volatile organic analysis (VOA) vials with open-faced (Teflon-faced) silicon rubber septa. The large VOA vials were used for the three shortest residence times and the small ones for the longer times. VOA vials of different sizes were used to limit exposure during sample collection. All VOA vials were positioned so that the end of the outlet tube extended to the bottom of the vial, thus allowing ground water to be transferred without agitation and with minimal surface area exposure. Vials were filled until overflowing, and the caps were also filled, making it easier to avoid trapping air bubbles.

In a similar fashion, samples of approximately 8 mL were collected for the analysis of metals; however, caution was used to avoid solution contact with the exterior surface of the discharge tube. The samples collected for the determination of metals were obtained in small pre-cleaned polyethylene bottles (10.5 mL) and were acidified below pH 2 shortly after collection by adding 0.25 mL of concentrated HNO₃ (G. Frederick Smith, redistilled).

Analysis

Cadmium, copper, chromium, iron, nickel, and lead were determined by Graphite Furnace Atomic Absorption (GFAA) using a Perkin-Elmer Model 5100PC Zeeman background-corrected Atomic Absorption Spectrophotometer. These metals were selected for analysis based on the results of previous static well casing studies (Hewitt 1989a, 1989b, 1992).

TCE was determined by headspace gas chromatography (Dietz and Singley 1979; Hewitt et al. 1991). The gas chromatograph, a Photovac Model 10S10 (Photovac

Inc.), was equipped with a 30-cm-long, 10 percent SE-30 on chromosorb 80/100 mesh, packed column. Aqueous samples were prepared for analysis by puncturing the septa with two hypodermic needles and removing one-quarter of the solution via a Luer Lok syringe allowing air from the room to fill the void created. Space equilibrium was facilitated by two minutes of vigorous hand shaking.

All analyses were performed at appropriate levels of sensitivity for the native (Fe) and contaminant (TCE) constituent concentrations present, or so that method detection limits (MDL) (*Federal Register* 1984) were either less than 1 µg/L or less than 1 percent of the current National Interim Primary Drinking Water Regulation (*Federal Register* 1975) (Table 2). Two criteria were used to evaluate if the screen materials influenced analytes of interest as the ground water

Table 2
Method Detection Limits (MDL)* Established for This Study and the National Interim Primary Drinking Water Regulation (NIPDWR) Levels**

Analyte	MDL (µg/L)	NIPDWR Levels (µg/L)
Cd	0.096	10
Cu	0.35	NA
Cr	0.24	50
Fe	23	NA
Ni	0.95	NA‡
Pb	0.46	50
TCE	0.17	5

* *Federal Register* 1984

** *Federal Register* 1975

‡ 100 µg Ni/L has been suggested by the National Primary Drinking Water Regulation (Code of Federal Regulations, 40 CFR 141-43).

Table 3
Average Analyte Concentrations (µg/L) for Bleed-Off Line and Controls

	Cr	Cu	Fe	Ni	Cd	Pb	TCE
1st Experiment							
Bleed-off line	<MDL	<MDL	215 (24)*	<MDL	<MDL	<MDL	1.82 (0.12)
Controls	<MDL	<MDL	205 (27)	<MDL	<MDL	<MDL	1.82 (0.09)
2nd Experiment							
Bleed-off line	<MDL	<MDL	215 (9.4)	<MDL	<MDL	<MDL	ND
Controls	<MDL	<MDL	209 (11)	<MDL	<MDL	<MDL	ND
3rd Experiment							
Bleed-off line	<MDL	1.12 (0.37)	298 (16)	<MDL	<MDL	<MDL	ND
Controls	<MDL	1.21 (0.38)	272 (18)	<MDL	DA	DA	ND

* standard deviation

ND not determined

DA does not apply, analyte spiked into ground water

flowed through the chamber system. An analysis of variance (ANOVA) and least-significant-difference analysis, performed at the 95 percent confidence level, was used when concentrations were greater than the MDLs. When analyte concentration for control chamber samples was below the MDL, materials causing analyte increases greater than five times this detection level estimate were deemed significant. Table 3 shows the average analyte concentrations for bleed-off line samples and the controls. Average analyte values for all of the sampling events can be found elsewhere (Hewitt 1993).

Conductivity, pH, and dissolved oxygen water quality measurements were made using a Leeds and Northrup electrolytic conductivity bridge, a semimicro glass combination pH electrode (Orion) and low ionic strength buffers, and a micro-oxygen electrode (Microelectrodes Inc.), respectively.

Results

Water Quality

Table 4 lists the water quality measurements made in conjunction with the three experiments performed.

Comparison of values within individual sampling events, and over the course of the three experiments, shows only minor variations in these parameters. In addition, comparison of the background water quality (bleed-off line) with that which passed through the chambers failed to show any apparent effects due to either the individual screen materials or the experimental apparatus.

First Experiment – Effects of Residence Time on Virgin Materials

Figure 2 shows the materials that influenced the analyte concentrations relative to the control or that caused analyte concentrations to exceed five times the MDL of the first experiment. Both Cd and Pb were consistently found at concentrations below their respective MDLs, and no significant (ANOVA) effects were determined for the TCE in the ground water with the materials tested. Small amounts (greater than MDL to less than five times the MDL) of Cr were leached into the solution from both stainless steel well screens, but the concentration never exceeded five times the MDL. In addition, small amounts of both Cu and Ni were leached from SS 316. Independent of residence time, both Cu and Ni were leached from the SS 304 casing to the extent that ground water sample concentrations

Table 4
Ground Water Parameters Measured During Sampling

	Background	Control	PTFE	PVC	SS 304	SS 316
1st Experiment						
Day 1						
Conductance (μ mhos)	497	488	492	492	490	494
pH	7.65	7.63	7.62	7.63	7.65	7.63
Day 2*						
Conductance (μ mhos)	503	504	514	518	518	518
pH	7.85	7.77	7.80	7.80	7.81	7.76
Day 3**						
Conductance (μ mhos)	496	484	484	500	504	502
pH	7.70	8.01	7.84	7.83	7.82	7.84
Day 4‡						
Conductance (μ mhos)	488	488	488	498	500	502
pH	7.71	7.84	7.85	7.83	7.91	7.79
2nd Experiment						
Day 5 (Five Flushes)						
Conductance (μ mhos)	458	458	456	456	448	458
pH	7.71	7.84	7.85	7.83	7.91	7.79
D.O. (mg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
3rd Experiment						
Day 6 (Five Flushes)						
Conductance (μ mhos)	450	427	444	424	430	432
pH	7.89	7.86	7.85	7.88	7.86	7.88

* Between day 1 and day 2 system failed to maintain flow in control, PTFE, and SS 316 chambers.

** Between day 2 and day 3 system failed to maintain flow in control and PVC chambers.

‡ Between day 3 and day 4 flow stopped in all chambers.

exceeded five times their respective MDL. In contrast, total Fe concentrations significantly (ANOVA) decreased for all of the casing materials relative to the control. The magnitude of this effect increased with residence time (Figure 2). The loss of total Fe was most pronounced for SS 316, compared to the polymeric materials and the control, for residence times of one-half hour and longer. A consistent pattern of total Fe sorption occurred for the two longest residence time samples, showing SS 316 greater than SS 304 greater than PVC and PTFE greater than control.

Second Experiment - The Effect of Chamber Flushes

In the second experiment, Cu, Cd, and Pb failed to be detected above their respective MDLs. Both SS 316 and SS 304 leached Cr and Ni in excess of five times their respective MDLs and sorbed Fe in statistically significant (ANOVA) amounts when compared to the polymeric materials and the control (Figure 3). The influences appeared independent of the number of chamber flushes, and showed SS 304 to leach the most Cr and Ni while both stainless casings sorbed Fe.

Third Experiment - Spiked Water Chamber Flushes

Figures 4 through 6 show the material influences on the solution analyte concentrations for the experiment where the ground water was spiked with Pb^{2+} and Cd^{2+} . Although Cu was found to be influenced (ANOVA) by well screen materials, this analyte was not plotted since the average concentrations showed only a percent relative difference that ranged from 79 to 139 percent, as compared to the controls. As in the second experiment, both SS 316 and SS 304 leached Cr and Ni in excess of five times their respective MDLs and significantly (ANOVA) sorbed Fe (Figure 4). The addition of Pb and Cd to the ground water resulted in statistically significant (ANOVA) effects on all the materials tested. Both polymeric screens sorbed Pb (Figure 5), and PTFE also showed an apparent memory effect (delayed release of surface-sorbed analyte). For Cd, both polymeric screens showed memory and sorption effects (Figure 6). The stainless steel screens showed only sorption effects for both Pb and Cd. However, the extent of sorption by the stainless steel was significantly greater than that by the polymeric casings during the period of peak solution concentration (seventh and eighth chamber flushes).

Discussion

This experimental design provided realistic periods of exposure between well screens and the ground water from which samples were taken, while maintaining common water quality parameters (Table 4). However, some system analyte losses may have occurred independent of well screen material, as suggested by the appearance of small amounts of hydrated ferric oxide ($Fe_2O_3 \cdot 3H_2O$) in all of the chambers for the longest residence time tests (first experiment). This development was most likely accentuated by unplanned interruptions to continuous flow (Table 4) and exemplifies the care required

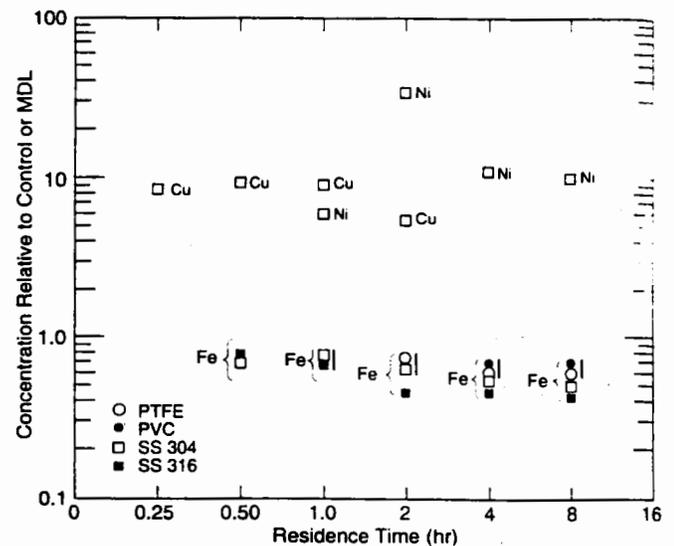


Figure 2. First experiment: Significant well screen material influences relative to the control of 5X greater than the respective MDL. Vertical bar indicates no significant (ANOVA) difference.

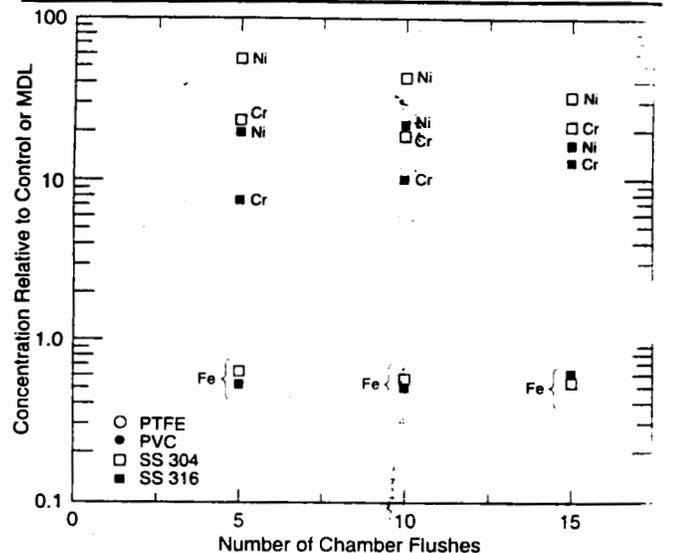


Figure 3. Second experiment: Significant well screen material influences relative to the control or 5X greater than the respective MDL.

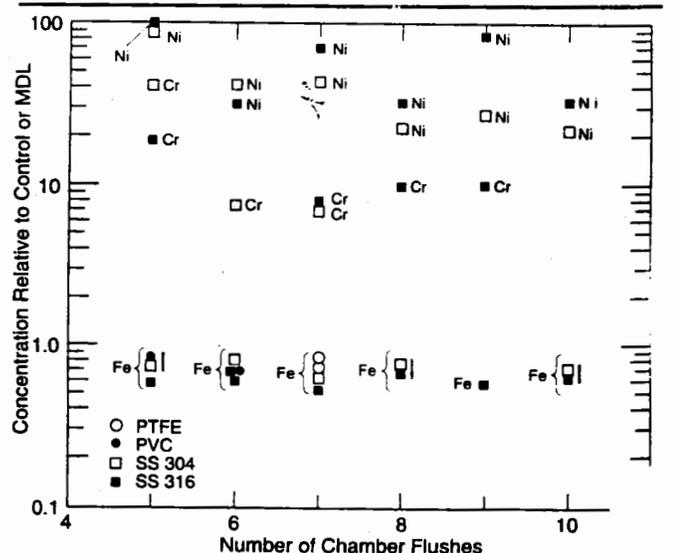


Figure 4. Third experiment: Significant well screen material influences relative to the control or 5X greater than their respective MDL for Cr, Fe, and Ni. Vertical bar indicates no significant (ANOVA) difference.

to prevent shifts in the chemical equilibria of ground water.

A possible explanation for the significant Fe losses from solution in residence time tests of two hours and greater for the polymeric materials as compared to the control (Figure 2) is that these screens trapped air bubbles when the chambers were initially filled with ground water due to their poor wetting characteristics. Thus the Fe could have been oxidized by the air bubbles that remained attached to polymeric screen throughout the first experiment. The stainless steel screens did not retain air bubbles, but it was visibly apparent within two weeks of solution exposure that they were actively being corroded (pH 7.6 to 7.8). By the time of the second and third experiments, approximately 20 percent and 5 percent of the external surfaces of the SS 304 and SS 316, respectively, were rusted. These sites of corrosion started with black or dark green centers rimmed by bands of orange, and were located on welds at points where the coiled screen connected to vertical rods or where the end caps were attached. This observation, along with the low dissolved oxygen state of the ground water (Table 3), is consistent with the precipitation of ferrous hydroxide ($\text{Fe}[\text{OH}]_2$) by galvanic corrosion (Lloyd and Heathcote 1985), thus providing a mechanism for the loss of ferrous iron from the solution. With time, the hydrated ferrous oxide slowly oxidized further to hydrated ferric oxide.

Other than the decrease of Fe (Figure 2), the first experiment failed to show any general concentration dependence on residence time. The absence of trends correlating with residence time was confounded by the number of well volumes passing through the chambers prior to sampling and by interruptions to continuous flow. Aqueous samples representative of shorter contact times (faster recharge) experienced the fewest chamber flushes (cleansing). Intermittent flow imposes uncertainty in the material exposure period since the exchange of five volumes through this type of system might not completely remove an influence caused by stagnation. The combination of these effects may explain why the elevated levels of Cu and Ni were independent of residence time.

No significant (ANOVA) material sorption effects were found for TCE under the range of dynamic conditions used for the first experiment, and average concentrations were within ± 5 percent of those of the controls. Previously, static laboratory-based experiments had shown significant (ANOVA) sorption (about a 10 percent loss as compared to controls) of TCE by PTFE after eight hours (Parker et al. 1990). The different conditions (dynamic vs. static) under which these two experiments were performed likely accounts for this discrepancy. However, since a dynamic study is more representative, the sorption of TCE by PTFE will likely not be significant for ground water samples when exposure to this casing material lasts for periods of eight hours or less.

The two experiments performed after the development of visible corrosion on the stainless steel well

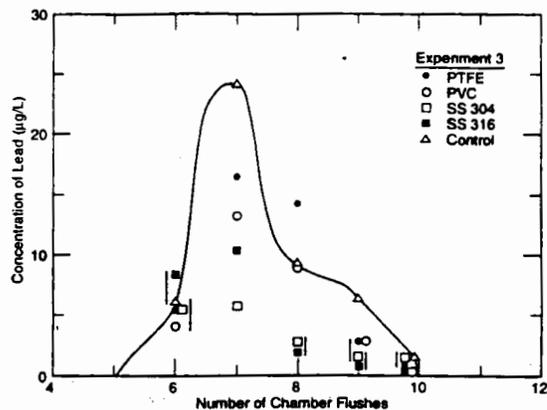


Figure 5. Third experiment: Concentrations of Pb in ground water sampled after passing through chamber system. Vertical bar indicates no significant (ANOVA) difference.

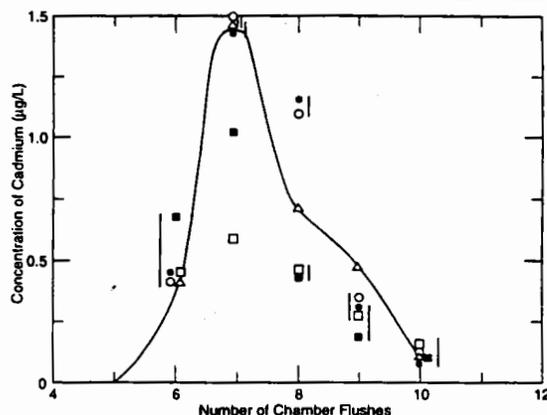


Figure 6. Third experiment: Concentrations of Cd in ground water sampled after passing through chamber system. Vertical bar indicates no significant (ANOVA) difference.

screens showed that material effects for Fe, Cr, and Ni often persisted even after 10 system flushes. Moreover, the magnitude of the Ni and Cr leached into solution was far greater than for virgin, noncorroded materials. Comparing the average solution concentrations for each experiment's first round of samples collected (five chamber flushes) shows increasing Ni concentrations for both stainless steel screens and increasing Cr concentrations for the SS 304 screen (Table 5). Furthermore, with the development of iron oxide coatings, new surfaces were generated that provided large and active exchange sites for the sorption of metals from solution. The third experiment provided strong evidence for the occurrence of

	SS 316		SS 304	
	Cr	Ni	Cr	Ni
1st Exp.	<MDL	2.6	0.57	3.1
2nd Exp.	5.4	20	1.9	55
3rd Exp.	4.7	97	9.9	92

this loss mechanism, since both Pb^{2+} and Cd^{2+} were sorbed from the solution as the ground water passed through chambers with the corroded stainless screens. An adsorption study using radio-labeled metals and porous vacuum pore-water samplers also found stainless steel to be very active (McGuire et al. 1992). Most likely, the amount of corrosion on the surface of the two stainless screens magnified effects on aqueous metal chemistry, the extent of which might be inferred from increasing levels of Ni and Cr in ground water samples. Consistent with previous studies performed with these four casing materials (Hewitt 1989a, 1989b; Parker et al. 1990; Hewitt 1992), SS 304 and SS 316 presented the greatest material challenges to obtaining representative metal concentrations in ground water samples.

Conclusion

Common stainless steel well screens significantly affect solution metal concentrations under dynamic conditions consistent with typical ground water sampling protocol. The magnitude of the influence appears directly correlated with the presence of corrosion products on stainless steel casings, and concentrations of Ni (and perhaps Cr) could approach those that would affect regulatory compliance. Along with leaching, surface corrosion also causes significant sorption losses for metals such as Pb^{2+} and Cd^{2+} . Only PVC and PTFE, which showed no influence or diminished influences in comparison to the stainless steel screens, should be recommended for construction of wells intended for monitoring metals in ground water. No significant sorption of TCE was observed for dynamic conditions that limited the exposure between casing materials and ground water to eight hours or less.

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Influence of Casing Materials on Trace-Level Chemicals in Well Water

by Louise V. Parker, Alan D. Hewitt, and Thomas F. Jenkins

Abstract

Four well casing materials — polyvinyl chloride (PVC), polytetrafluoroethylene (PTFE), and stainless steel 304 (SS 304) and 316 (SS 316) — were examined to determine their suitability for monitoring inorganic and organic constituents in well water.

The inorganic study used a factorial design to test the effect of concentration of mixed metals (arsenic [As], chromium [Cr], lead [Pb], and cadmium [Cd]), pH, and organic carbon. Sample times were 0.5, 4, 8, 24, and 72 hours. Except for slow loss of Pb, PTFE well casings had no significant effect on the concentration of metals in solution. For the other casings, changes in analyte concentration often exceeded 10 percent in eight hours or less and, thus, could bias analyses of samples taken from wells constructed with these materials. Specifically, PVC casings sorbed Pb and leached Cd; SS 316 casings sorbed As and Pb and leached Cd; and SS 304 casings sorbed As, Cr, and Pb and leached Cd. Both stainless steel casing materials showed markedly poorer performance than the PVC casings.

The well casings were also tested for sorption/desorption of 10 organic substances from the following classes: chlorinated alkenes, chlorinated aromatics, nitroaromatics and nitramines. Sample times were 0, 1, 8, 24, and 72 hours, seven days, and six weeks. There were no detectable losses of analytes in any of the sample solutions containing stainless steel well casings. Significant loss of some analytes was observed in sample solutions containing plastic casings, although losses were always more rapid with the PTFE casings than with PVC. Chlorinated organic substances were lost most rapidly. For samples containing PTFE casings, losses of some of these compounds were rapid enough (>10 percent in eight hours) to be of concern for ground water monitoring. Losses of hydrophobic organic constituents in samples containing PTFE casings were correlated with the compound's octanol/water partition coefficient.

Introduction

The U.S. Environmental Protection Agency's (EPA's) RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD) (U.S. EPA 1986a) states that only fluorocarbon resins or stainless steel (SS) casings should be used for monitoring volatile organics in the saturated zone. The original draft of this document (U.S. EPA 1985) suggested that Teflon® or stainless steel 304 be used for all ground water monitoring at RCRA sites. The EPA was concerned that many of the casing materials used for ground water monitoring could either affect the quality of the ground water or did not have the long-term structural characteristics required of RCRA monitoring wells. With respect to the EPA's first concern, a review of the literature published prior to 1986 did not reveal substantial evidence to support the position taken by the EPA in either edition of this document (Parker et al. 1989).

Few studies have specifically addressed the possible interactions between well casing materials and metal species. There is considerable evidence, however, that sorption of metals by plastic and glass containers can

be significant (Eicholz et al. 1965, Robertson 1968, Batley and Gardner 1977, and Masse et al. 1981). In one study of PVC well casings, there was negligible loss of chromium but large losses of lead from a deionized water solution (Miller 1982). Other studies with Pyrex glass and polyethylene also found that lead was the most rapidly lost analyte (Shendrikar et al. 1976). Barcelona and Helfrich (1986) compared the concentrations of several metal species in samples taken from adjacent PVC, PTFE, and SS wells. They found increased levels of iron in water samples from the non-purged SS well to be the only statistically significant difference. In a previous in situ study by Houghton and Berger (1984), a steel-cased well appeared to leach a number of metal species, including iron, cadmium, chromium, copper, manganese, molybdenum, selenium, and zinc, when compared with a PVC well and one constructed of acrylonitrile-butadiene-styrene (ABS).

Sorption of organic solutes by well casing materials has been reported in several publications. Miller (1982) tested PVC well casing for sorption of trace levels (2-14 ppb) of six halogenated organic compounds (bromo-

form, trichlorofluoromethane, trichloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, and tetrachloroethylene) in aqueous solution and found slow losses of tetrachloroethylene (25-50 percent in six weeks).

Reynolds and Gillham (1986) tested both PVC and PTFE materials for sorption of trace levels (ppb) of five halogenated organics. They found rapid sorption of tetrachloroethylene by PTFE, slow sorption of 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane and hexachloroethane, and no sorption of bromoform. They also found slow sorption of all the analytes except trichloroethane by PVC. While 50 percent of the tetrachloroethylene was sorbed by the PVC in five weeks, the same amount was sorbed by PTFE in only eight hours. They attributed loss of these organics to absorption and developed a model where uptake of the compound proceeds by sorption/dissolution into the polymer surface, followed by diffusion into the polymer matrix. However, Reynolds and Gilham (1986) could not predict which organic chemicals were most susceptible to absorption.

Sykes et al. (1986) compared sorption of several organics by PVC, SS, and PTFE well casings. The casing materials were equilibrated for seven days (5 C) in analyte solution, placed in fresh analyte solution, and then tested for losses due to sorption after one and 24 hours. After 24 hours they did not find any significant losses for any of the casing materials.

While these studies indicate that sorption of some organics may be a significant problem for plastic casings over the long term, only the study by Miller (1982) examined desorption during the first two weeks. In that study, he observed some desorption (25 percent) of the tetrachloroethylene that had been previously sorbed by the PVC casings.

Casing materials may also leach a variety of organic substances. In two studies (Miller 1982, Parker and Jenkins 1986), analytical interferences in leachates from PVC well casings were sought but none were found. Curran and Tomson (1983) also examined the leachates from five plastics, including PVC and PTFE. They found that PTFE leached the fewest contaminants and that non-glued PVC was a close second. While it is possible that organic substances such as lubricants used during manufacture or inks from printing could leach from stainless or plastic casings, no information currently available in the literature confirms this.

It is interesting to note that despite the literature that is available regarding sorption of organics by PTFE, articles have recently been published that claim it is superior for sampling organic substances (e.g., Bryden and Smith 1989).

The purpose of the studies conducted by the authors was to determine the suitability of four well casing materials (PVC, PTFE, SS304, and SS316) for monitoring inorganic and organic solutes in ground water. To do this, two separate studies were conducted, one for inorganics and one for organics.

General Comments on the Inorganic and Organic Studies

Two-inch (inner) diameter well casings manufactured specifically for ground water monitoring were used in all studies. These casings were purchased specifically for the studies and were stored in a cool, dry room prior to use. Precautions were taken while the casings were being cut to prevent contamination from grease, dirt, oil, solvents, and excessive handling. The ground water used in the studies was obtained from a domestic well (249 feet [76m] deep) in Weathersfield, Vermont. No attempt was made to maintain the native dissolved oxygen level. As a general guideline for evaluating our results, we considered any change in concentration (relative to the control samples) of 10 percent in an eight-hour period to be the maximum change tolerable.

Inorganic Study

Experimental

Mixed metal solutions were prepared by spiking ground water with arsenic (As), cadmium (Cd), chromium (Cr) and lead (Pb) at two concentrations: 50 and 100 $\mu\text{g/L}$ (ppb) for As, Cr, and Pb, and 10 and 2 $\mu\text{g/L}$ for Cd. The higher concentrations are the current maximum concentration limits set by the EPA for drinking water (U.S. EPA 1986b). Prior to treatment, the ground water used in this study was analyzed and found to contain no detectable amounts of any of these metals at the sensitivity levels used for analysis. To simulate a wider range of ground water conditions, the tests were run at the natural pH (7.8) of the well water plus a lower pH (5.8) and at two levels of organic carbon. HCl (reagent grade) was added to lower the pH and 5 mg/L (ppm) of humic acid was added to raise the organic carbon content. A complete (2³) factorial experiment was used to test the effect of these treatments (concentration of metals, pH and organic carbon content) (Table 1).

Because the wall thicknesses varied between the plastic and the two stainless steel casings, the casings

TABLE 1
Matrix Design for Inorganic Study

Test Condition	Metal Concentrations ¹	pH	Organic Carbon Added ²
1	high	7.8	no
2	high	7.8	yes
3	high	5.8	no
4	high	5.8	yes
5	low	7.8	no
6	low	7.8	yes
7	low	5.8	no
8	low	5.8	yes

¹ High metal concentrations were 50 $\mu\text{g/L}$ As, Cr, Pb, and 10 $\mu\text{g/L}$ Cd. Low metal concentrations were 10 $\mu\text{g/L}$ As, Cr, Pb, and 2 $\mu\text{g/L}$ Cd.

² 5 mg/L humic acid was added as a source of organic carbon.

were cut to different lengths so that the surface area of each was constant (80 cm²). Cut sections were rinsed with deionized water and air-dried before use. Individual well casings were then placed in 125mL polypropylene jars containing 100mL of test solution; the ratio of casing surface area to aqueous volume was 0.82 cm²/mL. Similar jars that contained the test solutions without any casings were used for control samples. The sample vessels were covered, stored at 24 C and kept from natural light. Duplicates were run for each combination of variables and each casing material.

Sample aliquots (2.5mL) were taken from each container after 0.5, 4, 8, 24, and 72 hours. The aliquots were placed in clean 7.5mL polyethylene vials and acidified to a pH of less than 1 with nitric acid to prevent sorption by the containers. Metal concentrations were obtained by graphite furnace atomic absorption spectroscopy (Perkin-Elmer, model 703 atomic absorption spectrophotometer coupled with a PE model 2200 heated graphite atomizer). The concentrations of metals given in this study were measured as total.

The metal concentrations were normalized by dividing the values obtained for sample solutions that contained well casings by the values found for equivalent

controls. This allowed the results for both concentrations to be analyzed by a single analysis of variance (ANOVA). Thus, it was possible to simultaneously test for the effect of solute concentration, pH and organic carbon at each sample time for each casing material. If a casing exerted no influence on analyte concentration, the expected value would be 1.00. An increase in the ratio indicates that the well casing released metal into the solution, while a decrease in the ratio indicates that metal was sorbed by the casing.

Results and Discussions

Approximately half of the stainless steel casings showed signs of surface rust. In some cases (SS 316 at a low pH), sufficient oxidation occurred to form a hydrous iron oxide precipitate. This precipitate was never observed in the control samples or those with PVC or PTFE casings. While the authors realize that rusting of the stainless casings is very condition-specific, the test conditions should be generally representative of shallow wells. Also, it was noticed that the casings had rusted some during storage prior to any testing.

Table 2 gives the normalized mean values and standard deviations for each analyte, well casing and time.

TABLE 2
Normalized Mean Metal Values¹ for Samples as a Function of Time

Time (hr)	Pipe	Arsenic		Cadmium		Chromium		Lead	
		Mean Value	Standard Deviation						
0.5	PVC	0.991 ±	0.038	1.01 ±	0.025	1.01 ±	0.018	0.999 ±	0.009
	PTFE	0.999 ±	0.050	1.01 ±	0.011	1.01 ±	0.007	1.00 ±	0.026
	SS304	0.997 ±	0.057	1.06 ±	0.036	1.01 ±	0.016	1.02 ±	0.008
	SS316	0.994 ±	0.040	1.04 ±	0.021	1.02 ±	0.015	1.01 ±	0.025
4.0	PVC	1.02 ±	0.045	1.13 ±	0.037	0.999 ±	0.013	0.889 ±	0.030
	PTFE	0.993 ±	0.052	1.03 ±	0.054	1.01 ±	0.011	0.974 ±	0.019
	SS304	0.978 ±	0.063	1.17 ±	0.15	0.957 ±	0.037	0.784 ±	0.035
	SS316	0.945 ±	0.060	1.24 ±	0.49	0.921 ±	0.052	0.803 ±	0.077
8.0	PVC	1.00 ±	0.045	1.15 ±	0.037	1.00 ±	0.014	0.893 ±	0.035
	PTFE	1.01 ±	0.098	1.03 ±	0.016	0.989 ±	0.019	0.985 ±	0.032
	SS304	0.962 ±	0.057	1.16 ±	0.14	0.972 ±	0.16	0.699 ±	0.031
	SS316	0.945 ±	0.068	1.30 ±	0.47	0.872 ±	0.10	0.804 ±	0.10
24.0	PVC	0.994 ±	0.064	1.16 ±	0.056	1.00 ±	0.016	0.808 ±	0.051
	PTFE	0.992 ±	0.054	1.03 ±	0.017	1.01 ±	0.024	0.951 ±	0.040
	SS304	0.894 ±	0.051	1.12 ±	0.12	1.03 ±	0.37	0.538 ±	0.042
	SS316	0.853 ±	0.080	1.36 ±	0.68	0.855 ±	0.11	0.793 ±	0.19
72.0	PVC	1.03 ±	0.046	1.14 ±	0.049	1.01 ±	0.018	0.743 ±	0.064
	PTFE	1.02 ±	0.045	1.02 ±	0.022	1.00 ±	0.013	0.899 ±	0.034
	SS304	0.891 ±	0.084	1.03 ±	0.14	1.03 ±	0.42	0.452 ±	0.061
	SS316	0.874 ±	0.083	1.25 ±	0.66	0.836 ±	0.099	0.720 ±	0.17

¹ (Concentration for samples with casing) / (Concentration for control samples) = Normalized mean value

These normalized values are the mean of all the treatments (i.e., for both pHs, organic carbon content, and concentration).

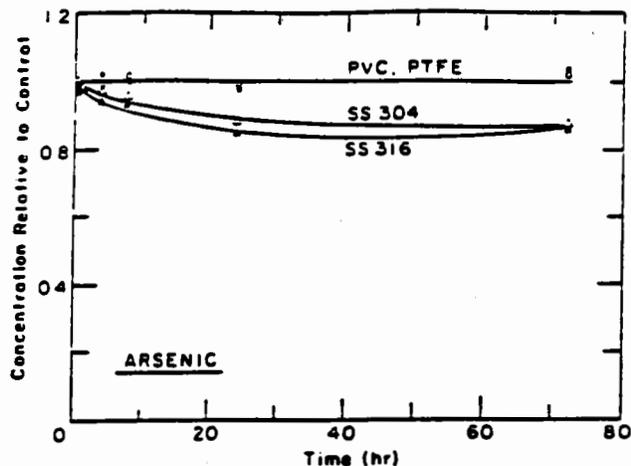


Figure 1. Trends in mean arsenic concentration for four well casing materials.

In general, there was no change in arsenic concentration for the sample solutions containing either the PVC or PTFE casings during the 72-hour test period (Figure 1), and no consistent pattern of effects was evident from the ANOVA. The reason As did not interact with these casings may be because As exists in natural waters in the anionic form (Fowler et al. 1979). Masse et al. (1981) found that anions do not strongly associate with plastic (polyethylene and PTFE) surfaces, which are known for their cation exchange capacity. The samples containing the stainless steel casings, on the other hand, showed a 10 percent decrease in aqueous arsenic concentration relative to the controls after 24 hours (Figure 1). It appears that there was no further loss of this analyte after 24 hours. Although these results cannot be used to predict exactly what losses might occur under field conditions, it is doubtful that this loss was rapid enough to impact water quality measurements (losses were less than 10 percent after eight hours).

The results for Cd are quite different. After only four hours, Cd concentrations in the samples containing PVC and stainless steel casings had increased by more than 10 percent (Figure 2), with the most leaching occurring in the samples containing the SS 316 casings. Cadmium may have been added to the PVC as a UV stabilizer (Wilson et al. 1982), and may have been added to the stainless steel to enhance resistance to chloride cracking (Sedricks 1979). The concentration of Cd in the samples containing PVC casings leveled off after eight hours. ANOVA revealed that pH had a significant effect (at the 95 percent confidence level) for this casing. Although the same amount of Cd leached in all the samples (approximately 0.5 mg/L), concentration was also significant (at the 95 percent confidence level), but only because relatively more was leached in the low-concentration samples. Concentrations in samples containing SS 304 casings decreased after eight hours and after 72 hours had returned to the same levels that were found in the control samples. Again, more Cd leached in the low pH samples. Cd was leached most rapidly in samples containing SS 316 casings. There was a large discrepancy between duplicate treatments for the sam-

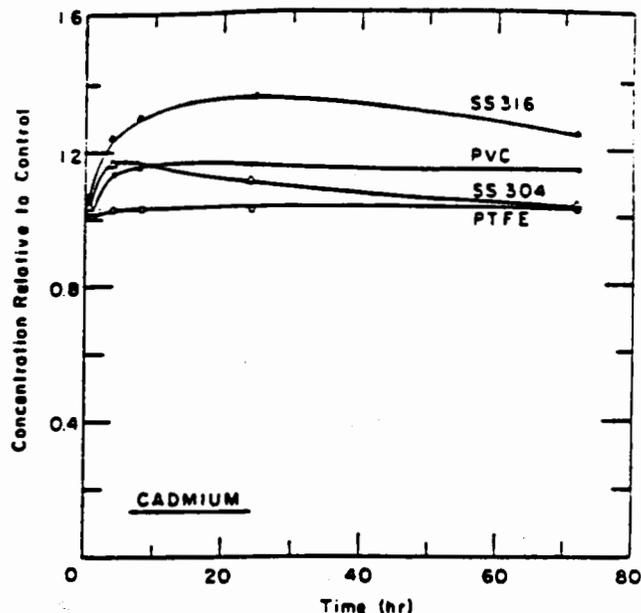


Figure 2. Trends in mean cadmium concentration for four well casing materials.

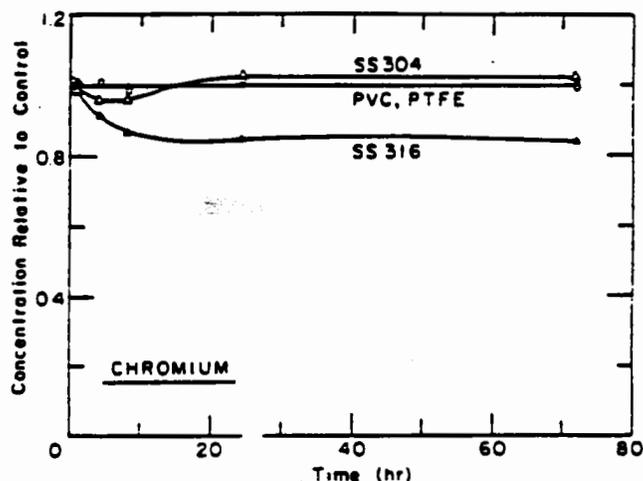


Figure 3. Trends in mean chromium concentration for four well casing materials.

ples that contained stainless steel casings. With the exception of the first set of samples ($t = 0.5$ hr), the relative standard deviations ranged from 12 to 15 percent for samples containing SS 304 and from 47 to 68 percent for those containing SS 316. In contrast, the standard deviations for samples containing PVC and PTFE casings were consistently below 6 percent. Because the variance in the samples containing SS 316 was so large, there was no consistent detectable effect of pH for these casings. However, surface oxidation appeared to be the major source of this variance. With respect to the leaching of metal stabilizers from PVC pipes, the literature indicates that loss can be a surface phenomenon that can be reduced or eliminated by either washing (with detergent) or soaking in dilute mineral acid before use (Packham 1971). It may be that the loss of Cd from PVC casings can also be reduced by a similar treatment, although we did not test this possibility.

There was no measurable sorption of chromium by the PTFE, PVC, and SS 304 casings (Figure 3). Absence

of interaction with the plastic casings may be due to chromium speciation. In solution, chromium exists predominantly as dichromate and chromate ($\text{Cr}_2\text{O}_7^{2-}$, CrO_4^{2-}) and, as mentioned previously, anions are not as likely to exchange with plastic surfaces. However, loss of chromium was rapid enough (13 percent after eight hours) for SS 316 casing material to be of concern for ground water monitoring. Losses were greater at the higher pH. Cr speciation is known to be affected by pH and may be responsible for some of these differences. Surface oxidation was greater at the lower pH, which likely contributed to the larger variability. Also, for those samples where a hydrous iron oxide precipitate was formed, co-precipitation may have contributed to the losses from solution. Again, the standard deviations were considerably greater for the samples containing the stainless steel casings. Humic acids apparently increased the stability of aqueous Cr, perhaps by acting as a complexing agent (Stumm and Morgan 1970s).

Lead was by far the most actively sorbed metal species. While all sample solutions containing casing materials showed some loss of Pb with time (Figure 4), PTFE was the least active surface and SS 304 was the most active. The losses for samples containing PTFE casings do not appear to be of concern with respect to ground water monitoring; losses were only 5 percent after 24 hours. However, losses for samples containing PVC and stainless casings are of concern: losses were 10 percent after only four hours in the samples containing PVC casings and 20 percent in those containing stainless casings. Although loss was initially rapid in samples containing SS 316 casings, it leveled off after eight hours. The standard deviation was higher for the samples containing SS 316 casings than for the other casings. For both stainless steel casings, there was less sorption of Pb at the lower pH where hydrogen ions may have competed for sorption sites. Added humic material apparently acted as a complexing agent in solution, making lead less prone to sorption. Concentration had no consistent effect.

Undoubtedly, there were shifts in the chemical equilibria of the well water solutions from the time the well water was collected until the end of the experiment. Ground water that is removed from an anoxic environment and exposed to oxygen-rich air may undergo redox and precipitation reactions (Stumm and Morgan 1970b). Also, lowering the pH shifts the carbonate equilibrium in solution from predominantly bicarbonate species toward carbon dioxide (Manahan 1972) and causes shifts in Cr speciation. Clearly, such changes would alter the trace metal species distribution. These possible changes were not monitored in this experiment.

For further details on this portion of the study, refer to Hewitt (1989).

Organic Study

Experimental

The four well casing materials were also tested for sorption/desorption of low levels of 10 organic substances. The substances tested were hexahydro-1,3,5-

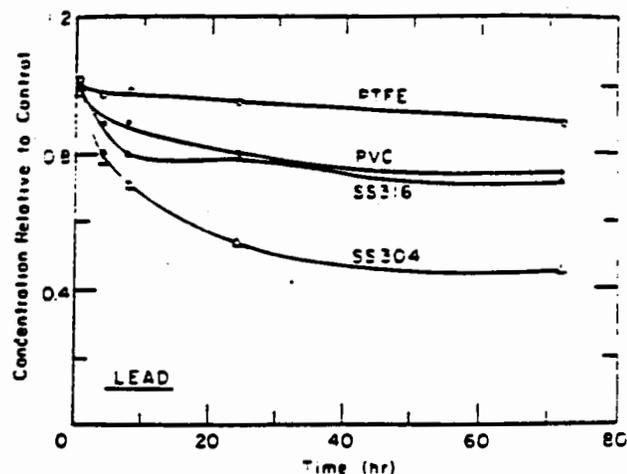


Figure 4. Trends in mean lead concentration for four well casing materials.

trinitro-1,3,5-triazine (RDX), 1,3,5-trinitrobenzene (TNB), cis- and trans-1,2-dichloroethylene (CDCE and TDCE), m-nitrotoluene (MNT), trichloroethylene (TCE), chlorobenzene (CLB), and o-, p- and m-dichlorobenzene (ODCB, PDCB, MDCB). The criteria used for selecting these analytes included being an EPA priority pollutant, molecular structure, solubility in water, K_{ow} value, and retention time (using reversed-phase high performance liquid chromatography [HPLC] analysis). HPLC analysis of the ground water used in these studies revealed no detectable levels of any of these substances.

For these experiments, casings were cut into 11- to 14mm-long sections, which were then cut into quarters. Again, the length was varied so that the surface area could be maintained constant. The casings were washed in solutions of detergent and deionized water, rinsed many times with deionized water, drained and left to air dry. Two pieces of each type of casing were placed in 40mL glass vials that were filled with the aqueous test solution so there was no head space, and capped with Teflon-lined plastic caps. Vials with test solution but no well casing material served as controls. These controls allowed us to eliminate any effects such as those that might be due to the vials or caps. The ratio of casing surface area to solution volume was $0.79 \text{ cm}^2/\text{mL}$. The ratio of solution volume to volume of casing material was approximately 10:1.

In the first experiment, the test solution was prepared by adding known amounts of each of the organic solutes directly to 2.2 L of well water in a glass-stoppered bottle, which was stirred overnight. The final concentration was approximately 2 mg/L for each organic constituent. The solution also contained 40 mg/L of HgCl_2 , which was added to prevent biodegradation of the organics. Separate vials were prepared for each sample time so that the test solution could be discarded after sampling; there were three replicate samples for each material and time. Contact times were 0 hours, one hour, eight hours, 24 hours, 72 hours (three days), 168 hours (seven days), and approximately 1000 hours (six weeks).

After an aliquot was removed for analysis from each

TABLE 3
Normalized¹ Average Concentrations of Organic Analytes for the Four Well Casings with Time

Analyte	Treatment	1 Hour	8 Hours	24 Hours	72 Hours	168 Hours	1000 Hours
RDX	PTFE	1.03	1.00	1.00	1.02	0.91	0.99
	PVC	1.01	1.00	0.98	1.00	1.02	1.00
	SS304	0.99	0.99	1.01	1.02	1.10	0.98
	SS316	1.01	0.99	1.01	1.02	1.11	1.00
TNB	PTFE	1.01	1.00	1.00	0.98	0.95	1.01
	PVC	1.01	1.00	0.98	1.02	1.01	1.02
	SS304	0.99	1.00	1.00	1.05	1.07	1.00
	SS316	1.02	0.99	1.01	1.07	1.06	1.02
C12DCE	PTFE	1.01	0.96*	0.96*	0.94	0.91*	0.79*
	PVC	1.00	0.99	0.95*	0.96	0.95	0.90
	SS304	0.97	1.00	1.00	0.96	1.04	0.98
	SS316	0.95	0.99	1.00	1.01	0.98	0.99
T12DCE	PTFE	1.00	0.92*	0.88*	0.83	0.66	0.56*
	PVC	1.00	0.98	0.93*	1.06	0.83	0.83
	SS304	0.95*	1.00	1.00	0.96	1.11	1.00
	SS316	1.00	0.99	1.00	1.12	1.03	1.00
MNT	PTFE	1.03	1.00	0.99	0.99	0.90	0.90*
	PVC	1.02	1.00	0.98	1.05	0.99	0.94
	SS304	1.00	1.00	1.01	1.00	1.08	1.07
	SS316	1.02	1.00	1.02	1.08	1.10	0.99
TCE	PTFE	1.00	0.90*	0.85*	0.78*	0.64*	0.40*
	PVE	1.01	0.98	0.94*	0.99	0.94*	0.88*
	SS304	0.96	1.00	1.01	0.96	1.04	0.99
	SS316	1.00	0.99	1.00	1.04	0.98	1.00
CLB	PTFE	1.01	0.93*	0.90*	0.85*	0.74*	0.51*
	PVC	1.01	0.98	0.95*	0.98	0.94*	0.86*
	SS304	0.98	1.00	1.00	0.97	1.05	0.99
	SS316	0.99	0.99	1.01	1.04	0.98	0.99
ODCB	PTFE	1.01	0.91*	0.88*	0.81*	0.68*	0.43*
	PVC	1.02	0.97*	0.94*	0.98	0.93	0.86*
	SS304	0.98	0.99	1.00	0.99	1.04	1.00
	SS316	1.01	0.98*	1.01	1.03	0.98	1.00
PDCB	PTFE	0.92*	0.84*	0.77*	0.64*	0.47*	0.26*
	PVC	0.95	0.95*	0.92*	0.97	0.88*	0.80*
	SS304	0.91*	0.98	1.00	0.98	1.02	1.02
	SS316	0.94	0.97*	1.00	1.04	0.97	1.02
MDCB	PTFE	1.00	0.84*	0.78*	0.66*	0.48*	0.26*
	PVC	1.02	0.95*	0.92*	0.97	0.88*	0.80*
	SS304	0.99	0.96*	1.00	0.99	1.02	1.02
	SS316	1.03	0.96*	1.00	1.04	0.96	1.01

¹ Values are determined by dividing the mean concentration of a given analyte at a given time and for a particular well casing by the mean concentration (for the same analyte) of the control samples taken at the same time.

* Values significantly different from control values ($\alpha = 0.05$)

of the 1000-hour samples, the vials were emptied and the pieces of casing were rinsed with approximately 40 mL of fresh well water to remove any residual solution adhering to the surfaces. The casing pieces were then placed in new vials, and fresh unspiked well water was added. The vials were capped with new caps and allowed to equilibrate for three days. Aliquots were then taken from these samples and analyzed to determine if desorption had occurred.

In the second experiment 2.0 g/L of NaCl was also added to the test solution to determine the effect of increased ionic strength on the rates of sorption. Sampling times were the same except that the last samples were taken after approximately 1200 hours (seven weeks).

All analytical determinations were made by reversed-phase high performance liquid chromatography. A modular system was employed that consisted of a Spectra Physics SP 8810 isocratic pump, a Dynatech LC-241 autosampler with a 100- μ L loop injector, a Spectra-Physics SP8490 variable wavelength UV detector set at 210 nm, a Hewlett-Packard 3393A digital integrator, and a Linear model 555 strip chart recorder. Separations were obtained on a 25cm x 4.6mm (5 μ m) LC-18 column (Supelco) eluted with 1.5 mL/min of 62/38 (v/v) methanol-water. Baseline separation was achieved for all 10 analytes. Detector response was obtained from the digital integrator operating in the peak height mode. Analytical precision ranged from 0.4 to 3.98 percent, as determined by the pooled standard deviation of triplicate initial measurements.

For each analyte and sample time, a one-way analysis of variance (ANOVA) was performed to determine if the well casing material had a significant effect on analyte concentration. Where significant differences were found, Duncan's multiple range test was performed to determine which samples were significantly different from the controls.

Before the two experiments described previously were performed, a preliminary leaching study was conducted to determine if any substances that could interfere with the analytical determinations leached from the casing materials. For this study, two pieces of each type of well casing were placed in each of two vials. The vials were filled with fresh well water so that there was no headspace, capped and allowed to sit for one week. An aliquot was taken from each vial and analyzed. No detectable peaks were observed in any of the samples.

Results and Discussion

The data for the first experiment are summarized in Table 3, where the normalized concentrations for solutions containing well casings are given as a function of time. Neither type of stainless steel casing affected the concentrations of any of the analytes in solution. However, significant loss of solute did occur in the solutions that contained plastic casings. While the rate of loss differed dramatically from analyte to analyte, losses were always greater for PTFE than PVC.

For RDX and TNB there was no loss of analyte from solutions containing either plastic casing, even

after 1000 hours. There was some loss of MNT in the sample solutions that contained PTFE casings but the loss only became significant after 1000 hours (10 percent loss); there was no loss with the PVC casings. TDCE was lost much more readily in samples containing PTFE casings than was its isomer pair, CDCE (Figure 5). (The solid lines shown in this figure and Figures 6-9 were fitted manually.) Figure 6 shows the losses of TCE for the four well casings. Figure 7 shows the rate of loss of the three DCB isomers and CLB in the samples that contained PTFE casings. The order of loss was PDCB and MDCB > ODCB > CLB. While the rate of loss did not exceed 10 percent in eight hours for any of the previous solutes, it is noted that losses of PDCB and MDCB were 16 percent in eight hours and thus were rapid enough to be of concern with respect to ground

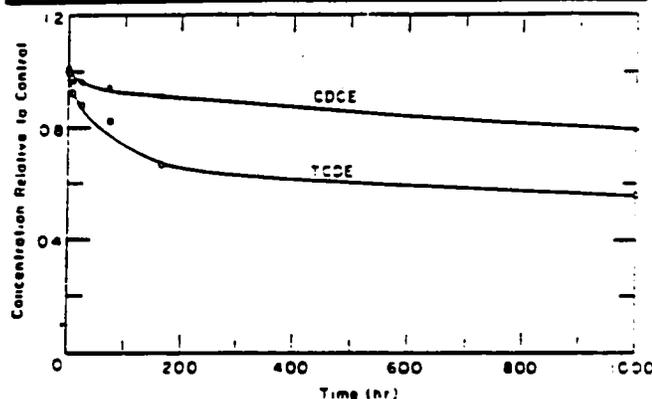


Figure 5. Sorption of CDCE and TDCE by PTFE well casings.

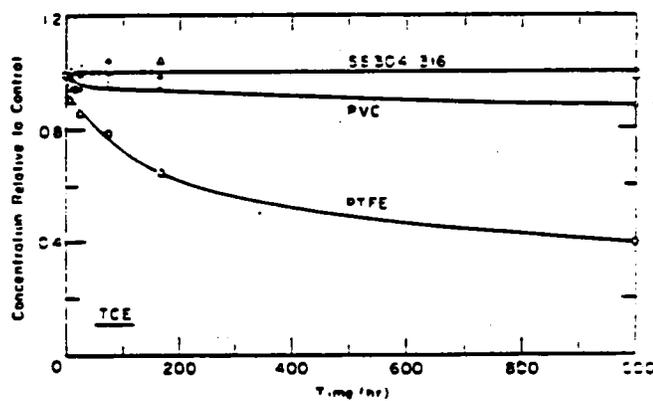


Figure 6. Sorption of TCE by the four well casing materials.

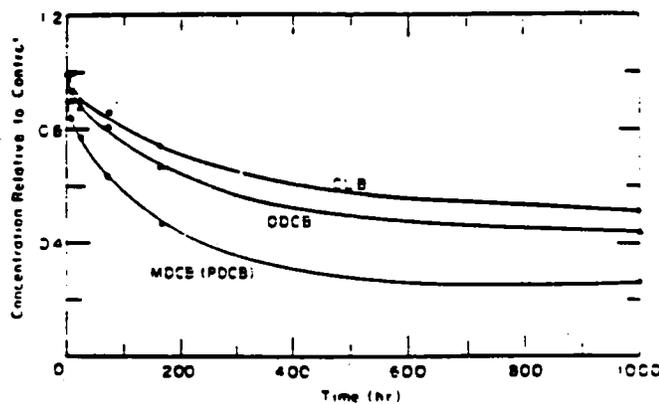


Figure 7. Sorption of CLB, ODCB, MDCB and PDCB by PTFE well casings.

TABLE 4
Results of Desorption Study

Casing Material	Concentration in mg/L after three days equilibration									
	RDX	TNB	CDCE	TDCE	MNT	TCE	CLB	ODCB	PDCB	MDCB
Teflon	ND	ND	0.20	0.43	0.075	0.47	0.28	0.38	0.30	0.35
	ND	ND	0.21	0.45	0.076	0.48	0.28	0.35	0.34	0.36
	ND	ND	*	*	0.074	*	*	*	*	*
PVC	ND	ND	0.079	0.15	0.046	0.14	0.10	0.15	0.17	0.18
	ND	ND	0.080	0.14	0.046	0.14	0.10	0.15	0.16	0.21
	ND	ND	0.080	0.15	0.043	0.13	0.11	0.16	0.16	0.20

* Results not presented because of additional loss of volatiles, probably resulting from a loose cap on this vial.
ND = Not detected.

water monitoring. For PVC, losses never reached 10 percent in eight hours for any of the organics tested, and thus the authors believe that PVC is clearly superior to PTFE for wells where water samples will be analyzed for organic constituents.

To determine if the loss of organic solutes was reversible, the pieces of casing that had been exposed to test solution for 1000 hours were rinsed and then exposed to fresh well water for three days. Measurable quantities of all the organics were recovered where significant losses had been observed (Table 4). Thus, loss was due to sorption and was at least partially reversible. Although this experiment did not give us information on the kinetics of desorption, the amount of analyte desorbed after three days generally paralleled the amount sorbed. However, PDCB and MDCB were sorbed to the greatest extent while TCE and TDCE were desorbed to the greatest extent. Therefore, it may be that diffusion out of the polymer is more rapid for smaller molecules.

In the second experiment NaCl was added to raise the chloride concentration above 1000 mg/L. High chloride concentrations are known to corrode 304 stainless steel. Specifically, tests were performed to determine if rusting would alter the sorptivity of the stainless steel surfaces. It is also possible that sorption on plastic materials would change with increasing ionic strength of the test solution.

While addition of NaCl caused rapid rusting of both stainless steel casings (<24 hr), it did not cause sorption of any of the organic solutes by them. In addition, the increased ionic strength had no detectable effect on the rate of sorption by either plastic casing (for example, Figures 8 and 9). These two figures also demonstrate the excellent reproducibility of the results from these two experiments.

Modeling the Sorption Process

These organic studies clearly demonstrated that the loss of organic chemicals from solutions exposed to plastic casing materials is via some reversible sorption process. However, it was uncertain whether this loss was due to sorption on the surface or whether there was

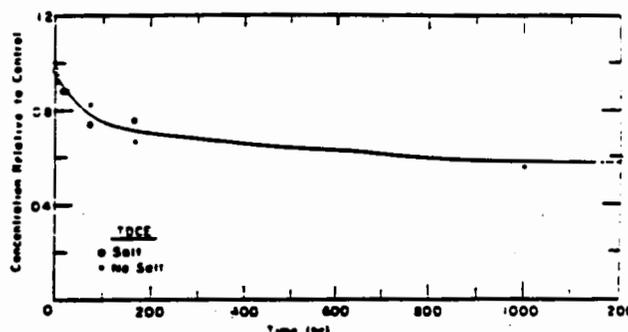


Figure 8. Sorption of TDCE by PTFE well casings in the presence and absence of salt.

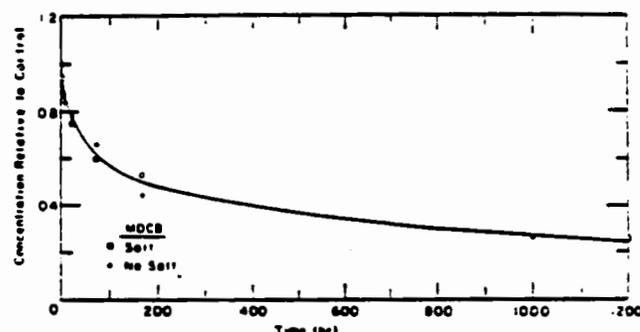


Figure 9. Sorption of MDCB by PTFE well casings in the presence and absence of salt.

penetration into the polymer matrix. The rate of sorption was found to be slow, with no established equilibrium after hundreds of hours. One explanation for this slow rate was that penetration into the polymer was occurring, with the rate controlled by slow diffusion within the bulk polymer and/or the rate of penetration into the small pores on the polymer surface. If it is assumed that this is the case, the process can be kinetically modeled by treating the plastic casing as an immiscible liquid phase in contact with water and relating the degree of partitioning for individual analytes to their octanol/water partition coefficients (K_{ow}). While there are immiscible liquids other than octanol that are better structural models for PTFE or PVC, the most extensive collection of partition coefficients is available for octanol.

If it is assumed that sorption is a reversible process.



and is first order in both directions, then the rate equation can be written as (Gould 1959):

$$\frac{d[A_w]}{dt} = -k_1 [A_w] + k_2 [A_s] \quad (2)$$

where $[A_w]$ is the concentration of solute A in aqueous solution, $[A_s]$ is the concentration of solute A in the plastic casing material, and k_1 and k_2 are the first-order rate constants for sorption and desorption, respectively.

Integration of the rate equation results in a non-linear relationship for A_w as a function of time t and two constants a and b (Equation 3), where a and b are defined in Equations 4 and 5:

$$\frac{\ln(a[A_w] + b)}{a} = t \quad (3)$$

$$a = k_1 + k_2 \quad (4)$$

$$b = 10k_2 [A_0] \quad (5)$$

where A_0 is the initial concentration of solute A in aqueous solution.

Optimal values for a and b were obtained for each solute exposed to PTFE by application of the Gauss-Newton method of non-linear curve fitting using the measured concentrations at 1, 8, 24, 72, 128, and 1000 hours (Parker et al. 1989). Using determined values for a and b , the authors simultaneously solved Equations 4 and 5 for each solute to obtain estimates of k_1 and k_2 . Because the process described is assumed to be reversible and first order, the ratio of the rate constants, k_1/k_2 , is the equilibrium constant, K_{eq} .

When the eight values of K_{eq} were plotted vs. Log K_{ow} , six of the eight points appeared to fall on a straight line, while the points for MNT and ODCB did not (Figure 10). The poor fit for MNT and the lack of significant sorption for TNB and RDX can be explained by the tendency of nitro-containing organic molecules to form strong hydrogen bonds, which keeps them in solution. While octanol can be a donor in hydrogen bonding, PTFE cannot. Thus, if the authors predict partitioning into PTFE for these molecules based on their octanol/water coefficients, the amount of sorption for these types of compounds will be overestimated.

The poor prediction for ODCB can be explained by the well-documented "ortho effect," which is a complex combination of electronic and steric interactions that often results in ortho di-substituted aromatic molecules behaving much differently than the meta- and para-isomers.

A similar model predicting the loss of analyte for PVC was not created because the percent sorbed was small when compared with the experimental error and this would produce an unacceptable degree of uncertainty in the calculated rate constants.

Therefore, it is concluded that for hydrophobic

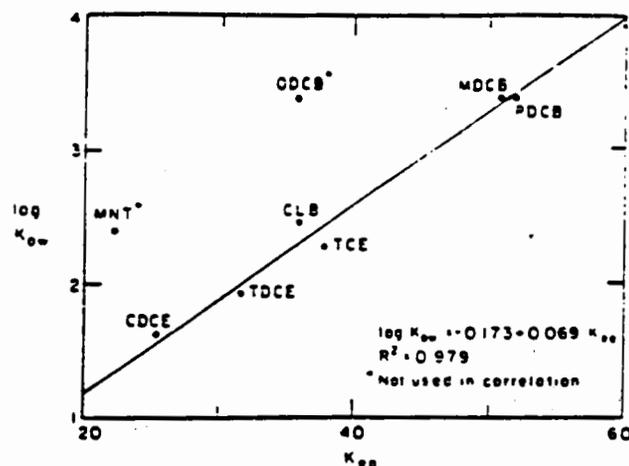


Figure 10. Correlation between $\log K_{ow}$ and K_{eq} for solutes exposed to PTFE casings.

organic molecules that are not subject to hydrogen bonding, the relationship presented in Figure 10 can be used to estimate the equilibrium partitioning of an analyte between the aqueous phase and PTFE. It is expected that losses in new wells would occur for some time until equilibrium with the water is achieved.

While K_{eq} will determine the equilibrium concentrations of each analyte in the water and plastic phases, it is the magnitude of k_1 that will determine how quickly various analytes are depleted. For small, planar molecules like TCE, the k_1 values are quite high compared to the other analytes. This may explain the rapid loss of tetrachloroethylene from solutions containing PTFE casings observed by Miller (1982) and Reynolds and Gillham (1986).

Because the rate of sorption appears to be first order, the relative concentration (concentration at a given time relative to its initial concentration) is independent of initial concentration (Castellan 1964). Thus, the percent loss at a given exposure time is expected to be independent of concentration, as was also predicted by the model of Reynolds and Gillham (1986). We did not confirm this, however, by conducting the test at several concentrations.

For further details on the organic portion of this study, refer to Parker et al. (1989).

Summary and Conclusions

In summary, the inorganic study indicated that three of the metals (As, Cr and Pb) were sorbed by one or more of the casing materials. Specifically, Cr was sorbed by SS 316 casings, As was sorbed by both 304 and 316 stainless steel casings, and Pb was sorbed by all four casings. On the other hand, Cd leached from the stainless steel and PVC casings, although subsequent sorption lowered concentrations in the samples containing stainless steel casings. While sorption of As was slow enough that it is probably not of concern for ground water monitoring, the changes in the Cr, Cd and Pb concentrations are of concern. Both SS 304 and 316 casings were subject to surface oxidation, presumably by galvanic action, which apparently provided active sites for sorption and release of major and minor constitu-

ents. Sorption and leaching of metal species was affected in some cases by the ground water composition (pH and organic carbon content). Specifically, there was more leaching of Cd and less sorption of Pb at the lower pH. Our results indicate that humic material may have acted as a complexing agent, making lead and chromium less prone to sorption. If chemical interactions are used as the only criterion, PTFE is clearly the best candidate for monitoring metal species in ground water. PVC would be a good second choice because its performance was considerably better than either SS 304 or SS 316 casing.

In contrast, the organic studies clearly indicated that PTFE was the poorest choice of the four well casing materials tested. PTFE casings sorbed all the chlorinated compounds and one nitroaromatic compound, and losses of PDCB and MDCB were rapid enough to be of concern for ground water monitoring. PVC casings also sorbed some of the same compounds, but always at rates that were considerably slower than those observed for PTFE casings. The rates of these losses on PVC were slow enough that they did not appear to be of concern for ground water monitoring. There was no loss of any of the organic solutes in the presence of either type of SS casing.

The desorption study showed that the loss of organics from aqueous solution is due to a sorption process that was reversible, or at least partially so. Desorption from contaminated casings could potentially result in falsely high concentrations of analytes if the concentrations of the analytes in the ground water were to drop.

The loss of hydrophobic organic constituents in the samples containing PTFE casings could be correlated with the substance's K_{ow} values. However, this correlation overestimates losses for hydrophilic organic substances.

There are several effects that make extrapolating these test data to a real monitoring situation difficult:

- Casings were tested and not well screens. The rate of sorption could be substantially greater in the screened portions of the well because the surface area of the screened portion would be greater.
- This experiment was conducted under static conditions. The effect of sorption under real conditions would be mitigated to some degree, depending on the rate of exchange of water between the aquifer and well casing.

Clearly, choosing one casing material for samples that will be analyzed for both trace metals and organics involves compromise. However, based on the results of the tests that the authors have performed to date, PVC appears to be the best compromise choice of the four casing materials tested.

Future studies will examine leaching of inorganic and organic solutes, the effect of low dissolved oxygen on interactions between the metals and well casings, and the suitability of other materials for ground water monitoring.

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Alan D. Hewitt

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PREFACE

This report was prepared by Alan D. Hewitt, Research Chemist, Geochemical Sciences Branch, Research Division, U.S. Army Cold Regions and Research and Engineering Laboratory. This project was funded by the U.S. Army Toxic and Hazardous Materials Agency (R-90 Multi-analytical Services), Martin H. Stutz, project monitor.

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Leaching of Metal Pollutants From Four Well Casings Used for Ground-water Monitoring

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INTRODUCTION

Ground-water monitoring requires the installation of conduits to transfer water to the surface for collection. Four commonly used well casings are made from 2-in. (5-cm) diameter polyvinylchloride (PVC), stainless steel 304 (SS 304), stainless steel 316 (SS 316) and polytetrafluoroethylene (PTFE) pipes. Representative sampling of ground water requires that materials employed in the saturated zone do not influence the concentration of analytes of interest.

Only a few studies have reported the influence of well-casing materials on the concentrations of inorganic substances in ground water during water quality analyses. Several studies have demonstrated that these materials (stainless steel, PVC and PTFE) sorb appreciable quantities of certain ionic species (Eichholz et al. 1965, Miller 1982, Hewitt 1989). Evidence also exists showing that metals are released into ground water from stainless steel and PVC pipes (Houghton and Berger 1984, Barcelona and Helfrich 1986, Hewitt 1989). The release of metal analytes by stainless steel has been associated with its corrosion, which in some instances has been observed to produce a hydrous iron precipitate (Barcelona and Helfrich 1986, Hewitt 1989).

Recently, a laboratory experiment was conducted testing the effects of ground-water composition on the well casings cited above (Hewitt 1989). In this experiment two concentrations of metals (As, Cd, Cr and Pb), pH and total organic carbon were introduced as ground-water solution variables. Results of this experiment indicated that PTFE was inert to the variables, whereas both PVC and stainless steel well casings were affected. These two materials leached and sorbed some of the metals introduced into the ground water. In addition, several stainless steel casing sections developed

surface oxidation, which introduced a random source of variation by providing release mechanisms and active sites for sorption. PVC was a low-level source for Cd and provided sorption sites for Pb. Stainless steel 316 was a low-level source for Cd and provided sorption sites for As, Cr and Pb. Stainless steel 304 was also a low-level source for Cd and provided sorption sites for As and Pb. The extent of the sorption or release of metals was often influenced by the solution variables. This study concluded that the stainless steel casings were the least suitable for monitoring the metals studied (As, Cd, Cr and Pb) in the ground water solutions.

A concurrent study done at CRREL (Parker et al. 1989) looked at ground-water solutions spiked with organic compounds exposed to the same four well casings. In contrast to the results for metals, eight (cis and trans-1,2-dichloroethylene, m-nitrotoluene, trichloroethylene, chlorobenzene, o-,p- and m-dichlorobenzene) of the ten organic compounds studied sorbed more quickly and to a greater extent onto PTFE than PVC and did not sorb onto the stainless steels. The same results were obtained when the ground water was treated with 2.0 g NaCl/L to test for effects of ionic strength. These findings support the earlier work of Reynolds and Gillham (1985) who observed rapid sorption of tetrachloroethylene by PTFE well casing. They suggested that PTFE is the least desirable material for a well casing when organic compounds are monitored in ground water.

The results of these two recent CRREL studies (Hewitt 1989, Parker et al. 1989) and supporting evidence in the literature led to the suggestion that PVC may be the best compromise among these four well casings for monitoring ground water for both inorganic and organic analytes (Parker et al. 1988).

The objective of this study is to examine metal leaching characteristics of these four well-casing materials in ground water. Leaching studies that

compare these four well casings have not been reported in the literature. The results of this experiment will determine which casings are the most or the least susceptible to leaching the metals. The analytes analyzed included all of the metals on the Environmental Protection Agency's priority pollutant list, along with copper.

MATERIALS AND METHODS

Materials

The PVC and stainless steel well casings were obtained from Johnson Well Screen, and the PTFE was obtained from MIP, Inc. All well casings were specifically manufactured for ground-water monitoring. The casings all had approximately a 5-cm inner-wall diameter and were cut in lengths of approximately 2 cm. The exact length of the rings depended on the wall thickness and diameter of the pipe because we wanted to maintain a constant surface area of 80 cm². Cut surfaces composed 17% of the area for the PTFE and PVC well casings and 9% for the stainless steels.

Precautions were taken during pipe milling to prevent exposure to grease, dirt, oil and solvents, and to avoid excessive handling. After milling, the individual well-casing rings were rinsed with deionized water (Millipore, Type 1) and air dried before being placed into the ground-water-filled sample containers. During rinsing we made no attempt to remove surface discoloration or ink on the pipes; we used them as we had received them from the manufacturer. This limited cleaning was consistent with commonly employed field protocols.* The well-casing sections were handled with plastic gloves and nylon forceps after milling. Two sections of the SS 316 pipe were not used because excessive surface rust had formed. In general the stainless steel well casings appeared to have developed more rust during the 9-month storage period than they had when first obtained. All experimental work was performed in class 100 cleanrooms.

Polypropylene jars (69 mm od × 62 mm height, 125 mL, Model 6185-E37, Thomas Scientific) served as the sample containers. The jars were soaked in a 10% v/v concentrated, redistilled HNO₃ (G. Fredrick Smith [GFS]) deionized water solution, then rinsed with and soaked for several days in deionized water prior to use. Other materials, such as the 7.5-mL sample aliquot bottles (polyethylene, Nagle),

pipette tips (Eppendorf), and the 2-L glass bottles (reagent grade HNO₃ bottles, Baker), were cleaned similarly.

Test design

Tests for the release of metals from PVC, PTFE, SS 304 and SS 316 well casings were done in triplicate by exposing sections of each to ground water for periods of 1, 5, 20 and 40 days. Three sample containers with no well casings served as controls for each of the exposure periods. The containers with and without well casings were filled with 98 mL of ground water collected from a 76-m-deep domestic well system in Weatherfield, Vermont; 60 containers, 12 with a single section of each of the four well-casing candidates (12 × 4) and 12 controls, made up the experimental sample setup. The well-casing rings were submerged in the ground-water-filled sample containers creating a pipe-surface-area-to-aqueous-volume ratio of 0.82 cm²/cm³. This experimental design provides a surface-area-to-solution ratio similar to that of well casings in ground-water monitoring wells below the saturated zone; however, the ratio is much lower than that which exists for well screens.

Samples were prepared by transferring weighed amounts of ground water into each jar from a single 2-L glass bottle. The jars were selected randomly for the experiment because the ground water was transported in three separate 2-L glass bottles. The pH and conductivity of the ground water from all of the bottles was 7.8 and 2.40 × 10⁻² mho/cm, respectively. Ground water collected from this source previously showed similar pH and conductivity levels (Hewitt 1989). While the well casings were exposed to the ground water, the jars were sealed with a cap and stored in the dark at 24°C. After the well-casing sections had been removed from the jars at the end of each time interval, 2 mL of concentrated HNO₃ (GFS) was added to the ground water to bring the pH below 1.0. Studies have shown that acidification below pH 1.5 is effective in preventing the loss of trace metals from natural waters (Subramanian et al. 1978). The acidified, ground-water-filled jars were recapped, hand-swirled for 10 seconds, then left at rest for at least 72 hours before we transferred a 5-mL aliquot to a 7.5-mL sample vial (polyethylene, Nagle) for the subsequent determination of Ag, As, Ba, Cd, Cu, Cr, Pb and Se.

The entire experimental setup was duplicated for the analysis of Hg, except that we determined Hg immediately after the ground-water-filled jar was acidified.

In a preliminary experiment, ground water stored in the polypropylene jars was spiked with

*Personal communication with Louise V. Parker, CRREL, 1989.

Cd, Cr and Pb to see if sorption of metals ions on the jar walls would interfere with the test results. These metal ions, added to the ground water and stored for 6 days in the sample jars, were recovered upon acidification (Table 1). The desorption of metal ions from container walls has been reported by Choa et al. (1968). For this preliminary test, 5.00 µg/L of Cd, Cr and Pb was allowed to sit in ground-water-filled jars (100 mL) for 6 days. Then we added 2 mL of concentrated HNO₃ (GFS), hand swirled the solution for 10 seconds, and removed a 5-mL aliquot. A second 5-mL aliquot was removed 72 hours later, following the same procedure. The results in Table 1 show that an average of 95% of the aqueous metal was recovered immediately after acidification, and aliquots removed 3 days later showed only 2% (not significant at the 95% confidence level) additional analyte recovery. Thus the metals either remained in the laboratory ground-water solution or were desorbed from the jar walls quickly upon acidification.

Table 1. Recovery of Cd, Cr and Pb (4.90 µg/L) from ground water stored in the sample jars and allowed to equilibrate for 6 days before being acidified with 2 mL of concentrated HNO₃.

	Acidification period			
	Less than 10 minutes		72 hours	
	Amount # added (µg/L)	Percent recovered	Amount # added (µg/L)	Percent recovered
Cd	4.65	94.9	4.72	96.3
	4.72	96.3	4.85	99.0
Cr	4.48	91.4	4.58	93.5
	4.48	91.4	4.69	95.7
Pb	4.93	100.2	4.72	96.3
	4.72	96.3	5.01	102.2
Average recovery		95.1%		97.2%

* determined

Analysis

Silver, arsenic, barium, cadmium, copper, chromium and lead were determined by Graphite Furnace Atomic Absorption (GFAA) using a Perkin-Elmer (PE) model 403 Atomic Absorption Spectrophotometer (AAS) coupled with a PE model 2200 heated graphite atomizer. Instrumental procedures followed the general guidelines provided in the manufacturer's instrument manual (Perkin-Elmer 1981). Hand injections of either 20, 50 or 100 µL were employed for the analytes mentioned above.

For the determination of Se, a matrix modifier—0.015 mg Pd and 0.01 mg Mg(NO₃)₂—was added so that the charring temperature could be raised to 1200°C. Of this group, only As and Se determinations required deuterium background correction.

Mercury was determined by Cold Vapor Atomic Absorption (CVAA). We employed a 48-mL aliquot for the Hg determinations, following a modified Hatch and Ott (1968) procedure. Aliquots of 48 mL of ground water were reduced with 2 mL of 10% v/v stannous chloride and then sparged with Hg-free air. The reduced Hg vapor passed through a Mg(ClO₄)₂ water vapor trap into an optical cell designed to enhance detection (Tuncel and Ato-man 1980). The optical cell was positioned in the light path of the PE model 403 AAS.

Mercury was determined the same day that well casings were removed from ground-water-filled jars to limit volatilization of Hg from solution (Coyne and Collins 1972, Lo and Wai 1975) and to avoid vapor contamination associated with storage in poly containers (Cragin 1979). All of the other metals were determined within 2 weeks after the last exposure period.

Analysis procedures were designed to achieve detection limits of 1% or less of the present domestic water quality levels set by the EPA (Table 2). Selenium, determined by graphite furnace, was the only metal with a detection limit slightly above this level (Table 2). Method Detection Limits (MDLs) were established following the procedure outlined in the Federal Register (1984) for the analysis of a sample in a given solution. The MDL estimate requires that a minimum of seven replicate determinations be made of an analyte concentration that is one to five times the estimated detection level.

Table 2. EPA interim primary drinking water quality levels (1983) and the method detection limits (MDL).

Metal	EPA primary drinking water	
	levels (µg/L)	MDL (µg/L)
Ar	50	0.48
Ba	1000	2.4
Cd	10	0.059
Cu	1000	4.3
Cr	50	0.16
Pb	50	0.11
Hg	2.0	0.010
Se	10	0.21
Ag	50	0.12

Table 3. Summary of ANOVA and LSD determinations for average analyte concentrations ($\mu\text{g/L}$). Materials with common underlining are not different at the 95% confidence level as determined by the LSD.

Days		Well casing				
a. Barium						
1	Control	<u>PTFE</u>	<u>PVC</u>	<u>SS304</u>	<u>SS316</u>	
	4.5	6.0	6.6	7.1	7.7	
(LSD = 1.4)						
5	<u>PTFE</u>	<u>Control</u>	<u>PVC</u>	<u>SS304</u>	<u>SS316</u>	
	5.3	5.8	6.6	7.8	9.9	
(LSD = 2.1)						
20	<u>PTFE</u>	<u>Control</u>	<u>PVC</u>	<u>SS304</u>	<u>SS316</u>	
	5.5	5.9	6.1	7.4	11.3	
(LSD = 2.2)						
40	<u>PTFE</u>	<u>PVC</u>	<u>Control</u>	<u>SS304</u>	<u>SS316</u>	
	5.2	5.6	5.9	7.0	10.1	
(LSD = 2.0)						
b. Chromium						
1	<u>Control</u>	<u>PTFE</u>	<u>PVC</u>	<u>SS304</u>	<u>SS316</u>	
	0.20	0.22	1.23	1.60	6.06	
(LSD = 9.76)						
5	<u>Control</u>	<u>PTFE</u>	<u>PVC</u>	<u>SS316</u>	<u>SS304</u>	
	0.20	0.22	1.12	1.79	3.34	
(LSD = 0.31)						
20	<u>PTFE</u>	<u>Control</u>	<u>PVC</u>	<u>SS316</u>	<u>SS304</u>	
	0.19	0.22	1.20	3.30	4.61	
(LSD = 1.17)						
40	<u>Control</u>	<u>PTFE</u>	<u>PVC</u>	<u>SS316</u>	<u>SS304</u>	
	0.21	0.21	1.11	2.53	5.13	
(LSD = 1.04)						
c. Lead						
1	<u>Control</u>	<u>PTFE</u>	<u>SS316</u>	<u>SS304</u>	<u>PVC</u>	
	0.16	0.35	0.90	1.14	2.46	
(LSD = 1.45)						
5	<u>Control</u>	<u>PTFE</u>	<u>SS316</u>	<u>SS304</u>	<u>PVC</u>	
	0.21	0.27	1.27	1.56	2.23	
(LSD = 1.53)						
20	<u>Control</u>	<u>PTFE</u>	<u>SS316</u>	<u>PVC</u>	<u>SS304</u>	
	0.14	0.35	1.00	1.04	2.86	
(LSD = 2.80)						
40	<u>PTFE</u>	<u>Control</u>	<u>PVC</u>	<u>SS316</u>	<u>SS304</u>	
	0.21	0.33	0.78	1.26	2.06	
(LSD = 1.52)						
d. Copper						
1	<u>PVC</u>	<u>SS304</u>	<u>Control</u>	<u>PTFE</u>	<u>SS316</u>	
	9.4	10.7	11.9	12.1	35.8	
(LSD = 12.0)						
5	<u>PTFE</u>	<u>PVC</u>	<u>Control</u>	<u>SS304</u>	<u>SS316</u>	
	7.8	9.9	10.1	11.0	42.6	
(LSD = 12.4)						
20	<u>PVC</u>	<u>PTFE</u>	<u>Control</u>	<u>SS304</u>	<u>SS316</u>	
	6.8	8.3	10.1	26.1	81.2	
(LSD = 38.5)						
40	<u>PVC</u>	<u>PTFE</u>	<u>SS304</u>	<u>Control</u>	<u>SS316</u>	
	4.4	5.2	11.5	14.0	82.3	
(LSD = 17.2)						

The MDL is obtained by multiplying the standard deviation of the replicate measurements by the appropriate one-sided t -statistic corresponding to $n-1$ degrees of freedom at the 99% confidence level.

Each sample aliquot with a determined analyte concentration above the MDL was analyzed at least twice. Analyte concentrations were based on the average peak heights from a strip chart recording.

Aqueous calibration standards for Ag, As, Cd, Cr, Cu, Pb, Hg and Se were prepared by diluting 1000-mg/L certified atomic absorption stock solutions (Fisher Scientific Corp.). A Ba stock standard was made by dissolving a weighed amount of $\text{Ba}(\text{NO}_3)_2$ (Baker, Reagent Grade) in deionized water. Working standards were prepared in deionized water acidified to 2% v/v with HNO_3 (GFS).

Calibrations were established by determining three different concentration standards in tripli-

cate. Standards were randomly introduced throughout the course of sample analysis, and all of the calibration curves were linear over the concentration range examined. To see if the intercepts were significantly different from zero, we compared the residuals for the models with an intercept and for the models with zero intercept using the F -ratio at the 95% confidence level. Analyte concentrations in the samples and controls were determined based on the slope and intercept only if the intercept was deemed significant. Otherwise, a zero-intercept linear model was employed.

To assess leaching of metals from the surfaces of the four well-casing materials, an analysis of variance (ANOVA) was performed on those metals (Ba, Cr, Cu and Pb) that had been consistently found above the established MDL for the four well-casing materials and the control. If a significant

difference was detected by the ANOVA among the average analyte concentrations in the ground water for a given material, then a Least-Significant-Difference (LSD) analysis was performed. Both analyses (ANOVA and LSD) used the 95% confidence level. The results of these analyses established which well casings contributed particular analytes to the ground water over and above those contributed by other well casings or the control for the different exposure periods (Table 3). In addition the aqueous metal concentrations that exceed 1% of the EPA drinking water quality level were identified. This low-level warning criterion was chosen since this study did not always establish the native levels present in the ground water. Thus, the contribution of metals from the well casings could range from one or more orders of magnitude above the background concentrations.

RESULTS

Barium

The analysis of the 1-day exposure samples showed that all of the ground-water-filled vessels containing pipe sections had aqueous Ba concentrations that were significantly greater than that of the control; however, all of the values were low (Table 3a). The subsequent exposure periods do not follow this pattern but instead established that SS 316 was the only material that consistently contributed significant levels of Ba to the solution relative to the other samples and the controls (Fig. 1a). The average increase in aqueous concentration for the ground water exposed to SS 316 was about 70% compared to the control. After 5 days of exposure, ground water in contact with SS 316 developed aqueous Ba concentrations that exceeded 1% of the drinking water quality level established by the EPA. None of the other well casings tested produced aqueous Ba concentrations that exceeded 1% of the EPA drinking water quality criterion or were significantly different from the control after the initial exposure period.

Cadmium

We did not use ANOVA with Cd since the majority of concentrations determined were below the MDL (Appendix A). After 1 day of exposure, both ground-water solutions containing SS 316 and PVC had aqueous Cd that exceeded 1% of the EPA drinking water quality level.

Figure 1b shows the average Cd concentrations determined for the control and well casings. It appears that Cd is initially released from SS 316 and

PVC but becomes resorbed onto the well casing with time. Stainless steel 316 contributes approximately an order of magnitude (more than 10% of the EPA drinking water quality level in some cases) more Cd than PVC for equivalent exposure periods.

Chromium

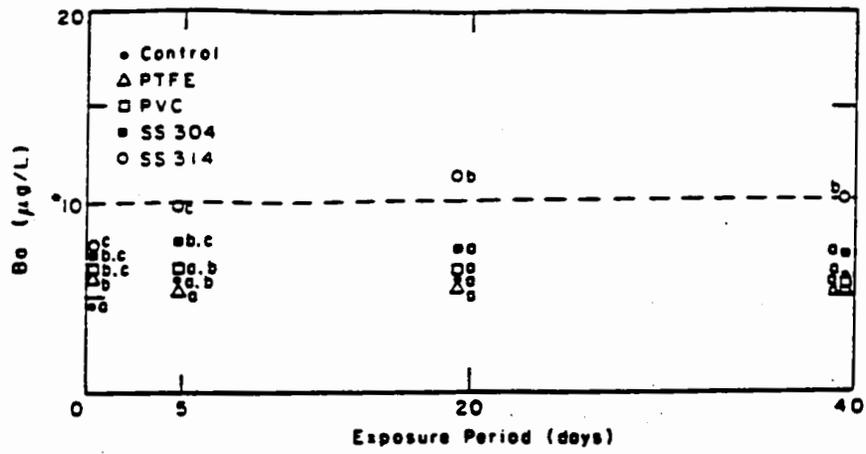
Beyond the 1-day exposure, the analysis consistently demonstrated that both stainless steel well casings contributed significantly greater quantities of Cr to the ground water than the control or the other materials tested (Table 3b). These metal well casings, along with PVC, increased Cr concentrations in the ground water above 1% of the EPA drinking water quality level (Fig. 1c). The extent of the Cr contamination coming from the PVC was three to five times less than that coming from the SS 304, which usually showed the highest average contamination for a given exposure period, the exception being the initial exposure period.

The ANOVA and LSD tests failed to distinguish any difference between the materials for the 1-day exposure because of the large variation among the the three SS 316 samples. If SS 316 is removed, the analysis shows both PVC and SS 304 to contribute significantly greater quantities of Cr to the ground water than do the control and PTFE. The only material that showed a consistent trend was SS 304 (Fig. 1c), which created increasing concentrations of Cr with time. Throughout the experiment there was no significant difference for Cr between the control and the PTFE well casing.

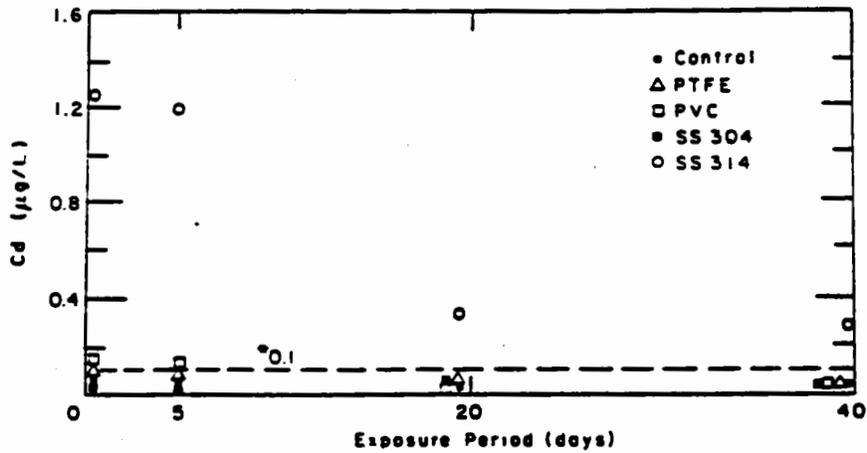
Lead

The first two exposure periods showed PVC to leach the greatest amount of Pb and to be significantly different from the control and PTFE. The two longest exposure periods showed that SS 304 leached the greatest amount of Pb to ground water; however, the levels observed in solution for SS 304 were only statistically different from the rest for the 40-day exposure period (Table 3c). The average levels obtained for both of the stainless steels and for PVC consistently exceeded 1% of the EPA drinking water quality standard (Fig. 1d).

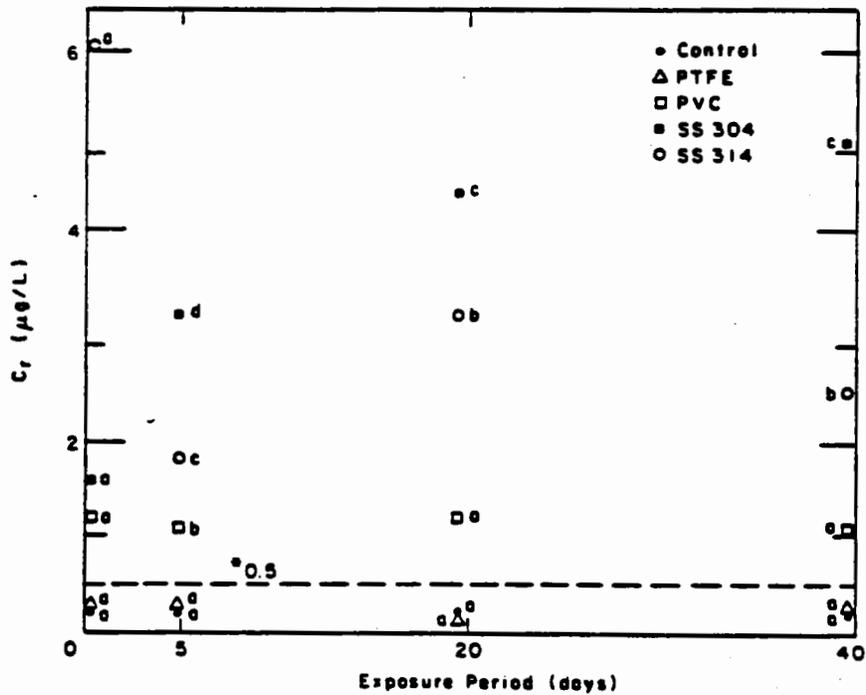
The most distinctive trend was the decrease in Pb with increasing time of exposure for PVC (Fig. 1d). Both stainless steel well casings showed slight decreases in Pb levels after aqueous concentration maxima were obtained. The Pb that was initially released was resorbed by the PVC and stainless steel well casings. Throughout the experiment, there was no significant difference among the control, SS 316 and PTFE.



a. Ba.

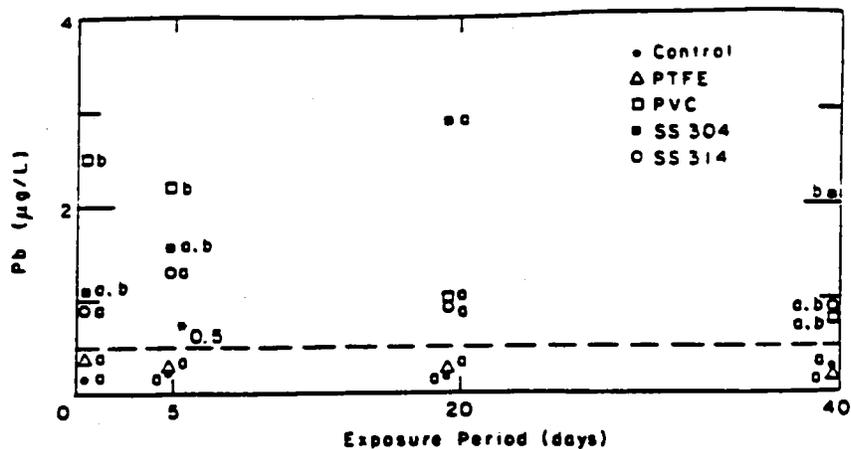


b. Cd.

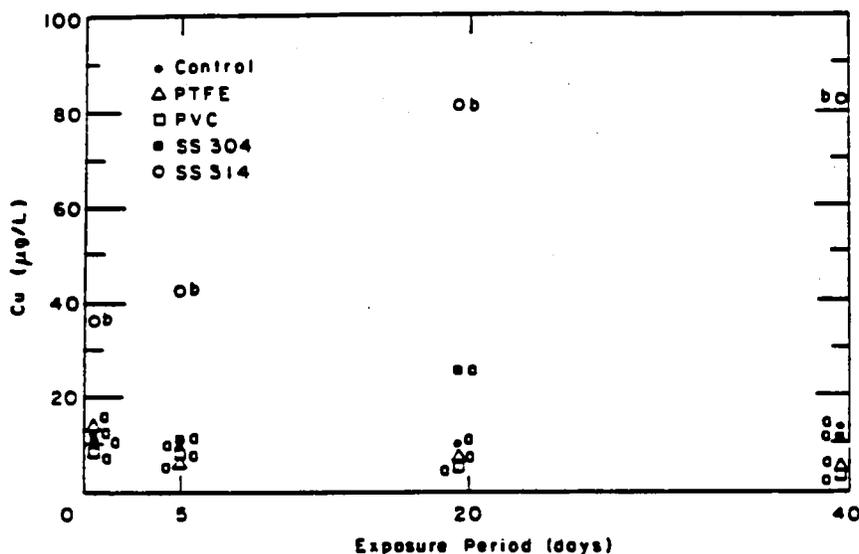


c. Cr.

Figure 1. Ground-water leaching of metals from well casings being examined. Common letters next to points denote no significant difference at the 0.05% confidence interval as determined by ANOVA and LSD.



d. Pb.



e. Cu.

Figure 1 (cont'd).

Copper

The statistical analysis distinguished SS 316 as the only material that contributed significantly more Cu when exposed to ground water than the other materials tested (Table 3d). Aqueous concentrations exceeded 80 µg/L for SS 316 versus about 10 µg/L for the other materials and the control.

Both PTFE and PVC well casing showed a general trend of decreasing Cu with increasing time of exposure and often showed concentrations below the control (Fig 1e). This trend, along with the lack of any trend with respect to the control, demonstrates that these two plastic pipes provided the substrate for sorption.

Arsenic, mercury, selenium and silver

The determinations for As, Hg, Se and Ag were not statistically analyzed because the majority of the concentrations were at or below the established MDLs. Based on the analysis methods employed, none of the well casings consistently contributed As, Hg or Ag above 1% or Se above 2% of the EPA drinking water quality level.

DISCUSSION

Ground water was collected from a domestic well system and stored in sealed 2-L glass bottles

for approximately 24 hours prior to being transferred into test jars. Ground water collected in this fashion is aerated at the faucet and exposed to an oxygen-rich environment every time the lid of the container is removed. Handling the ground water in this manner most likely changed the oxidation potential, facilitating oxidation reactions (Stumm and Morgan 1970). We made no attempt to simulate the natural ground-water redox state or to quantitatively assess the chemical equilibria that existed during the course of this experiment.

There was visible rust on 11 of 24 sections of the stainless steel pipes (Table 4). Each pipe section was carefully examined prior to submersion and after removal from the ground water. In this experiment and in a previous one (Hewitt 1989), oxidation on the stainless steel was predominantly found on the wall. If oxidation is providing sites for sorption or release mechanisms, then the freshly cut surfaces were most likely not a major factor in the behavior of these two materials. Fresh surfaces on the PVC pipe is not an experimental artifact since PVC well screen is made by slotting the pipe.

It was apparent from the values determined for the control samples that the three 2-L glass bottles used to transport the ground water had different

concentrations of aqueous Cu (Appendix A). The range of aqueous Cu concentrations most likely reflect the residence time of the ground water in the household and well plumbing. Three distinct populations of Cu concentration were determined for the controls at the 99% confidence level ($X_1 = 9.8 \pm 0.0$, $n = 4$; $X_2 = 10.3 \pm 0.22$, $n = 5$; $X_3 = 16.0 \pm 0.0$, $n = 3$). Differences between adjacent mean concentrations were established by testing against the maximum variance determined for all of populations (i.e., $X_1 X_2$ and $X_2 X_3$).

The groups established by the three Cu populations were then tested to determine if any of the other metals found above its MDL were also significantly different. Table 5 presents the averages and standard deviations for the metal groups based on the Cu populations for the controls. Only Pb shows the same increasing mean concentration trend as the Cu groupings; however, the averages for the adjacent Pb groups were not significantly different at the 95% or even the 80% confidence level when analyzed in the same manner as the Cu populations. This analysis establishes that only Cu was significantly influenced by the sample preparation procedure. Mixing the ground water from the three collection bottles would have eliminated

Table 4. Physical state of stainless steel pipes after exposure to ground water.

	Section											
	1	2	3	4	5	6	7	8	9	10	11	12
SS 304	WR	WR	—	—	WR	—	WR	WR	ER	WR	WR	WR
SS 316	—	—	—	—	ER	—	—	—	—	—	—	ER

KEY: WR = rust on wall; ER = rust on edge; dash means no rust.

Table 5. Average metal concentrations for the controls based on the groups established by the Cu populations ($\mu\text{g/L}$).

Populations		Cu	Cr	Pb	As	Ba
1	Avg.	9.8*	0.22	0.11	0.55	5.2
	Std. Dev.	0.0	0.021	0.00	0.114	0.92
2	Avg.	10.3*	0.20	0.25	0.48	5.8
	Std. Dev.	0.19	0.032	0.154	0.00	0.29
3	Avg.	16.0*	0.22	0.28	0.48	5.6
	Std. Dev.	0.0	0.021	0.048	0.00	0.75

* Statistically different at the 99% confidence level.

Table 6. Summary of results.

	Ba	Cd	Cr	Pb	Cu
Materials that leached >1% of the EPA drinking water quality level in ground-water solutions.	SS 316 PVC	SS 316 PVC	SS 304 SS 316 PVC	SS 304 PVC SS 316	NA*
Material that showed the highest average overall amount of analyte leached	SS 316	SS 316	SS 304	SS 304	SS 316

* Does not apply.

this artifact. The level of Cu leached from the SS 316 far exceeded the difference between the established populations.

The results of this study support our previous work (Hewitt 1989) showing that PTFE is the least reactive material, whereas both PVC and stainless steel well casings influence aqueous concentrations of metals in laboratory ground-water solutions. As in the first study, the variance among the stainless steel replicates was often the greatest, indicating that this material is susceptible to producing random error. Both studies found that SS 316 and PVC leach and sorb Cd; in addition, these two materials, along with SS 304, sorb Pb. Studies in the future should be conducted under anoxic conditions to see if oxidation of the stainless steel is simply an artifact of these experiments. If corrosion of stainless steel is absent under reducing conditions, then we might expect less random variation and less of an influence on the metal analytes in ground-water solutions.

A summary of the results (Table 6) clearly shows that the stainless steels were the greatest sources of contamination under these experimental conditions. When PVC leached metals (Pb, Cr and Cd) that exceeded 1% of the EPA drinking water quality specifications into solution, there was always a trend showing a decrease in concentration with time of exposure. This would suggest that the leaching of Pb, Cr and Cd from PVC is a surface process and is small. Most likely the initial release could be decreased by more extensive cleaning before the pipes are used. The same statement does not apply to the stainless steel well casings. In the cases of leached Cu from SS 316 and leached Cr from SS 304, the concentrations of these metals continually increased with time over 40 days. It is possible that stainless steels could supply these analytes to ground water over an extended period of time, perhaps the entire life of the casing.

CONCLUSION

Among the four types of well casings tested, PTFE was the only material that did not leach any of the nine metals examined. The other materials tested in this experiment (PVC, SS 304 and SS 316) compromised laboratory ground-water samples by contributing analytes of interest (Ba, Cd, Cr, Pb and Cu). Investigations where only trace metals are of interest should use PTFE below the saturated zone. PVC would be the appropriate second choice since its influence on metal analytes appears predictable and small. In contrast, the two stainless steel materials should be avoided.

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APPENDIX A: LEVELS OF CD, PB, CR, BA AND CU DETERMINED
IN GROUND-WATER SOLUTIONS (MG/L).

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Pipe	Replicate	Time (days)	Number	Cl	Pb	Cr	Ba	Cu
Cntrl	1	1	1	< D*	0.11	0.21	4.2	9.8
Cntrl	2	1	2	< D	0.11	0.19	4.6	9.8
Cntrl	3	1	3	< D	0.26	0.21	4.8	16.0
Cntrl	1	5	4	< D	0.40	0.15	5.5	10.5
Cntrl	2	5	5	< D	0.11	0.24	5.8	9.8
Cntrl	3	5	6	< D	0.11	0.20	6.1	10.1
Cntrl	1	20	7	< D	0.11	0.24	6.1	10.1
Cntrl	2	20	8	< D	0.11	0.22	6.1	9.8
Cntrl	3	20	9	< D	0.19	0.20	5.5	10.5
Cntrl	1	40	10	< D	0.42	0.20	5.8	10.1
Cntrl	2	40	11	< D	0.24	0.20	5.7	16.0
Cntrl	3	40	12	< D	0.33	0.24	6.3	16.0
PTFE	1	1	1	< D	0.40	0.19	5.9	10.8
PTFE	2	1	2	< D	0.26	0.28	6.1	9.8
PTFE	3	1	3	< D	0.40	0.19	5.9	15.7
PTFE	1	5	4	0.117	0.40	0.24	4.9	9.1
PTFE	2	5	5	< D	0.30	0.21	5.5	8.4
PTFE	3	5	6	< D	0.11	0.21	5.5	5.9
PTFE	1	20	7	0.117	0.40	0.21	5.8	15.3
PTFE	2	20	8	< D	0.30	0.16	5.2	4.9
PTFE	3	20	9	< D	0.36	0.19	5.5	4.6
PTFE	1	40	10	< D	0.11	0.21	4.9	4.3
PTFE	2	40	11	< D	0.11	0.16	5.5	7.0
PTFE	3	40	12	< D	0.40	0.26	5.2	4.3
PVC	1	1	1	0.109	2.19	1.13	6.7	9.4
PVC	2	1	2	0.125	3.09	1.40	7.0	9.8
PVC	3	1	3	0.175	2.11	1.15	6.1	9.1
PVC	1	5	4	0.075	2.39	1.15	7.3	8.0
PVC	2	5	5	0.142	2.43	1.30	6.4	13.2
PVC	3	5	6	0.109	1.87	0.91	6.1	8.4
PVC	1	20	7	< D	2.11	1.30	6.4	11.9
PVC	2	20	8	< D	0.66	1.40	5.8	4.3
PVC	3	20	9	< D	0.34	0.91	6.1	4.3
PVC	1	40	10	< D	0.93	1.08	6.1	4.3
PVC	2	40	11	< D	0.75	1.03	5.2	4.3
PVC	3	40	12	< D	0.66	1.22	5.5	4.6
SS 304	1	1	1	< D	0.48	1.22	6.7	9.8
SS 304	2	1	2	< D	0.88	1.13	7.0	13.2
SS 304	3	1	3	< D	2.05	2.45	7.6	9.1
SS 304	1	5	4	< D	1.25	3.33	7.3	9.8
SS 304	2	5	5	< D	0.96	3.21	8.2	8.0
SS 304	3	5	6	< D	2.47	3.48	7.9	15.3
SS 304	1	20	7	0.092	0.80	4.36	7.3	9.1
SS 304	2	20	8	< D	2.81	3.87	7.6	49.7
SS 304	3	20	9	< D	4.98	5.59	7.3	19.6
SS 304	1	40	10	< D	2.97	5.10	6.7	9.1
SS 304	2	40	11	< D	1.47	4.56	6.4	9.4
SS 304	3	40	12	< D	1.73	5.73	7.9	15.9
SS 316	1	1	1	2.629	0.41	1.48	7.0	27.5
SS 316	2	1	2	0.209	0.60	1.29	7.3	35.5
SS 316	3	1	3	0.926	1.70	15.36	8.7	44.5
SS 316	1	5	4	0.217	0.96	1.81	8.5	37.2
SS 316	2	5	5	2.930	2.30	1.69	11.5	37.6
SS 316	3	5	6	0.451	0.53	1.86	9.6	52.9
SS 316	1	20	7	0.326	1.50	3.45	12.3	102.2
SS 316	2	20	8	0.376	0.76	2.96	9.3	56.7
SS 316	3	20	9	0.326	0.75	3.50	12.3	84.8
SS 316	1	40	10	0.267	0.67	3.18	11.5	97.3
SS 316	2	40	11	0.384	0.75	1.94	9.0	77.2
SS 316	3	40	12	0.209	2.36	2.45	9.8	72.3

* Less than MDL

STANDARD NUMBER 14

Plastics Piping Components
and related materials



NATIONAL SANITATION FOUNDATION
LISTING SERVICES

The mission of NSF is to provide clients and the general public with objective, high quality, timely, third-party services at acceptable cost. Services include development of consensus standards, voluntary product testing and certification with policies and practices which protect the integrity of registered Marks, education and training, and research and demonstration, all relating to public health and the environmental sciences.

Listed products (other than ingredients, materials, or products specifically exempted by policy) must bear an NSF Listing Mark. A Company shall not use the same trade designation and/or model designation on Listed and non-listed products.

***This Standard is subject to revision.
Contact NSF to confirm this revision is current.***

**National Sanitation Foundation
3475 Plymouth Road, P.O. Box 1468
Ann Arbor, Michigan 48106 USA**

NATIONAL SANITATION FOUNDATION
STANDARD 14
FOR
PLASTICS PIPING SYSTEM COMPONENTS AND RELATED
MATERIALS

As Prepared by
The NSF Joint Committee
on
Plastics
and
Recommended for Adoption
by
The NSF Council of Public Health Consultants
Adopted
by
The NSF Board of Trustees
October 1965

Revised February 1977
Revised November 1978
Revised November 1980
Revised November 1983
Revised November 1984
Revised November 1985
Revised August 1986
Revised October 1987
Revised December 1988

National Sanitation Foundation
3475 Plymouth Road
P. O. Box 1468
Ann Arbor, Michigan 48106 USA

The following is a list of nationally uniform sanitation standards and criteria established by the National Sanitation Foundation.

- 1 Soda Fountain and Luncheonette Equipment
- 2 Food Service Equipment
- 3 Commercial Spray-Type Dishwashing Machines
- 4 Commercial Cooking and Hot Food Storage Equipment
- 5 Hot Water Generating and Heat Recovery Equipment
- 6 Dispensing Freezers
- 7 Food Service Refrigerators and Storage Freezers
- 8 Commercial Powered Food Preparation Equipment
- 12 Automatic Ice Making Equipment
- 13 Refuse Compactors and Compactor Systems
- 14 Plastics Piping Components and Related Materials
- 18 Manual Food and Beverage Dispensing Equipment
- 20 Commercial Bulk Milk Dispensing Equipment
- 21 Thermoplastic Refuse Containers
- 24 Plumbing System Components for Manufactured Homes and Recreational Vehicles
- 25 Vending Machines for Food and Beverages
- 26 Pot, Pan, and Utensil Washers
- 29 Detergent/Chemical Feeders for Commercial Spray-Type Dishwashing Machines
- 30 Cabinetry and Laboratory Furniture for Hospitals
- 35 Laminated Plastics for Surfacing Food Service Equipment
- 36 Dinnerware
- 37 Air Curtains for Entranceways in Food Establishments
- 40 Individual Aerobic Wastewater Treatment Plants
- 41 Wastewater Recycle/Reuse and Water Conservation Devices
- 42 Drinking Water Treatment Units - Aesthetic Effects
- 44 Cation Exchange Water Softeners
- 49 Class II (Laminar Flow) Biohazard Cabinetry
- 50 Circulation System Components for Swimming Pools, Spas, or Hot Tubs
- 51 Plastic Materials and Components Used in Food Equipment
- 52 Supplemental Flooring
- 53 Drinking Water Treatment Units - Health Effects
- 54 Flexible Membrane Liners
- 56 Pitless Well Adapters
- 58 Reverse Osmosis Drinking Water Treatment Systems
- 59 Food Carts
- 60 Drinking Water Treatment Chemicals - Health Effects
- 61 Drinking Water System Components - Health Effects
- C-2 Special Equipment and/or Devices
- C-9 Evaluation of Special Processes, Components, or Devices Used in Treating Wastewater

THE NATIONAL SANITATION FOUNDATION

Purpose and Organization

The National Sanitation Foundation, popularly referred to as NSF, is a nonofficial and noncommercial agency. It is incorporated under the laws of Michigan as a not-for-profit organization devoted to research, education, and service. It seeks to solve problems involving man and his environment. It wishes to promote health and enrich the quality of life through conserving and improving that environment. Its fundamental principle of operation is to serve as a neutral medium in which business and industry, official regulatory agencies, and the public come together to deal with problems involving products, equipment, procedures, and services related to health and the environment.

NSF is perhaps best known for its role in the developing of standards and criteria for equipment, products, and services that bear upon health. The NSF Mark is widely recognized as a sign that the article to which it is affixed complies with the applicable NSF standard. NSF conducts research; tests and evaluates equipment, products, and services for compliance with NSF standards and criteria; and grants and controls the use of the NSF Mark.

A brochure is available discussing in some detail the purpose, objectives, and philosophy of NSF and its standards and listing programs. It describes the way in which distinguished leaders from business, industry, public health, and related professions give generously of their time and talent in helping achieve NSF objectives. The brochure is available upon request.

DISCLAIMERS

The National Sanitation Foundation (NSF), in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of NSF represent its professional judgement. NSF shall not be responsible to anyone for the use of or reliance upon this standard by anyone. NSF shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this standard.

NSF standards provide basic criteria to promote sanitation and protection of the public health. Provisions for safety have not been included in this standard because governmental agencies or other national standards-setting organizations provide safety requirements.

Participation in NSF standards development activities by regulatory agency representatives (federal, local, state) shall not constitute their agency's endorsement of NSF or any of its standards.

Preference is given to the use of performance criteria measurable by examination or testing in NSF standards development when such performance criteria may reasonably be used in lieu of design, materials, or construction criteria.

Unless otherwise referenced, the appendices are not considered an integral part of NSF standards. The appendices are provided as general guidelines to the manufacturer, regulatory agency, user or certifying organization.

Plastics pipe has been satisfactorily used for potable water systems for many years. During this time, occurrences of permeation have been unusual and then only in installations where extreme environmental conditions exist. All types of piping could be affected under these same conditions. While permeation is outside the scope of this standard, it is recommended that special consideration be given where the potential exists for permeation from chemicals or petroleum products or materials.

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PARTICIPATING COMMITTEES

National Sanitation Foundation Joint Committee on Plastics
National Sanitation Foundation Council of Public Health Consultants

**NSF STANDARD 14
FOR
PLASTICS PIPING SYSTEM COMPONENTS AND RELATED MATERIALS**

SECTION 1. GENERAL

- 1.0 **SCOPE:** This standard covers thermoplastic and thermoset plastics piping system components (pipe, fittings, valves, joining materials, appurtenances, etc.). It also covers ingredients and materials used to fabricate components and plastics coatings. It provides definitions and requirements for ingredients, materials, products, quality assurance, marking, and record keeping. These are covered in separate sections of this standard. All sections need to be examined to determine the total requirements for a specific product. This standard includes minimum requirements for plastics piping system components and related materials.
- 1.1 **MINIMUM REQUIREMENTS:** Variations from these minimum requirements may be permitted when they provide products suitable for the intended end use. Units with components covered under other NSF standards or criteria shall comply with those applicable requirements.
- 1.2 **STANDARD REVIEW:** A complete review of this standard shall be conducted at least every five years. These reviews shall be conducted by representatives from industry, public health, and user groups of the NSF Joint Committee on Plastics.

SECTION 2. DEFINITIONS

- 2.0 **APPURTENANCES:** Accessories of a plastics piping system designed for special applications or end uses. Appurtenances may include, but not be limited to pipe, fittings, valves, storage tanks, tank liners, special coatings, faucet parts, and riser assemblies.
- 2.1 **BOND:** The union of materials.
- 2.2 **BUILDING DRAIN:** The lowest part of a drainage piping system receiving discharge from soil, waste, and other drainage pipe inside the building. It conveys these wastes to the building sewer, beginning 3 feet (0.9 m) outside the building wall.
- 2.3 **BUILDING SEWER:** The portion of horizontal piping of a drainage system extending from the end of the building drain, receiving discharge of the building drain. It conveys the discharge to a public or private sewer, individual sewage disposal system, or other point of disposal.
- 2.4 **CALCIUM CARBONATE:** An ingredient obtained by crushing or grinding limestone or precipitating calcium carbonate, that may be modified by the application of calcium stearate or stearic acid to improve dispersion characteristics.
- 2.5 **CALCIUM STEARATE:** An ingredient consisting of calcium with a mixture of solid organic acids obtained from fats.

- 2.6 **COMPOUND:** A mixture of polymers with other ingredients such as fillers, catalysts, processing aids, lubricants, modifiers, pigments, or curing agents. material and compound are synonymous as used in this standard.
- 2.7 **COMPOUNDER:** A corporation, company, or individual that blends, mixes, or otherwise modifies materials supplied by a raw material manufacturer, for use at another location.
- 2.7.1 **IN-PLANT COMPOUNDER:** A manufacturer who blends, mixes, or otherwise modifies materials supplied by a raw material supplier within the manufacturing facility where the final product is extruded, molded or fabricated.
- 2.8 **CONTAMINATION:** Presence of foreign materials, impurities, or diluents affecting one or more physical, chemical or toxicological properties of plastics piping system components and related materials.
- 2.9 **CONTINUOUS WASTE:** A drain connecting two or more plumbing fixtures or components of plumbing fixtures to a common trap.
- 2.10 **CORROSIVE WASTE:** Industrial, chemical, processed liquid, or liquid borne material limiting the useful service life of the piping system due to chemical or mechanical erosion. Term is synonymous with special wastes.
- 2.11 **CRITICAL DIMENSIONS:** Dimensions of a product (pipe, fittings, etc.) that directly affect performance and/or the capacity of making a sound joint.
- 2.12 **DRAINAGE SYSTEM:** Perforated and/or nonperforated piping that receives and conveys nonpressure sewage, surface water, or groundwater by gravity flow.
- 2.13 **DRAIN, WASTE, AND VENT SYSTEM:** A combined sanitary drainage and vent system within a building drainage system. It includes all piping within a building that conveys sewage or other liquid wastes, and provides air flow to or from a drainage system or air circulation within the system to protect trap seals from siphonage and back pressure.
- 2.14 **ELASTOMER:** A macromolecular material which at room temperature returns rapidly to approximately its initial dimensions and shape, after substantial deformation from stress and release.
- 2.15 **ELASTOMERIC SEAL:** A device, elastomeric in nature, used to produce a fluid tight seal between two or more parts without producing a bond.
- 2.16 **FITTING:** A piping component used to join or terminate sections of pipe or to provide changes of directions or branching in a pipe system.
- 2.17 **GASKET LUBRICANT:** A material used to reduce friction between two mating surfaces being joined by sliding contact action, such as pushing a pipe end into a gasketed pipe end.
- 2.18 **GENERIC INGREDIENTS:** Ingredients that are physically and chemically similar, but vary in composition due to manufacturing process, source of materials, or trace components in the material.
- 2.19 **HEAT JOINING:** A joint made by heating the mating surfaces of pipe components and pressing them so they fuse and become essentially one piece.

- 2.20 **HYDROCARBON WAXES:** Waxes comprised of the branched or linear hydrocarbons essentially alkane in chemical character.
- 2.21 **HYDROSTATIC DESIGN STRESS:** The recommended maximum hoop stress in the wall of the pipe that can be applied continuously with a high degree of certainty that failure of the pipe will not occur.
- 2.22 **JOINING MATERIAL:** A substance used to produce a fluid tight joint (solvent cement, adhesive, sealant, etc.) between two or more components.
- 2.23 **MATERIAL:** A mixture of polymers with other ingredients such as fillers, stabilizers, catalysts, processing aids, lubricants, modifiers, pigments, or curing agents. The terms material and compound are synonymous as used in this standard.
- 2.24 **NEW INGREDIENT:** Any chemical or substance not previously accepted for use in products intended for potable water applications.
- 2.25 **OXIDIZED POLYETHYLENE WAXES:** Waxes composed of oxidized homopolymers of ethylene.
- 2.26 **PIPING PRODUCTS:** Includes pipe, fittings, and valves.
- 2.27 **PLASTICS:** A material that contains as an essential ingredient one or more organic polymeric substances of large molecular weight, is solid in its finished state, and can be shaped by flow at some stage in its manufacturing or processing into finished articles.
- 2.27.1 **THERMOPLASTICS:** Plastics that can be repeatedly softened by heating and hardened by cooling through a temperature range characteristic of the plastics. In the softened state, the plastics can be shaped by flow into articles by molding or extrusion.
- 2.27.2 **THERMOSET PLASTICS:** Plastics that, when cured by application of heat (radiation, electrical energy, or chemical), change into a substantially infusible and insoluble product.
- 2.28 **PLASTICS PIPE:** A hollow cylinder of a plastics material in which the wall thicknesses are usually small when compared to the diameter, and in which the inside and outside walls are essentially concentric.
- 2.29 **PRIMER:** An organic liquid that does not contain any undissolved particles and is used to soften surfaces of pipe and fittings before application of a solvent cement.
- 2.30 **POTABLE WATER SYSTEMS:** Systems used to convey drinking water.
- 2.31 **QUALITY ASSURANCE:** A formal system for verifying that products conform to specific standards. Quality assurance is intended as an audit of quality control testing.
- 2.32 **QUALITY CONTROL:** The methods used to insure that a production process yields products in conformance with the appropriate specifications established by the quality assurance program.
- 2.33 **RESIN:** A solid or pseudosolid organic material of high molecular weight exhibiting a tendency to flow when subjected to stress. It usually has a softening or melting range and fractures conchoidally.

- 2.34 **RESIDUAL VINYL CHLORIDE MONOMER (RVCM):** Unreacted vinyl chloride remaining in a polyvinyl chloride (PVC) or chlorinated polyvinyl chloride (CPVC) or piping product. The concentration is reported on a weight-to-weight basis as ppm.
- 2.35 **SEALANT:** A material used on two mating surfaces to produce a pressure seal without producing a bond.
- 2.36 **SEWER SYSTEM:** A public or private piping system that receives discharge from a building drainage system and transports it to a point of disposal.
- 2.37 **SOLVENT CEMENT:** A joining material made by dissolving plastic resin or compound in a solvent, or mixture of solvents. When applied to the joining surfaces of pipe and fitting, it softens the surfaces to form a bond.
- 2.38 **SPECIAL ENGINEERED PRODUCTS (SE):** Plastics products specifically designed for a particular end use or application that are not covered by an established consensus standard.
- 2.39 **TITANIUM DIOXIDE:** An ingredient consisting of at least 92 percent titanium dioxide rutile that may be chemically modified through the addition of alumina and/or silica.
- 2.40 **TOTAL TRIHALOMETHANES (TTHMs):** The sum of four trihalomethanes: chloroform, bromodichloromethane, chlorodibromomethane, and bromoform.
- 2.41 **TOXIC SUBSTANCE:** A substance that has a known or potential adverse physiological effect on humans.
- 2.42 **TRAP:** A properly vented fitting or device to provide a liquid seal to prevent the backflow of air and not affect the flow of liquid.
- 2.43 **VALVE:** A device used to regulate flow of liquids or gases.
- 2.44 **VENT SYSTEM:** Pipe to provide air flow to or from a drainage system or air circulator in the system, and protect trap seals from siphonage and back pressure by limiting pressure differentials.
- 2.45 **VIRGIN MATERIAL:** A plastics material in the form of pellets, granules, powder, or liquid that has not been subjected to use or processing other than that required for manufacture.
- 2.46 **WELL CASING SYSTEM:** A system composed of pipes, fittings and appurtenances used as a casing for water wells.

SECTION 3. REQUIREMENTS FOR PLASTICS PIPING SYSTEM COMPONENTS AND RELATED MATERIALS

- 3.0 **GENERAL:** Plastics piping system components and related materials shall meet the public health and performance-oriented requirements as established for the intended application. Plastics piping system components and related materials shall be produced only from materials complying with this standard. Clean rework material, of the same form as the original material, from the same production facility, may be used if the finished products meet the requirements of the intended application. Plastics piping system components and related materials shall be manufactured to prevent contamination.

- 3.1 **PHYSICAL/PERFORMANCE REQUIREMENTS:** Plastics piping system components and related materials shall comply with the requirements of Section 4.
- 3.2 **POTABLE WATER REQUIREMENTS:** Plastics piping system components and related materials intended for use in potable water supply systems shall comply with the applicable requirements of Sections 6 and 7.
- 3.3 **SPECIAL ENGINEERED PRODUCTS:** Special engineered products shall comply with the applicable requirements of Sections 5, 6, and 7.
- 3.4 **MARKING REQUIREMENTS:** All plastics piping system components and related materials shall comply with the marking requirements of Section 8.
- 3.5 **QUALITY ASSURANCE:** Records and test frequencies shall comply with Section 9.

SECTION 4. PHYSICAL/PERFORMANCE REQUIREMENTS

- 4.0 **GENERAL:** Plastics piping system components and related materials shall comply with the physical and performance requirements of the applicable standards as referenced in Appendix A.
- 4.1 **HYDROSTATIC DESIGN STRESS:** Manufacturers of materials for use in plastics pipe for pressure applications shall submit evidence of hydrostatic design stress compliance in accordance with the following:
 - THERMOPLASTICS MATERIALS:** Thermoplastic materials shall comply with the PPI Technical Report TR-3, Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.¹
 - THERMOSET MATERIALS:** The maximum hydrostatic design stress of thermoset plastics materials shall be determined in accordance with ASTM D2992 as referenced in Appendix A.
- 4.2 **CRITICAL DIMENSIONS:** Plastics piping system components shall comply with the critical dimensions of the applicable standards as referenced in Appendix A. For pipe, the critical dimensions are the minimum wall thickness, diameter, and out-of-roundness. For fittings, the critical dimensions are wall thickness, socket entrance and bottom diameter and out-of-roundness, spigot outside diameter and out-of-roundness, socket depth, and threads and thread length.
- 4.3 **GENERIC INGREDIENTS:** Generic ingredients (calcium carbonate, calcium stearate, hydrocarbon waxes, oxidized polyethylene waxes, titanium dioxides) intended for use in PVC materials and compounds shall comply with the applicable sections of the PPI Technical Report TR-3, Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials as referenced in Appendix A.

¹ Available from the Plastics Pipe Institute, 355 Lexington Avenue, New York, NY 10017

SECTION 5. SPECIAL ENGINEERED PRODUCT REQUIREMENTS

- 5.0 **GENERAL:** Special engineered products covered by this section may be intended for potable water, waste drainage or other special applications, and shall comply with applicable requirements of this standard.
- 5.1 **CORROSIVE WASTE MATERIALS:** Corrosive waste materials shall comply with physical, chemical, and performance requirements of applicable standards as referenced in Appendix A, and the following requirement:
- 5.1.1 **CHEMICAL RESISTANCE²**
50 percent acetic acid
25 percent sodium hydroxide
100 percent acetone
100 percent methanol
25 percent nitric acid
- TENSILE STRENGTH:** Change in tensile strength shall not exceed ± 15 percent of the unexposed sample, when tested in accordance with ASTM D638 as referenced in Appendix A.
- WEIGHT:** Change in weight shall not exceed ± 15 percent of the unexposed sample.
- 5.2 **CORROSIVE WASTE PRODUCTS:** Corrosive waste system components, when used as directed by the manufacturer, shall be capable of conveying and discharging the corrosive wastes for which they were designed. Corrosive waste system components shall be evaluated against the manufacturer's product specifications and claims.
- 5.2.1 **INSTALLATION AND USE:** The manufacturer shall provide recommended installation procedures, limitations of use, and a list of corrosive wastes the system is capable of safely handling.
- 5.2.2 **DIMENSIONS:** Dimensions and tolerances for polyethylene and polypropylene shall conform to the manufacturer's specifications.
- 5.2.3 **HYDROSTATIC SHORT TERM PRESSURE:** Hydrostatic short term pressure testing shall be conducted on pipe and fittings assemblies in conformance with ASTM D1599 as referenced in Appendix A. The assemblies shall meet or exceed the manufacturer's specified minimum requirements for hydrostatic short term pressure.
- 5.3 **OTHER SPECIAL ENGINEERED PRODUCTS:** Variations in composition and/or color may be allowed if the design, engineering, and product specifications are found acceptable. The product shall comply with the agreed upon test specifications.
- 5.4 **FIELD APPLIED COATINGS:** Field applied coatings shall meet all applicable requirements in this standard for the intended end use when applied in accordance with the manufacturer's instructions.

²Special chemical exposure resistance may be claimed by the manufacturer if verified by testing. Tensile bars shall be totally immersed in each reagent for 28 days and tested in accordance with ASTM D543 as referenced in Appendix A.

**SECTION 6. QUALIFICATION REQUIREMENTS FOR POTABLE WATER
PLASTICS PIPING SYSTEM COMPONENTS AND RELATED MATERIALS**

- 6.0 **QUALIFICATION:** All new materials, compounds, products, and changes in accepted formulations shall be shown to comply with the applicable requirements of NSF Standard 61: Drinking Water System Components - Health Effects as referenced in Appendix A.
- 6.1 **GENERIC INGREDIENT REQUIREMENTS:** Generic ingredients for use in PVC potable water pipe and fittings shall meet the requirements of this section.
- 6.1.1 **CALCIUM CARBONATES:** Calcium carbonates shall comply with one of the following requirements:
- The Food Chemicals Codex, as referenced in Appendix A, or
 - Applicable requirements of NSF Standard 61 when one gram of calcium carbonate is exposed in 1.0 L of low pH extractant water, or
 - Applicable requirements of NSF Standard 61 when tested in PVC pipe or fittings formulated to contain the ingredient at the maximum use level.
- 6.1.2 **CALCIUM STEARATES:** Calcium stearates shall comply with the applicable requirements of NSF Standard 61 when tested in PVC pipe or fittings formulated to contain the ingredient at the maximum use level.
- 6.1.3 **HYDROCARBON WAXES:** Hydrocarbon waxes shall comply with Title 21, (food and drugs) CFR-178.3710 and the applicable requirements of NSF Standard 61 when tested in PVC pipe or fittings formulated to contain the ingredient at the maximum use level.
- 6.1.4 **OXIDIZED POLYETHYLENE WAXES:** Oxidized polyethylene waxes shall comply with Title 21, (food and drugs) CFR-172.260 OR CFR-177.1620 and the applicable requirements of NSF Standard 61 when tested in PVC pipe or fittings formulated to contain the ingredient at the maximum use level.
- 6.1.5 **TITANIUM DIOXIDES:** Titanium dioxides shall comply with Title 21, (food and drugs) CFR 73.575, and/or shall comply with the applicable requirements of NSF Standard 61 when tested in PVC pipe or fittings formulated to contain the ingredient at the maximum use level.

**SECTION 7. MONITORING REQUIREMENTS FOR POTABLE WATER
PLASTICS PIPING SYSTEM COMPONENTS AND RELATED MATERIALS**

- 7.0 **MONITORING:** Plastics piping system components and related materials shall be monitored at least once each calendar year for the chemical extraction parameters in Table 1. Only antimony containing products shall be monitored for antimony. Only copper containing products shall be monitored for copper. The levels of substances in the low pH extractant water shall not exceed the maximum permissible levels (mpls) in Table 1 after the third exposure. The extractant waters may also be analyzed for additional substances based on the formulation information, and shall not exceed levels of toxicological significance.

- 7.1 **TOTAL TRIHALOMETHANES:** The maximum permissible level of total triha. in the organic extractant water after exposure to CPVC pipe shall not exceed 0.10 mg/L.
- 7.2 **RESIDUAL VINYL CHLORIDE MONOMER (RVCM):** The maximum permissible level of RVCM in PVC and CPVC piping products shall not exceed 3.2 mg/kg.
- 7.3 **EXTRACTION TESTING:** Plastics piping system components and related materials shall be extraction tested in accordance with the following procedures for monitoring.
- 7.3.1 **EXPOSURE CONDITIONS:** Exposure of samples shall be conducted using the multiple exposure procedure; except that dip tubes, shall be tested using the single exposure procedure. Pans and tanks shall be filled with the extractant water and exposed using the multiple exposure procedure.

SINGLE EXPOSURES: (DIP TUBES ONLY)
72 ± 4 HOURS AT 99 ± 0.5° C

MULTIPLE EXPOSURES:
COLD APPLICATIONS:

1. 24 ± 1 HOUR AT 37 ± 0.5° C
2. 24 ± 1 HOUR AT 37 ± 0.5° C
3. 72 ± 4 HOURS AT 37 ± 0.5° C

HOT APPLICATIONS:

1. 1 HOUR AT 82 ± 0.5° C
2. 1 HOUR AT 82 ± 0.5° C
3. 0.5 HOUR AT 82 ± 0.5° C AND
72 ± 4 HOURS AT 37 ± 0.5° C

TABLE 1. MAXIMUM PERMISSIBLE LEVELS FOR CHEMICAL SUBSTANCES

<u>SUBSTANCES</u>	<u>MPL</u> <u>mg/L</u>	<u>Action Levels</u> <u>mg/L</u>
Antimony	0.05	
Arsenic	0.050	
Cadmium	0.005	
Copper	1.3	
Lead	0.020	
Mercury	0.0020	
Phenolic Substances		0.05 ³
Tin	0.05	
TOC		5.0 ³
TTHM	0.10	
RVCM*	3.2	2.0 ⁴

*In the finished product ppm (mg/kg).

³This is an action level. If the level is exceeded, further review and/or testing shall be initiated to identify the specific substance(s), and acceptance or rejection shall be based on the level of specific substances in the water.

⁴Additional samples shall be selected from inventory and tested to monitor for conformance with the MPL.

- 7.4 **EXTRACTANT WATERS:** Extractant waters shall contain 100 mg/L hardness as calcium carbonate (CaCO_3) in deionized water. The deionized water shall meet the requirements of ASTM 1193 type II reagent water.

PH 5 EXTRACTANT WATER: One part of stock buffer solution consisting of 13.89 g/L of sodium dihydrogen phosphate (NaH_2PO_4) in deionized water is added to 40 parts of reagent water and adjusted with a chlorine solution to yield 2 mg/L total free available chlorine.

PH 8 ORGANIC EXTRACTANT WATER: One part of stock buffer solution consisting of 3.60 g/L of sodium bicarbonate (NaHCO_3) in deionized water is added to 36 parts of reagent water. Organic extractant water shall be verified by analysis as chlorine free.

- 7.5 **SAMPLE SURFACE AREA/EXTRACTANT WATER RATIO:** Unless otherwise specified, the ratio shall be equivalent to 1000 square inches (6500 cm^2) of surface area of the plastics sample to four liters of extractant water for all exposures.

Solvent cements shall be spread over 10 square inches (65 cm^2) of surface on a plastic pipe and cured for 72 ± 4 hours before exposure. The sample surface area/extractant water ratio for solvent cements, primers, and lubricants shall be equivalent to 10 square inches (65 cm^2) to four liters of extractant water.

The sample surface area/extractant water ratio for tanks and coatings shall be the highest surface area to volume ratio expected (which is the smallest tank) for actual use.

SECTION 8. MARKING

- 8.0 **GENERAL:** Markings on plastics piping system components shall be legible and permanent.
- 8.1 **PIPE:** The manufacturer shall place on all plastics pipe, the designations and identifications required in the applicable standards as referenced in Appendix A. Plastics pipe shall also bear an appropriate code identifying the day, month, and year of production, the extruder, and the compound designation. If pipe is made by a multiple head extrusion technique with intermediate storage before marking, the code may indicate the week rather than the day of production. If the manufacturer has more than one plant location or produces for other suppliers/distributors, an identifying symbol shall be used.
- 8.2 **FITTINGS AND APPURTENANCES:** The manufacturer shall place on all plastics fittings and appurtenances, the designations and identifications required in the applicable standards as referenced in Appendix A. The fittings and appurtenances shall also bear an appropriate code identifying the mold and cavity used. If the manufacturer has more than one plant location or produces for other suppliers/distributors, an identifying symbol shall be used.
- 8.3 **THREAD COMPOUNDS, SEALANTS, GASKET LUBRICANTS, SOLVENT CEMENTS, ADHESIVES AND COATINGS:** The manufacturer shall label each container, with the designations and identifications required in the applicable standards as referenced in Appendix A. The container shall bear an appropriate batch number identifying the day,

month, and year of manufacture, and formulation designation. If the manufacturer has more than one plant location or produces for other suppliers/distributors, an identifier shall be used on the container.

- 8.4 **SPECIAL ENGINEERED PRODUCTS:** The manufacturer shall place the symbol "SE" on all special engineered products in addition to the other applicable marking requirements specified in the Special Engineered specifications.
- 8.5 **INGREDIENTS:** The manufacturer shall place on all ingredient containers the manufacturer's name, trade name, product designation, and lot number or date.

SECTION 9. QUALITY ASSURANCE TESTING

- 9.0 **GENERAL:** A quality assurance program shall be operated at each facility to verify product quality and conformance with applicable standards as referenced in Appendix A. It is the manufacturer's responsibility to maintain a quality control program which will ensure that products continue to conform to applicable requirements of the standard on a continuing basis. Variations from these minimum requirements shall be permitted, if an alternate program is established in writing and determined to be equivalent. The tests and frequencies in the following tables are the minimum established to meet the requirements for quality control. Special Engineered products shall be tested in accordance with the quality control program specified in the Special Engineered specifications.
- 9.1 **GENERIC INGREDIENTS:** Generic ingredient manufacturers shall perform tests necessary to assure that each lot complies with the requirements of Item 4.3. Records shall be maintained according to Item 9.3.
- 9.2 **TESTING FACILITIES:** The manufacturer shall provide and maintain quality assurance testing facilities at each production facility.
- 9.3 **QUALITY ASSURANCE RECORDS:** The manufacturer shall maintain records of quality assurance testing at each production location for at least two years.
- 9.4 **PRODUCTION CODE IDENTIFICATION:** If code identification of products is required, the manufacturer shall maintain additional records necessary to confirm identification of products.
- 9.5 **TESTING FREQUENCY:** The manufacturer shall perform quality assurance testing at the frequencies specified in this section.
 - 9.5.1 **FREQUENCY INTERPRETATION:** In each case the frequency indicated shall be interpreted as follows: The indicated test shall be performed at the start-up of production operation, on each extruder or injection molder, and continued at steady state operation that meets the test requirement is obtained, and then the required frequency until any change in the steady state operation. When there is a change in operation, testing shall be resumed continuously until a new steady state operation is obtained and then the required frequency shall be resumed.

The test frequency indicated for firings shall be used only after the mold has been qualified. Qualification means complete dimensioning, and conducting appropriate tests on all products from all cavities in the mold until they are in compliance. After qualification, the indicated frequencies shall apply per mold. Any change is made to the mold, whereupon all cavities within the mold shall be re-qualified.

requaified.

Where annual testing is required, the annual testing done by NSF shall satisfy the requirement.

Unless otherwise specified by the applicable consensus standard, the minimum number of test specimens for a sample of one size, style, configuration, etc., shall be:

<u>TEST</u>	<u>NUMBER OF SPECIMENS</u>
Acetone	1
Burst Pressure	5
Deflection Load & Crush Resistance	3
Degree of Crosslinking	1
Elongation (Microtensile)	2
Environmental Stress Crack Resistance	6
Flattening	3
Impact	10
Pipe Stiffness	3
Stabilizer Migration	2
Sustained Pressure	6
Top Puncture Resistance	3

ABS PIPE

<u>TEST</u>	<u>POTABLE WATER</u>	<u>DWV</u>	<u>SEWER</u>	<u>WELL CASING¹</u>	<u>DWV CELLULAR CORE</u>
Dimensions	2 hours	2 hours	2 hours	2 hours	2 hours
Deflection Load and Crush Resistance	--	--	--	annually	--
Flattening Resistance	annually	annually	annually	--	annually
Impact @ 32° F (0° C) ⁶	--	--	--	24 hours	24 hours
Impact @ 73° F (22.8° C) ⁶	--	24 hours	24 hours	--	24 hours
Burst Pressure ⁶	24 hours	--	--	--	--
Stiffness	--	annually	annually	--	annually
Sustained Pressure	annually	--	--	--	--
Top Puncture Resistance	--	--	--	annually	--
Joint Tightness	--	--	annually	--	--
ASTM Reference (see Appendix A)	D1527 D2661 D2282		D2751	F480	F628

¹Impact testing shall be in accordance with ASTM F-480 as referenced in Appendix A at the specified impact classification of IC-1, IC-2, or IC-3.

⁶If one material is continuously used in several machines or sizes, and when operation is obtained on each machine, sample selection shall be from a different size each day, and rotated in sequence among all machines or sizes.

ABS FITTINGS

<u>TEST</u>	<u>POTABLE WATER</u>	<u>DWV</u>	<u>SEWER</u>	<u>WELL CASING</u>
Dimensions				
Body Wall Thickness	weekly	weekly	weekly	weekly
Socket Bottom ⁷	24 hours	24 hours	24 hours	24 hours
Socket Entrance ⁷	24 hours	24 hours	24 hours	24 hours
Socket Depth ⁷	24 hours	24 hours	24 hours	24 hours
Socket Wall Thickness	24 hours	24 hours	24 hours	24 hours
Thread Length	weekly	weekly	weekly	weekly
Thread Gauge	weekly	weekly	--	weekly
Deflection Load and Crush Resistance	--	--	--	annually
Pipe Stiffness	--	annually	--	--
Flattening	--	annually	--	--
Impact @ 73° F(22.8° C)	--	weekly	weekly	--
Joint Tightness	--	--	annually	--
Burst Pressure	weekly	--	--	--
Tup Puncture Resistance	--	--	--	annually
Socket Concentricity	--	--	--	annually
ASTM Reference (see Appendix A)	D2468	D2661	D2751	F480

⁷Plug gauges may be permitted, provided the mold has been qualified by complete dimensioning and conducting appropriate testing on all products from all mold cavities, to verify compliance with the referenced standard.

CONTINUOUS WASTE TUBING AND FITTINGS ABS, PVC, & I

TEST

Dimensions - pipe	2 hours
Dimensions - fittings	
Body Wall Thickness	weekly
Socket Bottom ^a	24 hours
Socket Entrance ^a	24 hours
Socket Depth ^a	24 hours
Socket Wall Thickness	24 hours
Thread Length	weekly
Hydrostatic Pressure	annually
Axial Stress	annually
ASTM Reference (see Appendix A)	F409

^aPlug gauges may be permitted, provided the mold has been qualified dimensioning and conducting appropriate testing on all products from all molds. verify compliance with the referenced standard.

CPVC PIPE

TEST

Dimensions	2 hours
Flattening Resistance ⁹	annually
Burst Pressure ^{9,10}	24 hours
Sustained Pressure Pipe and Fittings Assemblies	annually
ASTM Reference (see Appendix A)	D2846 F441 F442

⁹Applies to ASTM F441 and F442 only as referenced in Appendix A.

¹⁰If one material is continuously used in several machines or sizes, and when a steady state operation is obtained on each machine, sample selection shall be from a different extruder each day, and rotated in sequence among all machines or sizes.

CPVC FITTINGS

TEST

Dimensions	
Body Wall Thickness	weekly
Socket Bottom ¹¹	24 hours
Socket Entrance ¹¹	24 hours
Socket Depth ¹¹	24 hours
Socket Wall Thickness	24 hours
Thread Length	weekly
Thread Gauge	weekly
Burst Pressure*	weekly
Sustained Pressure Pipe and Fittings Assemblies ¹²	annually
Thermocycling ¹²	annually
ASTM Reference (see Appendix A)	D2846 F437 F438 F439

* SPECIAL NOTE: Burst pressure does not apply to ASTM D2846 as referenced in Appendix A.

¹¹Plug gauges may be permitted, provided the mold has been qualified by cor dimensioning and conducting appropriate testing on all products from all mold cavi
verify compliance with the referenced standard.

¹²Applies only to products produced under ASTM D2846 as referenced in Appendix A.

PE, PEX AND PB PIPE AND TUBING

<u>TEST</u>	<u>PE PIPE</u>	<u>PEX TUBING</u>	<u>PB PIPE</u>
Dimensions	2 hours	2 hours	2 hours
Elongation (Microtensile) ¹³	--	--	annually
Environmental Stress Crack Resistance	annually	annually	--
Elevated Temperature Sustained Pressure (176° F) ° C	annually	--	--
Burst Pressure ¹⁴	24 hours	24 hours	24 hours
Sustained Pressure	annually	annually	annually
Excessive Temperature and Pressure Capability of Tubing and Pipe ¹⁵	--	annually	annually
Degree of Crosslinking	--	weekly	--
Stabilizer Migration	--	annually	--
Bent Tube Hydrostatic Sustained Pressure (Hot and Cold)	--	annually	--
ASTM Reference (see Appendix A)	D2104 D2239 D2447 D2737 D3035	F876 F877	D2662 D2666 D3000 D3309

¹³Applies to ASTM D2662, D2666, and D3309 as referenced in Appendix A.

¹⁴If one material is continuously used in several machines or sizes, and when a steady state operation is obtained on each machine, sample selection shall be from a different extruder each day, and rotated in sequence among all machines or sizes.

¹⁵Applies to ASTM D3309 and F877 as referenced in Appendix A.

PB FITTINGS AND INSERT FITTINGS FOR PE AND PB TUBING

TEST	PB FITTINGS	INSERT FITTINGS <u>PE PIPE</u>	INSERT FITTINGS <u>PB TUBING</u>
Dimensions			
Wall Thickness (Insert)	—	24 hours	24 hours
Barb OD	—	weekly	weekly
Barb Length	—	weekly	—
Thread Gauge	—	weekly	weekly
Insert Length	weekly	weekly	weekly
Thread Length	—	weekly	weekly
Body Wall Thickness	weekly	weekly	weekly
Socket Wall Thickness	24 hours	—	—
Socket Bottom ¹⁶	24 hours	—	—
Socket Entrance ¹⁶	24 hours	—	—
Socket Depth ¹⁶	24 hours	—	—
Burst Pressure	weekly	weekly	weekly
Sustained Pressure	annually	—	annually
Thermocycling	annually	—	annually
Excessive Temperature and Pressure Capability	—	—	annually
ASTM Reference (see Appendix A)	D3309	D2609	F845

¹⁶Plug gauges may be permitted, provided the mold has been qualified by correct dimensioning and conducting appropriate testing on all products from all molders to verify compliance with the referenced standard.

PVC PIPE

TEST	POTABLE WATER¹⁷	DWV¹⁸	DWV (3.25" OD)	SEWER	WELL CASING¹⁹
Dimensions	2 hours	2 hours	2 hours	2 hours	2 hours
Acetone	24 hours	—	24 hours	24 hours	—
Deflection Load and Crush Resistance	—	annually	annually	—	annually
Flattening Resistance	annually	—	annually	annually	—
Impact @ 32° F (0° C) ²⁰	—	—	24 hours	—	24 hours
Impact @ 73° F (22.8° C) ²⁰	24 hours	24 hours	24 hours	24 hours	—
Burst Pressure ²⁰	24 hours	annually	annually	—	—
Stiffness	—	annually	annually	annually	annually
Sustained Pressure	annually	—	—	—	—
Top Puncture Resistance	—	—	—	—	annually
Joint Tightness	—	—	—	annually	—
ASTM Reference	D1785 D2241 D2740	D2665 F891	D2949	D2729 D3033 D3034	F480

(see Appendix A)

¹⁷73° F impact only applies to ASTM D2241 only as referenced in Appendix A.

¹⁸ASTM F891 as referenced in Appendix A provides testing and frequency requirements for PVC cellular core pipe.

¹⁹Impact testing shall be in accordance with ASTM F480 as referenced in Appendix A and the specified impact classification of IC-1, IC-2, or IC-3.

²⁰If one material is continuously used in several machines or sizes, and when a steady state operation is obtained on each machine, sample selection shall be from a different extruder each day, and rotated in sequence among all machines or sizes.

PVC FITTINGS

<u>TEST</u>	<u>POTABLE WATER</u>	<u>DWV²¹</u>	<u>SEWER²²</u>	<u>WELL CASING</u>
Dimensions				
Body Wall Thickness	weekly	weekly	weekly	weekly
Socket Bottom ²³	24 hours	24 hours	24 hours	24 hours
Socket Entrance ²³	24 hours	24 hours	24 hours	24 hours
Socket Depth ²³	24 hours	24 hours	24 hours	24 hours
Socket Wall Thickness	24 hours	24 hours	24 hours	24 hours
Thread Length	weekly	weekly	weekly	weekly
Thread Gauge	weekly	weekly	--	weekly
Acetone	--	--	24 hours	--
Deflection Load and Crush Resistance	--	annually	--	annually
Burst Pressure	weekly	annually	--	weekly
Impact @ 32° F (0° C)	--	weekly	--	--
Impact @ 73° F (22.8° C)	--	weekly	--	--
Flattening	--	annually	--	--
Tup Puncture for Resistance	--	--	--	annually
ASTM Reference (see Appendix A)	D2464 D2466 D2467	D2665 D2949	D2729 D3033 D3034	F480

²¹32° F impact and flattening only apply to ASTM D2949 as referenced in Appendix A.

²²Acetone only applies to ASTM D2729 as referenced in Appendix A.

²³Plug gauges may be permitted, provided the mold has been qualified dimensioning and conducting appropriate testing on all products from all manufacturers to verify compliance with the referenced standard.

SOLVENT CEMENTS AND PRIMERS

<u>TEST</u>	<u>ABS</u>	<u>PVC</u>	<u>CPVC</u>	<u>ABS/PVC</u>	<u>PVC PRIMER</u>
Dissolution	semi-annually	semi-annually	semi-annually	semi-annually	semi-annually
Resin Content	annually	annually	annually	annually	--
Stability	--	--	--	--	semi-annually
Viscosity	once per lot	once per lot	once per lot	once per lot	--
Shelf Stability	--	--	annually	--	--
Burst Strength	--	annually	annually	annually	--
Sustained Pressure Strength	--	--	annually	--	--
ASTM Reference (see Appendix A)	D2235	D2564	F493 D2846	D3138	F656

THERMOSET AND THERMOSET MORTAR PIPE

<u>TEST</u>	<u>THERMOSET</u>	<u>THERMOSET MORTAR</u>
Dimensions	each length	each length
Hoop Tensile	--	annually
Burst Pressure	weekly	--
Soundness	--	annually
Stiffness	annually	annually
Sustained Pressure	--	annually
ASTM Reference (see Appendix A)	D2996 D2997	D3517

MATERIAL SUPPLIERS AND SPECIAL COMPOUNDERS

Cell Classification Verification - Material Suppliers and Special Compounders

The material suppliers and special compounders shall check their manufactured and blended materials for all of the parameters in the cell classification on a semiannual basis (twice a year). Records of the test data shall be maintained at each production facility.

Lot-by-Lot Quality Control - Material Suppliers

The following tests shall be performed on a lot-by-lot basis and records of the test results be maintained at each production facility.

RVCM (PVC/CPVC)

Standard 14

APPENDIX A

APPLICABLE STANDARDS AND REFERENCE DOCUMENTS

<u>DESCRIPTION</u>	<u>DESIGNATION</u>
Test Method for Resistance of Plastics to Chemical Reagents	ASTM D543-78
Test Method for Tensile Properties of Plastics	ASTM D638-82
Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80	ASTM D1527-77(82)
Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings	ASTM D1599-86
Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120	ASTM D1785-86
Specification for Polyethylene (PE) Plastic Pipe Schedule 40	ASTM D2104-85
Specification for Solvent Cement for Acrylonitrile- Butadiene-Styrene (ABS) Plastic Pipe and Fittings	ASTM D2235-81
Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter	ASTM D2239-85
Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)	ASTM D2241-87
Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR)	ASTM D2282-82
Specification for Polyethylene (PE) Plastic Pipe Schedules 40 and 80 Based on Outside Diameter	ASTM D2447-85
Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80	ASTM D2464-76
Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40	ASTM D2466-78
Specification for Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80	ASTM D2467-87
Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40	ASTM D2468-80 (85)
Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings	ASTM D2564-84

Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe	ASTM
Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Drain, Waste, and Vent Pipe and Fittings	ASTM D2661
Specification for Polybutylene (PB) Plastic Pipe (SDR-PR)	ASTM D2662
Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings	ASTM D2665
Specification for Polybutylene (PB) Plastic Tubing	ASTM D2666
Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings	ASTM D2725
Specification for Polyethylene (PE) Plastic Tubing	ASTM D2737
Specification for Poly (Vinyl Chloride) (PVC) Plastic Tubing	ASTM D2740
Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings	ASTM D2751
Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems	ASTM D2846
Specification for 3.25-in. Outside Diameter Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings	ASTM
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Specification for Type PSP Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings	ASTM D3003
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Specification for Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Non-Pressure Piping Components	ASTM D313

Specification for Polybutylene (PB) Plastic Hot-Water Distribution Systems	ASTM D3309-85b
Specification for Reinforced Plastic Mortar Pressure Pipe	ASTM D3517-86
Specification for Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings	ASTM F409-81
Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80	ASTM F437-82
Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40	ASTM F438-82
Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80	ASTM F439-87
Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80	ASTM F441-86a
Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)	ASTM F442-87
Specification for Thermoplastic Water Well Casing Pipe and Made in Standard Dimension Ration (SDR)	ASTM F480-81
Specification for Solvent Cements for Chlorinated Poly (VC) Plastic Pipe and Fittings	ASTM F493-85
Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Drain, Waste, and Vent Pipe Having A Foam Core	ASTM F628-87a
Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings	ASTM F656-80
Specification for Plastic Insert Fittings for Polybutylene (PB) Tubing	ASTM F845-86
Standard Specification for Crosslinked Polyethylene (PEX) (PEX) Plastic Hot- and Cold-Water Distribution Systems	ASTM F876-85
Standard Specification for Coextruded Poly (Vinyl Chloride) (PEX) Plastic Hot- and Cold-Water Distribution Systems	ASTM F877-85
Standard Specification for Crosslinked Polyethylene (PEX) Tubing	ASTM F876-85
Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems	ASTM F877-85
Standard Specification for Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core	ASTM F891-86

Polyethylene (PE) Pressure Pipe and Tubing, 1/2" through 3", for Water Service

AWWA

Polybutylene (PB) Pressure Pipe and Tubing, 1/2" through 3", for Water

AWWA C902-

Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials

PPI TR-3-87

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NSF 61 - Octo

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JUSTIFICATION FOR THE USE OF PVC WELL MATERIALS AT SWMUs 1 AND 5 NAS MEMPHIS, MILLINGTON, TENNESSEE

Southern Division Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) is committed to using only the most reliable methods to obtain the data used in its investigations. Therefore, SOUTHNAVFACENGCOM recommends the use of well casings made of Polyvinyl chloride (PVC) material for monitoring wells installed at several Solid Waste Management Units (SWMUs) at NAS Memphis. After reviewing the literature, SOUTHNAVFACENGCOM has concluded that PVC is a superior well casing material when monitoring a plume consisting of both metals and organics. Attached are two recent publications supportive of SOUTHNAVFACENGCOM's position: "Influence of Casing Materials on Trace-Level Chemicals in Well Water" (Parker, 1990) and "Leaching of Metal Pollutants from Four Well Casing Used for Groundwater Monitoring" (Hewitt, 1989). Also attached is the National Sanitation Foundations "Standard 14 - Plastics Piping Components and Related Materials" which contains the specifications and performance evaluations of the proposed well construction material.

SOUTHNAVFACENGCOM request that U.S. EPA consider the following information as required in the "Alternate Well Casing Justification" form.

1. The Data Quality Objectives (DQO) for the samples to be collected from wells with PVC casing per EPA/540/G-87/003., Data Quality Objectives for Remedial Response Activities.

Response: The DQO's for the RFI at NAS Memphis are to provide information of sufficient quality to support risk assesement and to characterize all active and inactive SWMUs at NAS Memphis. The quality assurance (QA) and quality control (QC) procedures are specified in the Comprehensive RFI Work Plan. Sample collection and accompanying QA/QC procedures are designed to meet Level III and Level IV (80/20 per cent split) DQOs.

2. The anticipated compounds and their concentrations.

Response: PVC should not interfere with the anticipated compounds and their concentration range. (See attached analytical data for contaminant concentrations identified in soil and groundwater at SWMUs #1 and #5).

3. The anticipated residence time of the sample in the well and the aquifers productivity.

Response: Each well will be purged immediately prior to the collection of the sample. The anticipated residence time of the water after purging and prior to sampling is approximately 20 minutes. Permeability data from the shallow aquifer from various locations throughout NAS Memphis range from 3.8×10^{-8} cm/second to 7.6×10^{-5} cm/second and an average hydraulic conductivity ranging from 0.102 ft./day to 0.234 ft./day.

4. The reason for not using a hybrid well of PVC casings and stainless steel screen.

Response: SOUTHNAVFACENGCOM feels that PVC is the preferred material when sampling mixed waste plumes. Stainless steel may absorb or adsorb heavy metals such as lead, chromium, and arsenic. Also, the cutting oils used in the manufacturing of stainless steel riser and screen are difficult to remove. These oils, if not completely removed by the decontamination process, may contaminate the well. Hybrid wells introduce additional problems. For instance, the junction is usually a weak point subject to breakage or is a place for down-hole equipment to become ensnared.

5. Literature on adsorption/desorption characteristics of the compounds and elements of interest for the type of PVC to be used.

Response: Two reprints are attached that evaluate the sorptive characteristics of stainless steel and PVC.

6. If an anticipated increase in the thickness of the monitor well wall would require an increase in annular space.

Response: No change in the annular space is required.

7. The type of PVC to be used and if available the manufacturer's specifications, and an assurance that the PVC to be used does not leach, mask, react, or otherwise interfere with the contaminants being monitored within the limits of the DQO(s).

Response: The PVC will to be used in the well construction will meet National Sanitation Foundation (NSF) Standard 14. Attached is a reprint of the NSF Standard 14 for Plastic Piping System Components and Related Materials with performance requirements of the PVC in question. In addition to NSF Standard 14 PVC, a high solids bentonite grout will be used in place of a cement/bentonite grout.

**NAS Memphis RFI
Interim Measure - SWMU 1**

Table TM-1 Summary of Validated Positive Results Total Petroleum Hydrocarbons (GC/FID)	
Sample I.D. Number	Concentration (mg/kg)
01-B-1-1	4.1
01-B-8-5	4.7
01-B-9-1	4.7
01-B-10-1	7.1
01-B-10-5/5D	4.2/< 4.0
01-B-11-5	5.3

Table TM-2 Summary of Validated Positive Results Volatile Organic Compounds	
Sample I.D. Number	Acetone (mg/kg)
01-B-5-1	36
01-B-5-5	130
01-B-5-5D	130
01-B-8G-1	0.18
01-B-8G-5	0.19
01-B-8G-5D	0.20

**NAS Memphis RFI
Interim Measure - SWMU 1**

**Table TM-3 (1 of 3)
Summary of Validated Positive Results
Inorganic Analytical Data
(mg/kg)**

	Sample 01-B-1-1	Sample 01-B-1-5	Sample 01-B-2-1	Sample 01-B-2-6	Sample 01-B-3-1	Sample 01-B-3-6	Sample 01-B-4-1	Sample 01-B-4-6	Sample 01-B-5-1	Sample 01-B-5-5	Sample 01-B-5-5D
Arsenic									9.1	3.2	4.6
Barium									121	198	178
Beryllium									0.41	0.71	0.50
Cadmium	0.17				0.19	0.16	0.22				
Chromium	11.0	8.4	9.3	11.2	11.5	16.0	9.1	12.2	10.6	13.6	13.0
Cobalt									6.6	8.2	8.5
Copper									15.1	13.4	12.2
Lead	9.3	7.4	7.5	9.8	8.5	10.0	8.0	9.1	10.7	9.6	6.5
Nickel									18.1	19.7	16.6
Vanadium									21.9	23.4	20.7
Zinc									48.1	48.0	43.1

**NAS Memphis RFI
Interim Measure - SWMU 1**

Table TM-3 (2 of 3) Summary of Validated Positive Results Inorganic Analytical Data (mg/kg)										
	Sample 01-B-6-1	Sample 01-B-6-5	Sample 01-B-8G-1	Sample 01-B-8G-6	Sample 01-B-8G-5D	Sample 01-B-7-1	Sample 01-B-7-5	Sample 01-B-8-1	Sample 01-B-8-5	Sample 01-B-9-1
Arsenic			5.1	9.6	2.8					
Barium			111	166	176					
Beryllium			0.36	0.44	0.42					
Cadmium	0.14	0.50				0.15		0.11		0.10
Chromium	10.2	12.7	6.4	10.9	11.1	7.3	11.8	8.2	12.1	9.1
Cobalt			4.4	2.0	1.5					
Copper			9.0	10.2	9.8					
Lead	10.3	14.0	11.8	15.3	5.3	6.6	11.2	7.2	7.0	8.8
Nickel			9.5	10.7	11.2					
Vanadium			15.7	15.0	14.1					
Zinc			27.4	39.0	37.4					

**NAS Memphis RFI
Interim Measure - SWMU 1**

**Table TM-3 (3 of 3)
Summary of Validated Positive Results
Inorganic Analytical Data
(mg/kg)**

	Sample 01-B-9-5	Sample 01-B-10-1	Sample 01-B-10-5	Sample 01-B-10-5D	Sample 01-B-11-1	Sample 01-B-11-5	Sample 01-B-11-10	Sample 01-B-12-1	Sample 01-B-12-5	Sample 01-B-12-10
Arsenic								6.6	3.8	6.5
Barium								123	119	150
Beryllium								0.37	0.40	0.43
Cadmium		0.11			0.12		0.36			
Chromium	9.0	9.4	8.7	9.4	9.1	10.5	10.7	9.7	10.5	11.4
Cobalt								6.9	5.8	6.3
Copper								14.6	10.6	15.5
Lead	6.4	8.8	14.4	7.4	8.7	8.9	9.0	10.6	15.6	10.3
Nickel								17.3	9.3	18.7
Silver								1.0		
Vanadium								19.8	17.7	22.4
Zinc								47.6	30.2	51.4

Table D-1 Soil Analytical Results UST Parameters Results in mg/kg (ppm)							
Sample ID/Date	Benzene		Toluene		Total Xylenes	Total BTX	GRO
MW-01-9 (06/22/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	(10) U
MW-02-06 (06/22/92)	4.2		1.6		54	59.8	640 D
MW-02-10 (06/22/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	16
MW-03-10 (06/23/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	(10) U
MW-04-8 (06/23/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	(10) U
MW-05-8 (06/24/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	(10) U
MW-06-6 (06/24/92)	(0.1)	U	0.2		5.4	5.6	170
MW-06-8 (06/24/92)	(0.1)	U	(0.1)	U	0.4	0.4	21
MW-06-10 (06/24/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	(10) U
MW-07-4 (06/25/92)	0.5		0.8		17	18.3	230
MW-07-6 (06/25/92)	(0.1)	U	(0.1)	U	0.2	0.2	(10) U
MW-07-8 (06/25/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	(10) U
MW-08-2 (06/25/92)	1 D		40 D		83	134 D	3,300 D
MW-08-8 (06/25/92)	0.1		(0.1)	U	(0.1) U	0.1	(10) U
MW-09-8 (06/25/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	(10) U
MW-10-2 (06/25/92)	(0.2)	U*	(0.2)	U*	11 D	11 D	210 D
MW-10-6 (06/26/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	10 U
MW-10-10 (06/26/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	(10) U
MW-11-4 (06/26/92)	1.5 D		4.5 D		35 D	41.0 D	500
MW-11-11 (06/26/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	(10) U
B-03-8 (06/22/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	(10) U
B-04-8 (06/22/92)	(1.3)	U*	(1.3)	U*	6.7	6.7	210 D
B-04-10 (06/22/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	(10) U
B-04-12 (06/22/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	(10) U
B-07-2 (06/23/92)	2.5		4.5		61	68	230 D
B-07-8 (06/23/92)	2.8		2.4		7.7	12.9	320
B-08-4 (06/23/92)	(0.1)	U	0.5		2.2	2.7	300
B-08-10 (06/23/92)	(1.3)	U*	1.3		2.4	3.7	140

Table D-1 Soil Analytical Results UST Parameters Results in mg/kg (ppm)							
Sample ID/Date	Benzene		Toluene		Total Xylenes	Total BTX	GRO
B-09-4 (06/24/92)	(0.1)	U	0.5	*	9.1	9.6	130 D
B-09-9 (06/24/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	(10) U
B-12-4 (06-24-92)	(0.5)	U*	0.7		3.4	4.1	230 D
B-12-10 (06/24/92)	(0.5)	U	5.2		33	38.2	960 D
B-15-2 (06/25/92)	0.6		0.4	D	33	33.4 D	950 D.
B-15-8 (06/25/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	(10) U
B-15-10 (06/26/92)	(0.1)	U	(0.1)	U	(0.1) U	(0.1) U	(10) U
B-16-10 (06/25/92)	(0.1)	U	(0.1) U	U	(0.1) U	(0.1) U	(10)

NOTES:

Sample depths are indicated in the last number of each sample ID. The number represents the top of the 2-foot collection interval. An exception is MV-11-11, which was collected between 11 and 1.5 ft.

U Compound was analyzed for but not detected. The number in parentheses is the detection limit for sample.

D Quantitation taken from a dilution.

* Detection limit is higher than normal due to sample matrix interferences.

Table D-2 Soil Analytical Results Volatile Organic Compounds Results in ug/kg (ppb)				
Sample ID/Date	Compound Concentrations			
	Benzene	Toluene	Ethylbenzene	Total Xylenes
MW-02-6 (06/22/92)	3,000 E	1,700 E	8,200 E	26,000 E
MW-02-6 DL (06/22/92)	4,800 J	3,300 J	19,000	97,000
MW-05-8 (06/24/92)	—	—	—	—
MW-06-6 (06/24/92)	3 J	—	62	380 E
MW-06-6 DL (06/24/92)	—	—	920 J	5,600
MW-08-4 (06/25/92)	2,500	—	4,600	21,000
MW-08-14 (06/25/92)	—	—	—	—
MW--11-4 (06/26/92)	6,500	—	20,000	120,000 E
MW-11-4 DL (06/26/92)	6,800 J	—	17,000	75,000
B-08-4 (06/23/92)	—	—	2,400	1,700
B-08-4 RE (06/23/92)	—	—	730 J	1,300 J
B-08-10 (06/23/92)	140	—	440 E	630 E
B-08-10 DL (06/23/92)	250 J	—	2,600	5,000
B-09-4 (06/24/92)	—	—	—	1,500
B-15-2 (06/25/92)	110	—	110	—

NOTES:

- E · Compound exceeded calibration range.
- DL · Diluted
- J · Compound detected but below quantitation limit; value estimated.
- RE · Reanalyzed

Table D-3 Soil Analytical Results Base/Neutral and Acid Extractables Results in ug/kg (ppb)						
Sample/ID/Date	Compound Concentrations					
	Naphthalene	2-Methyl-naphthalene	Acenaphthene	Phenanthrene	Fluoranthene	Pyrene
MW-02-6 (06/22/92)	3,000 J	3,900 J	8,200 E	1,800 --	1,400 J	1,100 J
MW-05-6 (06/24/92) (6-10 ft.)	--	--	--	-- --	--	--
MW-06-4 (06/24/92) (4-8 ft.)	280 J	100 J	--	--	--	--
MW-11-3 (06/26/92) (3-7 ft.)	4,100	18,000	440 J	--	--	--
B-07-2 (06/24/92)	3,200 J	2,000 J	--	--	--	--
B-08-4 (06/23/92)	320 J	2,500	41 J	--	--	--
B-09-4 (06/24/92)	530 J	3,000	--	--	--	--
B-15-2 (06/25/92)	6,300 J	24,000	--	--	--	--

NOTES:

Unless otherwise noted, sample depths are in 2-foot intervals; the top is noted (in ft.) by the last number in the sample ID.

J - Compound detected but below quantitation limit; value estimated.

E - Compound exceeded calibration range.

Table D-4
Soil Analytical Results
Appendix IX Metals
Results in mg/kg (ppm)

Sample ID Parameter	MW-02-6 (06/22/92)	MW-05-06 (6-10 ft) (06/24/92)	MW-06-4 (4-8 ft) (06/24/92)	MW-11-3 (3-7 ft) (06/26/92)	B-07-2 (06/26/92)	B-08-4 (06/23/92)	B-09-4 (06/24/92)	B-15-2 (2-6 ft) (06/26/92)
Antimony	(0.48) U	(0.50) U	(0.51) U	(0.51) U	(0.50) U	(0.50) U	(0.50) U	(0.50) U
Arsenic	10.5	12.9	2.5	11.3	12.0	12.9	7.2	1.5
Barium	53	173	272	201	151	173	151	183
Beryllium	0.73	1.2	0.77	0.75	0.72	1.2	0.77	0.80
Cadmium	(0.60) U	0.96	0.96	(0.64) U	(0.63) U	0.96	(0.63) U	(0.63) U
Chromium	14.6	16.3	15.3	16.4	17.3	16.3	13.4	12.1
Cobalt	7.0	14.0	10.7	8.2	10.6	14.0	9.2	(2.5) U
Copper	15.1	21.1	10.2	17.9	17.4	21.1	10.8	7.2
Lead	9.1	12.5	10.2	10.4	14.1	12.5	14.2	10.4
Mercury	0.03	0.03	0.04	0.04	0.03	0.03	0.03	0.04
Nickel	17.4	19.5	14.4	21.4	14.4	19.5	13.0	11.9
Selenium	(0.24) U	(0.25) U	0.26 B	(0.25) U	(0.25) U	(0.25) U	(0.25) U	0.31 B
Silver	(0.60) U	(0.62) U	(0.63) U	(0.64) U	(0.63) U	(0.62) U	(0.63) U	(0.63) U
Thallium	0.27 B	0.26 B	(0.25) U	0.29 B	0.28	0.26 B	(0.25) U	(0.25) U
Vanadium	27.5	34.7	25.9	33.0	36.4	34.7	36.5	16.1
Zinc	55.2	72.0	58.2	67.5	63.5	72.0	41.9	49.6
Tin	3.9 B	6.0 B	6.9 B	—	7.7 B	6.0 B	8.0 B	5.5 B

NOTES:

Unless otherwise noted, sample depths are 2-foot intervals, the top of which is denoted by the last number of the sample ID.

— Compound found in method blank.

() Compound analyzed for but not detected; value given in parentheses is quantitation limit.

Table C-5 Groundwater Analytical Results UST Parameters Results in ug/L (ppb)				
Sample ID (Date)	Benzene	Toluene	Total Xylenes	GRO
MW-01 - (07/09/92)	(1) U	(1) U	(1) U	(100) U
MW-02 - (07/09/92)	350	51	460	1,200
MW-03 - (07/09/92)	(1) U	1	(1) U	(100) U
MW-04 - (07/09/92)	(1) U	(1) U	(1) U	(100) U
MW-05 - (07/09/92)	(1) U	(1) U	(1)	(100) U
MW-06 - (07/09/92)	2	(1)U	9	(100) U
MW-07 - (07/10/92)	5	(1) U	8	(100) U
MW-08 - (07/10/92)	1,100 D	9	150 D	2,600 D
MW-09 - (07/10/92)	(1) U	(1) U	(1) U	(100) U
MW-10 - (07/10/92)	(1) U	(1) U	(1) U	(100) U
MW-11 - (07/10/92)	130 D	(2.5) U*	45	420

NOTES:

- U Compound was analyzed for but not detected. The number in parentheses is the detection limit.
- D Quantitated from 1:5 dilution.
- * Detection limit higher than normal due to sample matrix interferences.

Table C-6 Groundwater Analytical Results Volatile Organic Compounds Results in ug/L (ppb)		
Sample ID/Date	Compound Detected	Concentration (ppb)
MW-05 (07/09/92)	1,2 - Dichloroethene (total)	5 J
MW-06 (07/09/92)	Benzene Ethylbenzene	2 J 9 J
MW-08 (07/10/92)	Benzene Ethylbenzene Xylenes (total)	1300 E 14 100
MW-11 (07/10/92)	Benzene Toluene Ethylbenzene Xylenes (total)	280 E 1 J 13 83

NOTES:

- J Compound detected, but below quantitation limit; value estimated
- E Compound exceeded calibration range

Table C-7 Groundwater Analytical Results Base/Neutral Acid Extractables Results in ug/L (ppb)		
Sample ID/Date	Compound Detected	Concentration (ppb)
MW-05 (07/09/92)	1,2 - Dichlorobenzene	1 J
MW-06 (07/09/92)	Naphthalene	7 J
MW-08 (Re) (08/06/92)	Phenol Naphthalene 2-Methylnaphthalene	26 17 9 J
MW-11 (Re) (08/06/92)	Phenol Naphthalene 2-Methylnaphthalene Acenaphthene	12 28 21 1 J

NOTES:

- J Compound detected but below quantitation limit; value estimated
- Re Well resampled after laboratory exceeded holding times

Table C-8 Groundwater Analytical Results Appendix IX Metals Results in ug/L (ppb)								
Sample ID Date	MW-05 (07/09/92)		MW-06 (07/09/92)		MW-08 (07/10/92)		MW-11 (07/10/92)	
Parameter								
Antimony	(4.0)	U	(4.0)	U	(4.0)	U	(4.0)	U
Arsenic ₁	20.9		12.9		82.5 ₁		26.2	
Barium	617		183	B	583		355	
Beryllium	4.0	B	1.7	B	3.8	B	2.3	B
Cadmium ₂	11.3 ₂		9.1		14.4 ₂		11.3 ₂	
Chromium ₃	92.4 ₃		42.2		70.0 ₃		57.6 ₃	
Cobalt	36.6	B	22.9	B	46.8	B	29.3	
Copper	60.1		17.8	B	68.2		44.1	
Lead	37.7		(2.0)	U	26.7		9.9	
Mercury	(0.20)	U	(0.20)	U	(0.20)	U	(0.20)	U
Nickel	88.4		37.9	B	98.8		56.0	
Selenium	(6.0)	U	(2.0)	U	(4.0)	U	(4.0)	U
Silver	9.7	B	10.6		14.7		12.6	
Thallium	(2.0)	U	(2.0)	U	(2.0)	U	(2.0)	U
Tin	381		317		514		344	
Vanadium	73.6		33.3	B	81.4		53.1	
Zinc	217		46.0		134		92.8	

NOTES:

- U Compound was analysed for but not detected. The number in parentheses is the detection limit.
- B Compound found in method blank
- 1 Federal MCL for Arsenic is 50 ug/L
- 2 Federal MCL for Cadmium is 10 ug/L
- 3 Federal MCL for Chromium is 50 ug/L

Sample ID/Date	CN Concentration (ppb)
MW-05 07/09/92	40
MW-06 07/09/92	90
MW-08 07/10/92	70
MW-11 07/10/92	20

These results are intended to provide a background or baseline for the upcoming RFI at the site. The limited data of the present investigation have indicated undefined solvent contamination in the southeast of the site and areawide cyanide contamination, —the sources have not been identified. Future RFI work will address these discoveries.

Copies of the laboratory reported results are included in this report as Appendix C.

C.8 Groundwater Classification Procedure

The Tennessee State UST Guidelines set forth requirements to determine if the impacted aquifer is a drinking water source or a non-drinking water source. The cleanup level is directly dependent on classification of the aquifer use. This process consists of three parts including: (1) water use survey, (2) water quality analysis, and (3) yield testing. Each step is completed in sequence until the results of one step show that the aquifer is not suitable as a drinking water source.

NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-1
Summary of Validated Positive Results
Volatile Organic Compounds
(mg/kg)

	Sample IM-B-1-0 (0-2 ft)	Sample IM-B-1-4 (4-6 ft)	Sample IM-B-1-16 (16-18 ft)	Sample IM-B-6-0 (0-2 ft)	Sample IM-B-6-5 (5-7 ft)	Sample IM-B-7-5 (5-7 ft)	Sample IM-B-10-5 (5-7 ft)	Sample IM-B-10-11 (11-13 ft) (duplicates)	Sample IM-M-8-0 (Sediment)
Acetone	4.60		0.35	0.34	0.22	0.96	6.70	0.43/0.15	
Benzene							5.20	0.17/0.10	
1,1-Dichloroethene						0.27/0.29 MS/MSD			
1,2-Dichloroethene									0.10
Xylenes (total)		0.52					14.00		

Table TM-2
Summary of Validated Positive Results
Semivolatile Organic Compounds
(mg/kg)

	Sample IM-B-10-5 (5-7 ft)	Sample IM-B-10-11 (11-13 ft) (duplicates)	Sample IM-M-2-0 (Sediment)
Naphthalene	10.00		
2-Methylnaphthalene	44.00	1.20/ND	
Benzo(b)fluoranthene			1.80
Fluoranthene			2.30

NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-3 Summary of Validated Positive Results Total Petroleum Hydrocarbons (mg/kg)		
Sample I.D. Number	Sample Depth	TPH Concentration
IM-B-10-5	5-7 ft	1,010
IM-B-10-11 (duplicates)	11-13 ft	33.1/ND
IM-M-1-0	Sediment	23.0
IM-M-2-0	Sediment	28.6
IM-M-3-0	Sediment	29.7
IM-M-4-0	Sediment	45.4
IM-M-5-0	Sediment	292
IM-M-6-0	Sediment	660
IM-M-6R-0 (duplicates)	Sediment	279/332
IM-M-7-0	Sediment	50.9
IM-M-10-0	Sediment	261
IM-M-11-0	Sediment	43.9
IM-M-12-0	Sediment	32.1

NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-4 Summary of Validated Positive Results Pesticides (mg/kg)			
Sample I.D. Number	Sample Depth	Dieldrin Concentration	Data Qualifier
IM-B-1-0	0-2 ft	0.31	V
IM-B-2-0	0-2 ft	0.78	V
IM-B-2-5	5-7 ft	0.07	V
IM-B-3-0	0-2 ft	1.0	V
IM-B-5-0	0-2 ft	0.14	
IM-B-5-5	5-7 ft	0.04	
IM-B-6-0	0-2 ft	0.24	
IM-B-6-5	5-7 ft	0.07	
IM-B-7-0	0-2 ft	0.46	
IM-B-7-5 (MS/MSD)	5-7 ft	0.11/0.10	
IM-B-7-5	5-7 ft	0.10	
IM-B-10-0	0-2 ft	0.48	
IM-M-1-0	Sediment	3.0	
IM-M-2-0	Sediment	1.4	

V = Second column value

Dieldrin was only pesticide detected.

NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-6 (1 of 3)									
Summary of Validated Positive Results									
Inorganic Analytical Data									
(mg/kg)									
	Sample IM-B-1-0 (0-2 ft)	Sample IM-B-1-4 (4-6 ft)	Sample IM-B-1-16 (16-18 ft)	Sample IM-B-2-0 (0-2 ft)	Sample IM-B-2-5 (5-7 ft)	Sample IM-B-2-10 (10-12 ft)	Sample IM-B-3-0 (0-2 ft)	Sample IM-B-3-5 (5-7 ft)	Sample IM-B-3-10 (10-12 ft)
Lead	6.2	7.3	6.2	19.0	6.2	6.2	19.3	6.3	5.2
Nickel	14.0	12.6	8.9	17.2	12.9	17.3	12.8	22.9	11.7
Silver	1.1			1.2				1.2	
Arsenic		0.57	0.57		1.8	9.7		4.6	6.0
Barium	154	173	58.4	273	158	152	146	276	76.1
Beryllium	0.51	0.66	0.27	0.95	0.57	0.36	0.51	0.49	0.27
Cadmium	0.61						0.87	0.78	
Chromium	12.0	12.0	6.4	10.3	11.8	9.4	14.5	9.8	8.8
Cobalt	6.6	2.5	4.9	7.3	2.3	5.0	5.5	7.8	3.8
Copper	17.8	11.2	7.7	11.3	10.4	11.3	12.8	12.9	9.7
Vanadium	18.4	8.6	10.6	21.5	12.0	14.5	15.9	17.9	11.5
Zinc	46.5	61.3	31.4	47.9	53.3	47.9	53.4	53.2	33.8

NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-5 (2 of 3) Summary of Validated Positive Results Inorganic Analytical Data (mg/kg)									
	Sample IM-B-5-0 (0-2 ft)	Sample IM-B-5-5 (5-7 ft)	Sample IM-B-5-10 (10-12 ft)	Sample IM-B-6-0 (0-2 ft)	Sample IM-B-6-5 (5-7 ft)	Sample IM-B-6-10 (10-12 ft)	Sample IM-B-7-0 (0-2 ft)	Sample IM-B-7-5 (5-7 ft) (MS)	Sample IM-B-7-5 (5-7 ft)
Mercury								0.57	
Lead	14.4	10.6	7.8	12.3	14.8	3.9	22.6	9.5	7.4
Nickel	13.8	11.4	16.5	22.5	13.5	11.6	11.1	57.3	13.8
Silver	1.0								
Arsenic	5.7	1.5	6.8	3.7	4.1	1.5	5.9	3.1	
Barium	194	153	178	273	175	92.5	148	298	125
Beryllium	0.72	0.54	0.38	0.75	0.59	0.38	0.60	5.0	0.47
Cadmium				0.76			0.97	5.1	
Chromium	9.6	11.4	9.2	12.3	12.2	10.4	10.7	29.4	11.2
Cobalt	6.8	4.0	8.8	7.4	5.4	3.2	4.5		2.5
Copper	11.1	10.7	11.8	12.7	13.1	8.6	10.7	30.9	8.8
Vanadium	19.7	12.0	16.4	19.6	14.7	10.8	18.1	57.1	12.0
Zinc	44.5	53.2	44.2	58.4	58.8	47.3	50.9	90.7	47.8

NAS Memphis RFI
Interim Measure - SWMUs 4 & 5

Table TM-5 (3 of 3)
Summary of Validated Positive Residue
Inorganic Analytical Data
(mg/kg)

	Sample IM-B-10-0 (0-2 ft)	Sample IM-B-10-5 (5-7 ft)	Sample IM-B-10-11 (11-13 ft) Duplicates	Sample IM-M-1-0 (Sediment)	Sample IM-M-2-0 (Sediment)	Sample IM-M-3-0 (Sediment)	Sample IM-M-4-0 (Sediment)	Sample IM-M-5-0 (Sediment)	Sample IM-B-6-0 (Sediment)	Sample IM-B-7-0 (Sediment)
Cyanide									3.6	
Mercury									0.62	0.20
Tin		249					94.6	450		
Lead	14.9	5.9	6.2/5.8	44.0	25.2	31.2	39.0	18.8	63.7	66.6
Nickel	7.2	33.1	11.2/10.5	10.2	11.2	11.5	22.0	47.0	32.8	14.9
Silver										
Arsenic	4.6	8.3	1.4/2.1	5.7	6.9	3.6	3.5	1.9	12.2	5.3
Berium	80.3	201	35.5/33.2	105	111	162	235	200	196	106
Beryllium	0.50	0.45	0.25/0.23	0.44	0.47	0.56	0.59	0.61	0.61	0.43
Cadmium						0.82	1.0	2.3	5.7	4.8
Chromium	5.9	44.8	6.7/6.9	8.0	8.0	10.3	25.5	83.5	25.6	18.7
Cobalt	4.4	4.7	3.7/3.1	3.9	4.8	4.0	4.1	2.9	19.9	4.8
Copper	8.7	11.4	9.1/9.8	11.1	11.2	16.7	28.6	29.0	21.4	21.4
Vanadium	13.7	17.6	11.1/12.7	14.9	16.1	15.3	14.5	10.1	22.8	12.6
Zinc	25.9	34.3	29.5/33.2	63.0	49.9	82.2	85.1	96.2	170	80.5

ATTACHMENT B

Data Summary Tables



GENERAL ENGINEERING LABORATORIES

Environmental Engineering and Analytical Services

Alabama
Arkansas
California
Colorado
Florida
Georgia
Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
Maine
Maryland
Massachusetts
Michigan
Minnesota
Mississippi
Missouri
Montana
Nebraska
Nevada
New Hampshire
New Jersey
New Mexico
New York
North Carolina
North Dakota
Ohio
Oklahoma
Oregon
Pennsylvania
Rhode Island
South Carolina
South Dakota
Tennessee
Texas
Utah
Virginia
Washington
West Virginia
Wisconsin
Wyoming

CERTIFICATE OF ANALYSIS

Client: ENVIRONMENTAL & SAFETY DESIGNS, INC
P.O. BOX 341315
MEMPHIS, TN 38184
Contact: MR. J. SPEAKMAN, PhD, PE

Date: 06/17/88

Released by:

Allen M. Crane
ALLEN M. CRANE

cc/fc: ENSA/ENSA3

Page No.: 1

Parameter	Sample ID : SY1 0-1' 06/07/88	SY2 0-1' 06/07/88	SY3 0-1' 06/07/88
	Lab ID : 88060470	88060471	88060472
	Sample Type : 15	15	15
	Date Received: 06/09/88	06/09/88	06/09/88
	Collected by : ENSA	ENSA	ENSA
TOTAL HYDROCARBONS	1100 ppm	1850 ppm	839 ppm
LEAD	70.3 ppm	15.7 ppm	17.9 ppm
ACID DIGESTION	YES	YES	YES

GENERAL ENGINEERING LABORATORIES

Environmental Engineering and Analytical Services

Molly F. Greene
President

George C. Greene, P.E., Ph.D.
Vice President
SC Registration No. 9103

Laboratory Certificate
FL 8071504
NC
SC
VA
NACTH 317

CERTIFICATE OF ANALYSIS

Client: ENVIRONMENTAL & SAFETY DESIGNS, INC
P.O. BOX 341315
MEMPHIS, TN 38184
Contact: MR. J. SPEAKMAN, PhD, PE

Date: 08/09/88

Released by:

Alan M. Crane
for ALLAN M. CRANE
Page No. 1 1

cc/tc: ENSA/ENSAJ

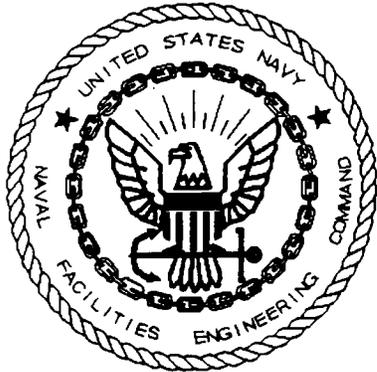
Sample ID	SY1 1-3'	SY2 1-3'	SY3 1-3'
Lab ID	88070677	88070678	88070679
Sample Type	15	15	15
Date Received	07/18/88	07/18/88	07/18/88
Parameter Collected by	ENSA	ENSA	ENSA

TOTAL HYDROCARBONS	<1 ppm	<1 ppm	<1 ppm
LEAD	7.49 ppm	6.79 ppm	10.0 ppm
ACID DIGESTION	YES	YES	YES
LEAD	<1.00 ppm	<1.00 ppm	<1.00 ppm
EP TOX EXTRACTION-SOLID	YES	YES	YES
BENZENE	<5 ppb	<5 ppb	<5 ppb
ETHYLBENZENE	<10 ppb	<10 ppb	<10 ppb
TOLUENE	<10 ppb	<10 ppb	<10 ppb
XYLENE	<10 ppb	<10 ppb	<10 ppb
AROCLOR 1016	<1 ppm	<1 ppm	<1 ppm
AROCLOR 1221	<1 ppm	<1 ppm	<1 ppm
AROCLOR 1232	<1 ppm	<1 ppm	<1 ppm
AROCLOR 1242	<1 ppm	<1 ppm	<1 ppm
AROCLOR 1248	<1 ppm	<1 ppm	<1 ppm
AROCLOR 1254	<1 ppm	<1 ppm	<1 ppm
AROCLOR 1260	<1 ppm	<1 ppm	<1 ppm
AROCLOR 1262	<1 ppm	<1 ppm	<1 ppm
SAMPLE PREP - PCB'S	YES	YES	YES

Appendix E

Site-Specific Health and Safety Plan

**COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY
NAVAL AIR STATION
MEMPHIS, TENNESSEE**

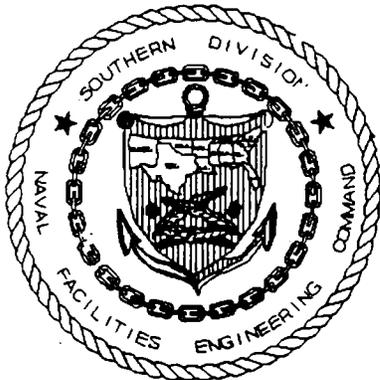


**SITE-SPECIFIC HEALTH AND SAFETY PLAN
SWMU 40 — SALVAGE YARD NO. 1**

**CTO-016
Contract Number:N62467-89-D-0318**

Prepared for:

**Department of the Navy
Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina**



Prepared by:

**EnSafe/Allen & Hoshall
5720 Summer Trees Drive, Suite 8
Memphis, Tennessee 38134
(901) 383-9115**

January 3, 1995

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Attachment A	Material Safety Data Sheets
Attachment B	Directions to Emergency Medical Facilities
Attachment C	Health and Safety Plan Forms

1.0 INTRODUCTION

A RCRA Facility Investigation (RFI) is being conducted at the Salvage Yard No. 1 (SWMU 40) located at the Naval Air Station Memphis (NAS Memphis), Millington, Tennessee. The purpose of the monitoring program is to assess the nature and extent of potential contamination at the site and to determine if additional action is required to maintain compliance with environmental regulations.

This Site-Specific Health and Safety Plan (SSHSP) is written for field operations to be conducted at SWMU 40. This plan is to be used in conjunction with the approved NAS Memphis Comprehensive Health and Safety Plan (CHASP). Copies of both this plan and the CHASP should be onsite during all field operations. The Navy project contract number with EnSafe/Allen & Hoshall (E/A&H) is N62467-89-D-0318, CTO-094.

Applicability

See CHASP Section 7.0.

Current Hazardous Waste and Emergency Response Operators (HAZWOPER) training certificates for E/A&H and U.S. Geological Survey (USGS) employees and all subcontractors anticipated to be conducting field work onsite will be filed onsite and available for review. Individuals whose certifications are not on file, or those who have a more recent certificate (have attended a refresher course), will provide the Site Supervisor with a copy of their certificate before being allowed to enter a work area.

Current OSHA refresher training certificates will be available onsite for all employees involved in field activities if their refresher course requirements come up for renewal before the project begins. All subcontractors, Navy oversight personnel, and any other site visitors must provide health and safety certification with appropriate refresher course documentation prior to site entry.

2.0 SITE CHARACTERIZATION

2.1 Site Description

Salvage Yard No. 1 is a combination of two formerly fenced-in, open storage areas designated as Area No. 813 and Area No. 1666. It is located in the northern half of the base, south of Building N-1694 (Hazardous Waste Storage Facility) and east of the Aircraft Carrier Flight Deck Fire Training Area. The yard was used from 1945 until 1989 and, based on historical information, was not used for burying waste. Area No. 813 was formerly used to store scrap pieces of airplanes, anchor chains, and other hardware. Area No. 1666 (paved) was used for long-term, personally-owned vehicle (POV) parking and storage. In 1988-89, this area was converted into an asphalt parking area for mobile trailers used for electronic communications training. The parking area now consists of a fenced, concrete parking area in the southeastern portion of the site.

2.2 Work Areas

See Section 7.1.1 of the CHASP for a description of the following work zones:

- Exclusion Zone (EZ)
- Contaminant Reduction Zone (CRZ), and
- Support Zone (SZ).

For a description of field activities to be conducted at the site and within each work area see the Site Investigation Plan (SIP).

2.3 Work Area Access

Authorized personnel will be allowed access to work areas as long as they follow the requirements of this SSHSP and the CHASP. See also Work Area Access, Section 7.1.2 of the CHASP.

2.4 Site Map and Work Zones

The location of the site is shown in Figure 1, the vicinity map. A site map is shown in Figure 2. The EZ, CRZ, and SZ locations will be based on physical layout of the site, work task requirements, and current meteorological conditions.

3.0 SITE ACTIVITIES

Site activities will include soil sampling and monitoring well installations. Subsequent activities will include well development, purging, and sampling as required. Field methods described in the *Comprehensive RFI Work Plan*.

4.0 CHEMICAL HAZARDS

The site history suggests a potential for exposure to chemicals. Table 4-1 lists exposure guidelines for potential site chemicals.

Table 4-1 Exposure Guidelines For Expected Site Chemical Hazards						
Chemical Name	Odor ^(a) Threshold (ppm)	OSHA PEL ^(b) (ppm)	ACGIH TLV ^(c) (ppm)	NIOSH REL ^(d) (ppm)	Auto-ignition Temp.(°F)	Flammable range (% by volume)
Toluene	40	100 150 STEL	50	100 150 STEL	986.5	1.3 to 7.1%
Ethylbenzene	140	100 125 STEL	100 125 STEL	N.A.	860	1.0 to 6.7%
Benzene	4.68	1 5 STEL	0.1 Confirmed Human Carc.	0.1 1 STEL Potential Occupational Carcinogen	1097	1.3 to 7.1%
Xylene	Not Listed	100 150 STEL	100 150 STEL	100 150 STEL	Not Listed	1.0 to 7.0%

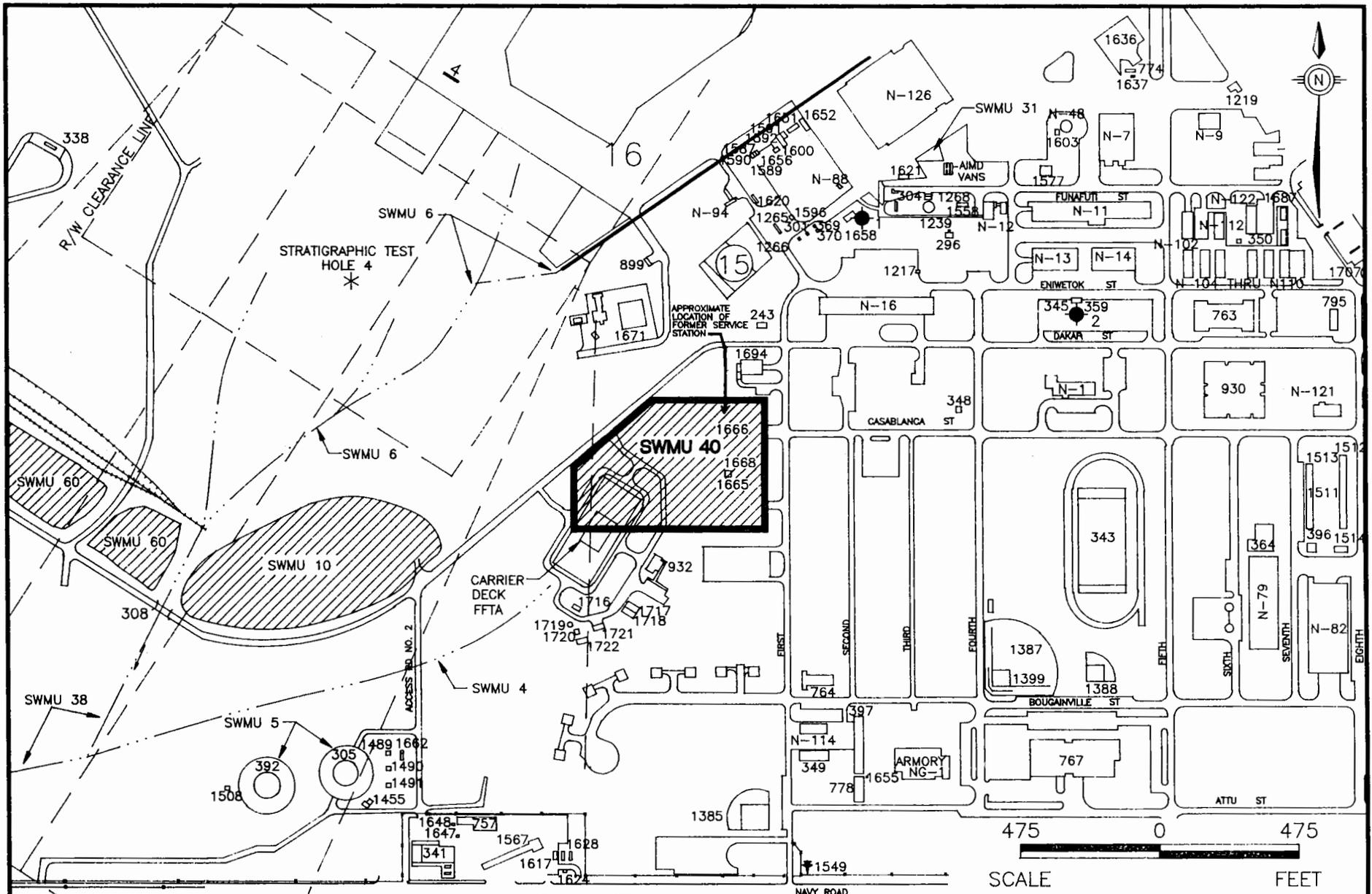
Notes:

- ^a Odor Thresholds for Chemicals with Established Occupational Health Standards, American Industrial Hygiene Association, 1989, Range of All Reference Values
 - ^b 29 CFR 1910.1000, Table Z-1-A. Limits For Air Contaminants, as amended through 1/15/81. (PEL = Permissible Exposure Limit)
 - ^c 1990-1991 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference for Governmental Industrial Hygienist. (STEL = Short Term Exposure Limit)
 - ^d NIOSH Pocket Guide to Chemical Hazards, June 1990. (REL = Recommended Exposure Limit)
- N.A. = Substance information not available, or substance unlisted.
 NIOSH = National Institute of Occupational Safety and Health.

Material Safety Data Sheets (MSDS) for these materials are included in Attachment A.

RFI Work Plan
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Site-Specific Health and Safety Plan — SWMU 40
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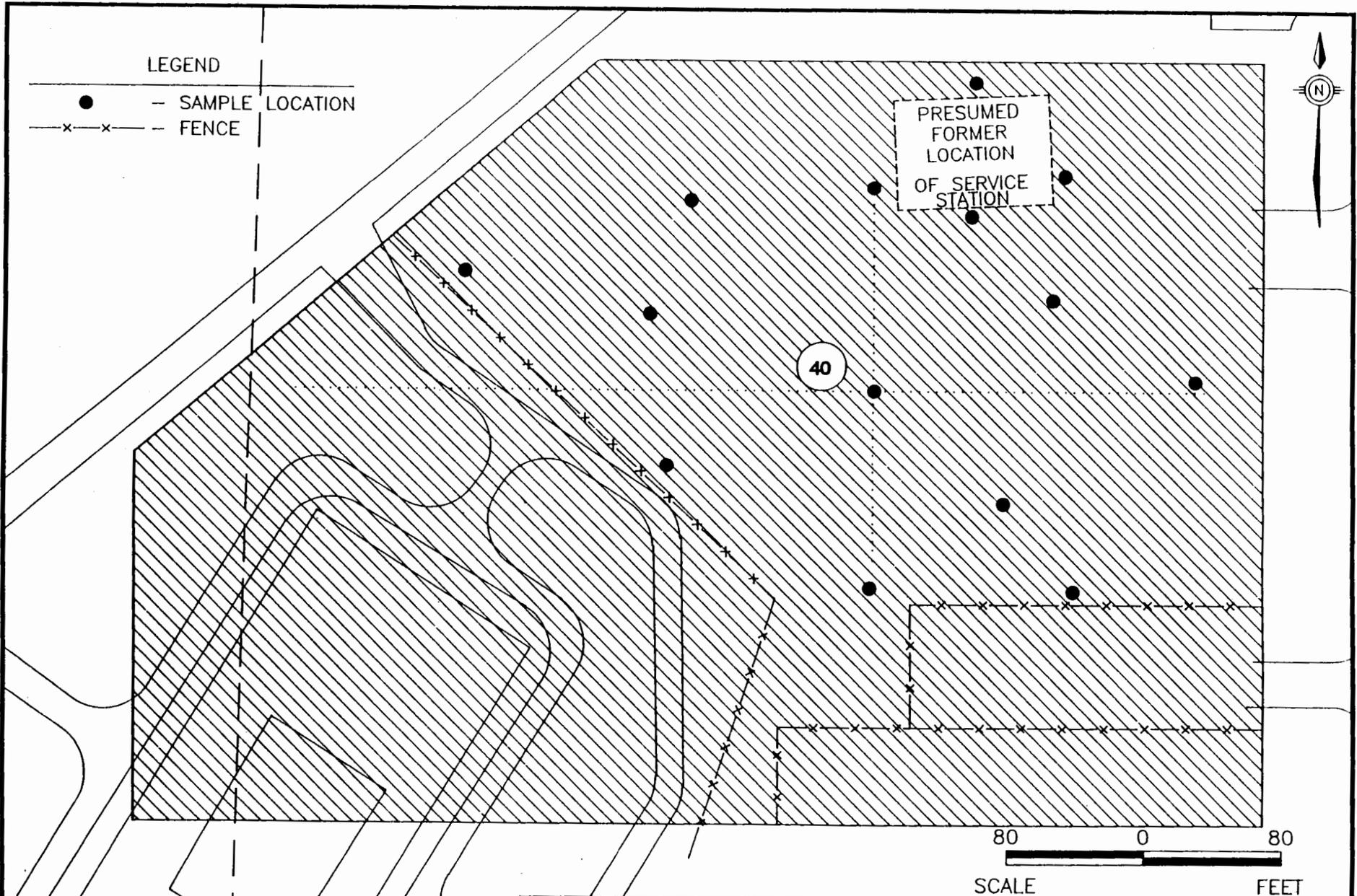
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RFI WORKPLAN
 NAS MEMPHIS
 MILLINGTON, TENNESSEE

FIGURE 1
 VICINITY MAP
 SWMU 40

DWG DATE: 03/13/95 DWG NAME: 16MEM006



RFI WORKPLAN
 NAS MEMPHIS
 MILLINGTON, TENNESSEE

FIGURE 2
 PROPOSED DPT SAMPLE LOCATIONS
 SWMU 40

Figure 2 Site Map

***RFI Work Plan
Naval Air Station Memphis
Site-Specific Health and Safety Plan — SWMU 40
January 3, 1995***

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5.0 OPERATIONS AND PHYSICAL HAZARDS

Physical hazards typically encountered during environmental investigations will be present at this site. These hazards include heat and cold-related illnesses, uneven terrain, slippery surfaces, lifting, and use of heavy equipment. The Site Supervisor and Site Health and Safety Officer shall be aware of the potential for heat and/or cold stress and other weather-related illnesses, and as necessary, implement appropriate work regimens to minimize the likelihood of field personnel becoming ill or injured.

Heavy equipment and drill rig operations will be conducted in accordance with the procedures outlined in the CHASP, Attachment A, Drilling Safety Guide. When conducting operations or survey work on foot, personnel will walk at all times. Running greatly increases the probability of slipping, tripping, and falling. If working in areas supporting habitat for poisonous snakes, personnel should wear protective chaps made of a heavy material designed to prevent snake bites to the legs.

6.0 EMPLOYEE PROTECTION

Employee protection for this project includes standard safe work practices, NAS Memphis rules of conduct, personal protective equipment (PPE), personal decontamination procedures, and equipment for extreme weather conditions, work limitations, and exposure evaluation.

6.1 Standard Safe Work Practices

- Eating, drinking, chewing gum or tobacco, smoking, or any activity that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited in any area designated as contaminated, unless authorized by the Site Health and Safety Officer.
- Hands and face must be thoroughly washed upon leaving the work area.
- No contact lenses will be worn in work areas while invasive actions are conducted.

- Whenever decontamination procedures for outer garments are in effect, the entire body should be thoroughly washed as soon as possible after the protective garment is removed.
- Contact with contaminated or suspected contaminated surfaces should be avoided. Whenever possible, do not walk through puddles, leachate or discolored surfaces, or lean, sit, or place equipment on drums, containers, or on soil suspected of being contaminated.
- Medicine and alcohol can exacerbate the effects from exposure to toxic chemicals. Prescribed drugs should not be taken by personnel on cleanup or response operations where the potential for absorption, inhalation, or ingestion of toxic substances exists unless specifically approved by a qualified physician. Consumption of alcoholic beverages is prohibited.
- Due to the possible presence of overhead power lines, adequate side and overhead clearance should be maintained to ensure that the drill rig boom does not touch or pass close to any overhead lines.
- Due to the possible presence of underground utilities (including electric, natural gas, water, sewer, telephone, etc.), the activity and local utility representatives should be contacted and requested to identify all lines at the ground surface using characteristic spray paint or labeled stakes. A 3-yard buffer zone should be maintained during all subsurface investigations.
- Due to the flammable properties of the potential chemical hazards, all spark or ignition sources should be bonded and/or grounded or mitigated before soil boring advancement or other site activities begin.

6.2 NAS Memphis General Rules of Conduct

- Liquor, firearms, narcotics, tape recorders, and other contraband items are not permitted on the premises.

- Any violation of local, state, or federal laws, or conduct which is outside the generally accepted moral standards of the community is prohibited.

- Violation of the Espionage Act, willfully hindering or limiting production, or sabotage is not permitted.

- Willfully damaging or destroying property, or removing government records is forbidden.

- Misappropriation or unauthorized altering of any government records is forbidden.

- Securing government tools in a personal or contractors tool box is forbidden.

- Gambling in any form, selling tickets or articles, taking orders, soliciting subscriptions, taking up collections, etc. is forbidden.

- Doing personal work in government shop or office, using government property or material for unauthorized purposes, or using government telephones for unnecessary or unauthorized local or long distance telephone calls is forbidden.

- Compliance with posted signs and notices is required.

- **Boisterousness and noisy or offensive work habits, abusive language, or any verbal, written, symbolic, or other communicative expression which tends to disrupt the work or morale of others is forbidden.**
- **Fighting or threatening bodily harm to another is forbidden.**
- **Defacing any government property is forbidden.**
- **Wearing shorts of any type and/or offensive logos, pictures, or phrases on clothing is forbidden. Shirts, shoes and pants or slacks, or coverall-type garments will be worn at all times on government property.**
- **All persons operating motor vehicles will obey all NAS Memphis traffic regulations.**

6.3 Selection of Personal Protective Equipment

It is important that PPE be appropriate to protect against the potential or known hazards at each cleanup or investigation site. Protective equipment will be selected based on the types, concentrations, and routes of personal exposure that may be encountered. In situations where the types of materials and possibilities of contact are unknown, or the hazards are not clearly identifiable, a more subjective determination must be made of the PPE required, based on past experiences and sound safety practices.

The Project Health and Safety Officer will determine the appropriate level of PPE prior to the initial entry based on the best available information. PPE requirements are subject to change as site information is updated or changes. **The decision to upgrade or downgrade levels of PPE shall be made by the Project Health and Safety Officer.**

Field activities which disturb soils will be initiated in modified Level D protection except when stated otherwise in the SSHSP or when site conditions (e.g., sampling results from previous studies) indicate that modified Level D is inappropriate. Modified Level D protection consists of a hard hat, appropriate chemical-resistant gloves (vinyl or nitrile), eye protection, and chemical-resistant, steel-toed and shank boots. Work coveralls (full length sleeves and pants) will be worn if free product or contaminants identified as skin irritants are encountered. This level of protection was selected because the levels of contamination detected in previous studies were low and free product was not detected.

PPE upgrades to Level C will be initiated if airborne concentrations exceed 2 ppm above the background concentration in the breathing zone or if the concentration of any contaminant exceeds 50 percent of the OSHA Permissible Exposure Limit (PEL). See Table 6-1 for the specific criteria for use and equipment for each level of protection.

Table 6-1 Level Of Protection And Criteria		
Level of Protection	Criteria for Use	Equipment
Level A	<ul style="list-style-type: none"> • When atmospheres are "immediately dangerous to life and health" (IDLH in the NIOSH/OSHA Pocket Guide to Chemical Hazards or other guides.) • When known atmospheres or potential situations exist that would affect the skin or eyes or be absorbed into the body through these surfaces. Consult standard references to obtain concentrations hazardous to skin, eyes, or mucous membranes. • Potential situations include those where immersion may occur, vapors may be generated, or splashing may occur through site activities. • Where atmospheres are deficient oxygen with the conditions above • When the type(s) and or potential concentration of toxic substances are not known 	<ul style="list-style-type: none"> • Positive pressure-demand full facepiece; self-contained breathing apparatus (SCBA) or positive pressure-demand supplied air respirator with escape SCBA • Totally encapsulating chemical protective suit • Chemical-resistant inner and outer gloves • Steel-toe-and-shank chemical resistant boots • Hard hat under suit • Two-way radios worn inside suit • Coveralls, long cotton underwear, disposable protective suit, gloves and boots, worn over fully encapsulating suit

RFI Work Plan
Naval Air Station Memphis
Site-Specific Health and Safety Plan — SWMU 40
January 3, 1995

Table 6-1 Level Of Protection And Criteria		
Level of Protection	Criteria for Use	Equipment
Level B	<ul style="list-style-type: none"> • When work areas contain less than 19.5 percent oxygen • When vinyl chloride is detected in the breathing zone 	<ul style="list-style-type: none"> • Chemical resistant clothes, long sleeves, hooded, one or two pieces • Full-faced positive-pressure demand supplied air breathing apparatus or airline system with a 30-minute escape bottle • Hard hat • Inner gloves and chemical resistant gloves • Steel-toe-and-shank boots • Coveralls and disposable outer boots
Level C	<ul style="list-style-type: none"> • When airborne dust particles warrant respiratory protection • When work areas contain at least 19.5 percent oxygen 	<ul style="list-style-type: none"> • Chemical resistant clothes, long sleeves, hood optional, one or two pieces • Full-face piece, air purifying respirator equipped with cartridges suitable for the hazard • Hard hat • Inner gloves and chemical resistant gloves • Steel-toe-and-shank boots • Coveralls and disposable outer boots
Level D	<ul style="list-style-type: none"> • When level B or C is not indicated • When airborne particles do not warrant respiratory protection • When work areas contain at least 19.5 percent oxygen 	<ul style="list-style-type: none"> • Inner gloves and chemical-resistant gloves needed to handle soil or water samples • Steel-toe-and-shank boots • Hard hat (ANSI Z891-1969 standard) • Eye protection (ANSI Z87.1-1968) standard • Sunscreen (SPF 15 or greater) • Coveralls and disposable outer boots

Notes:

Level A protection will be selected when the highest available level of respiratory, skin, and eye protection is needed. Level A protection will be required in Area A of the exclusion zone.

Contraindications for use of Level A:

- Environmental measures contiguous to the site indicate that air contaminants do not represent a serious dermal hazard.
- Reliable, accurate historical data do not indicate the presence of severe dermal hazards.
- Open, unconfined areas.
- Minimal probability of vapors or liquids (splash hazards) present which could affect or be absorbed through the skin.
- Total vapor readings indicate 500 ppm to 1,000 ppm.

Level B protection will be selected when the highest level of respiratory protection is needed, but cutaneous exposure to the small unprotected areas of the body, (neck and back of head) is unlikely, or where concentrations are not known to be within acceptable standards. Additionally, the permissible limit for exposure to mixtures of all site gases will be checked using the requirements of 1910.1000(d)(2)(i) to ensure that PEL is not exceeded. If the value calculated using this method exceeds 1.0, Level B PPE is required.

Level C protection will be selected when the types and concentrations of inoperable material are known, or reasonably assumed to be no greater than the protection factors associated with air-purifying respirators, and exposure to the unprotected areas of the body is unlikely to cause harm. Dust concentrations require Level C PPE, where the respirable fractions exceed the PEL of 5 mg/m³ or the total concentrations exceed the PEL of 15 mg/m³.

Level D protection will be chosen when measurements of atmospheric concentrations are at background levels and work functions preclude splashes, immersion, or the potential for unexpected inhalation or contact with hazardous levels of any chemicals.

6.4 Air Monitoring

Site history and previous site work indicates that workers may potentially be exposed to low concentrations of numerous chemicals including VOCs, halogenated compounds, and combustible gases/vapors. Based on site history and existing sampling data, "worst case" contaminated areas will be identified before field activities begin.

Air monitoring using a PID and/or other appropriate sampling equipment will be conducted prior to beginning field activities at a new EZ and during ground-disturbing activities. The PID will be field calibrated to measure VOCs relative to a 100 ppm isobutylene standard. If VOCs are detected downhole, colorimetric detector tubes and/or other sampling media may be used to determine the identification and approximate concentration of these compounds.

A combustible gas indicator (CGI) will be used during all soil borings and well installation activities. The CGI will be field calibrated to measure flammable gases relative to a 23 percent lower explosive limit (LEL) methane standard. Downhole CGI readings will be collected continuously during all soil disturbing operations. Field activities will immediately cease if downhole readings exceed 10 percent LEL. If CGI readings do not subside, a careful investigation and mapping of the area will be made. Operations may not proceed until readings are below 10 percent LEL. The area will be immediately evacuated and the situation re-evaluated to determine how to proceed.

If breathing zone levels exceed 2 ppm above background or site conditions indicate that additional health and safety precautions are needed, field activities in the area shall stop. Field staff shall notify the Site Supervisor of the situation and he/she shall contact both the Project Manager and the Project Health and Safety Officer. The Project Health and Safety Officer will be responsible for reassessing the hazards and prescribing revised health and safety requirements as necessary, including upgraded PPE requirements, revised work schedules, and revised decontamination procedures. (Typically, PPE will be upgraded to Level C assuming that

cartridge respirators are appropriate, otherwise Level B.) See Table 6-1 for specific criteria for each protection level. Work shall not proceed until breathing zone levels return to background levels and it is reasonably anticipated that breathing zone samples will stay approximately at background levels, or the chemical constituent(s) are identified and appropriate PPE is donned.

Field monitoring values will be recorded in a field logbook and copies must be posted for field personnel review.

On a daily basis, PIDs, CGIs, and other monitoring equipment shall be calibrated or their proper function verified before being used. Throughout the day this equipment shall be periodically checked to ensure that it is working properly. A final calibration shall be conducted at the end of the work day, at which time each instrument will be checked to ensure that it is free from surface contamination. Field staff shall note in their field notebooks that they conducted these calibrations and checks and note whether the equipment was or was not functioning properly. When equipment is not functioning properly it should be brought to the attention of the Site Supervisor or Site Health and Safety Officer who will arrange for repairs and/or replacement of that equipment as needed.

6.5 Procedures and Equipment for Extreme Hot or Cold Weather Conditions

See CHASP Section 7.5.5.

Severe Weather Conditions

All field work shall immediately cease at the first sign of thunder or lightning. Field personnel shall perform emergency personal and equipment decontamination (see Section 6.6) and seek immediate shelter.

6.6 Personal Decontamination

A CRZ will be established immediate to each sampling/boring site and will include a station for decontaminating equipment and personnel. The CRZ will be covered with sheets of 6-mil polyethylene (typically an area 20 feet x 20 feet is sufficient) with specific stations that will accommodate the removal and disposal of the protective clothing, boot covers, gloves, and respiratory protection if required.

As a general rule, equipment will be decontaminated using a soap and clean water wash solution. Equipment decontamination will be completed by personnel in Level D PPE. In the event of inclement weather (e.g., lightning) or an emergency requiring immediate evacuation, all contaminated equipment will be wrapped and taped in 6-mil polyethylene sheeting and tagged as "contaminated" for later decontamination.

Personnel working in the CRZ will be in one Level of PPE lower than personnel in the EZ. For example, if personnel in the EZ are in Level B, decontamination workers will be in Level C.

6.6.1 Personal Decontamination Procedures

The decontamination procedures, based on Level D protection, will consist of the following:

- Brushing heavily soiled boots and rinsing outer gloves and boots with soap and water.
- Removing outer gloves and depositing them in a labeled plastic-lined container.
- Remove outer chemical protective clothing.
- Wash and rinse inner gloves.

- **Hard hats and eye protection should be washed thoroughly at the end of each work day with a soap and water solution.**
- **Disposable gloves and other disposable clothing will be disposed of in sealable bags and placed in a labeled 55-gallon drum for disposal at the site.**
- **All field personnel are to be instructed to shower as soon as possible after leaving the site.**

Decontamination procedures will be conducted at the lunch break and at the end of each work day. If higher levels of PPE are needed, adjustments will be made to these procedures, and an amendment will be made to this SSHSP.

All wastes (soil and water) generated during personal decontamination will be collected in 55-gallon drums. The drums will be labeled by E/A&H and USGS personnel for final disposal by the Navy.

6.6.2 Closure of the Personal Decontamination Station

All disposable clothing and plastic sheeting used during site activities will be double-bagged and disposed of in a refuse container. Decontamination and rinse solutions will be placed in a labeled 55-gallon drum for later analysis and disposal. All washtubs, pails, buckets, etc. will be washed, rinsed, and dried at the end of each workday.

6.7 Work Limitations

All site activities will be conducted during daylight hours only. All personnel scheduled for these activities will have completed initial health and safety training and actual field training as specified in 29 CFR 1910.120(e). All supervisors must complete an additional 8 hours of

training in site management. All personnel must complete an 8-hour refresher training course on an annual basis in order to continue working at the site.

6.8 Exposure Evaluation

All personnel scheduled for site activities will have had a baseline physical examination which includes a stressing exam of the neurologic, cardiopulmonary, musculoskeletal and dermatological systems, pulmonary function testing, multi-chemistry panel and urinalysis, and have been declared fit for duty. An exposure history form will be completed for each worker participating in site activities. An examination and updated occupational history will be repeated on an annual basis and upon termination of employment as required by 29 CFR 1910.120(f). The content of the annual or termination examination will be the same as the baseline physical. A qualified physician will review the results of the annual examination and exposure data and request further tests or issue medical clearances as appropriate.

After any job-related injury or illness, there will be a medical examination to determine fitness for duty or any job restrictions. The Site Health and Safety Officer will review the results with the examining physician before releasing the employee for work. A similar examination will be performed if an employee has missed at least three days of work due to a non-job related injury or illness requiring medical attention. Medical records shall be maintained by the employer or the physician for at least 30 years following the termination of employment.

7.0 MEDICAL MONITORING PROGRAM

See CHASP Section 7.6.

8.0 AUTHORIZED PERSONNEL

Personnel anticipated to be onsite at various times during site activities include:

- Principal-In-Charge — Dr. James Speakman (E/A&H)
- Task Order Manager/Project Manager — Mr. Lawson Anderson (E/A&H)
- Project Health & Safety Officer — Mr. Doug Petty (E/A&H)
- Site Supervisor — To Be Determined
- Site Health & Safety Officer — To Be Determined
- Engineer-in-Charge — Mr. Mark Taylor (SOUTHDIV)
- Naval Air Station Memphis Site Contact — Ms. Tonya Barker

8.1 Responsibilities of Site Supervisor

The Site Supervisor will direct the site operations and, relative to health and safety, is responsible for assuring that:

- Field staff follow the CHASP, SSHSP, and other safety and health standard operating procedures (SOPs). Personnel that do not comply are retrained and/or instructed to leave the site and not allowed to return.
- Field staff have current HAZWOPER training.
- Field staff know who the Site Health and Safety Officer is.
- Field staff know the site-specific safety and health concerns.
- There is an adequate onsite supply of health and safety equipment.

- Field staff participate in the E/A&H Medical surveillance program (or in the case of the USGS or subcontractors, an equivalent program).
- Field staff attend safety and health "kick-off" orientation and other site safety briefings.

The Site Supervisor is also responsible for assuring that field staff who may be exposed to unique or special hazards have the training or experience necessary to safely conduct their work.

8.2 Responsibilities of Site Health and Safety Officer

The responsibilities of the Site Health and Safety Officer include:

- Providing the Site Supervisor technical input on site health and safety issues.
- Observing field personnel and reporting to the Site Supervisor on the effectiveness of the CHASP and SSHSP and whether field staff are utilizing proper work practices and decontamination procedures.
- Reporting significant safety violations to the Project Manager and/or Project Health and Safety Officer.
- Conducting safety briefings during field activities.
- Assuring that a copies of the CHASP and SSHSP are maintained onsite during all field activities.
- Maintaining a file of HAZWOPER training certificates and appropriate refresher training certificates for onsite personnel.

The Site Health and Safety Officer will have the following qualifications: (1) 40 hours OSHA training or equivalent experience, (2) 24 hours of supervisory training or equivalent experience, (3) knowledge of the health and safety concerns for the specific work tasks being conducted, and (4) shall be trained to use the air monitoring equipment; be able interpret the data collected with the instruments; be familiar with symptoms of chemical exposure, heat stress and cold exposure, and know the location and proper use of onsite safety equipment. He will also be familiar with the CHASP and SSHSP.

The position of Site Health and Safety Officer may rotate. Often, particularly on small projects, this function is not a full time responsibility, rather a member of the field team is selected to serve as the Site Health and Safety Officer. Then when that task is completed and/or field staff change, the Site Health and Safety Officer may change as well.

The following criteria outline when the Site Health and Safety Officer will be replaced: (1) termination of employment, (2) end of work task, (3) end of shift, (4) sickness, (5) injury, or (6) death. It should be noted that under site work schedules only one shift will be working. As a result, the Site Health and Safety Officer will be responsible for the day shift. If circumstances arise that require work during other periods, an alternate Site Health and Safety Officer will be designated.

8.3 Responsibilities of Onsite Field Staff

The health and safety responsibilities of field staff include:

- Being familiar with and complying with this CHASP and SSHSP.
- Attending site health and safety briefings and being aware of anticipated chemical, physical, and biological hazards and what to do when these hazards are encountered.

- Being properly trained on PPE to be used, safety work practices, decontamination procedures to be followed, and emergency procedures and communications.

- Utilizing required PPE including respiratory protective.

- Having up to date HAZWOPER training and providing the Site Supervisor with documentation that their training is current.

- Being an up to date participant in an acceptable medical surveillance program.

- Being fit-tested and physically capable of using a respirator and being in a position where using a respirator may be a requirement. Should the use of respiratory protection be required, field workers shall not have facial hair which intrudes into the sealing surface of the respirator.

- Using the buddy system when wearing respiratory protective equipment. When working in Level C or higher, a third person shall be at the work area. This person shall be suitably equipped to provide logistical and safety support to the entry team.

In addition, field staff should always be alert and use their senses (sight, smell, etc.) to identify and react to potentially dangerous situations. When working in the EZ, visual contact should be maintained between personnel; field personnel should be close enough to assist each other during an emergency. Procedures for leaving a contaminated area must be planned and implemented before going onsite in accordance with the CHASP and SSHSP.

The number of personnel and equipment in the contaminated area should be kept to a minimum, consistent with effective site operations. All visitors to the job site must comply with the

CHASP and SSHSP procedures. PPE may be modified for visitors depending on the situation. Modifications must be approved by the Project Health and Safety Officer.

9.0 EMERGENCY INFORMATION

All hazardous waste site activities present a potential risk to onsite personnel. During routine operations risk is minimized by establishing good work practices, staying alert, and using proper PPE. Unpredictable events such as physical injury, chemical exposure, or fire may occur and must be anticipated.

If any situation or unplanned occurrence requires outside or support service, Tonya Barker, NAS Memphis Site Contact, will be informed and the appropriate contact from the following list will be made:

Contact	Agency or Organization	Telephone
Tonya Barker	NAS Memphis	(901) 873-5461/5462
Mark Taylor	SOUTHDIV EIC	(803) 743-0573
Law Enforcement	NAS Memphis Base Security	9-911
Fire Department	NAS Memphis	9-911
Ambulance Service	Naval Hospital, Millington Navy Road	(901) 873-5801/5802 or 9-911
Hospital	Methodist North Hospital 3960 Covington Pike	(901) 372-5211 or 9-911
Southern Poison Control Center	—	(901) 528-6048
Lawson Anderson	EnSafe/Allen & Hoshall	(901) 372-7962
Doug Petty	EnSafe/Allen & Hoshall	(901) 372-7962

Mark Taylor, SOUTHDIV Engineer-in-Charge (EIC) will be contacted after appropriate emergency measures have been initiated onsite.

9.1 Site Resources

Cellular telephones or the telephone at the nearby Aircraft Firefighting Training Facility office trailer will be used for emergency use and communication/coordination with NAS Memphis. First aid and eye wash equipment will be available at the work area.

9.2 Emergency Procedures

Conditions which may constitute an emergency include any member of the field crew being involved in an accident or experiencing any adverse effects or symptoms of exposure while onsite, or if a condition is discovered that suggests the existence of a situation more hazardous than anticipated.

The following emergency procedures should be followed:

- Site work area entrance and exit routes will be planned and emergency escape routes delineated by the Site Health and Safety Officer. Copies of emergency contacts and routes will be posted onsite.
- If any member of the field team experiences any effects or symptoms of exposure while on the scene, the entire field crew will immediately stop work and act according to the instructions provided by the Site Health and Safety Officer.
- For applicable site activities, wind indicators visible to all onsite personnel will be provided by the Site Health and Safety Officer to indicate possible routes for upwind escape.

- **The discovery of any conditions that would suggest the existence of a situation more hazardous than anticipated will result in the suspension of work until the Site Health and Safety Officer has evaluated the situation and provided the appropriate instructions to the field team.**
- **If an accident occurs, the Field Project Manager is to complete an Accident Report Form (See Attachment C) for submittal to the managing principal-in-charge of the project.**
- **If a member of the field crew suffers a personal injury, the Site Health and Safety Officer will call (901) 372-5211 or 9-911 (serious injury) to alert appropriate emergency response agencies or administer onsite first aid (minor injury) as the situation dictates. An Accident Report Form will be completed for any such incident.**
- **If a member of the field crew suffers chemical exposure, the affected areas should be flushed immediately with copious amounts of clean water, and if the situation dictates, the Site Health and Safety Officer should alert appropriate emergency response agencies, or personally ensure that the exposed individual is transported to the nearest medical treatment facility for prompt treatment. (See Attachment B for directions to the emergency medical facility.) An Accident Report Form will be completed for any such incident.**

Additional information on appropriate chemical exposure treatment methods will be provided through Material Safety Data Sheets (MSDS) in Attachment A.

10.0 FORMS

The following forms will be used to implement this Health and Safety Plan:

- Plan Acceptance Form
- Plan Feedback Form
- Exposure History Form
- Accident Report Form

The Plan Acceptance Form will be filled out by all employees working on the site before site activities begin. The Plan Feedback Form will be filled out by the Site Safety Officer and any other onsite employee who wishes to fill one out. The Exposure History Form will be completed by both the Field Project Manager and the individual(s) for whom the form is intended. Examples of each form are provided in Attachment C of this plan.

All completed forms must be returned to the Task Order Manager at EnSafe/Allen & Hoshall, Memphis, Tennessee.

ATTACHMENT A
MATERIAL SAFETY DATA SHEETS

CHEMTOX DATA

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----- IDENTIFIERS -----

CHEMTOX RECORD 59
 NAME: BENZENE
 SYNONYMS: BENZOL; COAL TAR NAPHTHA; CYCLOHEXATRIENE; PHENYL HYDRIDE;
 PHENE; COAL NAPHTHA; PYROBENZOL
 CAS: 71-43-2 RTECS: CY1400000
 FORMULA: C6H6 MOL WT: 78.11
 WLN: RH
 CHEMICAL CLASS: Aromatic hydrocarbon

LAST UPDATE OF THIS RECORD: 12/03/92

See other identifiers listed below under Regulations.

----- PROPERTIES -----

PHYSICAL DESCRIPTION: colorless to pale yellow watery liquid with a gasoline-like odor

BOILING POINT:	353.15 K	80 C	176 F
MELTING POINT:	278.71 K	5.5 C	42 F
FLASH POINT:	262 K	-11.2 C	11.9 F
AUTO IGNITION:	864.8 K	591.6 C	1096.9 F
CRITICAL TEMP:	562.1 K	288.95 C	552.11 F
CRITICAL PRESS:	4.89 kN/M2	48.2 atm	708 psia
HEAT OF VAP:	169 Btu/lb	93.85 cal/g	3.927x E5 J/kg
HEAT OF COMB:	-17460 Btu/lb	-9707 cal/g	-406x E5 J/kg

VAPOR PRESSURE: 75 mm @ 20 C
 LEL: 7.1 %
 LEL: 1.3 %
 IONIZATION POTENTIAL (eV): 9.25
 VAPOR DENSITY: 2.77 (air=1)
 EVAPORATION RATE: 3.50 (n-BUTYL ACETATE=1)
 SPECIFIC GRAVITY: 0.86-0.88 20 C
 DENSITY: 0.8794 @ 20 C
 WATER SOLUBILITY: 0.06%
 INCOMPATIBILITIES: strong ox, chlorine, bromine with iron

REACTIVITY WITH WATER: No data on water reactivity
 REACTIVITY WITH COMMON MATERIALS: OXIDIZING MATERIALS (Br2, F2, CL2, CrO3, NaClO4, O2, O3), PERCHLORATES (AlCl3 +NaClO4), (H2SO4 & PERMANGANATES), K2O2, (AgClO4 & ACETIC ACID), Na2O2
 Source: SAX

STABILITY DURING TRANSPORT: No Data
 NEUTRALIZING AGENTS: No data
 POLYMERIZATION POSSIBILITIES: No data

TOXIC FIRE GASES: VAPOR IS HEAVIER THAN AIR AND MAY TRAVEL CONSIDERABLE DISTANCE TO SOURCE OF IGNITION AND FLASH BACK.

ODOR DETECTED AT (ppm): 4.68 ppm
 ODOR DESCRIPTION: odor; characteristic odor Source: CHRIS

100 % ODOR DETECTION:

No data

----- REGULATIONS -----

DOT hazard class: 3 FLAMMABLE LIQUID
DOT guide: 27
Identification number: UN1114
DOT shipping name: Benzene
Packing group: II
Label(s) required: FLAMMABLE LIQUID
Special provisions: T8
Packaging exceptions: 173.150
Non bulk packaging: 173.202
Bulk packaging: 173.242
Quantity limitations-
Passenger air/rail: 5 L
Cargo aircraft only: 60 L
Vessel stowage: B
Other stowage provisions: 40

STCC NUMBER: 4908110

CLEAN WATER ACT Sect.307:Yes

CLEAN WATER ACT Sect.311:Yes

National Primary Drinking Water Regulations

Maximum Contaminant Levels (MCL): 0.005 mg/L»(01/09/89)

Maximum Contaminant Level Goals (MCLG): 0 mg/L»(01/09/89)

CLEAN AIR ACT: CAA '90 Listed and CAA '77 Sect 109

HA WASTE NUMBER: U019,D018,D001

CERCLA REF: Y

RQ DESIGNATION: A 10 pounds (4.54 kg) CERCLA

SARA TPQ VALUE: Not listed

SARA Sect. 312
categories:

Acute toxicity: Irritant

Acute toxicity: adverse effect to target organs.

Chronic toxicity: carcinogen

Chronic toxicity: mutagen.

Chronic toxicity: reproductive toxin.

Fire hazard: flammable.

LISTED IN SARA Sect 313: Yes

de minimus CONCENTRATION: 0.1 percent

UNITED STATES POSTAL SERVICE MAILABILITY:

Hazard class: Not given

Mailability: Nonmailable

Max per parcel: 0

NFPA CODES:

- HEALTH HAZARD (BLUE): - (2) Hazardous to health. Area may be entered with self-contained breathing apparatus.

FLAMMABILITY (RED) : (3) This material can be ignited under almost all temperature conditions.

REACTIVITY (YELLOW): (0) Stable even under fire conditions.

SPECIAL

: Unspecified

----- TOXICITY DATA -----

SHORT TERM TOXICITY: INHALATION: benzene may produce both nerve and blood effects. irritation of the nose, throat and lungs may occur (3,000 ppm may be tolerated for only 30 to 60 minutes). lung congestion may occur. nerve effects may include an exaggerated feeling of well-being, excitement, headache, dizziness and slurred speech. at high levels, slowed breathing and death may result. death has occurred at 20,000 ppm for 5 to 10 minutes, or 7,500 ppm for 30 minutes. SKIN: irritation may occur, with redness and blistering if not promptly removed. benzene is poorly absorbed. whole body exposure for 30 minutes has been reported with no health effects. Eyes: may cause severe irritation. INGESTION: may cause irritation of mouth, throat and stomach. symptoms are similar to those listed under inhalation. one tablespoon may cause collapse, bronchitis, pneumonia and death. (NYDH)

LONG TERM TOXICITY: may cause loss of appetite, nausea, weight loss, fatigue, muscle weakness, headache, dizziness, nervousness and irritability. mild anemia has been reported from exposures of 25 ppm for several years and 100 ppm for 3 months. at levels between 100 and 200 ppm for periods of 6 months, or more, severe irreversible blood changes and damage to liver and heart may occur. temporary partial paralysis has been reported. (NYDH)

TARGET ORGANS: blood, CNS, skin, bone marrow, eyes, resp sys

SYMPTOMS: Dizziness, excitation, pallor, followed by flushing, weakness, headache, breathlessness, chest constriction. Coma and possible death. Source: CHRIS

CONC IDLH: 3000ppm

NIOSH REL: Potential occupational carcinogen 0.1 ppm Time weighted averages for 8-hour exposure 0.32 mg/M3 Time weighted averages for 8-hour exposure 1 ppm Ceiling exposures which shall at no time be exceeded 3.2 mg/M3 Ceiling exposures which shall at no time be exceeded

ACGIH TLV: TLV = 10ppm Suspected human carcinogen (A2)

ACGIH STEL: Suspected human carcinogen (A2)

OSHA PEL: Final Rule Limits:
TWA = 1 ppm
STEL = 5 ppm
CONSULT 29CFR 1910.1028

MAK INFORMATION: Danger of cutaneous absorption
Carcinogenic working material without MAK
Capable of inducing malignant tumors as shown by
experience with humans.

CARCINOGEN?: Y STATUS: See below
REFERENCES:

HUMAN SUSPECTED IARC** 7,203,74
HUMAN SUSPECTED IARC** 28,151,82
ANIMAL SUSPECTED IARC** 28,151,82
ANIMAL SUSPECTED IARC** 29,93,82
HUMAN POSITIVE IARC** 29,93,82
ANIMAL INDEFINITE IARC** 7,203,74

CARCINOGEN LISTS:

IARC: Carcinogen as defined by
IARC as carcinogenic to humans,
with sufficient epidemiological
evidence.
MAK: Capable of inducing malignant
tumors as shown by experience in
humans.
NIOSH: Carcinogen defined by NIOSH
with no further categorization.
NTP: Carcinogen defined by NTP as
known to be carcinogenic, with
evidence from human studies.
ACGIH: Carcinogen defined by ACGIH
TLV Committee as a suspected
carcinogen, based on either
limited epidemiological evidence or
demonstration of carcinogenicity
in experimental animals.
OSHA: Cancer hazard

HUMAN TOXICITY DATA: (Source: NIOSH RTECS)

* ihl-hmn LCLo:2 pph/5M TABIA2 3,231,33
* orl-man LDLo:50 mg/kg YAKUD5 22,883,80
* ihl-hmn LCLo:2000 ppm/5M YAKUD5 22,883,80
ihl-man TCLo:150 ppm/1Y-I BLUTA9 28,293,74
BLOOD
Other changes
NUTRITIONAL AND GROSS METABOLIC
Changes in:
Body temperature increase
ihl-hmn TCLo:100 ppm INMEAF 17,199,48
BEHAVIORAL
Somnolence (general depressed activity)
GASTROINTESTINAL
Nausea or vomiting
SKIN AND APPENDAGES

Skin - after systemic exposure
Dermatitis, other

ihl-hmn LCLo:65 mg/m3/5Y ARGEAR 44,145,74
BLOOD
Other changes

LD50 value: orl-rat LD50:930 mg/ kg

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)

orl-rat LD50:930 mg/kg
ihl-rat LC50:10000 ppm/7H
ipr-rat LD50:2890 ug/kg
orl-mus LD50:4700 mg/kg
ihl-mus LC50:9980 ppm
ipr-mus LD50:340 mg/kg
orl-dog LDLo:2 gm/kg
ihl-dog LCLo:146000 mg/m3
ihl-cat LCLo:170000 mg/m3
ihl-rbt LCLo:45000 ppm/30M
ivn-rbt LDLo:88 mg/kg
ipr-gpg LDLo:527 mg/kg
scu-frg LDLo:1400 mg/kg
ihl-mam LCLo:20000 ppm/5M
ipr-mam LDLo:1500 mg/kg

IRRITATION DATA: (Source: NIOSH RTECS 1992)

Reproductive toxicity (1992 RTECS):

This chemical is a mammalian reproductive toxin.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

ihl-rat TCLo:670 mg/m3/24H (15D pre/1-22D preg) HYSAAV
33(1-3),327,68

EFFECTS ON FERTILITY

Female fertility index

ihl-rat TCLo:56600 ug/m3/24H (1-22D preg) HYSAAV
33(7-9),112,68

EFFECTS ON NEWBORN

ihl-rat TCLo:50 ppm/24H (7-14D preg) JHEMA2 24,363,80
EFFECTS ON EMBRYO OR FETUS

Extra embryonic features(e.g.,placenta,umbilical
cord)

EFFECTS ON EMBRYO OR FETUS

Fetotoxicity(except death,e.g.,stunted fetus)

ihl-rat TCLo:150 ppm/24H (7-14D preg) JHEMA2 24,363,80
EFFECTS ON FERTILITY

Post-implantation mortality

SPECIFIC DEVELOPMENTAL ABNORMALITIES

Musculoskeletal system

- orl-mus TDLo:9 gm/kg (6-15D preg) TJADAB 19,41A,79
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
- orl-mus TDLo:12 gm/kg (6-15D preg) TJADAB 19,41A,79
EFFECTS ON FERTILITY
Post-implantation mortality
- orl-mus TDLo:6500 mg/kg (8-12D preg) TCMUD8 6,361,86
EFFECTS ON NEWBORN
Growth statistics(e.g.,reduced weight gain)
- ihl-mus TCLo:500 ppm/7H (6-15D preg) AIHAAP 40,993,79
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system
- ihl-mus TCLo:500 mg/m3/12H (6-15D preg) ATSUDG 8,425,85
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system
- ihl-mus TCLo:5 ppm (6-15D preg) TXCYAC 42,171,86
EFFECTS ON EMBRYO OR FETUS
Cytological changes(including somatic cell genetic material)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Blood and lymphatic systems(including spleen and marrow)
- ihl-mus TCLo:20 ppm/6H (6-15D preg) FAATDF 10,224,88
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Blood and lymphatic systems(including spleen and marrow)
- ipr-mus TDLo:5 mg/kg (1D male) TPKVAL 15,30,79
EFFECTS ON FERTILITY
Pre-implantation mortality
EFFECTS ON EMBRYO OR FETUS
Fetal death
- scu-mus TDLo:1100 mg/kg (12D preg) TOXID9 1,125,81
EFFECTS ON EMBRYO OR FETUS
Other effects on embryo or fetus
- scu-mus TDLo:7030 mg/kg (12-13D preg) SEIJBO 15,47,75
EFFECTS ON EMBRYO OR FETUS
Extra embryonic features(e.g.,placenta,umbilical cord)
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)

SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

ivn-mus TDLo:13200 ug/kg (13-16D preg) ICHUDW
4(6),24,82

EFFECTS ON EMBRYO OR FETUS
Cytological changes(including somatic cell genetic
material)

par-mus TDLo:4 gm/kg (12D preg) NEZAAQ 25,438,70
EFFECTS ON NEWBORN
Weaning or lactation index(#alive at weaning per #
alive at day 4)

ihl-rbt TCLo:1 gm/m3/24H (7-20D preg) ATSUDG 8,425,85
EFFECTS ON FERTILITY
Post-implantation mortality
EFFECTS ON FERTILITY
Abortion
EFFECTS ON EMBRYO OR FETUS
Fetal death

NO SIGNIFICANT
RISK LEVEL(Ca P65): 20 micrograms/day

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED

FROM THE CHRIS MANUAL:

hydrocarbon vapor canister, supplied air or hose mask;
hydrocarbon-insoluble rubber or plastic gloves; chemical goggles or face
splash shield; hydrocarbon-insoluble apron such as neoprene.

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS:

- ** WEAR APPROPRIATE EQUIPMENT TO PREVENT:
Repeated or prolonged skin contact.
- ** WEAR EYE PROTECTION TO PREVENT:
Reasonable probability of eye contact.
- ** EXPOSED PERSONNEL SHOULD WASH:
Promptly wash with soap when skin becomes contaminated.
- ** REMOVE CLOTHING:
Immediately remove any clothing that becomes wet to avoid any flammability.
- ** REFERENCE: NIOSH

RECOMMENDED RESPIRATION PROTECTION Source: NIOSH POCKET GUIDE (85-114)
OSHA (BENZENE)

Less than or equal to 10 ppm: Half-mask air-purifying respirator with
organic vapor cartridge.

Less than or equal to 50 ppm: Full facepiece respirator with organic
vapor cartridges. / Full facepiece gas mask with chin style canister.

Less than or equal to 100 ppm: Full facepiece powered air-purifying respirator with organic vapor canister.

Less than or equal to 1000 ppm: Supplied air respirator with full facepiece in positive-pressure mode.

Greater than 1000 ppm or Unknown concentration: (1) Self-contained breathing apparatus with full face-piece in positive pressure mode. (2) Full facepiece positive-pressure supplied-air respirator with auxiliary self-contained air supply.

Escape : (1) Any organic vapor gas mask; or (2) Any self-contained breathing apparatus with full facepiece.

Firefighting : Any full facepiece self-contained breathing apparatus operated in positive pressure mode.

FIRST AID SOURCE: NIOSHP

EYE: irr immed

SKIN: soap wash promptly

INHALATION: art resp

INGESTION: no vomit

FIRST AID SOURCE: CHRIS Manual 1991

SKIN: flush with water followed by soap and water; remove contaminated clothing and wash skin.

EYES: flush with plenty of water until irritation subsides.

INHALATION: remove from exposure immediately. Call a physician. IF breathing is irregular or stopped, start resuscitation, administer oxygen.

FIRST AID SOURCE: DOT Emergency Response Guide 1990.

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen. In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water. Remove and isolate contaminated clothing and shoes at the site.

----- INITIAL INCIDENT RESPONSE -----

FIRE EXTINGUISHMENT: Dry chemical, foam, or carbon dioxide. Note: Water may be ineffective CHRIS91

US Department of Transportation Guide to Hazardous Materials Transport Information - Publication DOT 5800.5 (1990).

DOT SHIPPING NAME: Benzene

DOT ID NUMBER: UN1114

ERG90

GUIDE 27

* POTENTIAL HAZARDS *

*FIRE OR EXPLOSION

Flammable/combustible material; may be ignited by heat, sparks or flames.

Vapors may travel to a source of ignition and flash back.

Container may explode in heat of fire.

Vapor explosion hazard indoors, outdoors or in sewers.

Runoff to sewer may create fire or explosion hazard.

*HEALTH HAZARDS

May be poisonous if inhaled or absorbed through skin.
Vapors may cause dizziness or suffocation.
Contact may irritate or burn skin and eyes.
Fire may produce irritating or poisonous gases.
Runoff from fire control or dilution water may cause pollution.

*** EMERGENCY ACTION ***

Keep unnecessary people away; isolate hazard area and deny entry.
Stay upwind; keep out of low areas.
Positive pressure self-contained breathing apparatus (SCBA) and structural firefighters' protective clothing will provide limited protection.
Isolate for 1/2 mile in all direction if tank, rail car or tank truck is involved in fire.
CALL CHEMTREC AT 1-800-424-9300 FOR EMERGENCY ASSISTANCE. If water pollution occurs, notify the appropriate authorities.

***FIRE**

Small Fires: Dry chemical, CO₂, water spray or regular foam.
Large Fires: Water spray, fog or regular foam.
Move container from fire area if you can do it without risk.
Apply cooling water to sides of containers that are exposed to flames until well after fire is out. Stay away from ends of tanks.
For massive fire in cargo area; use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn.
Withdraw immediately in case of rising sound of venting safety device or any discoloration of tank due to fire.

***SPILL OR LEAK**

Shut off ignition sources; no flares, smoking or flames in hazard area.
Stop leak if you can do it without risk.
Water spray may reduce vapor; but it may not prevent ignition in closed spaces.
Small Spills: Take up with sand or other noncombustible absorbent material and place into containers for later disposal.
Large Spills: Dike far ahead of liquid spill for later disposal.

***FIRST AID**

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen.
In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water.
Remove and isolate contaminated clothing and shoes at the site.

DISCLAIMER: The data shown above on this chemical represents a best effort on the part of the compilers of the CHEMTOX database to obtain useful, accurate, and factual data. The use of these data shall be in accordance with the guidelines and limitations of the user's CHEMTOX license agreement. The COMPILERS of the CHEMTOX database shall not be held liable for inaccuracies or omissions within this database, or in any of its printed or displayed output forms.

DOT shipping name: Toluene
Packing group: II
Label(s) required: FLAMMABLE LIQUID
Special provisions: T1
Packaging exceptions: 173.150
Non bulk packaging: 173.202
Bulk packaging: 173.242
Quantity limitations-
Passenger air/rail: 5 L
Cargo aircraft only: 60 L
Vessel stowage: B
Other stowage provisions:

STCC NUMBER: 4909305

CLEAN WATER ACT Sect.307:Yes
CLEAN WATER ACT Sect.311:Yes
National Primary Drinking Water Regulations
Maximum Contaminant Levels (MCL): 1 mg/L»(07/30/92)
Maximum Contaminant Level Goals (MCLG): 1 mg/L»(07/30/92)
CLEAN AIR ACT: CAA '90 Listed
EPA WASTE NUMBER: U220,D001
CERCLA REF: Not listed
RQ DESIGNATION: C 1000 pounds (454 kg) CERCLA
SARA TPQ VALUE: Not listed
SARA Sect. 312
categories:

Acute toxicity: Irritant
Acute toxicity: adverse effect to target organs.
Chronic toxicity: adverse effect to target organ
after long period of exposure.
Chronic toxicity: mutagen.
Chronic toxicity: reproductive toxin.

Fire hazard: flammable.

LISTED IN SARA Sect 313: Yes
de minimus CONCENTRATION: 1.0 percent

UNITED STATES POSTAL SERVICE MAILABILITY:
Hazard class: Flammable liquid - Mailable as ORM-D
Mailability: Domestic surface mail only
Max per parcel: 1 QT METAL; 1 PT OTHER

NFPA CODES:
HEALTH HAZARD (BLUE): (2) Hazardous to health. Area may be entered with
self-contained breathing apparatus.
FLAMMABILITY (RED) : (3) This material can be ignited under almost all
temperature conditions.
REACTIVITY (YELLOW): (0) Stable even under fire conditions.
SPECIAL : -Unspecified -

----- TOXICITY DATA -----

SHORT TERM TOXICITY: INHALATION: 100 ppm exposure can cause dizziness, drowsiness and hallucinations. 100-200 ppm can cause depression. 200-500 ppm can cause headaches, nausea, loss of appetite, loss of energy, loss of coordination and coma. in addition to the above, death has resulted from exposure to 10,000 ppm for an unknown time. **SKIN:** can cause dryness and irritation. absorption may cause or increase the severity of symptoms listed above. **Eyes:** can cause irritation at 300 ppm. **INGESTION:** can cause a burning sensation in the mouth and stomach, upper abdominal pain, cough, hoarseness, headache, nausea, loss of appetite, loss of energy, loss of coordination and coma. (NYDH)

LONG TERM TOXICITY: levels below 200 ppm may produce headache, tiredness and nausea. from 200 to 750 ppm symptoms may include insomnia, irritability, dizziness, some loss of memory, loss of appetite, a feeling of drunkenness and disturbed menstruation. levels up to 1,500 ppm may cause heart palpitations and loss of coordination. blood effects and anemia have been reported but are probably due to contamination by benzene. most of these effects are believed to go away when exposure stops. (NYDH)

TARGET ORGANS: CNS, liver, kidneys, skin, eyes

SYMPTOMS: Vapors irritate eyes and upper respiratory tract; cause dizziness, headache, anesthesia, respiratory arrest. Liquid irritates eyes and causes drying of skin. If aspirated, causes coughing, gagging, distress, and rapidly developing pulmonary edema. If ingested causes vomiting, griping, diarrhea, depressed respiration. Source: CHRIS

CONC IDLH: 2000ppm

NIOSH REL: 100 ppm Time weighted averages for 8-hour exposure
375 mg/M3 Time weighted averages for 8-hour exposure
200 ppm Ceiling exposures which shall at no time be exceeded(10-MIN)
750 mg/M3 Ceiling exposures which shall at no time be exceeded(10-MIN)

ACGIH TLV: TLV = 50ppm(188 mg/M3) Skin
ACGIH STEL: Not listed

OSHA PEL: Transitional Limits:
PEL = 200 PPM; CEILING = 300 PPM; MAXIMUM PEAK ABOVE CEILING
Final Rule Limits:
TWA = 100 ppm (375 mg/M3)
STEL = 150 ppm(560 mg/M3)

***** INFORMATION:** 100 ppm
380 mg/M3

Substance with systemic effects, onset of effect less than or equal to 2 hrs: Peak = 5xMAK for 30 minutes, 2 times per shift of 8 hours.

Risk of damage to the developing embryo or fetus must be considered probable. Damage cannot be excluded even when the MAK values are adhered to.

CARCINOGEN?: N STATUS: See below

CARCINOGEN LISTS:

IARC: Not listed
MAK: Not listed
NIOSH: Not listed
NTP: Not listed
ACGIH: Not listed
OSHA: Not listed

HUMAN TOXICITY DATA: (Source: NIOSH RTECS)

* orl-hmn LDLo:50 mg/kg YAKUD5 22,883,80

ihl-hmn TCLo:200 ppm JAMAAP 123,1106,43

BRAIN AND COVERINGS

Recordings from specific areas of CNS

BEHAVIORAL

Antipsychotic

BLOOD

Changes in bone marrow not included above

LD50 value: orl-rat LD50:636 mg/ kg

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)

orl-rat LD50:636 mg/kg
ihl-rat LC50:>26700 ppm/1H
ipr-rat LD50:1332 mg/kg
ivn-rat LD50:1960 mg/kg
unr-rat LD50:6900 mg/kg
ihl-mus LC50:400 ppm/24H
ipr-mus LD50:59 mg/kg
scu-mus LD50:2250 mg/kg
unr-mus LD50:2000 mg/kg
ihl-rbt LCLo:55000 ppm/40M
skn-rbt LD50:12124 mg/kg
ivn-rbt LDLo:130 mg/kg
ihl-gpg LCLo:1600 ppm
ipr-gpg LD50:500 mg/kg
scu-frg LDLo:920 mg/kg
ipr-mam LDLo:1750 mg/kg

IRRITATION DATA:- (Source:- NIOSH RTECS 1992)

Reproductive toxicity (1992 RTECS):

This chemical is a mammalian reproductive toxin.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

- ihl-rat TCLo:1500 mg/m³/24H (1-8D preg) TXCYAC 11,55,78
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system
- ihl-rat TCLo:1000 mg/m³/24H (7-14D preg) FMORAO
28,286,80
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system
- ihl-rat TCLo:100 ppm (51W male) SAIGBL 13,501,71
PATERNAL EFFECTS
Testes,epididymis,sperm duct
- orl-mus TDLo:9 gm/kg (6-15D preg) TJADAB 19,41A,79
EFFECTS ON EMBRYO OR FETUS
Fetal death
- orl-mus TDLo:15 gm/kg (6-15D preg) TJADAB 19,41A,79
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
- orl-mus TDLo:30 gm/kg (6-15D preg) TJADAB 19,41A,79
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Craniofacial(including nose and tongue)
- ihl-mus TCLo:500 mg/m³/24H (6-13D preg) TXCYAC 11,55,78
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
- ihl-mus TCLo:1000 ppm/6H (2-17D preg) TJEMDR 7,265,82
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system
- ihl-mus TCLo:400 ppm/7H (7-16D preg) FAATDF 6,145,86
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system
EFFECTS ON NEWBORN
- ihl-mus TCLo:200 ppm/7H (7-16D preg) FAATDF 6,145,86
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Urogenital system

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED
FROM THE CHRIS MANUAL:

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS:

WEAR APPROPRIATE EQUIPMENT TO PREVENT:

Repeated or prolonged skin contact.

**** WEAR EYE PROTECTION TO PREVENT:**

Reasonable probability of eye contact.

**** EXPOSED PERSONNEL SHOULD WASH:**

Promptly when skin becomes wet.

**** REMOVE CLOTHING:**

Immediately remove any clothing that becomes wet to avoid any flammability.

**** REFERENCE: NIOSH**

RECOMMENDED RESPIRATION PROTECTION Source: NIOSH POCKET GUIDE (85-114)
NIOSH (TOLUENE)

1000 ppm: Any chemical cartridge respirator with organic vapor cartridge(s). * Substance reported to cause eye irritation or damage may require eye protection. / Any supplied-air respirator. * Substance reported to cause eye irritation or damage may require eye protection. / Any powered air-purifying respirator with organic vapor cartridge(s). * Substance reported to cause eye irritation or damage may require eye protection. / Any self-contained breathing apparatus. * Substance reported to cause eye irritation or damage may require eye protection.

2000 ppm: Any supplied-air respirator operated in a continuous flow mode. * Substance reported to cause eye irritation or damage may require eye protection. / Any self-contained breathing apparatus with a full facepiece. / Any supplied-air respirator with a full facepiece. / Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister.

EMERGENCY OR PLANNED ENTRY IN UNKNOWN CONCENTRATIONS OR IDLH CONDITIONS.: Any self-contained breathing apparatus with full facepiece and operated in a pressure-demand or other positive pressure mode. / Any supplied-air respirator with a full facepiece and operated in 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 or front- or back-mounted organic vapor canister. / Any appropriate escape-type self-contained breathing apparatus.

FIRST AID SOURCE: NIOSH

EYE: irr immed

SKIN: soap wash promptly

INHALATION: art resp

INGESTION: no vomit

FIRST AID SOURCE: CHRIS Manual 1991

INHALATION: remove to fresh air, give artificial respiration and oxygen if needed; call a doctor.

INGESTION: do NOT induce vomiting; call a doctor.

EYES: flush with water for at least 15 min.

SKIN: wipe off, wash with soap and water.

FIRST AID SOURCE: DOT Emergency Response Guide 1990.

Move victim to fresh air and call emergency medical care; if not

breathing, give artificial respiration; if breathing is difficult, give oxygen. In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water. Move and isolate contaminated clothing and shoes at the site.

----- INITIAL INCIDENT RESPONSE -----

FIRE EXTINGUISHMENT: Carbon dioxide or dry chemical for small fires, ordinary foam for large fires. Note: Water may be ineffective CHRIS91

US Department of Transportation Guide to Hazardous Materials Transport Information - Publication DOT 5800.5 (1990).

DOT SHIPPING NAME: Toluene

DOT ID NUMBER: UN1294

ERG90

GUIDE 27

* POTENTIAL HAZARDS *

*FIRE OR EXPLOSION

Flammable/combustible material; may be ignited by heat, sparks or flames.

Vapors may travel to a source of ignition and flash back.

Container may explode in heat of fire.

Vapor explosion hazard indoors, outdoors or in sewers.

Runoff to sewer may create fire or explosion hazard.

*HEALTH HAZARDS

May be poisonous if inhaled or absorbed through skin.

Vapors may cause dizziness or suffocation.

Contact may irritate or burn skin and eyes.

Fire may produce irritating or poisonous gases.

Runoff from fire control or dilution water may cause pollution.

* EMERGENCY ACTION *

Keep unnecessary people away; isolate hazard area and deny entry.

Stay upwind; keep out of low areas.

Positive pressure self-contained breathing apparatus (SCBA) and structural firefighters' protective clothing will provide limited protection.

Isolate for 1/2 mile in all direction if tank, rail car or tank truck is involved in fire.

CALL CHEMTREC AT 1-800-424-9300 FOR EMERGENCY ASSISTANCE. If water pollution occurs, notify the appropriate authorities.

*FIRE

Small Fires: Dry chemical, CO₂, water spray or regular foam.

Large Fires: Water spray, fog or regular foam.

Move container from fire area if you can do it without risk.

Apply cooling water to sides of containers that are exposed to flames until well after fire is out. Stay away from ends of tanks.

For massive-fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Withdraw immediately in case of rising sound of venting safety device or any discoloration of tank due to fire.

*SPILL OR LEAK

Shut off ignition sources; no flares, smoking or flames in hazard area.

Stop leak if you can do it without risk.

Water spray may reduce vapor; but it may not prevent ignition in closed spaces.

Small Spills: Take up with sand or other noncombustible absorbent material and place into containers for later disposal.

Large Spills: Dike far ahead of liquid spill for later disposal.

***FIRST AID**

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen.

In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water.

Remove and isolate contaminated clothing and shoes at the site.

DISCLAIMER: The data shown above on this chemical represents a best effort the part of the compilers of the CHEMTOX database to obtain useful, accurate and factual data. The use of these data shall be in accordance with the guidelines and limitations of the user's CHEMTOX license agreement. The COMPILERS of the CHEMTOX database shall not be held liable for inaccuracies or omissions within this database, or in any of its printed or displayed output forms.

CHEMTOX DATA

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----- IDENTIFIERS -----

CHEMTOX RECORD 206 LAST UPDATE OF THIS RECORD: 06/03/93
 NAME: ETHYL BENZENE
 SYNONYMS: AETHYLBENZOL (German); EB; ETHYLBENZEEN (Dutch); ETHYL
 BENZENE; ETHYL BENZENE (DOT); ETHYLBENZOL; ETILBENZENE
 (Italian); ETYLOBENZEN (Polish); NCI-C56393; PHENYLETHANE
 CAS: 100-41-4 RTECS: DA0700000
 FORMULA: C8H10 MOL WT: 106.18
 WLN: 2R
 CHEMICAL CLASS: Aromatic hydrocarbon

See other identifiers listed below under Regulations.

----- PROPERTIES -----

PHYSICAL DESCRIPTION: colorless liquid with a sweet, gasoline-like odor.
 BOILING POINT: 409.2 K 136 C 276.8 F
 MELTING POINT: 178.15 K -95 C -139 F
 FLASH POINT: 294.26 K 21.11 C 69.9 F
 AUTO IGNITION: 733 K 459.8 C 1351.4 F
 CRITICAL TEMP: 617.1 K 343.95 C 651.11 F
 CRITICAL PRESS: 3.61 kN/M2 35.5 atm 523 psia
 HEAT OF VAP: 144 Btu/lb 79.97 cal/g 3.346x E5 J/kg
 HEAT OF COMB: -17780 Btu/lb -9885 cal/g -413x E5 J/kg
 VAPOR PRESSURE: 10mm @ 25.9 C
 L: 6.7 %
 LEL: 1.0 %
 IONIZATION POTENTIAL (eV): 8.76
 VAPOR DENSITY: 3.7 (air=1)
 EVAPORATION RATE: 0.84 (n-BUTYL ACETATE=1)
 SPECIFIC GRAVITY: 0.867 20C
 DENSITY: 0.866 g/mL @ 20 C
 WATER SOLUBILITY: 0.015%
 INCOMPATIBILITIES: strong oxidizers

REACTIVITY WITH WATER: No data on water reactivity
 REACTIVITY WITH COMMON MATERIALS: OXIDIZING MATERIALS Source: SAX
 STABILITY DURING TRANSPORT: No Data
 NEUTRALIZING AGENTS: No data
 POLYMERIZATION POSSIBILITIES: No data

TOXIC FIRE GASES: None reported other than possible
 unburned vapors
 ODOR DETECTED AT (ppm): 140
 ODOR DESCRIPTION: AROMATIC Source: CHRIS
 100 % ODOR DETECTION: No data

----- REGULATIONS -----

DOT hazard class: 3 FLAMMABLE LIQUID
DOT guide: 26
Identification number: UN1175
DOT shipping name: Ethylbenzene
(after shipping description):
Packing group: II
Label(s) required: FLAMMABLE LIQUID
Special provisions: T1
Packaging exceptions: 173.150
Non bulk packaging: 173.202
Bulk packaging: 173.242
Quantity limitations-
Passenger air/rail: 5 L
Cargo aircraft only: 60 L
Vessel stowage: B
Other stowage provisions:

STCC NUMBER: 4909163

CLEAN WATER ACT Sect.307:Yes

CLEAN WATER ACT Sect.311:Yes

National Primary Drinking Water Regulations

Maximum Contaminant Levels (MCL): 0.7 mg/L (07/30/92)

Maximum Contaminant Level Goals (MCLG): 0.7 mg/L (07/30/92)

CLEAN AIR ACT: CAA '90 Listed

EPA WASTE NUMBER: D001

CERCLA REF: Y

DESIGNATION: C 1000 pounds (454 kg) CERCLA

RA TPQ VALUE: Not listed

SARA Sect. 312

categories:

Acute toxicity: Irritant

Acute toxicity: adverse effect to target organs.

Chronic toxicity: mutagen.

Chronic toxicity: reproductive toxin.

Fire hazard: flammable.

LISTED IN SARA Sect 313: Yes

de minimus CONCENTRATION: 1.0 percent

UNITED STATES POSTAL SERVICE MAILABILITY:

Hazard class: Flammable liquid - Mailable as ORM-D

Mailability: Domestic surface mail only

Max per parcel: 1 QT METAL; 1 PT OTHER

NFPA CODES:

HEALTH HAZARD (BLUE): (2) Hazardous to health. Area may be entered with self-contained breathing apparatus.

FLAMMABILITY (RED) : (3) This material can be ignited under almost all temperature conditions.

REACTIVITY (YELLOW): (0) Stable even under fire conditions.

SPECIAL : Unspecified

----- SUMMARY OF REGULATORY LISTS THIS SUBSTANCE APPEARS ON -----

ACGIH TLV list "Threshold Limit Values for 1992-1993"
California Assembly Bill 1803 Well Monitoring Chemicals.
Canadian Domestic Substances List
Canadian Ingredient Disclosure List. 20/01/88 Canada Gazette part II, Vol 122.
Clean Air Act Section 111 List.
Clean Air Act of November 15, 1990. List of pollutants.
Clean Water Act Section 307 Priority Pollutants
Clean Water Act Section 311 Hazardous Chemicals List.
DOT Hazardous Materials Table. 49 CFR 172.101
EPA Carcinogen Assessment Group List
EPA List of VOC chemicals from 40 CFR 60.489
EPA TSCA 8(a) Preliminary Assessment Information Rule - effective 11/19/82
EPA TSCA 8(d) Health and Safety Data Rule - effective date 06/19/87
EPA TSCA Chemical Inventory List 1986
EPA TSCA Chemical Inventory List 1989
EPA TSCA Chemical Inventory List 1990
EPA TSCA Chemical Inventory List 1992
EPA TSCA Test Submission (TSCATS) Database - April 1990
EPA TSCA Test Submission (TSCATS) Database - September 1989
ETHYL BENZENE [100-41-4]
Massachusetts Substance List.
New Jersey DEQ100 list for release reporting.
New Jersey Right To Know Substance List. (December 1987)
OSHA Air Contaminant (Table Z-1-A). 54 FR 4332, Jan. 19, 1989 and revised.
HA Process Safety Rule chemical with a TQ. Effective May 26, 1992
Pennsylvania Hazardous Substance List
RCRA Hazardous Constituents for Ground Water Monitoring. Ap'dx IX to 40 CFR 264
RCRA Hazardous Waste
SARA Section 313 Toxic Chemicals List
Superfund/CERCLA RQ list. Table 302.4 in 54 FR 50968 (December 11, 1989)
Wisconsin Air Toxics Control Regulation NR-445 (December 1988)

----- TOXICITY DATA -----

SHORT TERM TOXICITY: INHALATION: 200 ppm for 30 minutes can cause irritation of the nose and throat, dizziness, difficult breathing and depression. very high levels can cause unconsciousness. SKIN: can cause irritation, inflammation, blisters and burns. Eyes: 200 ppm can cause irritation. higher levels can cause burning, tearing and injury. INGESTION: can cause headache, sleepiness and coma. (NYDH)

LONG TERM TOXICITY: may cause skin rash and irritation of eyes, nose and throat. (NYDH)

TARGET ORGANS: eyes, upper resp sys, skin, CNS

SYMPTOMS: Inhalation may cause irritation of nose, dizziness, depression. Moderate irritation of eye with corneal injury possible. Irritates skin and may cause blisters. Source: CHRIS

CONC IDLH: 2000PPM

NIOSH REL:

ACGIH TLV: TLV = 100ppm(435 mg/M3)
ACGIH STEL: STEL = 125 ppm(545 mg/M3)

OSHA PEL: Transitional Limits:
PEL = 100 ppm(435mg/M3)
Final Rule Limits:
TWA = 100 ppm (435 mg/M3)
STEL = 125 ppm(545 mg/M3)

MAK INFORMATION: 100 ppm
440 mg/M3
Local irritant: Peak = 2xMAK for 5 minutes, 8 times per shift.
Danger of cutaneous absorption

CARCINOGEN?: N STATUS: See below

CARCINOGEN LISTS:

IARC: Not listed
MAK: Not listed
NIOSH: Not listed
NTP: Not listed
ACGIH: Not listed
OSHA: Not listed

HUMAN TOXICITY DATA: (Source: NIOSH RTECS)
ihl-hmn TCLo:100 ppm/8H AIHAAP 31,206,70
SENSE ORGANS
Eye
Other
BEHAVIORAL
Sleep
LUNGS, THORAX, OR RESPIRATION
Other changes

LD50 value: orl-rat LD50:3500 mg/ kg

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)

- orl-rat LD50:3500 mg/kg
ihl-rat LCLo:4000 ppm/4H
ihl-mus LDLo:50 gm/m3/2H
ipr-mus LD50:2272 mg/kg

skn-rbt LD50:17800 mg/kg
ihl-gpg LCLo:10000 ppm

RITATION DATA: (Source: NIOSH RTECS 1992)

skn-rbt 15 mg/24H open MLD
eye-rbt 100 mg

Reproductive toxicity (1992 RTECS):

This chemical is a mammalian reproductive toxin.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

ihl-rat TCLo:97 ppm/7H (15D pre) NTIS** PB83-208074
EFFECTS ON FERTILITY
Female fertility index

ihl-rat TCLo:985 ppm/7H (1-19D preg) NTIS** PB83-208074
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)

ihl-rat TCLo:96 ppm/7H (1-19D preg) NTIS** PB83-208074
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

ihl-rat TCLo:600 mg/m3/24H (7-15D preg) ATSUDG 8,425,85
EFFECTS ON FERTILITY
Post-implantation mortality
EFFECTS ON EMBRYO OR FETUS
Fetal death
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

ihl-rat TCLo:2400 mg/m3/24H (7-15D preg) ATSUDG
8,425,85
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)

ihl-rbt TCLo:99 ppm/7H (1-18D preg) NTIS** PB83-208074
EFFECTS ON FERTILITY
Litter size(# fetuses per litter;measured before
birth)

ihl-rbt TCLo:500 mg/m3/24H (7-20D preg) ATSUDG 8,425,85
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)

California Prop 65: Not listed

----- EPA's IRIS DATA SUMMARY -----
Ethylbenzene; CASRN 100-41-4 (04/01/92)

_II. CARCINOGENICITY ASSESSMENT FOR LIFETIME EXPOSURE

Substance Name -- Ethylbenzene

Section II provides information on three aspects of the carcinogenic risk assessment for the agent in question; the U.S. EPA classification, and quantitative estimates of risk from oral exposure and from inhalation exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in three ways. The slope factor is the result of application of a low-dose extrapolation procedure and is presented as the risk per (mg/kg)/day. The unit risk is the quantitative estimate in terms of either risk per ug/L drinking water or risk per ug/cu.m air breathed. The third form in which risk is presented is a drinking water or air concentration providing cancer risks of 1 in 10,000, 1 in 100,000 or 1 in 1,000,000. Background Document 2 (Service Code 5) provides details on the rationale and methods used to derive the carcinogenicity values found in IRIS. Users are referred to Section I for information on long-term toxic effects other than carcinogenicity.

__II.A. EVIDENCE FOR CLASSIFICATION AS TO HUMAN CARCINOGENICITY

___II.A.1. WEIGHT-OF-EVIDENCE CLASSIFICATION

Classification -- D; not classifiable as to human carcinogenicity.

Basis -- nonclassifiable due to lack of animal bioassays and human studies.

___II.A.2. HUMAN CARCINOGENICITY DATA

None.

___II.A.3. ANIMAL CARCINOGENICITY DATA

None. NTP has plans to initiate bioassay. Metabolism and excretion studies at 3.5, 35 and 350 mg/kg are to be conducted as well.

___II.A.4. SUPPORTING DATA FOR CARCINOGENICITY

The metabolic pathways for humans and rodents are different (Engstrom et al., 1984). Major metabolites in humans, mandelic acid and phenylglyoxylic acid, are minor metabolites in rats and rabbits (Kiese and Lenk, 1974). The major animal metabolites were not detected in the urine of exposed workers (Engstrom et al., 1984).

Ethylbenzene at 0.4 mg/plate was not mutagenic for Salmonella strains

TA98, TA1535, TA1537 and TA1538 with or without Aroclor 1254 induced rat liver homogenates (S9) (Nestmann et al., 1980). Ethylbenzene was shown to increase the mean number of sister chromatid exchanges in human whole blood lymphocyte culture at the highest dose examined without any metabolic activation system (Norppa and Vainio, 1983).

Dean et al. (1985) used a battery of short-term tests including bacterial mutation assays, mitotic gene conversion in *Saccharomyces cerevisiae* JD1 in the presence and absence of S9 and chromosomal damage in a cultured rat liver cell line. Ethylbenzene was not mutagenic in the range of concentrations tested (0.2, 2, 20, 50 and 200 ug/plate) for *S. typhimurium* TA98, TA100, TA1535, TA1537 and TA1538 or for *Escherichia coli* WP2 and WP2uvrA. Ethylbenzene also showed no response in the *S. cerevisiae* JD1 gene conversion assay. In contrast, ethylbenzene hydroperoxide showed positive responses with *E. coli* WP2 at 200 ug/plate in the presence of S9 and an equally significant response with the gene conversion system of yeast.

___II.B. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM ORAL EXPOSURE

Not available.

___II.C. QUANTITATIVE ESTIMATE OF CARCINOGENIC RISK FROM INHALATION EXPOSURE

Not available.

___II.D. EPA DOCUMENTATION, REVIEW, AND CONTACTS (CARCINOGENICITY ASSESSMENT)

___II.D.1. EPA DOCUMENTATION

U.S. EPA. 1980. Ambient Water Quality Criteria Document for Ethylbenzene. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Water Regulations and Standards, Washington, DC. EPA 440/5-80-048. NTIS PB 81-117590.

U.S. EPA. 1984. Health Effects Assessment for Ethylbenzene. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Emergency and Remedial

Response, Washington, DC. EPA/540/1-86/008.

" S. EPA. 1987. Drinking Water Criteria Document for Ethylbenzene.
prepared by the Office of Health and Environmental Assessment, Environment
Criteria and Assessment Office, Cincinnati, OH for the Office of Drinking
Water, Washington, DC.

___ II.D.2. REVIEW (CARCINOGENICITY ASSESSMENT)

The Ambient Water Quality Criteria Document and the Health Assessment
Document have received Agency and external review. The Drinking Water
Criteria Document has been extensively reviewed.

Agency Work Group Review: 10/07/87

Verification Date: 10/07/87

___ II.D.3. U.S. EPA CONTACTS (CARCINOGENICITY ASSESSMENT)

Arthur S. Chiu / ORD -- (202)260-6764 / FTS 260-6764

Lynn Papa / ORD -- (513)569-7523 / FTS 684-7523

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED
FROM THE CHRIS MANUAL:
self-contained breathing apparatus; safety goggles.

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS:

- ** WEAR APPROPRIATE EQUIPMENT TO PREVENT:
Repeated or prolonged skin contact.
- ** WEAR EYE PROTECTION TO PREVENT:
Reasonable probability of eye contact.
- ** EXPOSED PERSONNEL SHOULD WASH:
Promptly when skin becomes contaminated.
- ** REMOVE CLOTHING:
Immediately remove any clothing that becomes wet to avoid any flammability
- ** REFERENCE: NIOSH

RECOMMENDED RESPIRATION PROTECTION Source: NIOSH POCKET GUIDE (85-114)
OSHA (ETHYL BENZENE)

1000 ppm: Any powered air-purifying respirator with organic vapor cartridge(s). * Substance reported to cause eye irritation or damage may require eye protection. / Any supplied-air respirator. * Substance reported to cause eye irritation or damage may require eye protection. / Any self-contained breathing apparatus. * Substance reported to cause eye irritation or damage may require eye protection. / Any chemical cartridge respirator with organic vapor cartridge(s). * Substance reported to cause eye irritation or damage may require eye protection.

2000 ppm: Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister. / Any supplied-air respirator with a full facepiece. / Any self-contained breathing apparatus with a full facepiece.

EMERGENCY OR PLANNED ENTRY IN UNKNOWN CONCENTRATIONS OR IDLH CONDITIONS.: Any self-contained breathing apparatus with full facepiece and operated in a pressure-demand or other positive pressure mode. / Any supplied-air respirator with a full facepiece and operated in 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 or front- or back-mounted organic vapor canister. / Any appropriate escape-type self-contained breathing apparatus.

FIRST AID SOURCE: CHRIS Manual 1991

INHALATION: if ill effects occur, remove victim to fresh air, keep him warm and quiet, and get medical help promptly; if breathing stops, give artificial respiration.

INGESTION: induce vomiting only upon physician's approval; material in mouth may cause chemical pneumonitis.

IN AND

EYES: promptly flush with plenty of water (15 min. for eyes) and get medical attention; remove and wash contaminated clothing before reuse.

FIRST AID SOURCE: DOT Emergency Response Guide 1990.

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen. In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water. Remove and isolate contaminated clothing and shoes at the site.

----- INITIAL INCIDENT RESPONSE -----

FIRE EXTINGUISHMENT: Foam (most effective), water fog, carbon dioxide or dry chemical. CHRIS91

US Department of Transportation Guide to Hazardous Materials Transport Information - Publication DOT 5800.5 (1990).

DOT SHIPPING NAME: Ethylbenzene

DOT ID NUMBER: UN1175

ERG93

GUIDE 26

POTENTIAL HAZARDS

*FIRE OR EXPLOSION

Flammable/combustible material; may be ignited by heat, sparks or flames.
Vapors may travel to a source of ignition and flash back.
Container may explode in heat of fire.

For explosion hazard indoors, outdoors or in sewers.
Runoff to sewer may create fire or explosion hazard.

***HEALTH HAZARDS**

May be poisonous if inhaled or absorbed through skin.

Vapors may cause dizziness or suffocation.

Contact may irritate or burn skin and eyes.

Fire may produce irritating or poisonous gases.

Runoff from fire control or dilution water may give off poisonous gases and ca

EMERGENCY ACTION

Keep unnecessary people away; isolate hazard area and deny entry.

Stay upwind; keep out of low areas.

Positive pressure self-contained breathing apparatus (SCBA) and structural fire

*Isolate for 1/2 mile in all directions if tank, rail car or tank truck is invc

CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping

If water pollution occurs, notify the appropriate authorities.

***FIRE**

Small Fires: Dry chemical, CO₂, water spray or alcohol-resistant foam.

Do not use dry chemical extinguishers to control fires involving nitromethane c

Large Fires: Water spray, fog or alcohol-resistant foam.

Move container from fire area if you can do it without risk.

Apply cooling water to sides of containers that are exposed to flames until wel

For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if

Withdraw immediately in case of rising sound from venting safety device or any

***SPILL OR LEAK**

Shut off ignition sources; no flares, smoking or flames in hazard area.

op leak if you can do it without risk.

Water spray may reduce vapor; but it may not prevent ignition in closed spaces.

Small Spills: Take up with sand or other noncombustible absorbent material and

Large Spills: Dike far ahead of liquid spill for later disposal.

***FIRST AID**

Move victim to fresh air and call emergency medical care; if not breathing, giv

In case of contact with material, immediately flush eyes with running water for

Remove and isolate contaminated clothing and shoes at the site.

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CHEMTOX DATA

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----- IDENTIFIERS -----

CHEMTOX RECORD 421 LAST UPDATE OF THIS RECORD: 12/03/92
 NAME: XYLENE
 SYNONYMS: XYLENE (XYLOL); XYLOL; METHYL TOLUENE; BENZENE, DIMETHYL-;
 DIMETHYLBENZENE; NCI-C55232; VIOLET 3; XYLOL (DOT); SOCIAL
 AQUATIC SOLVENT 3501
 CAS: 1330-20-7 RTECS: ZE2100000
 FORMULA: C8H10 MOL WT: 106.18
 WLN: 1R X1
 CHEMICAL CLASS: Aromatic hydrocarbon

See other identifiers listed below under Regulations.

----- PROPERTIES -----

PHYSICAL DESCRIPTION: colorless liquid with aromatic odor
 BOILING POINT: 412 K 138.8 C 281.9 F
 MELTING POINT: 247 K -26.2 C -15.1 F
 FLASH POINT: 300.35-305.35 27.2-32.2 C 80.9-89.9 F
 AUTO IGNITION: NA
 VAPOR PRESSURE: 6.7 mm @ 21 C
 UEL: 7 %
 LEL: 1 %
 IONIZATION POTENTIAL (eV): 8.56
 VAPOR DENSITY: 3.7 (air=1)
 EVAPORATION RATE: 0.77 (n-BUTYL ACETATE=1)
 SPECIFIC GRAVITY: 0.861 20C
 DENSITY: 0.861 g/cc or 8.0073 lb/gal
 WATER SOLUBILITY: VERY SL SOL
 INCOMPATIBILITIES: strong oxidizers

REACTIVITY WITH WATER: No data on water reactivity
 REACTIVITY WITH COMMON MATERIALS: No data
 STABILITY DURING TRANSPORT: No Data
 NEUTRALIZING AGENTS: No data
 POLYMERIZATION POSSIBILITIES: No data

TOXIC FIRE GASES: None reported other than possible
 unburned vapors

ODOR DETECTED AT (ppm): 0.05
 ODOR DESCRIPTION: LIKE BENZENE; CHARACTERISTIC AROMATIC
 Source: CHRIS
 100 % ODOR DETECTION: 0.4-20 ppm

----- REGULATIONS -----

DOT hazard class: 3 FLAMMABLE LIQUID
 DOT guide: 27
 Identification number: UN1307
 I shipping name: XYLENES

Packing group: II
Label(s) required: FLAMMABLE LIQUID
Special provisions: T1
Packaging exceptions: 173.150
Non bulk packaging: 173.202
Bulk packaging: 173.242
Quantity limitations-
Passenger air/rail: 5 L
Cargo aircraft only: 60 L
Vessel stowage: B
Other stowage provisions:

STCC NUMBER: 4909350, 4909351

CLEAN WATER ACT Sect.307:No

CLEAN WATER ACT Sect.311:Yes

National Primary Drinking Water Regulations

Maximum Contaminant Levels (MCL): 10 mg/L» (07/30/92)

Maximum Contaminant Level Goals (MCLG): 10 mg/L» (07/30/92)

CLEAN AIR ACT: CAA '90 Listed

EPA WASTE NUMBER: U239,D001

CERCLA REF: Not listed

RQ DESIGNATION: C 1000 pounds (454 kg) CERCLA

SARA TPQ VALUE: Not listed

SARA Sect. 312
categories:

Acute toxicity: Irritant

Acute toxicity: adverse effect to target organs.

Chronic toxicity: adverse effect to target organ
after long period of exposure.

Chronic toxicity: reproductive toxin.

Fire hazard: flammable.

LISTED IN SARA Sect 313: Yes

de minimus CONCENTRATION: 1.0 percent

UNITED STATES POSTAL SERVICE MAILABILITY:

Hazard class: Not given

Mailability: Nonmailable

Max per parcel: 0

NFPA CODES:

HEALTH HAZARD (BLUE): (2) Hazardous to health. Area may be entered with
self-contained breathing apparatus.

FLAMMABILITY (RED) : (3) This material can be ignited under almost all
temperature conditions.

REACTIVITY (YELLOW): (0) Stable even under fire conditions.

SPECIAL : Unspecified

----- TOXICITY DATA -----

SHORT TERM TOXICITY: Unknown

LONG TERM TOXICITY: unknown

TARGET ORGANS: CNS, eyes, gi tract, blood, liver, kidneys, skin

SYMPTOMS: DIZZ, EXCITEMENT, DROW, INCO, STAGGERING GAIT, IRRIT EYES, NOSE, THROAT, CORNEAL VACUOLIZATION, ANOREXIA, NAU, VOMIT, ABDOM PAIN; DERM Source: CHRIS

CONC IDLH: 1000ppm

NIOSH REL: 100 ppm Time weighted averages for 8-hour exposure
434 mg/M3 Time weighted averages for 8-hour exposure
200 ppm Ceiling exposures which shall at no time be exceeded(10-MIN)
868 mg/M3 Ceiling exposures which shall at no time be exceeded(10-MIN)

ACGIH TLV: TLV = 100ppm(435 mg/M3)
ACGIH STEL: STEL = 150 ppm(655 mg/M3)

OSHA PEL: Transitional Limits:
PEL = 100 ppm(435mg/M3)
Final Rule Limits:
TWA = 100 ppm (435 mg/M3)
STEL = 150 ppm(655 mg/M3)

MAK INFORMATION: 100 ppm
440 mg/M3
Substance with systemic effects, onset of effect less than or equal to 2 hrs: Peak = 2xMAK for 30 minutes, 4 times per shift of 8 hours.

CARCINOGEN?: N STATUS: See below

CARCINOGEN LISTS:
IARC: Not listed
MAK: Not listed
NIOSH: Not listed
NTP: Not listed
ACGIH: Not listed
OSHA: Not listed

HUMAN TOXICITY DATA: (Source: NIOSH RTECS)
* orl-hmn LDLo:50 mg/kg YAKUD5 22,883,80
ihl-man LCLo:10000 ppm/6H BMJOAE 3,442,70

LD50 value: orl-rat LD50:4300 mg/ kg

OTHER SPECIES TOXICITY DATA: (Source: NIOSH RTECS 1992)
orl-rat LD50:4300 mg/kg
ihl-rat LC50:5000 ppm/4H
ipr-rat LD50:2459 mg/kg
scu-rat LD50:1700 mg/kg
ipr-mus LD50:1548 mg/kg

ivn-rbt LDLo:129 mg/kg
ihl-gpg LCLo:450 ppm
ipr-gpg LDLo:2000 mg/kg
ipr-mam LDLo:2 gm/kg

IRRITATION DATA: (Source: NIOSH RTECS 1992)

Reproductive toxicity (1992 RTECS):

This chemical is a mammalian reproductive toxin.

REPRODUCTIVE TOXICITY DATA (1992 RTECS)

ihl-rat TCLo:250 mg/m3/24H (7-15D preg) ATSUDG 8,425,85
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

ihl-rat TCLo:50 mg/m3/6H (1-21D preg) JHEMA2 27,337,83
EFFECTS ON FERTILITY
Post-implantation mortality
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Craniofacial(including nose and tongue)

ihl-rat TCLo:50 mg/m3/6H (1-21D preg) JHEMA2 27,337,83
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Other developmental abnormalities
EFFECTS ON NEWBORN
Growth statistics(e.g.,reduced weight gain)

ihl-rat TCLo:600 mg/m3/24H (7-15D preg) PCBRD2
163B,295,85
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

orl-mus TDLo:20600 ug/kg (6-15D preg) JTEHD6 9,97,82
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Craniofacial(including nose and tongue)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

orl-mus TDLo:31 mg/kg (6-15D preg) JTEHD6 9,97,82
EFFECTS ON FERTILITY
Post-implantation mortality

ihl-mus TCLo:4000 ppm/6H (6-12D preg) TJADAB 28,22A,83
EFFECTS ON NEWBORN
Growth statistics(e.g.,reduced weight gain)
EFFECTS ON NEWBORN

Physical

ihl-mus TCLO:2000 ppm/6H (6-12D preg) TJADAB 28,22A,83
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)

ihl-mus TCLO:1 gm/m3/12H (6-15D preg) ATSUDG 8,425,85
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)
SPECIFIC DEVELOPMENTAL ABNORMALITIES
Musculoskeletal system

ihl-rbt TCLO:500 mg/m3/24H (7-20D preg) ATSUDG 8,425,85
EFFECTS ON EMBRYO OR FETUS
Fetotoxicity(except death,e.g.,stunted fetus)

----- PROTECTION AND FIRST AID -----

PROTECTION SUGGESTED
FROM THE CHRIS MANUAL:

NIOSH POCKET GUIDE TO CHEMICAL HAZARDS:

- ** WEAR APPROPRIATE EQUIPMENT TO PREVENT:
Repeated or prolonged skin contact.
- ** WEAR EYE PROTECTION TO PREVENT:
Reasonable probability of eye contact.
- ** EXPOSED PERSONNEL SHOULD WASH:
Promptly when skin becomes contaminated.
- ** REMOVE CLOTHING:
Immediately remove any clothing that becomes wet to avoid any flammability
- ** REFERENCE: NIOSH

RECOMMENDED RESPIRATION PROTECTION Source: NIOSH POCKET GUIDE (85-114)
NIOSH (XYLENE)

1000 ppm: Any chemical cartridge respirator with organic vapor cartridge(s). * Substance reported to cause eye irritation or damage may require eye protection. / Any powered air-purifying respirator with organic vapor cartridge(s). * Substance reported to cause eye irritation or damage may require eye protection. / Any supplied-air respirator. * Substance reported to cause eye irritation or damage may require eye protection. / Any self-contained breathing apparatus. * Substance reported to cause eye irritation or damage may require eye protection.
EMERGENCY OR PLANNED ENTRY IN UNKNOWN CONCENTRATIONS OR IDLH CONDITIONS.:
Any self-contained breathing apparatus with full facepiece and operated in a pressure-demand or other positive pressure mode. / Any supplied-air respirator with a full facepiece and operated in 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 or front- or back-mounted organic vapor canister. / Any appropriate escape-type self-contained breathing apparatus.

FIRST AID SOURCE: NIOSH
EYE: irr immed
SKIN: soap wash promptly
INHALATION: art resp
INGESTION: no vomit

FIRST AID SOURCE: DOT Emergency Response Guide 1990.
Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen. In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water. Remove and isolate contaminated clothing and shoes at the site.

----- INITIAL INCIDENT RESPONSE -----

US Department of Transportation Guide to Hazardous Materials Transport Information - Publication DOT 5800.5 (1990).

DOT SHIPPING NAME: XYLENES
DOT ID NUMBER: UN1307

ERG90

GUIDE 27

* POTENTIAL HAZARDS *

*FIRE OR EXPLOSION

Flammable/combustible material; may be ignited by heat, sparks or flames.
Vapors may travel to a source of ignition and flash back.
Container may explode in heat of fire.
Vapor explosion hazard indoors, outdoors or in sewers.
Runoff to sewer may create fire or explosion hazard.

*HEALTH HAZARDS

May be poisonous if inhaled or absorbed through skin.
Vapors may cause dizziness or suffocation.
Contact may irritate or burn skin and eyes.
Fire may produce irritating or poisonous gases.
Runoff from fire control or dilution water may cause pollution.

* EMERGENCY ACTION *

Keep unnecessary people away; isolate hazard area and deny entry.
Stay upwind; keep out of low areas.
Positive pressure self-contained breathing apparatus (SCBA) and structural firefighters' protective clothing will provide limited protection.
Isolate for 1/2 mile in all direction if tank, rail car or tank truck is involved in fire.
CALL CHEMTREC AT 1-800-424-9300 FOR EMERGENCY ASSISTANCE. If water pollution occurs, notify the appropriate authorities.

*FIRE

Small Fires: Dry chemical, CO2, water spray or regular foam.
Large Fires: Water spray, fog or regular foam.
Move container from fire area if you can do it without risk.

Apply cooling water to sides of containers that are exposed to flames until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Withdraw immediately in case of rising sound of venting safety device or any discoloration of tank due to fire.

***SPILL OR LEAK**

Shut off ignition sources; no flares, smoking or flames in hazard area. Stop leak if you can do it without risk.

Water spray may reduce vapor; but it may not prevent ignition in closed spaces.

Small Spills: Take up with sand or other noncombustible absorbent material and place into containers for later disposal.

Large Spills: Dike far ahead of liquid spill for later disposal.

***FIRST AID**

Move victim to fresh air and call emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen.

In case of contact with material, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water.

Remove and isolate contaminated clothing and shoes at the site.

DISCLAIMER: The data shown above on this chemical represents a best effort of the part of the compilers of the CHEMTOX database to obtain useful, accurate, and factual data. The use of these data shall be in accordance with the guidelines and limitations of the user's CHEMTOX license agreement. The COMPILERS of the CHEMTOX database shall not be held liable for inaccuracies or omissions within this database, or in any of its printed or displayed output forms.

ATTACHMENT B

DIRECTIONS TO EMERGENCY MEDICAL FACILITIES

DIRECTIONS TO THE NEAREST MEDICAL FACILITIES

The nearest hospital and the nearest facility capable of treating chemical burns are the same facility, which is located at Methodist North Hospital. Therefore, there is only one set of directions.

Nearest Hospital

**Methodist North Hospital
3960 Covington Pike
Memphis, Tennessee**

Emergency Room Telephone Number - (901) 372-5211

Directions to Methodist North Hospital from NAS Memphis Main Gate:

- 1) Exit site through South Gate (Singleton Parkway).
- 2) Continue on Singleton Parkway through the stop signs.
- 3) Singleton Parkway and Covington Pike will intersect at a red light (about 5 miles).
- 4) You will see the entrance to the emergency room 700 feet past this light on the left.

INSERT MAP TO HOSPITAL

ATTACHMENT C

HEALTH AND SAFETY PLAN FORMS

PLAN ACCEPTANCE FORM

PROJECT HEALTH AND SAFETY PLAN

INSTRUCTIONS: This form is to be completed by each person working on the project site and returned to: EnSafe/Allen & Hoshall, Memphis, Tennessee.

Job No: 2151-016

Contract No: N62467-89-D-0318

Project: SWMU 40 — Salvage Yard No. 1

I have read and understand the contents of the above plan and agree to perform my work in accordance with it.

Signed

Print Name

Company

Date

PLAN FEEDBACK FORM

Problems with plan requirements:

Unexpected situations encountered:

Recommendations for revisions:

ACCIDENT REPORT FORM

SUPERVISOR'S REPORT OF ACCIDENT		DO NOT USE FOR MOTOR VEHICLE OR AIRCRAFT ACCIDENTS	
TO		FROM	
		TELEPHONE (include area code)	
NAME OF INJURED OR ILL WORKER AND COMPANY			
WORKER'S SOCIAL SECURITY NUMBER			
DATE OF ACCIDENT	TIME OF ACCIDENT	EXACT LOCATION OF ACCIDENT	
NARRATIVE DESCRIPTION OF ACCIDENT			
NATURE OF ILLNESS OR INJURY AND PART OF BODY INVOLVED		LOST TIME	
		YES <input type="checkbox"/> NO <input type="checkbox"/>	
PROBABLE DISABILITY (Check one)			
FATAL <input type="checkbox"/>	LOST WORK DAY WITH ___ DAYS AWAY FROM WORK	LOST WORK DAY WITH ___ DAYS OF RESTRICTED ACTIVITY	NO LOST WORK DAY <input type="checkbox"/> FIRST-AID ONLY <input type="checkbox"/>
CORRECTIVE ACTION RECOMMENDED (By whom and by when)			
NAME OF SUPERVISOR		TITLE	
SIGNATURE		DATE	