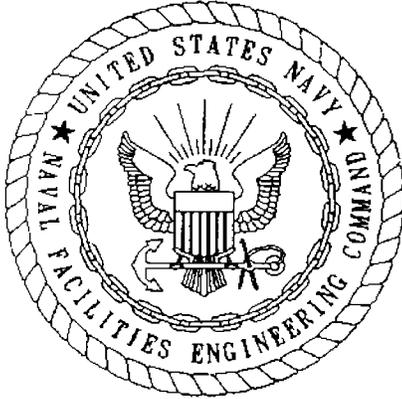


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FINAL REMEDIAL INVESTIGATION FEASIBILITY STUDY WORK PLAN FOR OPERABLE
UNIT 2 (OU 2) VOLUME 6 OF 6 NAS JACKSONVILLE FL
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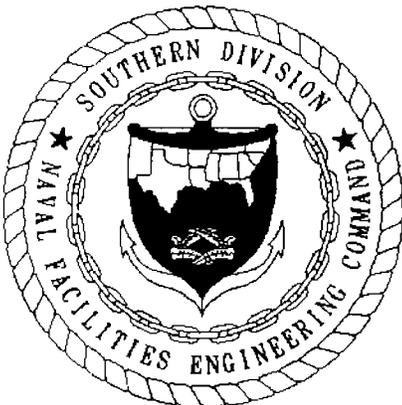


**NAVY INSTALLATION RESTORATION PROGRAM PLAN
NAVAL AIR STATION
JACKSONVILLE, FLORIDA**

**VOLUME 6
Remedial Investigation Feasibility Study
Work Plan for OU-2**

**Contract Task Order No. 053
Navy Clean - District 1
Contract No. N62467-89-D-0317**

December 1992



**SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SOUTH CAROLINA
29411-0068**

**OPERABLE UNIT 2
REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN**

for the

**NAVAL AIR STATION
JACKSONVILLE, FLORIDA**

JUNE 1992

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**REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN
OU-2, JACKSONVILLE NAVAL AIR STATION**

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GLOSSARY OF ACRONYMS

ABB-ES	ABB Environmental Services, Inc.
AOC	Area of Contamination
ARARs	Applicable or Relevant and Appropriate Requirements
ANOVA	analysis of variance
ASCII	American Standard Code for Information Exchange
AVGAS	aviation gasoline
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
CSF	carcinogenic slope factors
DQOs	Data Quality Objectives
ES&E	Environmental Science & Engineering
FDER	Florida Department of Environmental Regulation
FS	Feasibility Study
HEAST	Health Effects Assessment Summary Tables
IRIS	Integrated Risk Information System
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
NAS	Naval Air Station
NEESA	Naval Energy and Environmental Support Activity
NIRP	Naval Installation Restoration Program
PARCC	precision, accuracy, reproducibility, completeness, and comparability
PCB	polychlorinated biphenyl
ppb	parts per billion
ppm	parts per million
PSC	Potential Sources of Contamination
PVC	polyvinyl chloride
RAS	Routine Analytical Services

RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act
SOUTHNAVFACENGCOM	Southern Division Naval Facilities Engineering Command
SVOC	semivolatile organic compound
TOC	total organic carbon
TOX	total organic halogens
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound
$\mu\text{g/L}$	micrograms per liter

EXECUTIVE SUMMARY

The Navy has prepared this Remedial Investigation/Feasibility Study (RI/FS) Work Plan for Operable Unit No. 2 (OU-2), Wastewater Treatment Area, at the Naval Air Station, Jacksonville, Florida. OU-2 is located on the northern portion of the Naval Air Station; it is bounded by the St. Johns River to the north, the Timuquana Country Club Golf Course to the west, and Naval Air Station taxiways and runways to the south and east. A location map of OU-2 comprises Figure 1-1 of this Work Plan.

There are six Potential Sources of Contamination (PSCs) within OU-2. Five of these PSCs (Nos. 3, 4, 41, 42, and 43) are associated with past operations of the Jacksonville Naval Air Station's Sewage and Industrial Treatment Plant at OU-2. The sixth, PSC (No. 2), is an area formerly used for fire fighting training and is sited just north of the treatment plant. Waste materials previously disposed of at OU-2 reportedly include aviation fuels and spent oils domestic and industrial wastewater treatment sludges, and asbestos. Previous investigations have focused on individual sites as potential sources of groundwater contamination. These investigations detected the presence of organic and metal compounds. The focus of the RI/FS at OU-2 will be on investigating and remediating the operable unit as a whole. A combination of field and off-site laboratory analysis will be used at OU-2 to avoid iterative field investigations.

This RI/FS Work Plan documents activities to be conducted for a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Naval Installation Restoration Program response to contamination present at OU-2 as indicated by previous investigations. The Project Work Plan, which is the main document in the Work Plan, summarizes the site background and previous investigations, describes the data needs, and provides a "blueprint" for conducting the RI/FS at OU-2. Appendices to the Project Work Plan include: the Quality Assurance Project Plan (QAPjP), the Field Sampling Plan (FSP), and the Health and Safety Plan (HASP). The QAPjP describes the procedures that will be used to achieve data quality objectives. The FSP describes sample quantities, locations, and procedures that will be used during the field investigation. The HASP describes the procedures that will be used to maintain a safe working environment during field investigations.

The OU-2 RI/FS Work Plan is based on and references the *Navy Installation Restoration Program Plan, Naval Air Station, Jacksonville, Florida; Volume 1, Organization and Planning* (September 1991) and *Volume 4, The Basic Site Work Plan* (also dated September 1991). *The Basic Site Work Plan* comprehensively applies to all CERCLA work conducted at the site. OU-2 site-specific work requirements and procedures are based on these two documents.

1.0 INTRODUCTION

This Remedial Investigation/Feasibility Study (RI/FS) Work Plan was prepared for Operable Unit No. 2 (OU-2) at the Naval Air Station Jacksonville (NAS Jacksonville or Station) in northeast Florida.

Placed on the U.S. Environmental Protection Agency's (USEPA's) National Priorities List in December 1989, NAS Jacksonville is participating in the U.S. Department of Defense Installation Restoration Program (IRP), which identifies and remediates conditions related to past spills or disposals of hazardous wastes. The IRP complies with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act. These acts, passed by Congress in 1980 and 1986, respectively, establish the means to assess and clean up hazardous waste sites.

In October 1990, a federal Facilities Agreement was signed by the USEPA, the Florida Department of Environmental Regulation (FDER), and the Navy to coordinate IRP actions at NAS Jacksonville.

This work plan is Volume 6 of the *Navy Installation Restoration Program Plan* for NAS Jacksonville. Volume 1, *Organization and Planning* (Geraghty & Miller, 1991b), and Volume 4, *Base Site Work Plan* (Geraghty & Miller, 1991c updated 1992) were used to develop the OU-2 RI/FS Work Plan.

Volume 1 contains information for completing the IRP at NAS Jacksonville. It identifies NAS-wide Potential Sources of Contamination (PSCs) and groups PSCs requiring the RI/FS process into operable units, describes the NAS-wide environmental setting, addresses program and data management, and presents an events schedule for implementing the IRP. This schedule is updated annually in the NAS Jacksonville Management Plan. Appendices to Volume 1 include NAS Jacksonville background documents, the Community Relations Plan, the NAS-wide Health and Safety Plan, and the overall Site Management Plan.

Volume 4 identifies potential field investigations, establishes sampling and analysis methods for all environmental investigations at the NAS, and outlines procedures for CERCLA remedial activities including the RI, the baseline risk assessment, treatability studies, and the FS. Appendices to Volume 4 include the Quality Assurance/Quality Control Plan, the Data Analysis Plan, the Quality Assurance/Quality Control Final Product/Report Plan, and the Basic Sampling and Analysis Plan. This latter appendix has two parts - the Quality Assurance Program Plan and the Basic Field Sampling Plan.

1.1 SITE DESCRIPTION. Located on the northern portion of the NAS, OU-2 is bordered by the St. Johns River to the north, the Timuquana Country Club Golf Course to the west, and NAS taxiways and runways to the south and east. Figure 1-1 is a location map of OU-2 within NAS Jacksonville.

Past operations at the wastewater treatment plant within OU-2 that possibly affected soil and groundwater quality include:

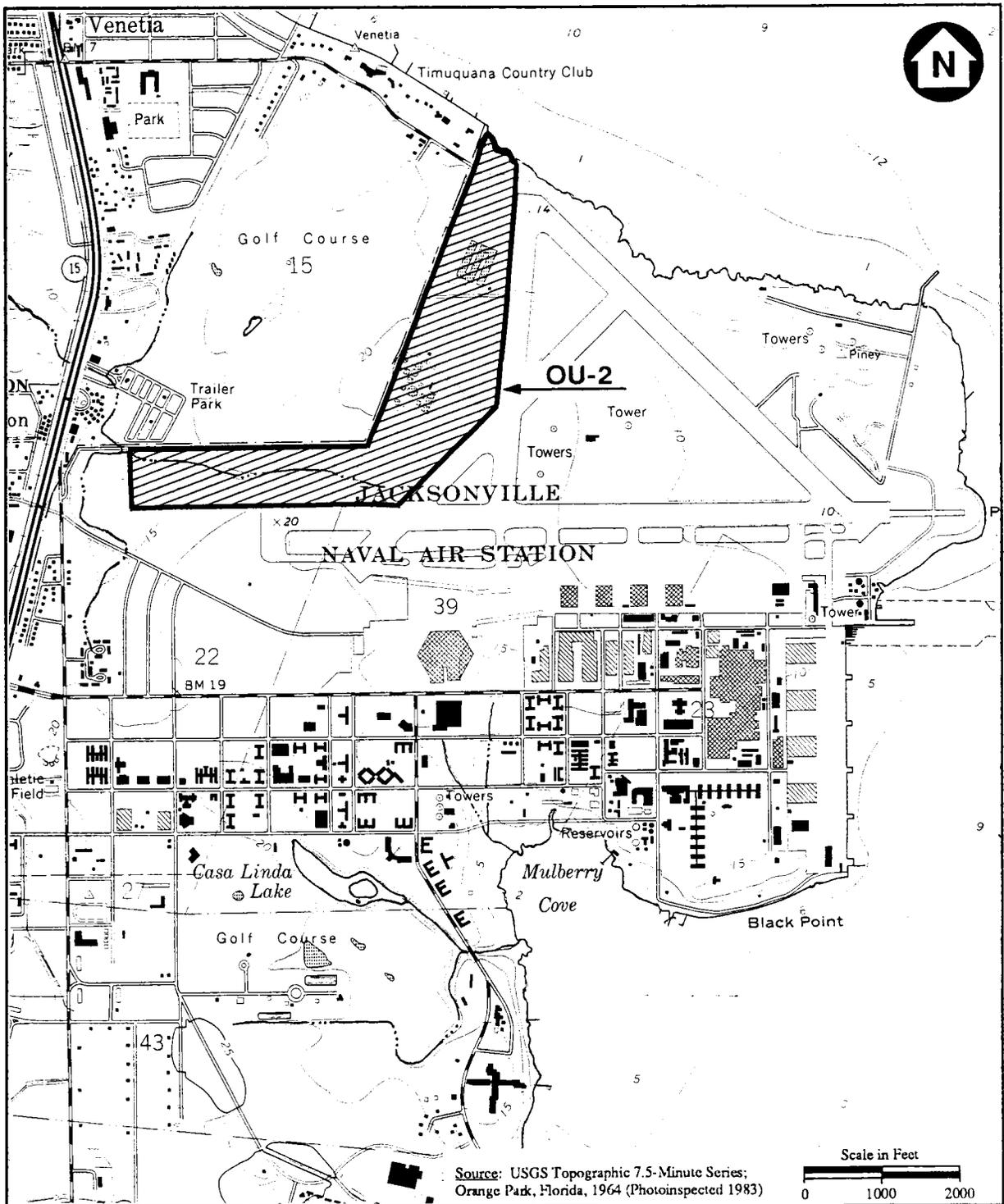
- land disposal of sludge
- drying sludge in beds at the plant
- discharge of treated water to a polishing pond

In addition to the treatment plant, a former Fire Fighting Training Area is located within OU-2. Burning fuel within the unlined pit at the training area could have impacted soil and groundwater.

Probable waste materials disposed of at OU-2 include aviation fuels and spent oils (at the Fire Fighting Training Area), domestic and industrial wastewater treatment sludges, and asbestos. During previous groundwater investigations, organic and inorganic compounds were detected at OU-2.

1.2 PURPOSE AND SCOPE OF THE OU-2 WORK PLAN. The purpose of the RI/FS process at OU-2 is to characterize the nature and extent of, and the risks posed by, existing contamination and to evaluate potential remedial alternatives. This Work Plan, prepared during the initial RI/FS planning phase, consists of the following sections:

- 1.0 INTRODUCTION
- 2.0 ENVIRONMENTAL SETTING, AND SITE HISTORY, DISPOSAL HISTORY, AND HISTORICAL RESPONSE. This section summarizes the environmental setting and background of OU-2.
- 3.0 INITIAL EVALUATION. This section presents a preliminary identification of the nature and distribution of contaminants based on previous investigation reports and a conceptual model summarizing the extent of what is currently understood about contamination, exposure pathways, and potential receptors.
- 4.0 DATA REQUIREMENTS. This section provides a preliminary identification of Applicable or Relevant and Appropriate Requirements (ARARs) for OU-2, states data quality objectives (DQOs), summarizes



R/FS
WORK PLAN FOR OU-2

NAS JACKSONVILLE
DECEMBER 1992



NAS JACKSONVILLE
LOCATION MAP
FIGURE 1-1

OU-2 data requirements, and lists data requirements for the baseline risk assessment and FS.

- 5.0 **REMEDIAL INVESTIGATION TASKS.** This section discusses the approach to the RI, including project management requirements (e.g., mobilization), additional field investigations, sample analysis and data management, data modeling, baseline risk assessment, and the RI Report.
- 6.0 **FEASIBILITY STUDY TASKS.** This section reviews requirements for developing and screening remedial alternatives, treatability testing studies, analyzing of remedial alternatives, and preparing of the FS Report.
- 7.0 **PROJECT ORGANIZATION AND RESPONSIBILITIES.** This section states project authorizations and responsibilities of key managers and support roles, provides a preliminary sequence of events schedule, and summarizes requirements for community relations.

The RI/FS Work Plan details the tasks and activities for the field investigation of OU-2. The appendices for the OU-2 Work Plan include the OU-2 Sampling and Analysis Plan (comprising the Field Sampling Plan and the OU-2 site-specific Quality Assurance Project Plan), and the OU-2 site-specific Health and Safety Plan.

2.0 ENVIRONMENTAL SETTING AND SITE HISTORY

This section describes the OU-2 environmental setting and history.

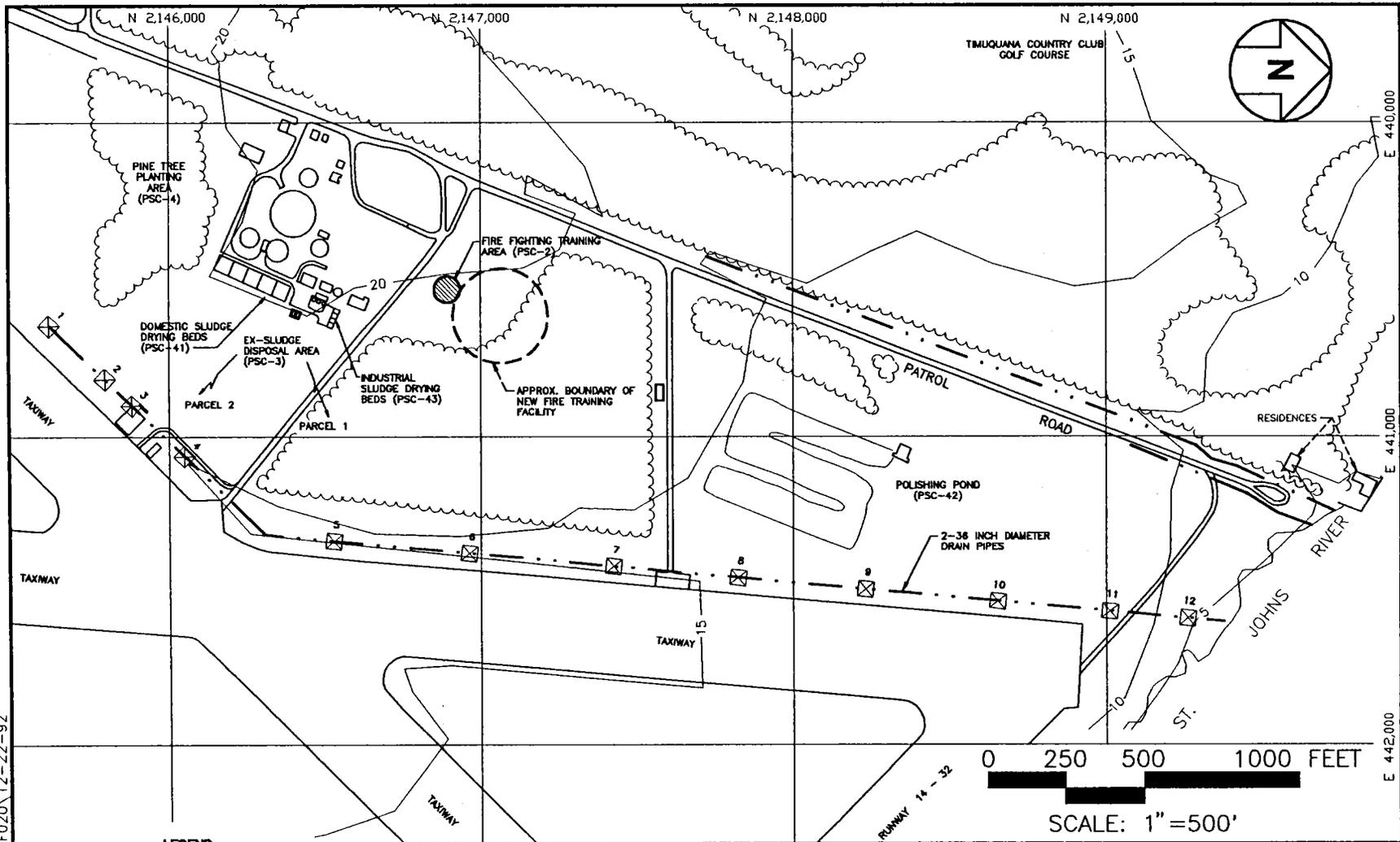
2.1 ENVIRONMENTAL SETTING. The physiography, geology, hydrology, hydrogeology, and meteorology of OU-2 are described in the following subsections. The environmental setting of NAS Jacksonville and the Jacksonville area is presented in Section 4, Volume 1, of the Navy Installation Restoration Program Plan (NIRP).

2.1.1 Physiography OU-2 is located near the tip of a peninsula between the Ortega and St. Johns rivers. The land surface elevation at OU-2 varies from approximately 14 feet above mean sea level in the southeastern section, rising to a high of 22 feet above mean sea level just north of the Domestic Waste Sludge Drying Beds, and falling to mean sea level along the St. Johns River at the northern boundary (Figure 2-1).

2.1.2 Geology A generalized geologic cross-section is shown and described in Volume 1 of the NIRP. The focus (depth of investigation) of the RI at OU-2 is the surficial soil unit overlying the Hawthorn Group. This soil consists of post-Miocene fluvial deposits including fine-grained sand, silty sand, clayey sand, and sandy clay. Based on the results of a cone penetrometer survey by the U.S. Army Corps of Engineers in 1990, these deposits are at least 75 feet thick.

Previous IRP investigations described the surficial soil as consisting of at least three distinct sequences: (1) an upper sand layer, (2) a clay layer, and (3) a lower sand layer. Monitoring well logs from previous investigations and results of the U.S. Army Corp of Engineers' cone penetrometer survey, however, indicate that geology of the surficial soil at OU-2 is more complex than the original interpretation.

2.1.3 Surface Hydrology A drainage divide runs northwesterly across OU-2 in the vicinity of the waste sludge drying beds. South of the divide, runoff flows into a drainage ditch that begins 1,200 feet south of the wastewater treatment plant. This ditch parallels the east-west runway for approximately 3,000 feet, then turns north and heads off base. Water in the ditch flows from east to west and eventually leaves the base. Only the western portion of the east-west ditch stays wet. OU-2 is not the only source of water for this ditch; at several locations, ditches conveying water from other portions of the Station and from the Timuquana Golf Course discharge into the main east-west ditch. Figure 2-2 shows interpreted flow directions in the east-west drainage ditch and its tributaries.



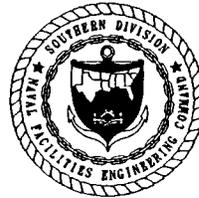
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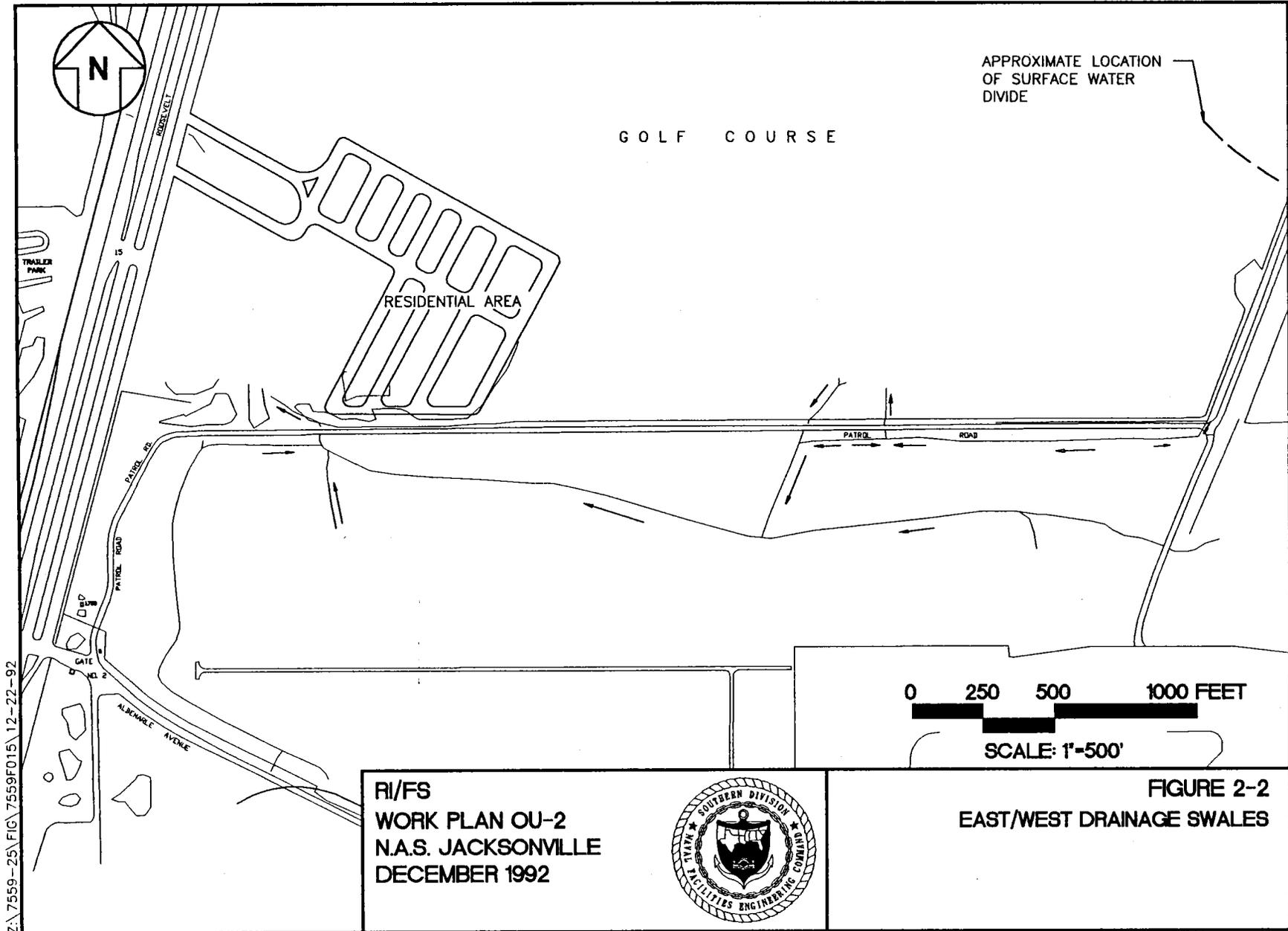
LEGEND

- - - DRAINAGE DITCHES
- ☒ DRAINAGE PIPE DROP BOX LOCATIONS FROM EACH DROP BOX, ONE ON EITHER SIDE (2 SEDIMENT SAMPLES IN DITCH)

**RI/FS
WORK PLAN OU-2
N.A.S. JACKSONVILLE
DECEMBER 1992**



**FIGURE 2-1
NORTHERN DRAINAGE AREAS**



Z:\7559-25\FIG\7559F015\12-22-92

North of the drainage divide, runoff flows toward the St. Johns River via swales on either side of the Patrol Road and two 36-inch-diameter drain pipes paralleling the taxiway on the east side of OU-2. Near the Patrol Road turnaround at the north end of OU-2, a drainage ditch from the Timuquana Golf Course intersects the swale that parallels the west side of the Patrol Road.

2.1.4 Hydrogeology OU-2 surficial soil has been described during previous IRP investigations as consisting of two aquifers; a water table sand aquifer, separated by 6 to 10 feet of sandy clay/clayey sand from a 5-foot-thick confined sand aquifer.

Hydraulic conductivity tests for "shallow" and "deep" wells are outlined below:

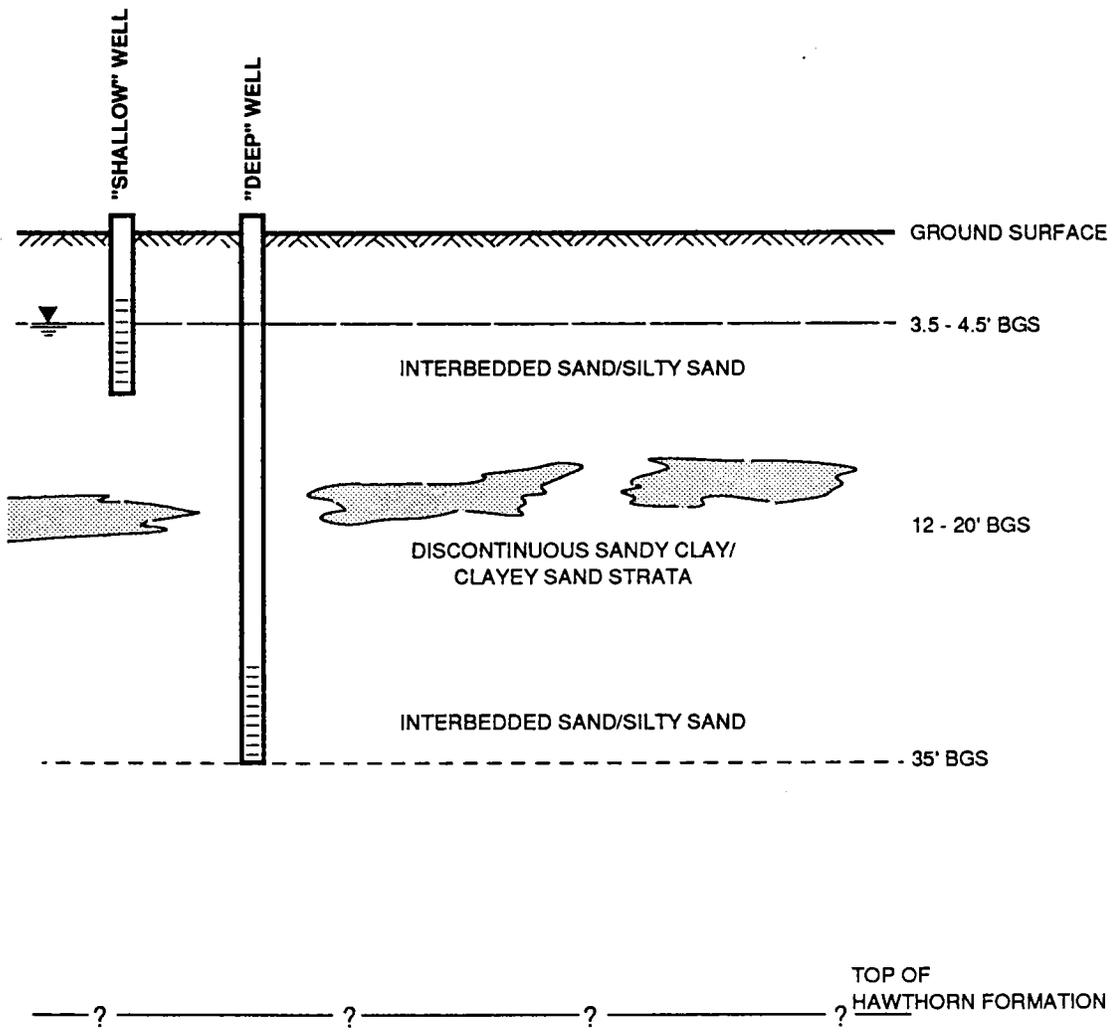
REPORT	SHALLOW	DEEP
SOUTHDIV, 1990,1991	0.23-9.33 feet/day	0.04-0.36 feet/day
IT, 1991a		3.54-81.35 feet/day
ESE, 1992	1.1-7.8 feet/day	3.6-142.5 feet/day

Contaminants, however, have been detected in groundwater samples collected from both "deep" and "shallow" wells next to the sludge drying beds. This indicates that the sandy clay/clayey sand is not acting as a true aquitard and that the two sand units are hydrologically connected. In addition, the extent of this reported "confining unit" has not been established and no geotechnical tests have been conducted on this soil. Because of uncertainties about the nature, extent, and importance of the sandy clay/clayey sand layer at OU-2, the current groundwater conceptual model has been revised and all the soil overlying the Hawthorn Group is considered one aquifer (Surficial Aquifer) (Figure 2-3).

Groundwater flow in the Surficial Aquifer has been interpreted to be generally northward toward the St. Johns River, except for the area south of the wastewater treatment plant where flow has been interpreted to be south-southwest. Depth to groundwater ranges from 3.5 to 5 feet. Dewatering operations associated with recent construction at the wastewater treatment plant temporarily disturbed the Surficial Aquifer flow.

2.1.5 Meteorology The meteorology of the Jacksonville area is described in detail in Volume 1 of the NIRP (Geraghty & Miller, 1991b).

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NOT TO SCALE

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NAS JACKSONVILLE
DECEMBER 1992

CONCEPTUAL STRATIGRAPHIC
PROFILE
FIGURE 2-3

2.1.6 Land Use and Demography Historically, the OU-2 area has been used primarily for Naval Air Station wastewater treatment. A secondary use has been for fire fighting training.

The Timuquana Country Club and Golf Course borders OU-2 to the west. Public access to the country club is restricted to members and guests. Two private residences abut the NAS boundary on the western side of OU-2 near the St. Johns River (see Figure 2-1). A residential area also abuts the NAS boundary west of the Timuquana Country Club. Access to OU-2 is limited because of its proximity to the NAS taxiways and runways, which have security requirements. A chain-link fence along the base boundary and continuous patrols make access by unauthorized personnel unlikely.

2.2 SITE BACKGROUND. The area incorporated into NAS Jacksonville has been used for U.S. Navy operations since 1940. NAS Jacksonville is primarily a maintenance and operations facility providing services and material to support aviation activities designated by the Chief of Naval Operations. Because of its primary missions, NAS Jacksonville engages in a wide variety of operations, a number of which require the use, handling, storage, or disposal of hazardous materials and substances. In the past, these materials came in contact with the environment through accidental spills, leaks in supply piping, landfilling operations, burning of waste liquids during fire fighting training exercises, and the cumulative effect of operations conducted at the NAS flightline and industrial areas.

OU-2 soil and groundwater have been impacted by operation of the wastewater treatment plant and fire fighting training exercises. Six potential source areas identified at OU-2 (shown on Figure 2-1) are described in the following subsections.

2.2.1 Wastewater Treatment Plant Sludge Disposal Area (PSC-3) Approximately 20,000 tons of domestic and industrial sewage sludge, reportedly containing metals and organic compounds were disposed of at PSC-3 from 1962 to 1980 (Geraghty & Miller, 1991b). The 15-acre area consists of two approximately equal parcels divided by an access road. The northern parcel (Parcel 1) was planted with pine trees. The eastern parcel (Parcel 2) is an unmaintained open field. No written records exist regarding quantities, locations, and the timing of sludge disposal in the two parcels. Both parcels presumably were used for disposal of domestic and industrial sludge.

2.2.2 Pine Tree Planting Area (PSC-4) The Pine Tree Planting Area (PSC-4) is south of the wastewater treatment plant. From 1968 to 1975, this area reportedly was used for disposal of wastewater treatment plant sludge, asbestos, and petroleum products. Sometime after 1975, this area was planted with pine trees.

2.2.3 Domestic Waste Sludge Drying Beds (PSC-41) The Domestic Waste Sludge Drying Beds (PSC-41), constructed in 1970 to receive sludge from the anaerobic digester, operated until 1987. The system consists of five unlined beds, each measuring 50 by 50 feet. The 3-foot-high containment walls and outside dikes are made of concrete blocks. The beds are underlain with 7 inches of sand, 3 inches of fine gravel, and 6 to 12 inches of coarse gravel. An underdrain system consisting of three, 6-inch-diameter vitrified clay drain lines collected leachate and returned it to the headworks of the wastewater treatment plant. During previous operations, approximately 300 cubic yards per year of dried sludge were removed from the Domestic Waste Sludge Drying Beds.

Before construction of the Industrial Waste Sludge Drying Beds, sludges from the industrial wastewater treatment operations were also channeled to the Domestic Waste Sludge Drying Beds.

In 1987, USEPA classified the Domestic Waste Sludge Drying Beds as surface impoundments operated to treat hazardous wastes F006 and F019 (40 CFR 261). F006 wastes are wastewater treatment sludges from electroplating operations, and F019 wastes are wastewater treatment sludges from the chemical conversion coating of aluminum. The domestic beds were also used to store sludges from electroplating operations (F001 through F005, wastes from paint stripping and parts cleaning operations), in addition to sludge from the anaerobic digester of the domestic wastewater treatment plant. An average of 170 gallons per day of dewatered sludge was removed from the Domestic Waste Sludge Drying Beds during their operation, and taken to a landfill for disposal. The Domestic Waste Sludge Drying Beds were permanently removed from service on June 10, 1987, with the remaining sludge removed and taken to an authorized landfill in 1991.

2.2.4 Industrial Waste Sludge Drying Beds (PSC-43) The Industrial Waste Sludge Drying Beds (PSC-43) were constructed in 1980 to dewater industrial wastewater treatment sludges from electroplating operations. Each of the four beds is approximately 15 by 18 feet and enclosed with concrete retaining walls. The bottoms of the beds are unlined and consist of a 12-inch sand layer, with an underlying 10-inch gravel layer. The beds were underdrained, and leachate was returned to the industrial wastewater treatment plant. Approximately 8,250 gallons of dried sludge were excavated annually from the drying beds. The Industrial Waste Sludge Drying Beds were permanently removed from service in November 1988, with the remaining sludge removed and taken to an authorized landfill in 1991.

In 1988, after a review of groundwater monitoring data, FDER issued a consent order requiring closure of the waste sludge drying beds. In response to the consent order, NAS Jacksonville developed a closure plan for the Domestic and Industrial Waste Sludge Drying Beds and the Wastewater Treatment Plant Polishing Pond (PSC-42). In

September 1991, FDER issued a permit for closure and post-closure at the three surface impoundments.

2.2.5 Wastewater Treatment Plant Effluent Polishing Pond (PSC-42) The Polishing Pond (PSC-42) was built in 1970 to provide final clarification for approximately 2.3 million gallons per day of combined domestic and industrial wastewater-treated effluent, prior to chlorination and discharge to the St. Johns River. USEPA classified the Polishing Pond as a surface impoundment to treat Resource Conservation and Recovery Act (RCRA-listed) hazardous wastes F006 and F019 (Process Code T02).

The unlined Polishing Pond has a capacity of approximately 3.7 million gallons (based on the design surface area of 3.8 acres and an average depth of 3.5 feet). The pond was permanently removed from service on May 23, 1987, and is currently filled with water.

2.2.6 Former Fire Fighting Training Area (PSC-2) The former Fire Fighting Training Area (PSC-2) is a shallow unlined pit, approximately 100 feet in diameter. Since 1966, obsolete vehicle chassis and parts were periodically covered with JP-4, JP-5, aviation gasoline, or waste oil and then ignited to simulate aircraft crashes. An estimated 6,000 gallons of fuel were burned annually. PSC-2 was removed from service in 1991. NAS Jacksonville completed construction of a new Fire Fighting Training Area just northeast of PSC-2 in 1992.

2.3 INVESTIGATIVE HISTORY. Tables 2-1 and 2-2 present a chronological summary of previous preliminary investigative activities, gleaned from a review of the referenced documents. These are grouped into two tables because, historically, the investigations focused on individual PSCs consolidated into either disposal operations (Table 2-1) or wastewater treatment plant operations (Table 2-2). Table 2-1 summarizes work performed at the Fire Fighting Training Area, the Wastewater Treatment Plant Sludge Disposal Area, and the Pine Tree Planting Area. Table 2-2 summarizes work conducted for the Wastewater Treatment Plant Effluent Polishing Pond, the Industrial Waste Sludge Drying Beds, and the Domestic Waste Sludge Drying Beds.

TABLE 2-1 OU-2 INVESTIGATIVE HISTORY, FIRE FIGHTING TRAINING AREA, WASTEWATER TREATMENT PLANT EX-SLUDGE DISPOSAL AREA, PINE TREE PLANTING AREA
NAS, JACKSONVILLE, FLORIDA OPERABLE UNIT 2

DATE	INVESTIGATION TITLE	OBJECTIVE	SCOPE	FINDINGS	CONCLUSIONS
March 1983	Preliminary Assessment (Initial Assessment Study) (Fred C. Hart Associates)	Navy initiated the Navy Assessment and Control of Installation Pollutants (NRCIP) to systematically identify, assess, and control contamination of the environment resulting from past hazardous materials management operations.	Information was collected from historical records, aerial photographs, field inspections, and personnel interviews. Sites were evaluated with regard to contamination characteristics, migration pathways, and pollutant receptors. Identified: Site #2 - Present Fire Fighting Training Area; Site #3 - Sludge Disposal Area; Site #4 - Pine Tree Planting Area	<p>Site #2 = 6000 gallons of JP-5 and waste oil burned annually since 1965.</p> <p>Site #3 = 20,000 tons of sludge containing toxics metals were dumped between 1962 - 1980.</p> <p>Site #4 = Area was used for disposal of paint shavings, sewage sludge, asbestos oil, and other petroleum products between 1968 - 1975.</p>	<p>Site #2 = Contaminant quantities and associated risk small so no confirmation study recommended.</p> <p>Site #3 = Sludge not considered hazardous under RCRA, no confirmation study recommended.</p> <p>Site #4 = Visual confirmation of contamination at site. Possibility of metals leaching into groundwater. Recommended for confirmation study.</p>
December 1985	Site Inspection (Verification Study) (Geraghty & Miller)	Initial site investigation to determine the presence or absence of contamination.	<p>Site #2 - 1 monitoring well was installed and tested for Pesticides PCBs & VOCs.</p> <p>Site #4 - 3 Monitoring wells installed and tested for VOCs, TOC, cyanide & metals. 3 soil samples collected analyzed for EP Toxicity.</p>	<p>Site #2 - All non detects.</p> <p>Site #4 - Low concentrations of VOCs:</p> <p>9.1 ppb T- 1,2- DCE 45 ppb TCE 1.1 ppb PCE</p>	<p>Site #2 - No further study recommended.</p> <p>Site #4 - No further study recommended.</p>

Notes:

PCBs = polychlorinated biphenyls
VOCs = volatile organic compounds
TOC = total organic carbon
EP = Extraction Procedure
ppb = parts per billion
DCE = dichloroethylene
TCE = trichloroethylene
PCE = tetrachloroethylene
RCRA = Resource Conservation and Recovery Act

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**TABLE 2-2 OU-2 INVESTIGATIVE HISTORY, WASTEWATER TREATMENT PLANT EFFLUENT POLISHING POND, INDUSTRIAL SLUDGE DRYING BEDS, DOMESTIC SLUDGE DRYING BEDS
NAS, JACKSONVILLE, FLORIDA OPERABLE UNIT 2**

DATE	INVESTIGATION TITLE	OBJECTIVE	SCOPE	FINDINGS	CONCLUSIONS
October 1983	Groundwater Monitoring Plan for RCRA Compliance NAS - JAX (Geraghty & Miller)	To address EPA standards for owners & operators of Hazardous Waste Treatment, Storage, and Disposal facilities.	Discuss general hydrogeologic conditions and propose monitoring well installation and sampling.	Recommended that wells be installed and monitored for 1 year to test for contamination.	April 1984 - 3 wells were installed around Industrial Waste Sludge Drying Beds to be sampled quarterly - 1 year. June 1984 - 3 wells installed around Polishing Ponds to be sampled quarterly - 1 year.
July 1985	Year-End Report of Groundwater Monitoring at the WWTP Polishing Ponds (Geraghty & Miller)	Report on work to date concerning groundwater quality.	Discuss assessment of groundwater quality and recommend quality and future course of action.	All analyses below drinking water primary standards, exceeded slightly for Fe and TPH. Low concentrations - 3 ppb of chloromethane and 0.5 ppb of 1,1,1-TCA.	Requested end to quarterly sampling.
June 1987	Permit Certification (FDER)	FDER authorizing permit #H016-119108 for sludge drying beds.	Details requirement by NAS/JAX to stay in compliance.	One additional well must be installed. Semiannual sampling is to take place. Cease adding waste to surface impoundments by November 1988.	October 1987 well NAS 4-11 was installed.
December 1987	Results of Hydrogeologic Evaluation (Geraghty & Miller)	Summarizes results of field investigations.	A round of water level measurements & groundwater sampling from 5 wells. In-situ hydraulic conductivity tests.	An upward hydraulic gradient between the Floridan aquifer and the surficial aquifer. 14 constituents were detected above permit levels.	Recommended 8 additional shallow wells and 4 deep wells.
April 1988	Compliance Sampling Report (Geraghty & Miller)	Summarizes groundwater sampling program.	Groundwater sampling from 5 wells.	Contamination exceeding permit levels for inorganics, volatile organics, and acid extractable compounds.	Sampling will continue.

2-10

continued

TABLE 2-2 OU-2 INVESTIGATIVE HISTORY, WASTEWATER TREATMENT PLANT EFFLUENT POLISHING POND, INDUSTRIAL SLUDGE DRYING BEDS, DOMESTIC SLUDGE DRYING BEDS NAS, JACKSONVILLE, FLORIDA OPERABLE UNIT 2

DATE	INVESTIGATION TITLE	OBJECTIVE	SCOPE	FINDINGS	CONCLUSIONS
June 1988	Consent Order 88-0280 (FDER)	Informing NAS/JAX that they were out of compliance.	Details NAS/JAX noncompliance and what was needed to get back into compliance.	Due to hazardous constituents in groundwater further action needed: 1. Electromagnetic Terrain Survey. 2. Conceptual Design Report. 3. Closure Plan.	1. Electromagnetic terrain conductivity survey indicated possible contamination under drying beds. Recommended 6 additional monitoring wells. 2. Listed possible remedial activities concerning contamination under drying beds. 3. In 1988 the industrial waste sludge drying beds were taken out of service and all sludge removed.
July 1989	Plume Delineation Report Industrial Wastewater Treatment Plant (IT Corporation)	To delineate the horizontal and verticals extent of contamination from ISDBs after closure.	Constructed 14 monitoring wells around former ISDBs.	Groundwater flow towards the northeast. Volatile & semi-volatile contamination in shallow aquifers. Metal contamination in both deep & shallow aquifers.	Recommended additional sampling to define plume.
August 1989	Corrective Action Plan (Geraghty & Miller)	Present a plan to remediate the groundwater plume. Report on groundwater sampling in Feb. & May 1989.	Design a groundwater recovery system to stop migration of contamination. 25 wells were sampled in Feb. & May.	Multiple constituents exceeding permit levels.	Still contamination in both upper & lower aquifer.
January 1991 & May 1991	Quarterly Compliance Monitoring of Polishing Ponds and Domestic Sludge Drying Beds (IT Corporation)	Continuance of post-closure monitoring for 1990.	11 wells surrounding DSDBs & PP were sampled quarterly during 1990.	Contamination above background was found in all shallow aquifer wells. One plume migrating from the PP and one from the DSDBs. The plume from the DSDBs is also in the deep aquifer.	Recommended installation of additional wells.
June 1991	Monitoring Well Completion Report (IT Corporation)	Present additional well installation information.	12 new monitoring wells were constructed. 6 surrounding the DSDBs and 6 around PP.	Wells were completed.	

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continued

**TABLE 2-2 OU-2 INVESTIGATIVE HISTORY, WASTEWATER TREATMENT PLANT EFFLUENT POLISHING POND, INDUSTRIAL SLUDGE DRYING BEDS, DOMESTIC SLUDGE DRYING BEDS
NAS, JACKSONVILLE, FLORIDA OPERABLE UNIT 2**

DATE	INVESTIGATION TITLE	OBJECTIVE	SCOPE	FINDINGS	CONCLUSIONS
August 1991	Quarterly Compliance Monitoring of Polishing Pond and Domestic Sludge Drying Beds (IT Corporation)	Present data for August sampling round.	Continuance of post closure monitoring for 1991.	Due to operation of dewatering wells & construction, groundwater flow has been disturbed.	Groundwater flow change has slowed the migration of contaminant plume away from the beds.
March 1992	Monitoring well redevelopment and January 1992 Semi-Annual Sampling Event (IT Corporation)	Inform FDER on work to date.	Attempt redevelopment of wells to improve yield and turbidity plus additional sampling.	Redevelopment only partially successful. Reaffirms that groundwater flow in shallow aquifer has been affected.	Still contamination in both shallow & deep aquifers.
July 1992	Monitoring Well Redevelopment and July 1992 Semi-Annual Sampling Event (ESE)	Present data for July sampling round.	Continuance of post closure monitoring for 1992.	Groundwater flow has returned to pre-dewatering gradients and flow rates.	Contaminants present in both shallow & deep aquifers.

Notes:

- RCRA = Resource Conservation and Recovery Act
- WWTP = Waste Water Treatment Plant
- FDER = Florida Department of Environmental Regulation
- EPA = U.S. Environmental Protection Agency
- TPH = total petroleum hydrocarbons
- ISDBs = Industrial Sludge Drying Beds
- DSDBs = Domestic Sludge Drying Beds
- PP = Polishing Pond

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3.0 INITIAL EVALUATION

The initial evaluation of the nature and distribution of contaminants at OU-2 and the site-wide conceptual model are summarized in the following subsections.

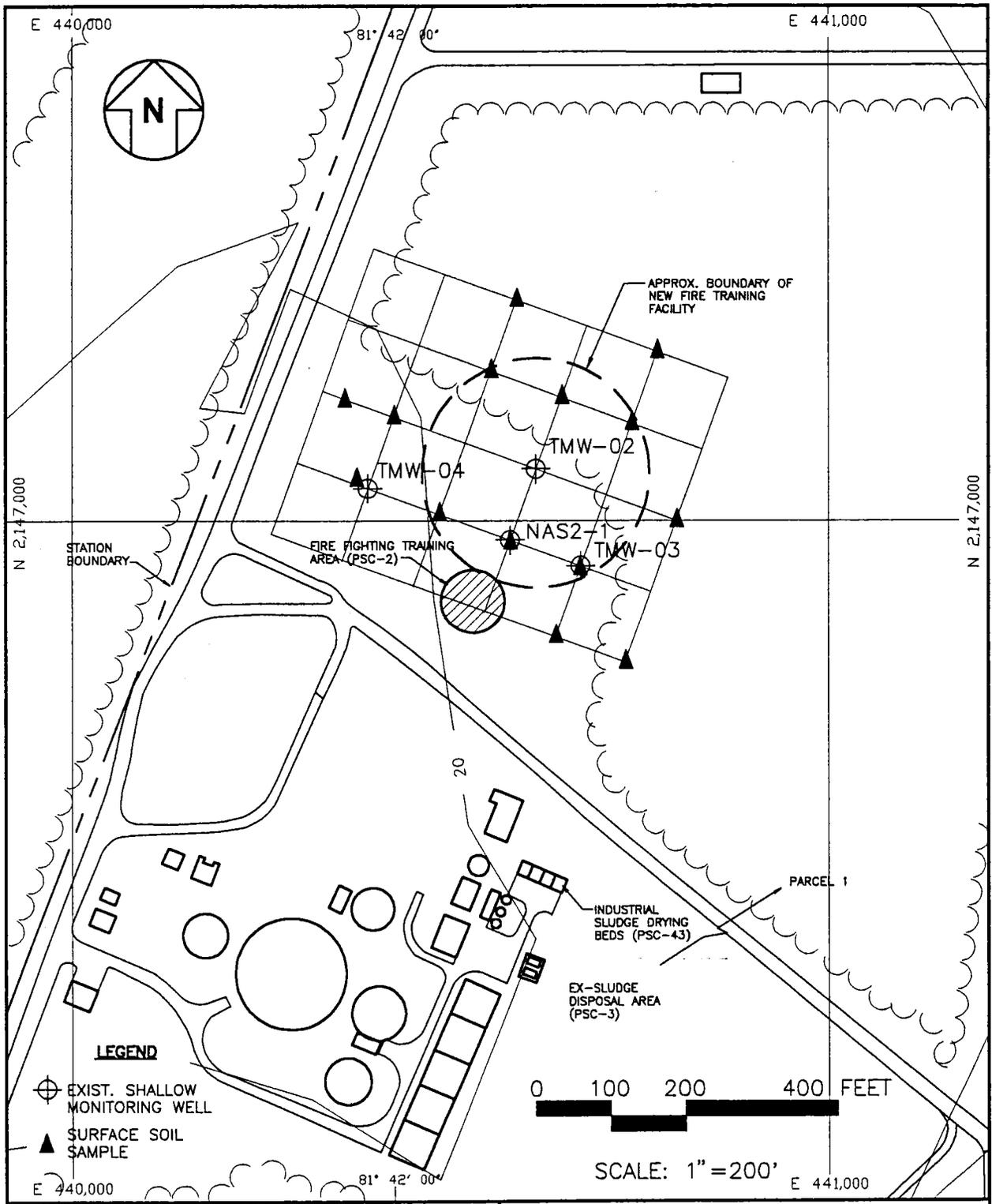
3.1 NATURE AND DISTRIBUTION OF CONTAMINANTS. The nature and distribution of contaminants evaluation is based primarily on previous investigations performed by Fred C. Hart and Associates, Inc., Geraghty & Miller, Inc., International Technology Corporation (IT Corporation), Environmental Science & Engineering, Inc., (ES&E), and background information provided by the FDER and the Southern Division Naval Facilities Engineering Command (SOUTHNAVFACENGCOM).

3.1.1 Soil Limited soil data were collected during previous investigations. Because previous investigations at OU-2 focused on each PSC separately, the summary of the nature and distribution of contaminants in soil is described individually for each PSC.

3.1.1.1 Former Fire Fighting Training Area (PSC-2) PSC-2 was originally identified in the Initial Assessment Study conducted in 1983 by Fred C. Hart and Associates, which included a review of historic records, aerial photographs, field investigations, and personal interviews. The Initial Assessment Study reported that an estimated 6,000 gallons of fuel were burned annually at PSC-2 since 1966, but concluded that contaminant quantities and associated risks were small and so did not recommend a confirmation study.

Before building the new Fire Fighting Training Area adjacent to the existing area, additional studies conducted in January 1991 identified contamination that could affect construction of the facility. Fifteen soil samples were collected from various nodes on a sampling grid with 100-foot node spacing (Figure 3-1). The samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), total recoverable petroleum hydrocarbon (TPH), and six metals. Fifteen SVOCs were detected but at estimated concentrations below the Practical Quantification Limit (PQL) (i.e., 10 micrograms per liter [$\mu\text{g/L}$]). The study concluded that contamination would not hinder construction of the new Fire Fighting Training Area.

Follow-up soil sampling as part of a March 1991 sampling event was conducted, to establish whether soils removed from the site would be subject to Land Disposal Restriction criteria. Seven composite soil samples were collected and analyzed for Toxicity Characteristic Leachate Procedure metals. All results were below detection



Z:\7559-25\FIG\7559F002\12-16-92

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FIGURE 3-1
 FIRE FIGHTING TRAINING
 AREA (PSC-2)
 PREVIOUS INVESTIGATION LOCATIONS

limits and it was established that the soils would not be subject to Land Disposal Restrictions.

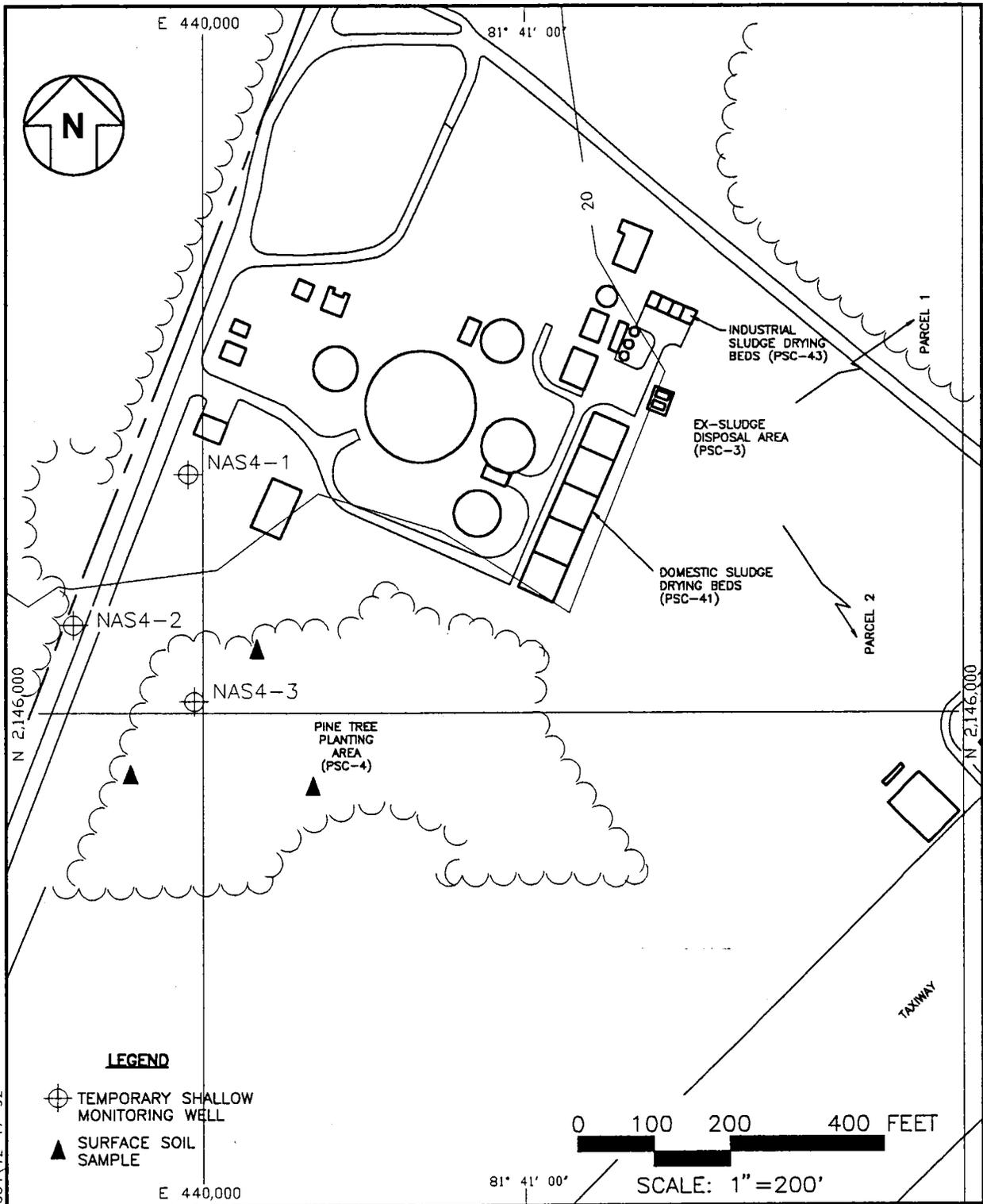
Blackened soil in the former Fire Fighting Training Area indicates that SVOCs and possibly VOCs might be in the soil as a result of incomplete combustion of fuels.

3.1.1.2 Former Wastewater Treatment Plant Sludge Disposal Area (PSC-3) A single sludge sample, collected and analyzed for Extraction Procedure Toxicity metals in October 1980, was found to be nonhazardous (Fred C. Hart and Associates, 1983). Based on this single sample, the Initial Assessment Study concluded that PSC-3 did not pose a threat to public health and the environment, and did not recommend this PSC for further study. No further soil sampling has been conducted at the site. Visual evidence of sludge disposal in the open field of Parcel 2, such as paint chips in areas of dying or stressed vegetation, indicate contaminants may be present in the soil. There is no obvious visual evidence of surficial contamination in Parcel 1 of PSC-3, which is covered by an approximately 3-inch layer of pine needles.

3.1.1.3 Pine Tree Planting Area (PSC-4) The 1983 Initial Assessment Study reported visual evidence of contamination and recommended a confirmation study to assess whether or not metals were leaching from this area into groundwater (Fred C. Hart and Associates, 1983). Three soil samples were collected by Geraghty & Miller, Inc., from a depth of approximately 6 inches (Figure 3-2). These samples were analyzed for Extraction Procedure Toxicity metals, but detected concentrations were below levels at which soils would be considered a hazardous waste. Based on results of this sampling, Geraghty & Miller, Inc., did not recommend further study of this area. There is visual evidence, however, that contaminants may be present in the soil at PSC-4, including blackened soil along the PSC-4 tree line and small piles of sludge containing paint chips.

3.1.1.4 Domestic and Industrial Waste Sludge Drying Beds (PSC-43, PSC-41) No soil samples have been collected from the sludge drying beds. Based on the nature of wastes treated in the wastewater treatment plant, however, the soils underlying the former waste sludge drying beds may contain organics, metals, and cyanide compounds. Organic and inorganic compounds detected during extensive groundwater monitoring near the beds indicate the sludge drying beds are PSCs.

3.1.1.5 Wastewater Treatment Plant Effluent Polishing Pond (PSC-42) No soil samples have been collected from the soil around the Polishing Pond. Contaminants detected in groundwater downgradient from the pond indicate that sediment and water in the pond



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FIGURE 3-2
PINE TREE PLANTING AREA (PSC-4)
PREVIOUS INVESTIGATION LOCATIONS

could contain contaminants. During heavy rainfall, it is possible the pond could overflow and transport contaminants to surrounding soil.

3.1.2 Surface Water and Sediment There have been no sediment or surface water samples collected from OU-2. The primary area of concern for surface water contamination is the Polishing Pond. Based on the chemicals detected in groundwater near the Polishing Pond, and nature of the industrial wastes treated in the wastewater treatment plant, sediment or surface water in the pond could contain organics, metals, and cyanide compounds.

The ditches and swales carrying runoff from OU-2 to drainage systems and the St. Johns River may also be affected by past activities. Contaminants sorbed to surface soil particles could be transported and deposited in the ditches and swales by runoff.

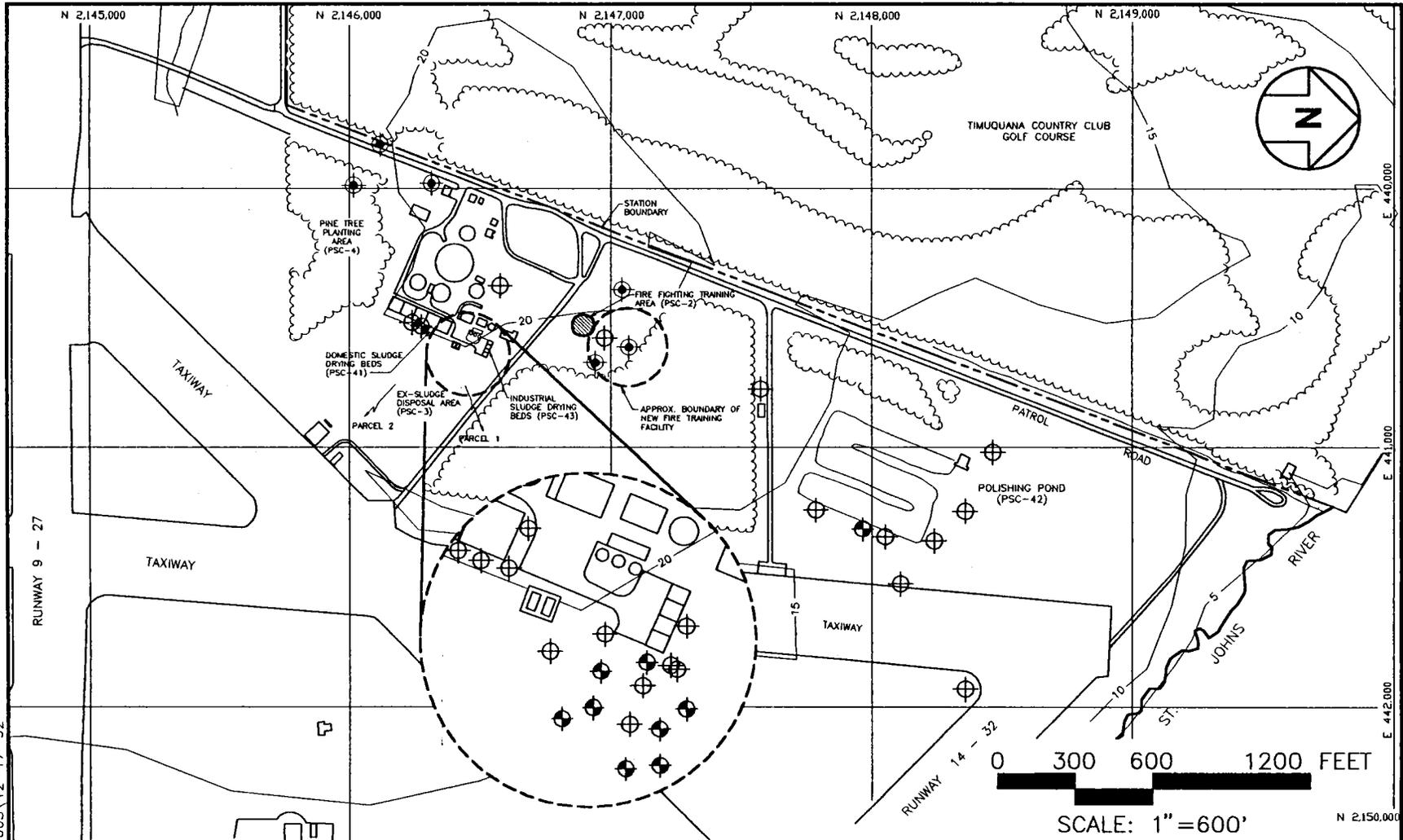
3.1.3 Groundwater Forty permanent and six temporary monitoring wells were installed at OU-2 during previous investigations (Figure 3-3). Like the soil sampling, previous groundwater investigations at OU-2 focused on individual PSCs. The results of sampling efforts are described by PSC in the following subsections. Additional groundwater sampling results are summarized in tables in Appendix D.

3.1.3.1 Former Fire Fighting Training Area (PSC-2) Monitoring well NAS 2-1 was installed north of PSC-2 in 1985 (see Figure 3-1). Groundwater samples were collected from the well and analyzed for pesticides, polychlorinated biphenyls (PCBs), and VOCs. All results were below detection limits and no further study of the site was recommended. Monitoring well NAS 2-1 probably was removed during the construction of the new Fire Fighting Training Area; this will be confirmed during the RI field program.

Groundwater samples were collected from three temporary wells (TMW02, TMW03, and TMW04 [see Figure 3-3]) in January 1991. The samples were analyzed for total organic carbon (TOC), VOCs, SVOCs, TPHs, radionuclides, and dissolved metals. Chromium and lead were detected in the groundwater in excess of Maximum Contaminant Levels (MCLs). Phenol was detected in groundwater but at estimated concentrations below the PQL (i.e., 10 $\mu\text{g/L}$). No VOCs were detected at concentrations above the analytical laboratory's PQL.

3.1.3.2 Former Wastewater Sludge Disposal Area (PSC-3) No wells have been installed specifically to investigate the impact of PSC-3 on groundwater quality. Inorganic and organic contaminants, however, were detected in six groundwater monitoring wells next

Z:\7559-25\FIG\7559F003\12-17-92



- LEGEND**
- ⊕ TEMPORARY MONITORING WELL
 - ⊕ EXIST. SHALLOW MONITORING WELL
 - ⊕ EXIST. SHALLOW AND DEEP MONITORING CLUSTER

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FIGURE 3-3
MONITORING WELL LOCATIONS
PREVIOUS INVESTIGATIONS

to the Domestic Waste Sludge Drying Beds (MW 41-1 through MW 41-6), which are located due west of Parcel 2. Although these wells are considered upgradient or crossgradient from Parcel 2, based on the lack of confirmation of groundwater flow directions, it is possible that Parcel 2 contributes some contaminants detected in these wells.

3.1.3.3 Pine Tree Planting Area (PSC-4) In 1987, three temporary monitoring wells (NAS4-1, NAS4-2, and NAS4-3) were installed in and around PSC-4 (Geraghty & Miller, 1987b). These wells were removed; approximate locations are shown on Figure 3-2. One round of groundwater samples was collected from each well and analyzed for in situ parameters (i.e., pH and specific conductance), VOCs, TOC, cyanide, and selected metals (i.e., cadmium, chromium, and nickel). VOCs were detected in each of the wells at the following concentrations:

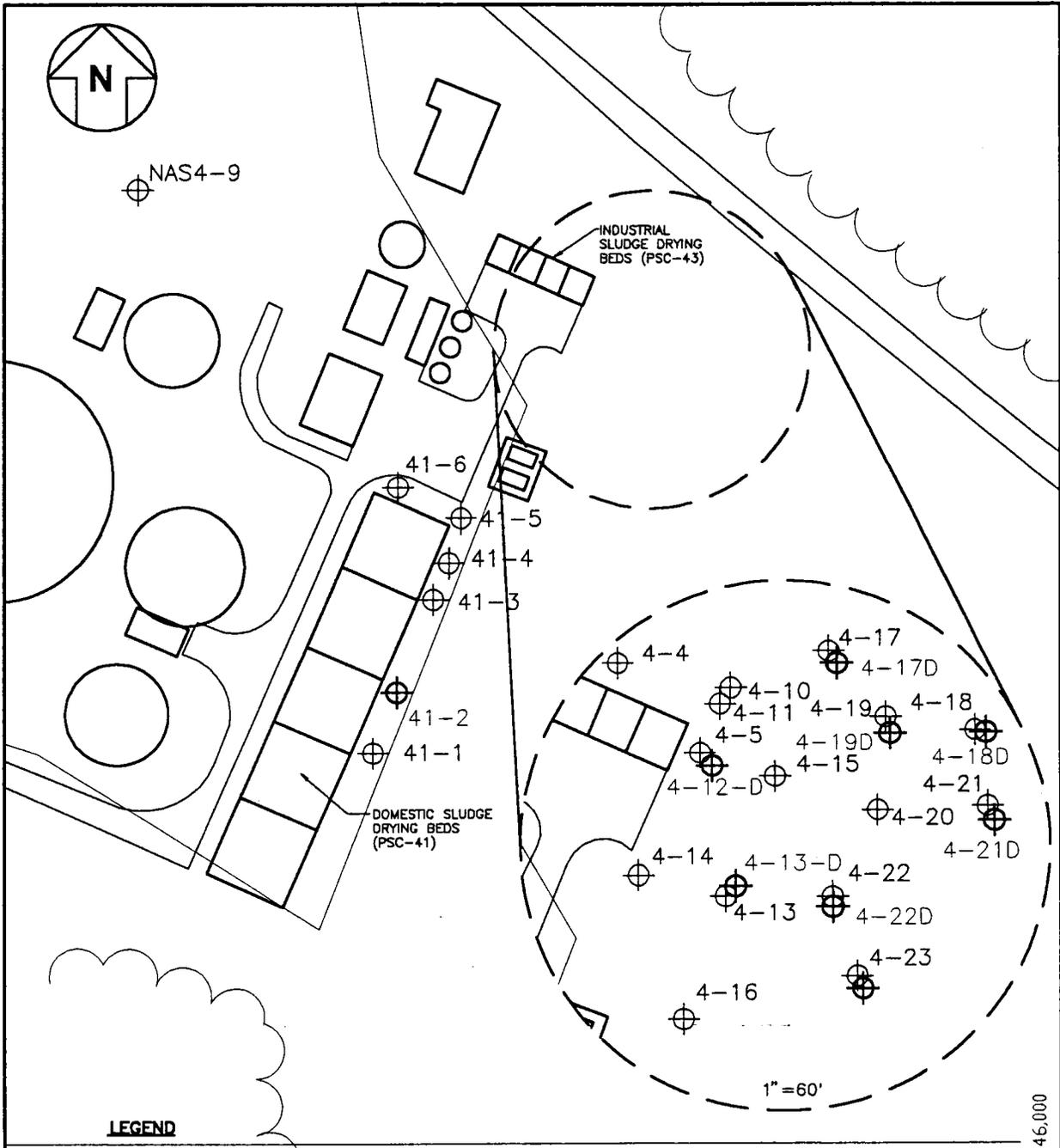
COMPOUND	NAS4-1	NAS4-2	NAS4-3
Trichloroethylene	15 µg/L	45 µg/L	0.7 µg/L
Tetrachloroethylene	-	1.1 µg/L	-
trans-1,2-dichloroethylene	-	9.1 µg/L	-

Cyanide and dissolved metals were not detected above the PQL. The TOC concentration ranged from 1 to 3.7 parts per million (ppm).

3.1.3.4 Domestic and Industrial Sludge Drying Beds (PSC-41 and PSC-43)

Groundwater near the waste sludge drying beds was investigated originally as part of the Groundwater Monitoring Plan for RCRA Compliance to establish background water quality (Geraghty & Miller, 1983). In April 1984, four shallow monitoring wells were installed near the Industrial Waste Sludge Drying Beds, one upgradient (NAS4-9) and three downgradient (NAS4-4, NAS4-5, and NAS4-10) (Figure 3-4). Groundwater samples were collected and analyzed for RCRA background parameters (pH, total organic halogens [TOX], TOC, and specific conductivity). Monitoring of these wells has continued since March 1984 as part of the Quarterly Compliance Monitoring Program.

In June 1987, FDER issued a permit (No. HO16-119108) authorizing the use of four Industrial Waste Sludge Drying Beds at the NAS Jacksonville. To fully comply with the permit conditions, NAS Jacksonville installed an additional monitoring well, NAS4-11, on September 28, 1987. After two years of monitoring, a statistical comparison confirmed significant increases in specific conductance, TOC, and TOX at downgradient well



LEGEND

- EXIST. SHALLOW MONITORING WELL
- EXIST. DEEP MONITORING WELL

0 50 100 200 FEET

SCALE: 1" = 60'

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FIGURE 3-4
DOMESTIC WASTE SLUDGE
DRYING BEDS (PCS-41)/
INDUSTRIAL WASTE SLUDGE
DRYING BEDS (PCS-43)
PREVIOUS INVESTIGATION LOCATIONS

Z:\7559-25\FIG\7559F005\12-17-92

NAS4-5. Additionally, inorganics (i.e., cadmium, nickel, and cyanide) were detected in the groundwater from monitoring well NAS4-5 at higher concentrations than in the upgradient well, NAS4-9. In December 1987, an additional hydrogeological evaluation and sampling event was conducted (Geraghty & Miller, 1987b). Based on a review of available historical data, Geraghty & Miller, Inc., concluded that the bulk of sludge channeled to the drying beds apparently originated from the paint-stripping operations with lesser contributions from the plating and metal-treating shops. Groundwater sampling and analysis results from this study indicated that 14 Appendix IX constituents (40 CFR 261) were detected in groundwater during this study. Cadmium, chromium, nickel, vanadium, sulfide, and methylene chloride concentrations exceeded state and federal groundwater standards. As a result of this study, eight additional monitoring wells, four water table and four intermediate depth (30 to 35 feet below ground surface [bgs]), were installed in May 1989 to help establish the vertical and horizontal extent of these constituents.

In a parallel investigation, samples were collected from five monitoring wells in January 1988. Reportedly, samples collected from upgradient and downgradient were significantly different from background levels for pH, specific conductivity, TOX (decrease), and TOC (increase) (Geraghty & Miller, 1988a). Several metals were detected in the downgradient wells at concentrations greater than background levels. This investigation recommended developing a corrective action program, sampling wells quarterly for permit parameters, and annual sampling and analysis for Appendix VIII constituents (40 CFR 261). This sampling program began in January 1991.

Analytical results from the April 1988 sampling of 25 monitoring wells also indicated that several inorganic and some organic compounds exceeded USEPA Groundwater Protection Standards. In June 1988, FDER issued a consent order to NAS Jacksonville stating that the Station was out of compliance with Permit No. HO16-119108 because of hazardous constituents found in the groundwater. The consent order mandated the following corrective actions: (1) conduct an electromagnetic terrain survey, (2) prepare a conceptual design report, and (3) prepare a closure plan. The electromagnetic terrain survey was performed in July 1988; it indicated possible contamination under the Industrial Waste Sludge Drying Beds. As a result of this survey, Geraghty & Miller, Inc. (1988b) recommended installing an additional six monitoring wells. The conceptual design report listed possible remedial activities for the contaminated areas (G&M Consulting Engineers, 1988). The Industrial Waste Sludge Drying Beds were taken out of service in November 1988 and the sludge and filter sand were removed soon thereafter.

In an attempt to characterize a groundwater contamination plume beneath OU-2, IT Corporation installed and sampled 14 new wells in May 1989 in the vicinity of the waste sludge drying beds (see Figure 3-4). The Plume Delineation Report indicated that

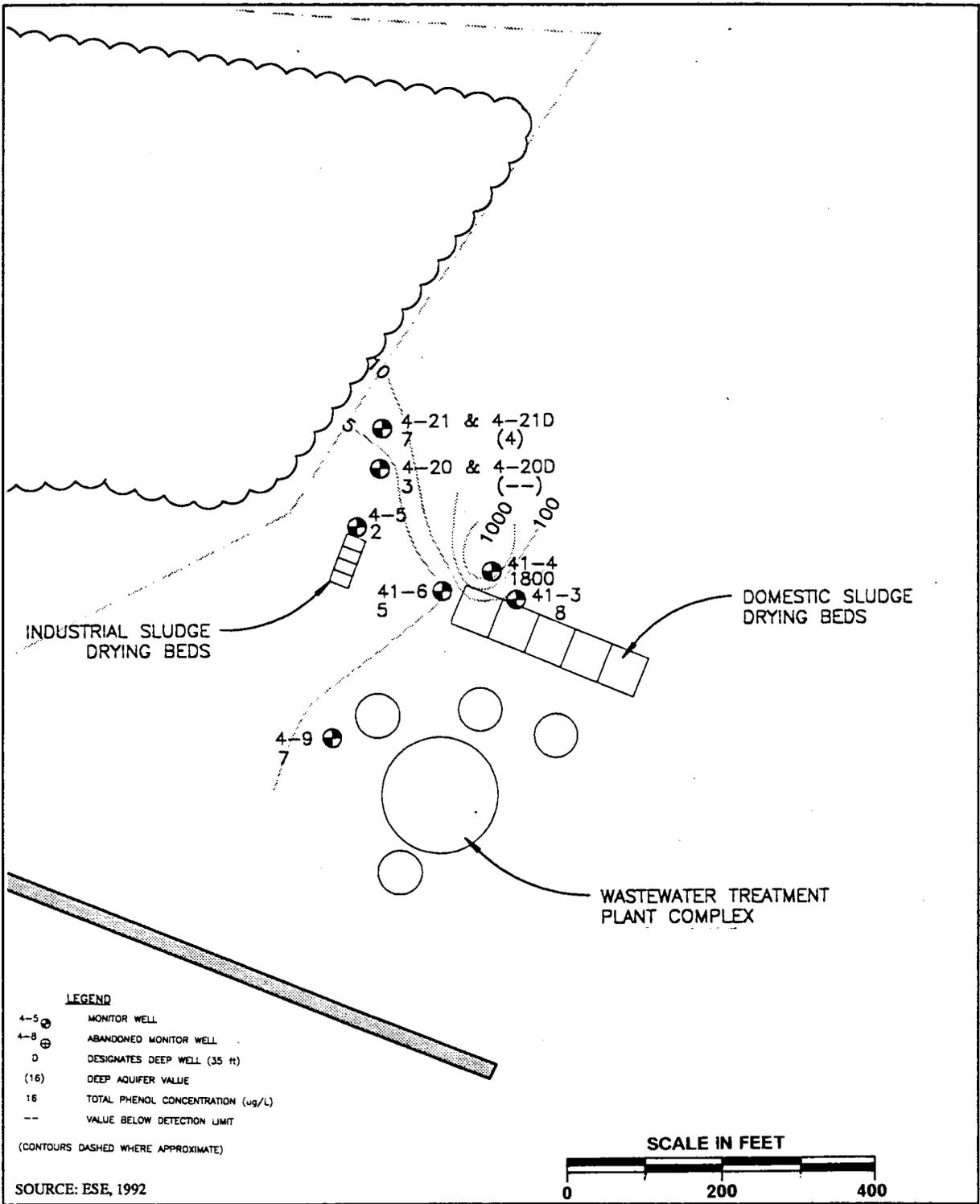
groundwater flow was northeast with a mounding effect near the beds (IT Corporation, 1989). The analytical results indicated VOC and SVOC contamination in shallow well NAS4-20. Metals contamination was detected in both shallow and deep monitoring wells.

RCRA quarterly compliance monitoring, as required by the closure permit for the waste sludge drying beds, has been conducted since January 1991. In January 1992, compliance monitoring was changed to semiannual. These reports indicate that contamination remains above background levels in the shallow and deep aquifer wells. Figure 3-5 outlines the extent of the groundwater contaminants for the sludge drying beds as of July 1992. The FDER closure permit expires on September 30, 1996.

3.1.3.5 Polishing Pond Groundwater near the Polishing Pond originally was investigated as part of the Groundwater Monitoring Plan for RCRA Compliance (Geraghty & Miller, 1983). Monitoring wells were sampled and analyzed quarterly for one year beginning in 1984. Quarterly monitoring continued in response to a Corrective Action Plan. The locations of existing Polishing Pond monitoring wells are shown in Figure 3-6. Several groundwater parameters have exceeded permit standards (IT Corporation, 1991a). Figure 3-7 outlines the extent of the groundwater contaminants for the Polishing Pond as of July 1992.

3.2 OU-2 CONCEPTUAL MODEL. Conceptual models describe a site and its environs and present hypotheses regarding the contaminants present, their routes of migration, and their potential impact on sensitive receptors. The hypotheses are tested, refined, and modified throughout the RI/FS.

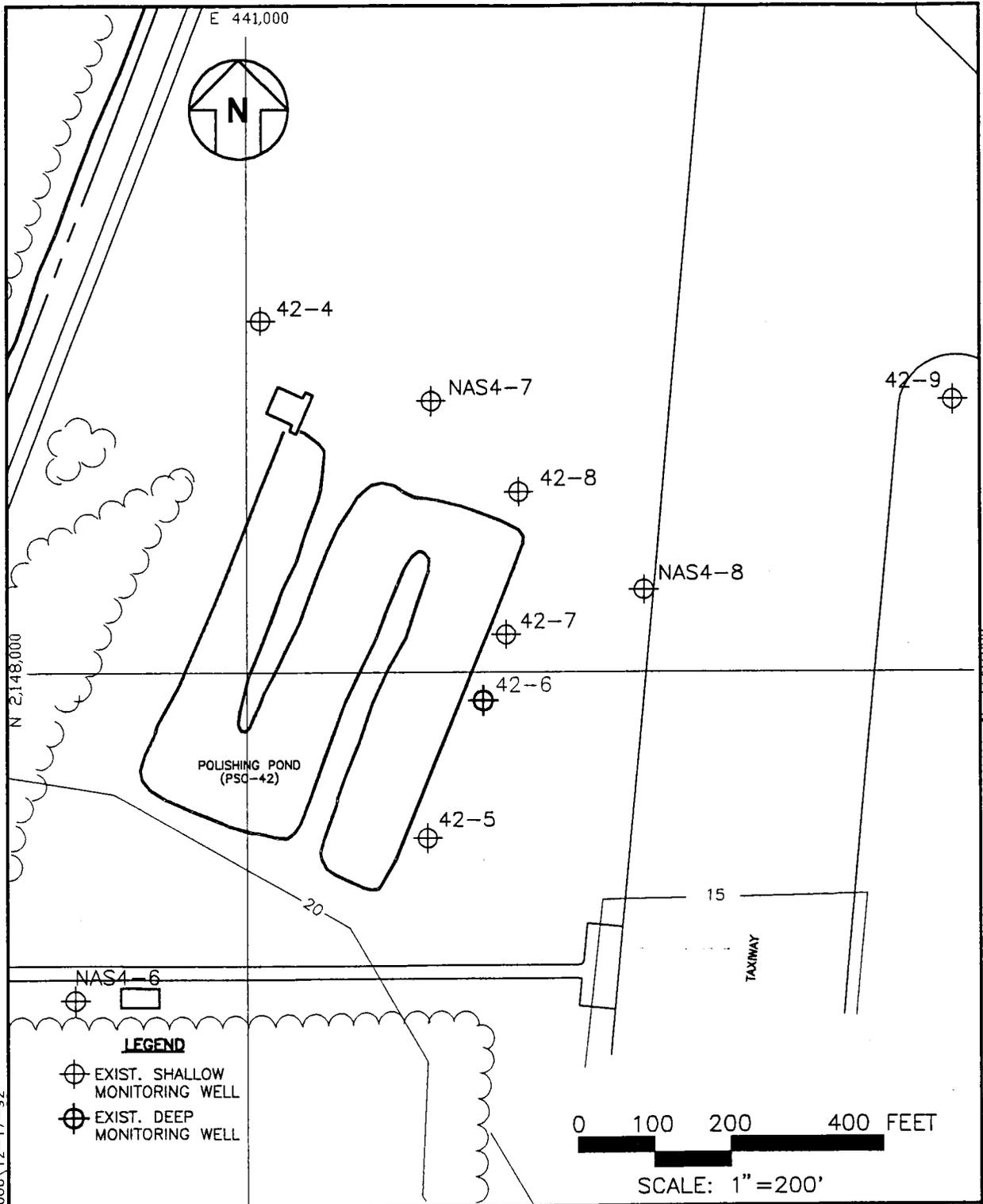
The wastewater treatment plant and fire fighting training activities have potentially introduced contaminants to soil and groundwater at OU-2. A conceptual model, showing the current understanding of potential sources, release mechanisms, pathways, and receptors of OU-2 site-related contaminants is illustrated in Figure 3-8. The conceptual model formed the basis for the development of the tasks to be conducted during the OU-2 RI/FS.



R/FS
 WORK PLAN FOR OU-2
 N.A.S. JACKSONVILLE
 DECEMBER 1992



EXTENT OF GROUNDWATER
 CONTAMINATION AT SLUDGE
 DRYING BODS, BASED ON PHENOLS
 FIGURE 3-5

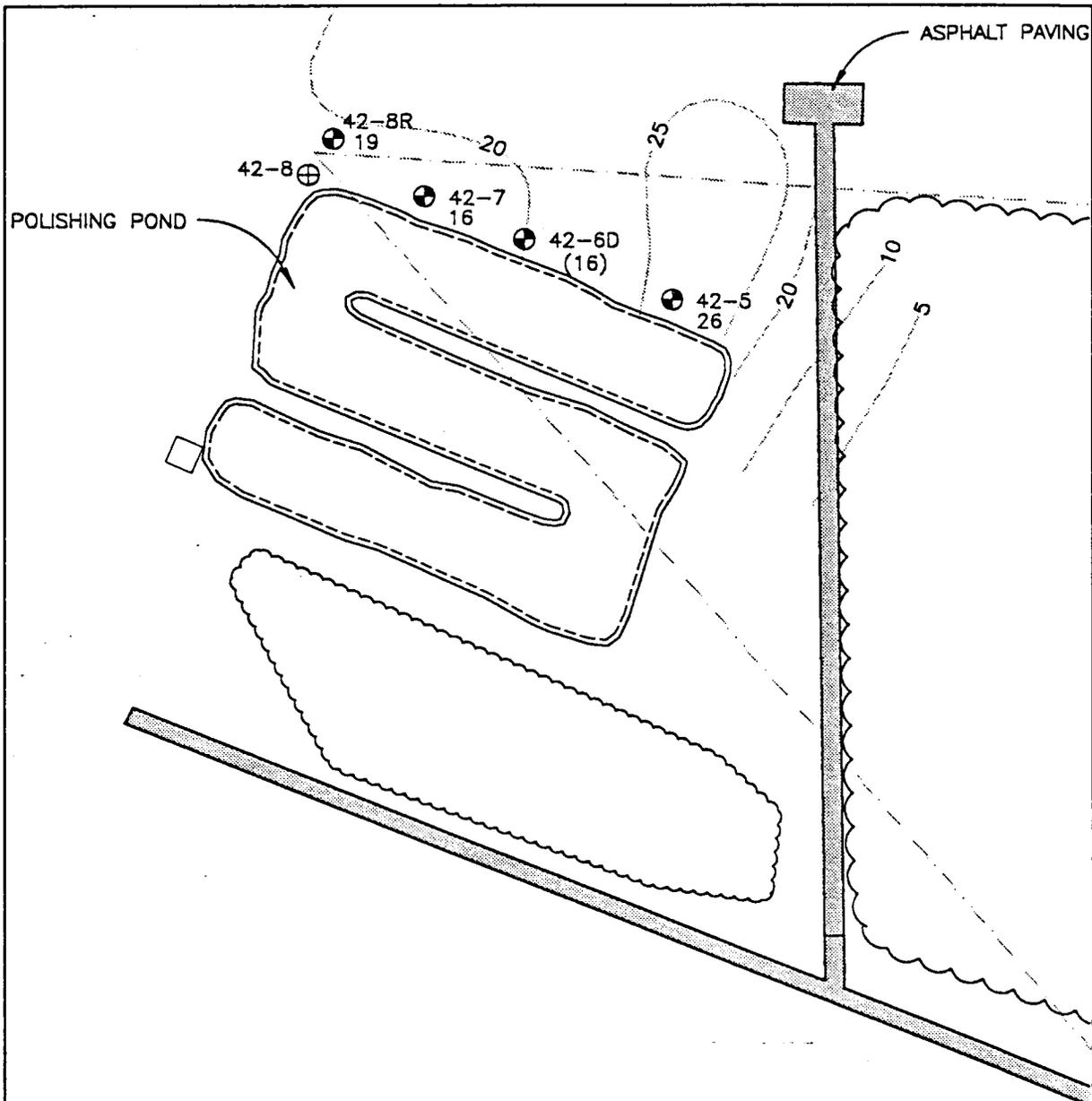


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RI/FS
 WORK PLAN OU-2
 N.A.S. JACKSONVILLE
 DECEMBER 1992



FIGURE 3-6
POLISHING POND FOR WASTE WATER
TREATMENT PLANT EFFLUENT (PSC-42)
PREVIOUS INVESTIGATION LOCATIONS



LEGEND

- 4-5 ⊕ MONITOR WELL
- 4-8 ⊕ ABANDONED MONITOR WELL
- 0 DESIGNATES DEEP WELL (35 ft)
- (16) DEEP AQUIFER VALUE
- 16 TOTAL PHENOL CONCENTRATION (ug/L)
- VALUE BELOW DETECTION LIMIT

(CONTOURS DASHED WHERE APPROXIMATE)

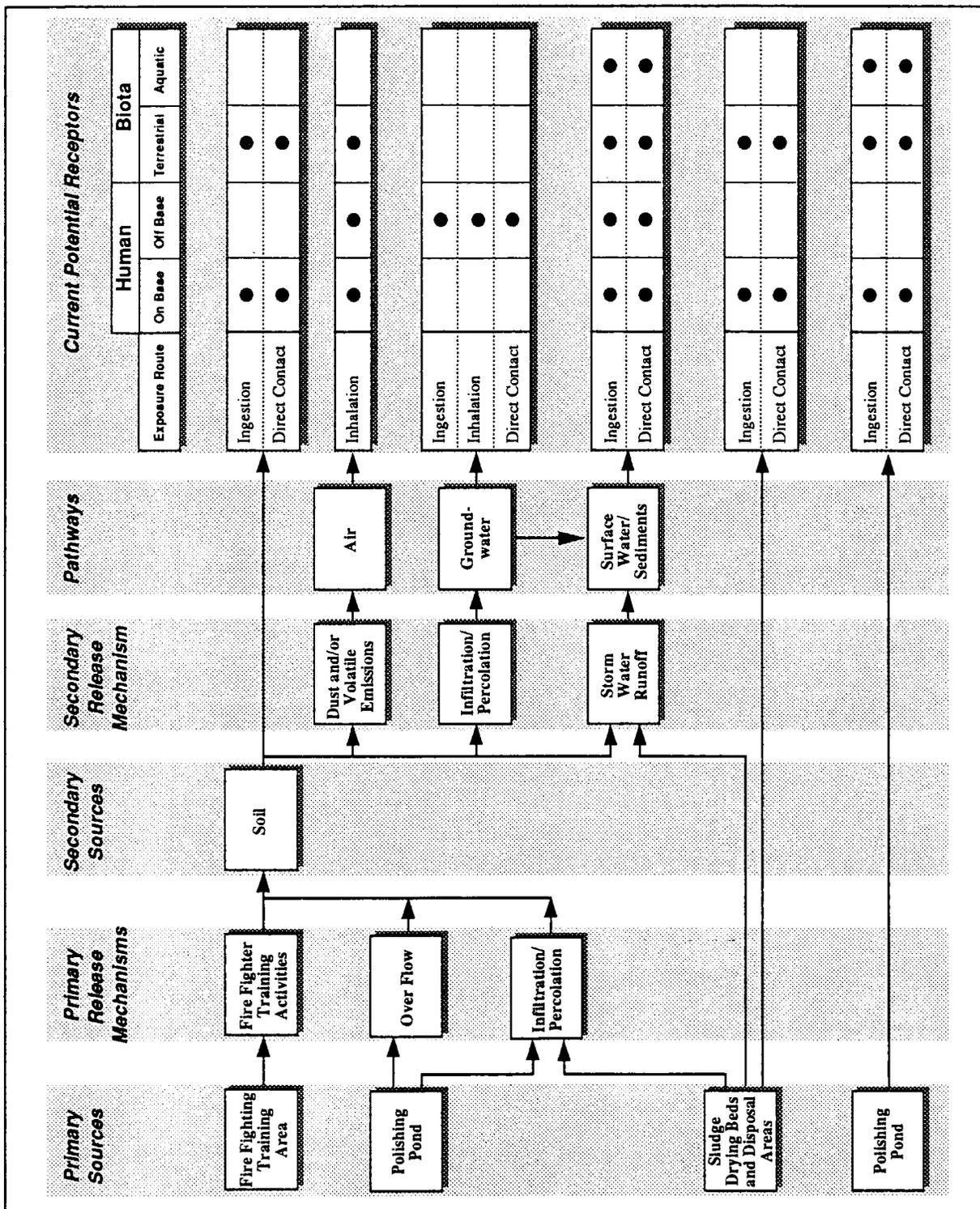


SOURCE: ESE, 1992

**R/FS
WORK PLAN FOR OU-2
N.A.S. JACKSONVILLE
DECEMBER 1992**



**EXTENT OF GROUNDWATER
CONTAMINATION AT POLISHING
POND, BASED ON PHENOLS
FIGURE 3-7**



RI/FS
 WORK PLAN FOR OU-2
 N.A.S. JACKSONVILLE
 DECEMBER 1992



MIGRATION PATHWAYS AND
 POTENTIAL RECEPTORS
 AT OU-2
 FIGURE 3-8

4.0 DATA REQUIREMENTS

The purpose of the RI is to collect adequate data to characterize OU-2 for a baseline risk assessment and the development and evaluation of effective remedial alternatives. Data collected during previous investigations at OU-2, summarized and discussed in Section 3.0 of this Work Plan, were reviewed to assess data gaps and identify additional data needed to characterize OU-2.

The existing data set has limited use for RI/FS requirements because of insufficient samples from soil, sediment, and surface water to characterize the nature and distribution of contaminants in those media; and the following limitations in samples collected from groundwater:

- the selection of sampling locations
- the lack of consistent sample collection methodologies and quality assurance/quality control documentation
- the age of most analytical reports
- the limited analyses conducted
- the lack of a consistent regulatory basis for selecting detection limit thresholds

Based on information provided from the existing data set and an assessment of existing data gaps, the following plan of action will be implemented to address data needs at OU-2.

Site Characterization To characterize the nature and distribution of contaminants at OU-2, samples will be collected from the following media:

Soil

- Evaluate the nature and distribution of contaminants in the sludge drying beds and within the sludge disposal areas.
- Evaluate the nature and distribution of contaminants in the former Fire Fighting Training Area.
- Investigate potentially unknown fire fighting training pits in the former Fire Fighting Training Area.
- Determine if contaminants have been transported by Polishing Pond overflow.

- Investigate the potential for contaminants in areas outside known source areas (i.e., PSCs).

Sediment

- Evaluate migration pathways in drainages.
- Evaluate the nature and distribution of contaminants within the Polishing Pond.

Surface Water

- Evaluate migration pathways in drainages.
- Evaluate the nature and distribution of contaminants within the Polishing Pond.

Groundwater

- Determine hydrogeologic conditions in the Surficial Aquifer to evaluate contaminant migration in groundwater.
- Evaluate the nature and distribution of contaminants within the groundwater.

Risk Assessment Once the nature and distribution of contaminants at OU-2 have been established, a Risk Assessment will be conducted to evaluate the threat posed to human health and the environment from contaminants at OU-2.

Feasibility Study Based on results of the Risk Assessment and/or ARAR exceedances, Remedial Activities might be needed at OU-2. An FS will develop and evaluate potential remedial alternatives.

Data requirements affecting the OU-2 RI/FS program are:

Applicable or Relevant and Appropriate Requirements — Federal and state public health and environmental requirements and guidelines that are the basis for establishing the appropriate extent of site cleanup.

Data Requirements for the Baseline Risk Assessment — These include the acquisition of chemical release and exposure data for quantitative human health and ecological risk assessments.

Feasibility Study Data Requirements — These include the confirmation that analyzing soil and fluid characteristics will support the conceptual design of remediation alternatives.

Data Quality Objectives — These are standards for analytical precision, reproducibility, completeness, and comparability.

4.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS.

4.1.1 Definition of ARARs ARARs are defined and explained in the *Navy Installation Restoration Program Plan, Naval Air Station, Jacksonville, Florida; Volume 4, The Basic Site Work Plan* Section 6.1, (Geraghty & Miller, 1991c).

4.1.2 Preliminary Definition of ARARs for OU-2 The three types of ARARs in relation to OU-2 have been identified as:

4.1.2.1 Chemical-Specific ARARs Federal MCLs, MCL Goals, and proposed MCLs as well as State of Florida Drinking Water Standards, and Groundwater Guidance Criteria are used to identify the chemical-specific ARARs for groundwater. Federal Ambient Water Quality Criteria (AWQC), Florida Surface Water Quality Standards (FSWQS), and State of Florida Water Quality Classifications are used to identify chemical-specific ARARs for surface water. The Toxic Substances Control Act regulates management options of contaminated soils containing PCBs at concentrations greater than 50 ppm. The USEPA Region III risk based concentration table will be used on a "to be continued" basis for soils. The remaining chemical-specific ARARs (or remediation goals) for soils and sediments are developed from an analysis of baseline risk and a review of background concentrations. The baseline risk assessment and the remediation goals developed for soil and sediment will be based on the sampling and analytical results obtained during the RI. Therefore, no regulatory chemical-specific ARARs for soil and sediments are included in this Work Plan.

Table 4-1 lists preliminary chemical-specific standards or criteria applicable to the constituents detected in groundwater and surface water at OU-2. As stated, the preliminary groundwater and surface water ARARs include federal and state requirements and guidance criteria. Florida enforces a groundwater protection act that

Table 4-1
Chemical-Specific Standards and Guidance

Naval Air Station, Jacksonville, Florida
Operable Unit 2

FEDERAL STANDARDS AND GUIDANCE												FLORIDA STANDARDS AND GUIDANCE		
Chemical Name	Safe Drinking Water Act (SDWA) (a)				CWA Ambient Water Quality Criteria (b)				Drinking Water Standards (c) (g)	Surface Water Quality Standards (d) (h)				
	MCL (e) (µg/l)	MCLG (e) (µg/l)	Proposed MCL (f) (µg/l)	Proposed MCLG (f) (µg/l)	For Protection of Human Health		For Protection of Aquatic Life			Class II (µg/l)	Class III Fresh/Marine (µg/l)			
					Water and Fish Consumption (µg/l)	Fish Consumption only (µg/l)	Fresh Water Acute/Chronic (µg/l)	Marine Acute/Chronic (µg/l)						
VOLATILE ORGANICS														
acetone	-	-	-	-	-	-	-/-	-/-	-	-	-/-			
1,1-dichloroethane	-	-	-	-	-	-	-/-	-/-	-	-	-/-			
1,2-dichloroethane	5	0	-	-	0.94	2.43	118,000/20,000 (6)	118,000 /- (6)	3	-	-/-			
trans-1,2-dichloroethene (trans-1,2-dichloroethylene)	100 (8)	100 (8)	-	-	-	-	-/-	-/-	- [100]	-	-/-			
4-methyl-2-pentanone (methyl isobutyl ketone)	-	-	-	-	-	-	-/-	-/-	-	-	-/-			
methylene chloride (dichloromethane)	5	0	-	-	-	-	-/-	-/-	- [5]	1,580 (22)				
tetrachloroethylene (1,1,2,2-tetrachloroethane)	5	0	-	-	0.8	8.85	5,280/ 840 (6)	10,200 /5,000 (6)	3	- [8.85 (22)]	-/- [8.85 (22)]			
toluene	1,000 (8)	1,000 (8)	-	-	14,300	424,000	17,500 /- (6)	6,300/ 5,000 (6)	- [1,000]	-	-/-			

4-4

Table 4-1
Chemical-Specific Standards and Guidance

Naval Air Station, Jacksonville, Florida
Operable Unit 2

Chemical Name	FEDERAL STANDARDS AND GUIDANCE								FLORIDA STANDARDS AND GUIDANCE		
	Safe Drinking Water Act (SDWA) (a)				CWA Ambient Water Quality Criteria (b)				Drinking Water Standards (c) (g)	Surface Water Quality Standards (d) (h)	
	MCL (e)	MCLG (e)	Proposed MCL (f)	Proposed MCLG (f)	For Protection of Human Health		For Protection of Aquatic Life				
(µg/l)	(µg/l)	(µg/l)	(µg/l)	Water and Fish Consumption (µg/l)	Fish Consumption only (µg/l)	Fresh Water Acute/Chronic (µg/l)	Marine Acute/Chronic (µg/l)	MCL (µg/l)	Class II (µg/l)	Class III Fresh/Marine (µg/l)	
1,1,1-trichloroethane	200	200	-	-	18,400	1,030,000	-/-	31,200 /- (6)	200	173,000	
trichloroethene (trichloroethylene)	5	0	-	-	2.7	80.7	45,000/21,900 (6)	2,000 /- (6)	3	80.7 (22)	
vinyl chloride	2	0	-	-	2	525	-/-	-/-	1	-	-/-
SEMIVOLATILE ORGANICS											
acenaphthene	-	-	-	-	-	-	1,700 /520 (6)	970/710 (6)	-	20 [2,700]	
anthracene	-	-	-	-	-	-	-/-	-/-	-	0.031 (19) [110,000]	
benzo(a)anthracene	-	-	0.1	0	-	-	-/-	-/-	- [0.1]	0.031 (19)	
benzo(a)pyrene	0.2	0	-	-	-	-	-/-	-/-	- [0.2]	0.031 (19)	
benzo(g,h,i)perylene	-	-	-	-	-	-	-/-	-/-	-	0.031 (19)	

4-5

Table 4-1
Chemical-Specific Standards and Guidance

Naval Air Station, Jacksonville, Florida
Operable Unit 2

Chemical Name	FEDERAL STANDARDS AND GUIDANCE								FLORIDA STANDARDS AND GUIDANCE		
	Safe Drinking Water Act (SDWA) (a)				CWA Ambient Water Quality Criteria (b)				Drinking Water Standards (c) (g)	Surface Water Quality Standards (d) (h)	
	MCL (e)	MCLG (e)	Proposed MCL (f)	Proposed MCLG (f)	For Protection of Human Health		For Protection of Aquatic Life				
(µg/l)	(µg/l)	(µg/l)	(µg/l)	Water and Fish Consumption (µg/l)	Fish Consumption only (µg/l)	Fresh Water Acute/Chronic (µg/l)	Marine Acute/Chronic (µg/l)	MCL (µg/l)	Class II (µg/l)	Class III Fresh/Marine (µg/l)	
butylbenzylphthalate	-	-	100	0	-	-	-/-	-/-	- [100]	-	-/-
chrysene	-	-	0.2	0	-	-	-/-	-/-	- [0.2]	0.031 (19)	
dibenzo(a,h)anthracene	-	-	0.3	0	-	-	-/-	-/-	- [0.3]	0.031 (19)	
bis(2-ethylhexyl) phthalate (di-2-ethylhexylphthalate)	6	0	-	-	15,000	50,000	400 /360 (12)	400/360 (12)	- [4]	-	3/- (18)
fluoranthene	-	-	-	-	42	54	3,980/- (6)	40/16 (6)	-	54 [370]	
indeno(1,2,3-cd) pyrene	-	-	0.4	0	-	-	-/-	-/-	- [0.4]	0.031 (19)	
2-methylphenol (o-cresol)	-	-	-	-	-	-	-/-	-/-	-	-	-/-
4-methylphenol (p-cresol)	-	-	-	-	-	-	-/-	-/-	-	-	-/-
phenol	-	-	-	-	3,500	-	10,200/2,560 (6)	5,800/- (6)	-	300 [4,600,000]	

4-6

Table 4-1
Chemical-Specific Standards and Guidance

Naval Air Station, Jacksonville, Florida
Operable Unit 2

FEDERAL STANDARDS AND GUIDANCE												FLORIDA STANDARDS AND GUIDANCE		
Chemical Name	Safe Drinking Water Act (SDWA) (a)				CWA Ambient Water Quality Criteria (b)				Drinking Water Standards (c) (g)	Surface Water Quality Standards (d) (h)				
	MCL (e) (µg/l)	MCLG (e) (µg/l)	Proposed MCL (f) (µg/l)	Proposed MCLG (f) (µg/l)	For Protection of Human Health		For Protection of Aquatic Life			MCL (µg/l)	Class II (µg/l)	Class III Fresh/Marine (µg/l)		
					Water and Fish Consumption (µg/l)	Fish Consumption only (µg/l)	Fresh Water Acute/Chronic (µg/l)	Marine Acute/Chronic (µg/l)						
pyrene	-	-	-	-	-	-	-/-	-/-	-	0.031 (19) [11,000]				
METALS														
arsenic	50 (4)	-	-	-	0.0022	0.0175	-/-	-/-	50	50				
barium	2,000 (5)	2,000 (5)	-	-	1,000	-	-/-	-/-	1,000 [2,000]	-	-/-			
cadmium	5 (8)	5 (8)	-	-	10	-	3.9/1.1 (11)	43/9.3	10 [5]	9.3	(17)/ 9.3			
chromium	100 (8)	100 (8)	-	-	-	-	-/-	-/-	50 [100]	-	-/-			
cyanide	200	200	-	-	200	-	22/5.2	1/-	- [200]	1	5.2/1			
iron	-	-	-	-	300	-	-/1,000	-/-	-	300	1,000/300			
lead	TT (9) (24)	0	-	-	50	-	83/3.2 (11)	220/8.5	50 [15]	5.6	(17)/ 5.6			

4-7

Table 4-1
Chemical-Specific Standards and Guidance

Naval Air Station, Jacksonville, Florida
Operable Unit 2

Chemical Name	FEDERAL STANDARDS AND GUIDANCE								FLORIDA STANDARDS AND GUIDANCE		
	Safe Drinking Water Act (SDWA) (a)				CWA Ambient Water Quality Criteria (b)				Drinking Water Standards (c) (g)	Surface Water Quality Standards (d) (h)	
	MCL (e)	MCLG (e)	Proposed MCL (f)	Proposed MCLG (f)	For Protection of Human Health		For Protection of Aquatic Life				
(µg/l)	(µg/l)	(µg/l)	(µg/l)	Water and Fish Consumption (µg/l)	Fish Consumption only (µg/l)	Fresh Water Acute/Chronic (µg/l)	Marine Acute/Chronic (µg/l)	MCL (µg/l)	Class II (µg/l)	Class III Fresh/Marine (µg/l)	
manganese	-	-	-	-	50	100	-/-	-/-	-	100	-/-
nickel	100	100	-	-	13.4	100	1,400/ 160 (11)	75/8.3	- [100]	8.3	(17)/ 8.3
selenium	50 (8)	50 (8)	-	-	10	-	20/5	300/71	10 [50]	71	5/71
silver	-	-	-	-	-	-	4.1/ 0.12 (11) (15)	2.3/- (15)	50 [-]	0.05	0.07/ 0.05
sodium	(8)	-	-	-	-	-	-/-	-/-	160,000	-	-/-
vanadium	-	-	-	-	-	-	-/-	-/-	-	-	-/-
zinc	-	-	-	-	-	-	120/ 110 (11)	95/86	-	86	(17)/86

4-8

Table 4-1
Chemical-Specific Standards and Guidance

Naval Air Station, Jacksonville, Florida
Operable Unit 2

SOURCES:

- (a) U.S. Environmental Protection Agency (USEPA), SDWA National Primary Drinking Water Regulations per 40 CFR 141: MCLs and MCLGs.
- (b) USEPA, "Water Quality Criteria Summary", Office of Science and Technology, Health and Ecological Criteria Division, Washington, D.C. May 1, 1991.
- (c) Florida Administrative Code, 17-550, "Safe Drinking Water Act", January, 1991.
- (d) Florida Administrative Code, 17-302, "Surface Water Quality Standards", February, 1992.
- (e) USEPA, "Drinking Water Standards and Health Advisories", Office of Water, Washington, DC, November, 1991.
- (f) USEPA, "National Primary and Secondary Drinking Water Regulations; Synthetic Organic Chemicals and Inorganic Chemicals; Proposed Rule", 55FR30370, July 25, 1990.
- (g) Florida Administrative Code, 17-550, "Safe Drinking Water Phase V Standards (Proposed)", April 7, 1992. [Proposed values are bracketed]
- (h) Florida Administrative Code, 17-302, "Surface Water Quality Standards (Proposed)", March 6, 1992. [Proposed values are bracketed]

ACRONYMS:

- Class II Shellfish Propagation or Harvesting
- Class III Recreation, Fish & Wildlife Propagation
- CWA Clean Water Act
- MCL Maximum Contaminant Level
- MCLG Maximum Contaminant Level Goal
- SDWA Safe Water Drinking Act
- TT Treatment Technique requirements are in effect
- USEPA United States Environmental Protection Agency
- µg/l Micrograms per liter

Notes:

- (1) MCL for arsenic currently under review.
- (2) Effective date of standard is January 1, 1993. (Current MCL is 1,000 µg/l).
- (3) Insufficient data to develop criteria. Value presented is the Lowest Observed Effect Level (LOEL).
- (4) Effective date of standard is July 30, 1992.
- (5) Treatment Technique (TT) requirement.
- (6) Hardness dependent criteria (100 mg/l CaCO₃, used).
- (7) Proposed Criteria.
- (8) No MCL has been set for sodium. However, a reporting level of 20 mg/l has been established. Monitoring is required and data is reported to health officials to protect individuals on restricted sodium diet.
- (9) Different levels are proposed (marine acute - 7.2 µg/l; marine chronic - 0.92 µg/l; freshwater acute - 0.92 µg/l).
- (10) Hardness-dependent (Values are in µg/l).

cadmium	=	$e^{(0.7852 \ln H - 3.48)}$	(ln H)	=	natural logarithm of the
copper	=	$e^{(0.8545 \ln H - 1.465)}$			total hardness expressed at
lead	=	$e^{(1.273 \ln H - 4.705)}$			mg/l calcium carbonate (CaCO ₃).
nickel	=	$e^{(0.848 \ln H - 1.1845)}$			
zinc	=	$e^{(0.8473 \ln H - 0.7614)}$			
chromium(III)	=	$e^{(0.818 \ln H - 1.581)}$			

4-9

Table 4-1
Chemical-Specific Standards and Guidance

Naval Air Station, Jacksonville, Florida
Operable Unit 2

- (11) Standard indicated is the standard for phthalate esters.
- (12) Standard indicated is the standard for total polycyclic aromatic hydrocarbons (PAHs) (i.e., the sum of concentrations of acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene) during average annual flow conditions.
- (13) At average annual flow conditions.
- (14) Effective date of this standard is December 7, 1992. (Current MCL=50 $\mu\text{g/l}$).

requires preserving groundwater quality for potable use. The receiving stream for surface water discharge from OU-2 is the St. Johns River, currently listed as Class II for protection of aquatic organisms. Consequently, state standards for Class II surface waters and/or FSWQS are identified as preliminary ARARs for surface water at OU-2. The ARARs for OU-2 will be reviewed following the RI to provide ARARs for new constituents identified during the RI. A detailed discussion of the ARAR development procedure is included in Section 6.0 of the Basic Site Work Plan (Volume 4).

4.1.2.2 Location-Specific ARARs Location-specific ARARs govern natural site features (such as wetlands, floodplains, and sensitive ecosystems) and man-made features (such as existing landfills, disposal areas, and places of historical or archeological significance). These ARARs generally restrict the concentration of hazardous substances or the conduct of activities based solely on the site's particular characteristics or location. Table 4-2 is a synopsis of potential location-specific ARARs.

4.1.2.3 Action-Specific ARARs Potentially applicable action-specific ARARs will be identified in a later stage of the RI/FS process. At a minimum, the federal, state, and Duval County statutes and regulations listed in Table 4-3 will be evaluated to determine whether they are applicable or relevant and appropriate to potential remedial activities at OU-2.

4.2 DATA REQUIREMENTS FOR THE BASELINE RISK ASSESSMENT. Activities involved in acquiring reliable chemical release and exposure data for the quantitative human health and ecological risk assessments are as follows:

- Review available site information.
- Identify preliminary potential human and ecological exposure routes.
- Determine modeling parameter needs.
- Select sampling locations and media.
- Choose the locations and number of background samples.
- Designate sampling methods and procedures.
- Specify quality assurance/quality control methods.
- Determine the need for special analytical procedures.

These activities are described in detail in the following subsections.

4.2.1 Review Available Site Information Available information has been reviewed and a preliminary list of compounds expected in the baseline risk assessment was derived based on those compounds detected at OU-2 during previous studies (Table 4-4). An effort

TABLE 4-2 PRELIMINARY LOCATION-SPECIFIC ARARs FOR OU-2, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

LOCATION	REQUIREMENT	PREREQUISITE(S)	CITATION
Within 100-year floodplain	Facility must be designed, constructed, operated, and maintained to avoid washout.	RCRA hazardous waste treatment, storage, or disposal	40 CFR 264.19 (b)
With floodplain	Action to avoid advance effects, minimize potential harm, restore and preserve natural and beneficial values.	Action that will occur in a floodplain (i.e., lowlands, and relatively low flat areas adjoining inland and coastal waters and other flood-prone areas.	Executive Order 11988 Protection of Floodplains (40 CRF 6, Appendix A); Fish and Wildlife Coordination Act (16 USC 661 et seq) 40 CRF 6 302; Dredge and Fill Activities, Ch 17-312, FAC; Surface Waters of the State, Ch 17-301, FAC; Water Management District Regulations, Ch 40, FAC.
Critical habitat upon which endangered species or threatened species depend	Action to conserve endangered species or threatened species, including consultation with the Department of Interior.	Determination of presence of endangered or threatened species.	Endangered Species Act of 1973 (16 USC 1531 et seq); 50 CFR Part 200, 50 CFR 402; Fish and Wildlife Coordination Act (16 USC 661 et seq); 33 CFR Part 320-330; Environmentally Endangered Lands, FS 259; Wildlife Code Ch 39, FAC; Mangrove Protection Ch 17-321, FAC
Area affecting stream or river	Action to protect fish or wildlife	Diversion, channeling, or other activity that modifies a stream or river and affect fish or wildlife.	Fish and Wildlife Coordination Act (16 USC 661 et seq); 40 CFR 6 302; Aquatic Preserve Act, FS 258; Game and Fish Commission Regulations, FS 372; Surface Waters of the State, Ch 17-301, FAC; Surface Water Quality Standards, Ch 17-302, FAC; Surface Water Improvement and Management Act, Ch 17-43, FAC.

TABLE 4-3 PRELIMINARY ACTION-SPECIFIC ARARs FOR OU-2, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

FEDERAL REQUIREMENTS
<ul style="list-style-type: none">• RCRA Subtitle C Hazardous Waste Treatment, Storage, Disposal, Facility Standards (design and operating standards for landfill, tanks, containers, etc.) (40 CFR 264 and 265)• RCRA Subtitle C Closure and Post-Closure Standards (40 CFR 264, Subpart C)• RCRA Groundwater Monitoring Requirements (40 CFR 264, Subpart F)• RCRA Land Disposal Restrictions (40 CFR 268) pertaining to onsite and off-site disposal of soil contaminated debris.• Clean Air Act, National primary and Secondary Ambient Air Quality Standards (40 CFR 50)• Clean Air Act, Standards of Performance for New Stationary Sources (40 CFR 60)• Clean Air Act, National Emission Standards for Hazardous Air Pollutants (40 CFR 61)• Clean Air Act, Federal Clean Air Act Amendments of 1990 (not yet promulgated)• Safe Drinking Water Act, Underground Injection Control Requirements (40 CFR 144 and 146)• Clean Water Act - Nation Pollutant Discharge and Elimination System (NPDES) Discharges to Groundwater and Surface Water (40 CFR 122-125, 129)• Department of Transportation (DOT) Rules for Hazardous Materials Transport (49 CFR 107, 171.1-171.500)• Occupational Safety and Health Standards for Hazardous Responses (Worker Safety) (29 CFR 1904, 1910)
STATE OF FLORIDA REQUIREMENTS
<ul style="list-style-type: none">• Environmental Control (FS 403)• Air Pollution (Chapter 17-2, FAC)• Permits (Chapter 17-4, FAC)• Underground Injection Control (Chapter 17-28, FAC)• Management of Hazardous Waste by Government Agencies (Chapter 17-32, FAC)• Water Policy (Chapter 17-40, FAC)• Hazardous Waste (Chapter 17-730, FAC)• Soil Thermal Treatment Facilities (Chapter 17-775, FAC)
DUVAL COUNTY REQUIREMENTS
<ul style="list-style-type: none">• Water Quality (Duval County Ordinance, Chapter 362)• Hazardous Materials (Duval County Ordinance, Chapter 364)• Air Quality (Duval County Ordinance, Chapter 368)• PCBs (Duval County Ordinance, Chapter 82-372-185)• PCBs (Duval County Ordinance, Chapter 82-549-224)• Odor Control (Duval County Environmental Protection Board Rule #2)• Federal Hazardous Waste Manifest Requirements for Off-Site Waste Transport (40 CFR 262)

TABLE 4-4 POTENTIAL COMPOUNDS OF CONCERN, NAS JACKSONVILLE,
FLORIDA, OPERABLE UNIT 2

1,1,1-Trichloroethane	Manganese
1,1-Dichloroethane	Methyl Ethyl Ketone
Acetone	Mercury
Arsenic	Nickel
Barium	Nitrate
Benzene	Phenol
Beryllium	Silver
Bis(2-ethylhexyl)phthalate	Sodium
Cadmium	Sulfate
Chloroform	Tetrachloroethene
Chloromethane	Toluene
Chromium	trans-1,2-Dichloroethene
o-Cresol	Trichloroethene
p-Cresol	Vanadium
Cyanide	Vinyl Chloride
Dichloromethane	Xylenes (total)
Fluoride	Zinc
Lead	

will be made during sample analysis to identify other contaminants of concern potentially associated with OU-2.

4.2.2 Preliminary Identification of Potential Exposure Routes To reach a decision on the number, type, and location of samples to be collected at the site, a preliminary identification of potential exposure pathways is presented in Subsection 3.2, OU-2 Conceptual Model (see Figure 3-6). The media of concern at NAS Jacksonville include surface soils, subsurface soils, sediment, surface water, groundwater, and air.

A preliminary identification of the potential human health routes of exposure includes: ingestion, dermal absorption, and inhalation of contaminants from potential future household use of contaminated groundwater; inhalation of particulates and volatiles from contaminated soils; inadvertent ingestion and dermal absorption from contaminated soils/sediments; inhalation, dermal absorption, and incidental ingestion of surface water; and ingestion of aquatic organisms.

A preliminary identification of the potential ecological exposure routes includes: dermal contact with and incidental ingestion of contaminated soils/sediments; dermal absorption, incidental ingestion, and exposure to surface water; and ingestion of contaminated prey.

4.2.3 Determine Modeling Parameter Needs Contaminant release, transport, and fate models are sometimes needed to supplement monitoring data when estimating exposure concentrations. When assessing human health risks, contaminant transport models can be required to evaluate fugitive dust emissions, VOC emissions, or the leachate potential of compounds from soils. When assessing ecological risks, contaminant transport models can be required to determine food-chain bioaccumulation from surface soils.

4.2.4 Sampling Locations and Media Samples will be collected from areas of potential contamination and potential exposure points, an important step in identifying appropriate exposure concentrations. Sufficient samples from each medium will be collected to encompass known and suspected areas of concern. The selected sampling routes are: (1) along routes of potential contaminant migration, (2) at appropriate depths correlating to waste disposal and potentially affected aquifer systems, (3) correlated with site historical information or visual observations of potential "hot spots," or (4) correlated with use of the site by sensitive or critical ecological receptors (that is, rare and endangered species). The sampling locations have been chosen in a manner most likely to represent the highest potential concentrations for use in the risk assessment.

To evaluate human health risk, groundwater will be sampled. Surface water samples will provide information on contaminant transport and contaminant uptake concentrations, which will be used to evaluate (1) human health exposure routes associated with the

inadvertent ingestion, dermal absorption, and inhalation of water during falls into the Polishing Pond, and (2) ecological exposure routes associated with aquatic exposure and bioaccumulation of contaminants.

Surface soil samples will provide information for the (1) human health scenarios of inadvertent ingestion, dermal absorption of soils, and inhalation of airborne particulates, and (2) ecological scenarios of inadvertent ingestion, dermal absorption, and food-chain bioaccumulation. If surface water or sediment samples are contaminated with chemicals that bioaccumulate, aquatic organism sampling in the St. Johns River and/or the Polishing Pond will be evaluated as a means of providing contaminant concentrations for inclusion in the ingestion and bioaccumulation scenarios.

4.2.5 Background Sampling Background sampling will be conducted to differentiate among site-related contaminants and naturally occurring or other non-site-related concentrations of chemicals in each environmental medium. Background samples will be collected during the RI in areas believed to be outside contaminated areas. If contaminant-free sites are not available, off-site reference stations will be employed. Background sediment and surface water sampling stations will be ecologically similar to contaminated stations.

Soil analyses will provide representative background inorganic and anion concentrations to correlate with potentially contaminated soil samples (that is, from the potential source areas). Additional background samples will be collected as necessary, if the initial RI background locations are not confirmed to be representative of background/upgradient conditions.

Background soil samples will be collected during the RI near OU-2 from soil horizons related to the sampling depths at OU-2. Soil depths will be established based on the exposure scenarios selected for evaluation. Surface soil samples will be collected from zero to 12 inches and subsurface soil samples will be collected from 1 to 5 feet bgs.

Surface water and sediment samples will be collected from areas not influenced by Station activities. Groundwater background samples will be obtained upgradient from OU-2. Surface water and groundwater quality parameters including pH, dissolved oxygen, salinity, conductivity, and temperature will be collected concurrent with sampling. TOC values will be provided for all sediment samples.

4.2.6 Sampling Methods All sampling methods will be consistent with those outlined in the Basic Site Work Plan (Volume 4). Methods will provide samples of sufficient data quality for use in risk assessment, as outlined in Subsection 4.5, DQOs.

4.2.7 Quality Assurance/Quality Control Methods Quality assurance/quality control measures and documentation are an integral part of the baseline risk assessment and are necessary for data validation and decision-making. For this reason, the success of the quality assurance/quality control measures will be evaluated in the risk assessment report.

Except for health and safety monitoring, all sample collection and analyses will incorporate quality assurance/quality control documentation. Investigative activities at NAS Jacksonville will comply with the applicable quality assurance/quality control standards in the Quality Assurance Project Plan, the analytical laboratory Quality Assurance Plan (which specifies Contract Laboratory Program [CLP] quality assurance documentation for data to be used in the risk assessment), the ABB Environmental Services, Inc. (ABB-ES) Standard Operating Procedures, and the Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program (NEESA, 1988).

4.2.8 Special Analytical Methods As part of the development of the RI/FS Work Plan, detection limits for identified chemicals of concern were evaluated to confirm that the RI/FS generates contaminant concentration data appropriate for the risk assessment process. To meet this objective, upper bound lifetime carcinogenic risks and Hazard Indices were calculated by assuming the concentrations of the contaminants of concern in water and solids to be at their respective Contract Required Quantitation Limits for proposed routine analytical methods (that is, USEPA CLP Routine Analytical Services). Toxicity values (chronic reference doses [RfDs] and carcinogenic slope factors [CSFs]) and exposure assumptions developed by the USEPA were used in these calculations.

Where chemical detection limits are associated with excess cancer risks above 1 in 10 million (10^{-7}), or Hazard Indices greater than 0.1, the exposure pathways at OU-2 were evaluated to determine if the exposure routes used in the calculations were appropriate. (Note: The 10^{-7} cancer risk level and the 0.1 Hazard Index are designed to protect against combined exposures to multiple chemicals and pathways; USEPA, 1989a.) If the exposure pathways are applicable to OU-2, alternative analytical methods will be evaluated to determine whether they can provide lower detection limits for the chemicals of concern than achievable by the proposed routine analytical methods.

The preliminary list of contaminants was evaluated using the above criteria. The results of the evaluation are presented in Tables 4-5 and 4-6.

4.3 FEASIBILITY STUDY DATA REQUIREMENTS. The Navy and its contractors may perform remedial actions at OU-2 if the Baseline Risk Assessment determines that response actions are required to protect human health, public welfare, and the

environment. To provide a conceptual basis for conducting the RI, the following preliminary response objectives were developed as part of the initial evaluation:

- Protect human health, public welfare, and the environment from potential adverse effects caused by direct contact with groundwater, soils, surface water, and sediments.
- Minimize the potential for migration of contaminants from sludge disposal areas, the surface water drainage ditches, and within the unconfined aquifer.
- Control emanation of airborne constituents to protect nearby residents and biological receptors.

Remedial action alternatives for source control, surface water management, and groundwater management may be required to achieve the preliminary remedial action objectives. Air emissions would be controlled by implementing source control and surface water management alternatives.

Data requirements for the FS include analyzing for soil and fluid characteristics to aid in the conceptual design and detailed analysis of each alternative. An alternative can consist of one or many technologies. Examples of groundwater treatment technologies that could be considered during the FS are listed below:

- oxidation/precipitation and/or ion-exchange for removal of metals
- carbon adsorption and/or ultraviolet/oxidation for removal of organics
- air stripping if high concentrations of VOCs are detected during the RI

Examples of soil/sludge treatment technologies that could be considered during the FS are listed below:

TABLE 4-5 CALCULATION OF CARCINOGENIC RISK AND HAZARD INDICES ASSOCIATED WITH DETECTION LIMITS FOR COMPOUNDS DETECTED IN SOIL¹, NAS JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

COMPOUND	MDL (mg/kg)	CHRONIC ORAL		CANCER RISK		HAZARD INDEX	
		RfD ² (mg/kg-day)	CANCER SLOPE ³ (mg/kg-day) ⁻¹	AT MDL ⁴	AT MDL ⁵		
1,1,1-Trichloroethane	0.01		9E-02			5.4E-08	
1,1-Dichloroethane	0.01		1E-01			4.9E-08	
Acetone	0.01		1E-01			4.9E-08	
Arsenic	0.002		1E-03	1.75E+00	6.1E-10	9.8E-07	
Barium	0.04		7E-02			2.8E-07	
Benzene	0.01			2.90E-02	5.1E-11		
Beryllium	0.001		5E-03	4.30E+00	7.5E-10	9.8E-08	
Bis(2-ethylhexyl)phthalate	0.33		2E-02	1.40E-02	8.1E-10	8.1E-06	
Cadmium (food)	0.001		1E-03			4.9E-07	
Chloroform	0.01		1E-02	6.10E-03	1.1E-11	4.9E-07	
Chloromethane	0.01			1.30E-02	2.3E-11		
Chromium ⁶	0.002		5E-03			2.0E-07	
o-Cresol	0.33		5E-02			3.2E-06	
p-Cresol	0.33		5E-02			3.2E-06	
Cyanide	0.001		2E-02			2.4E-08	
Dichloromethane	0.01		6E-02	7.50E-03	1.3E-11	8.2E-08	
Fluoride			6E-02				
Lead	0.0005						
Manganese	0.003		1E-01			1.5E-08	
Methyl Ethyl Ketone	0.01		5E-02			9.8E-08	
Mercury	0.0001		3E-04			1.6E-07	
Nickel	0.008		2E-02			2.0E-07	
Nitrate			1.6E+00				
Phenol	0.33		6E-01			2.7E-07	
Silver	0.002		3E-03			3.3E-07	
Sodium	1						
Sulfate							
Tetrachloroethene	0.01		1E-02	5.10E-02	8.9E-11	4.9E-07	
Toluene	0.01		2E-01			2.4E-08	
trans-1,2-Dichloroethene	0.01		2E-02			2.4E-07	
Trichloroethene	0.01			1.10E-02	1.9E-11		
Vanadium	0.01		7E-03			7.0E-07	
Vinyl Chloride	0.01			1.90E+00	3.3E-09		
Xylenes (total)	0.01		2E+00			2.4E-09	
Zinc	0.004		2E-01			9.8E-09	

1 - Based on ingestion of soil (see Table C-1, Appendix C for intake equation)

by WWTP worker (see Table C-2, Appendix C for exposure parameters)

2 - see Table C-8, Appendix C

3 - see Table C-7, Appendix C

4 - Cancer Risk = Intake (mg/kg-day) x Cancer Slope Factor (mg/kg-day)⁻¹

5 - Hazard Index = Intake (mg/kg-day) / Reference Dose (mg/kg-day)

6 - RfD for Chromium VI used

MDL = Method Detection Limit

TABLE 4-6 CALCULATION OF CARCINOGENIC RISK AND HAZARD INDICES ASSOCIATED WITH DETECTION LIMITS FOR COMPOUNDS DETECTED IN GROUNDWATER¹, NAS JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

COMPOUND	MDL (mg/L)	CHRONIC ORAL		CANCER RISK		HAZARD INDEX	
		RfD ² (mg/kg-day)	CANCER SLOPE ³ (mg/kg-day) ⁻¹	AT MDL ⁴	AT MDL ⁵		
1,1,1-Trichloroethane	0.001	9E-02				3.0E-04	
1,1-Dichloroethane	0.001	1E-01				2.7E-04	
Acetone	0.005	1E-01				1.4E-03	
Arsenic	0.06	1E-03	1.75E+00	1.2E-03		1.6E+00	
Barium	0.2	7E-02				7.8E-02	
Benzene	0.001		2.90E-02	3.4E-07			
Beryllium	0.005	5E-03	4.30E+00	2.5E-04		2.7E-02	
Bis(2-ethylhexyl)phthalate	0.005	2E-02	1.40E-02	8.2E-07		6.8E-03	
Cadmium (water)	0.005	5E-04				2.7E-01	
Chloroform	0.001	1E-02	6.10E-03	7.2E-08		2.7E-03	
Chloromethane	0.001		1.30E-02	1.5E-07			
Chromium ⁶	0.01	5E-03				5.5E-02	
o-Cresol	0.005	5E-02				2.7E-03	
p-Cresol	0.005	5E-02				2.7E-03	
Cyanide	0.01	2E-02				1.4E-02	
Dichloromethane	0.002	6E-02	7.50E-03	1.8E-07		9.1E-04	
Fluoride		6E-02					
Lead	0.003						
Manganese	0.015	1E-01				4.1E-03	
Methyl Ethyl Ketone	0.005	5E-02				2.7E-03	
Mercury	0.0002	3E-04				1.8E-02	
Nickel	0.04	2E-02				5.5E-02	
Nitrate		1.6E+00					
Phenol	0.005	6E-01				2.3E-04	
Silver	0.01	3E-03				9.1E-02	
Sodium	5						
Sulfate							
Tetrachloroethene	0.001	1E-02	5.10E-02	6.0E-07		2.7E-03	
Toluene	0.001	2E-01				1.4E-04	
trans-1,2-Dichloroethene	0.001	2E-02				1.4E-03	
Trichloroethene	0.001		1.10E-02	1.3E-07			
Vanadium	0.05	7E-03				2.0E-01	
Vinyl Chloride	0.001		1.90E+00	2.2E-05			
Xylenes (total)	0.001	2E+00				1.4E-05	
Zinc	0.02	2E-01				2.7E-03	

1 - Based on ingestion of groundwater (see Table C-1, Appendix C for intake equation)
by potential future adult resident (see Table C-4, Appendix C for exposure parameters)

2 - see Table C-8, Appendix C

3 - see Table C-7, Appendix C

4 - Cancer Risk = Intake (mg/kg-day) x Cancer Slope Factor (mg/kg-day)⁻¹

5 - Hazard Index = Intake (mg/kg-day) / Reference Dose (mg/kg-day)

6 - RfD for Chromium VI used

MDL = Method Detection Limit

- stabilization/solidification for hot spots with high concentrations of inorganics
- thermal soil aeration and/or incineration for hot spots with high concentrations of VOCs and SVOCs
- capping or covering hot spots to reduce infiltration and/or reduce exposure
- soil removal and disposal

Other technologies could be considered after the RI is complete. These technologies were chosen as examples based on existing groundwater data and disposal history.

The analyses or data needs necessary to evaluate these technologies are listed in Table 4-7. Other considerations include the volume of contaminated soil and aquifer properties.

TABLE 4-7 FEASIBILITY STUDY ANALYSIS REQUIREMENTS, NAS, JACKSONVILLE, FLORIDA - OPERABLE UNIT 2

ANALYSIS TYPE:	USEFUL IN EVALUATING:
LIQUID	
pH	Ultraviolet/Oxidation, Air Stripping, Oxidation/Precipitation
Temperature	Air Stripping
Total Dissolved Solids/ Total Suspended Solids	Air Stripping, Ion Exchange
Total Iron, Manganese	Oxidation/Precipitation, Ultraviolet/Oxidation
Hardness, Alkalinity	Oxidation/Precipitation, Ultraviolet/Oxidation, Ion Exchange
Chemical Oxygen Demand	Ultraviolet/Oxidation
SOIL/SLUDGE	
Btu Content	Incineration
Bulk Density	Disposal, Transportation Costs
Total Organic Carbon	Stabilization/Solidification
Moisture Content	Thermal Aeration
Toxicity Characteristic Leachate Procedure	Disposal Options

4.4 NUMERICAL MODELING REQUIREMENTS. Because the focus of previous investigations at OU-2 was on characterizing PSCs, existing monitoring wells at OU-2 are generally oriented along a north-south line from the wastewater treatment plant through the Polishing Pond area. This well orientation does not provide adequate information on groundwater flow directions and gradients sufficient for hydrogeologic interpretation or for developing a model to assess natural groundwater flow or variations caused by local stresses, such as dewatering operations for wastewater treatment plant renovation. Modeling groundwater flow is necessary to evaluate migration of contaminants within and potentially outside OU-2 boundaries. Additional geophysical investigations are needed in the vicinity of OU-2 to obtain more data on regional hydrogeology. Data to be collected in support of the modeling include water level measurements, determination of the top of clay to define upper aquifer thickness, determination of the thickness and

nature of the confining layer, determination of the horizontal extent (continuity) and permeability of the confining layer, and estimation of hydraulic conductivity for hydrogeologic units. Numerical modeling based on new piezometer and monitoring well data will help develop a better understanding of hydrogeology at OU-2, evaluate the impact of groundwater flow on potential contaminant migration, and place further monitoring wells in more optional locations.

4.4.1 Groundwater Modeling Requirements Because the focus of previous investigations at OU-2 was on characterizing PSCs, existing monitoring wells at OU-2 are generally oriented along a north-south line from the wastewater treatment plant through the Polishing Pond area. This well orientation does not provide adequate information on groundwater flow directions and gradients sufficient for hydrogeologic interpretation or for developing a model to assess natural groundwater flow or variation due to local stresses, such as dewatering operations for wastewater treatment plant renovation. Modeling groundwater flow is necessary to evaluate migration of contaminants within and potentially outside OU-2 boundaries. Additional geophysical investigations are needed in the vicinity of OU-2 to obtain more data on regional hydrogeology. Data to be collected in support of the modeling includes water level measurements, determination of thickness and nature of the confining layer, determination of the horizontal extent (continuity) and the permeability of the confining layer, and estimation of hydraulic conductivity for hydrogeologic units. Numerical modeling based on new piezometer and monitoring well data will assist in developing a better understanding of the hydrogeology at OU-2, in evaluating the impact of groundwater flow on potential contaminant migration, and aid in the placement of further monitoring wells in more optional locations.

4.4.2 Air Modeling Requirements An air sampling program will be conducted to support the air modeling. Air modeling is part of the air pathway analysis that will provide the calculated contaminant concentrations, based on emission rates and meteorological data, used as input into the risk assessment. The air sampling program will consist of two screening measurement techniques, head space sampling for VOCs and upwind/downwind monitoring for fugitive dust (particulate).

4.5 DATA QUALITY OBJECTIVES. The intended use of data and the required DQOs are best defined during the planning stages to ensure that collection, decontamination, containerization, shipping, and analytical methods used at OU-2 are consistent with the degree of confidence required of the resultant data. USEPA DQO levels are defined and explained in the *Navy Installation Restoration Program Plan, Naval Air Station, Jacksonville, Florida; Volume 4, The Basic Site Work Plan* (Geraghty & Miller, 1991c). Table 4-8 identifies the DQO levels associated with each RI/FS task.

TABLE 4-8 USEPA DQO LEVELS REQUIRED FOR RI/FS TASKS, NAS, JACKSONVILLE, FLORIDA - OPERABLE UNIT 2

TASK	USEPA DQO LEVEL			
	LEVEL I	LEVEL II	LEVEL III	LEVEL IV
Site Characterization	X	X	X	
Risk Assessment		X	X	
Evaluation of Alternatives		X	X	
Engineering Design of Remedial Alternatives			X	X

Site characterization will primarily use Level II field analyzed samples to identify the nature and distribution of contaminants with Level III CLP laboratory analyzed samples for confirmation. The Risk Assessment will use Level II samples for evaluating the threat posed by contaminants, backed up by the Level III confirmation samples. The FS will use Level II samples to establish the area and volume of material to be remediated and Level III samples for confirmation of the completed remediation.

5.0 REMEDIAL INVESTIGATION TASKS

The tasks in this RI Work Plan were derived from data requirements outlined in Section 4.0. RI tasks include the following:

- Task 1 - Project Management
- Task 2 - Field Investigations
- Task 3 - Sample Analysis and Data Management
- Task 4 - Data Evaluation and Modeling
- Task 5 - Baseline Risk Assessment
- Task 6 - RI Report

This section describes project plan preparation tasks, RI site characterization tasks, data evaluation and assessment methods, and preparation of associated reports. Procedural details are contained in the Basic Quality Assurance Project Plan (see Vol. 4, Appendix 4.4.1), the Basic Field Sampling Program (see Vol. 4, Appendix 4.4.2), the OU-2 Field Sampling Plan (see Appendix A-2), and the OU-2 Quality Assurance Project Plan (see Appendix A-1). The following subsections describe the RI tasks.

5.1 TASK 1 - PROJECT MANAGEMENT. Project management consists of the initial tasks necessary to implement the field program, subcontractor procurement, and mobilization. Field operations management planning (i.e., locating the field office, clearing boring locations for utilities, and establishing additional security measures such as gates, fences and so forth) will be developed in coordination with NAS Jacksonville.

5.1.1 Subcontractor Procurement ABB-ES will procure subcontractors for services necessary to complete the RI, including:

1. Piezometric Cone Penetrometer Testing (PCPT) Sampling
2. Monitoring Well/Piezometer Installation
3. Topographic Survey
4. Sample Analyses

The U.S. Geological Survey (USGS) will provide numerical groundwater modeling for OU-2.

5.1.2 Fieldwork Stages Fieldwork at OU-2 will be implemented in four stages. (See OU-2 Field Sampling Plan, Appendix A-2, for details on sampling, decontamination and construction.)

Stage I: Initial Activities — Field office and field analytical laboratory equipment will be set up. A field laboratory set up on site will house the following: atomic absorption (AA) instrument, gas chromatograph (GC), and an infrared (IR) detection unit. These instruments, with all the necessary ancillary equipment, must be mobilized and brought up to operational status. A temporary decontamination pad will be constructed and sampling grids laid out.

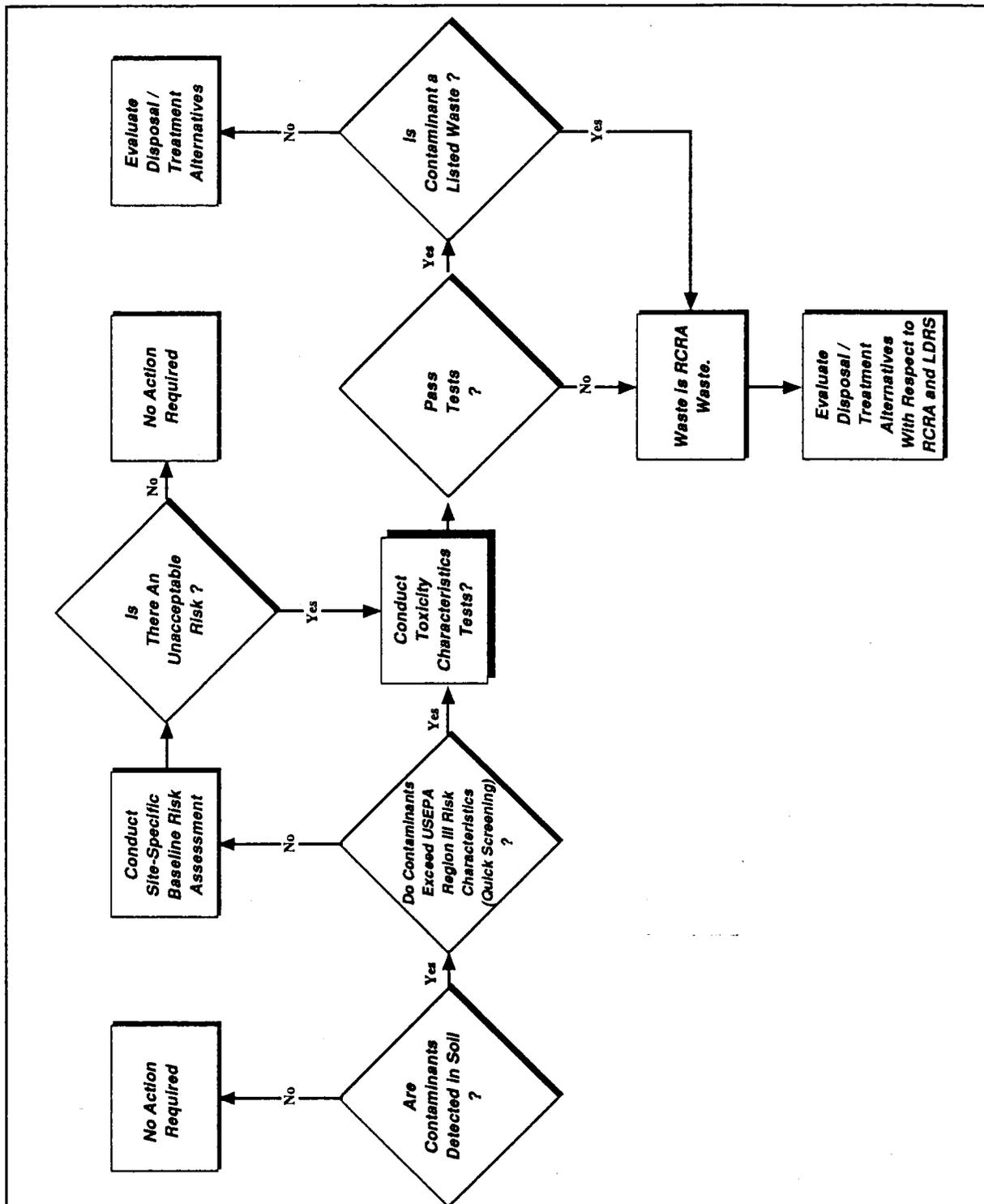
Stage II: Conduct Sampling and Field Screening — Field sampling plans will include collection of PCPT groundwater and geophysical samples, surface/subsurface soil samples, surface water/sediment samples, air samples, and ecological samples. Water levels will be measured in existing wells and PCPT borings to develop a groundwater surface contour map as the basis for groundwater modeling efforts and monitoring well/piezometer placement.

Stage III: Monitoring Well Installation — Based on the results of the PCPT survey, monitoring wells and piezometers will be installed.

Stage IV: Monitoring Well Sampling — During the final stage of fieldwork, groundwater samples will be collected and water levels will be measured at Stage III monitoring wells/piezometers. New wells, piezometers, selected PCPT borings, staff gauges, and reference points from each soil sampling grid will be surveyed. The temporary decontamination pad will be dismantled and containerized for disposal.

Due to the likely presence of contaminants, the former Fire Fighting Training Area and the sludge drying beds soil will be investigated using an accelerated remediation schedule following the decision tree outlined in Figure 5-1.

5.1.3 Mobilization/Demobilization One initial mobilization effort is planned to implement the OU-2 RI/FS Work Plan, conducted in four stages, associated with the stages of fieldwork. During the investigation, equipment and personnel will be mobilized to the site when needed and demobilized when their task is done (See OU-2 Field Sampling Plan, Appendix A-2, for details on decontamination and construction). Equipment to be mobilized/demobilized is summarized below:



OU-2
 FIELD SAMPLING PLAN
 N.A.S. JACKSONVILLE
 DECEMBER 1992



DECISION TREE FOR FFTA AND
 SLUDGE DRYING BED
 INVESTIGATIONS
 FIGURE 5-1

Stage I: Initial Mobilization Activities — The primary equipment required includes a field laboratory, a steam-cleaner, a field trailer, miscellaneous drilling equipment, tools, health and safety equipment, water level meters, 55-gallon drums for containerization of potentially contaminated materials, and materials for construction of the decontamination pad.

Stage II: Conduct Sampling and Field Screening — Mobilization for Stage II activities will require one PCPT rig, surface soil sampling tools, hand augers, surface water and sediment sampling tools, high volume air samplers and cartridges, a Climatronics Electronic Weather station or the equivalent, ecological sampling equipment, and survey equipment.

Stage III: Monitoring Well Installation — Mobilization for Stage III activities will require one drill rig and materials for the construction of monitoring wells and piezometers.

Stage IV: Monitoring Well Sampling - Mobilization for Stage IV activities will require a survey team with equipment to conduct the survey. All remaining materials will be removed.

5.2 TASK 2 - FIELD INVESTIGATIONS. This subsection previews RI field investigations to be conducted at OU-2. A more detailed description of the RI field procedures and protocols including sampling, field screening analysis, investigation-derived wastes, and decontamination is presented in the Field Sampling and Analysis Plan, Appendix A-2. Because the distribution of contaminants at OU-2 and potential migration from OU-2 have not been defined, a preliminary Area of Contamination (AOC), based on groundwater samples, has been identified for the field investigations (Figure 5-2). Based on data obtained as a result of the RI Field Program, the boundaries of the AOC may be adjusted to more accurately reflect the actual locations of contaminated media. Samples collected during the field investigations will be sufficient to meet the data needs of the risk assessment and FS as outlined in Section 4.0.

Primary contaminants identified at OU-2 are VOCs and inorganics. Media to be sampled within the OU-2 AOC are air, surface and subsurface soils, surface water, sediments, and groundwater. The field investigation will consist of both field screening and CLP laboratory analysis of samples. Field screening will identify the nature and distribution of primary contaminants at OU-2 (i.e., inorganics and VOCs). CLP analysis

will confirm the field screening results, provide data for risk assessment, and evaluate the presence of SVOCs, pesticides, and PCBs.

Sampling activities are outlined by media in the following subsections.

5.2.1 Air Sampling The air sampling program's objectives are to provide a general air quality assessment within OU-2 and to support air modeling conducted to predict contaminant concentrations used as input into the risk assessment. Screening methods will be used to assess the Polishing Pond and sludge drying beds' potential for air emissions. In-depth assessment methods will be used to determine air emissions from the former fire training area, background (upwind) air quality, and to evaluate the potential for airborne chemicals to migrate to areas that could impact human health and the environment.

Screening methods will be conducted at the Polishing Pond and sludge drying beds on a total of three days with favorable weather conditions. Air screening will be done using two screening techniques, head space sampling for VOCs and upwind/downwind monitoring for fugitive dust (particulates).

In-depth air monitoring will be conducted at the former Fire Fighting Training Area on three consecutive days, under general ambient conditions. Air samples will be collected for total suspended particulates, Target Analyte List (TAL) metals, and Target Compound List (TCL) VOCs, SVOCs, pesticides, and PCBs from an upwind/downwind sampling network that will be set up based on daily micrometeorological conditions. Details of sampling locations are presented in Section 2.0 of the Field Sampling and Analysis Plan (Appendix A-2).

5.2.2 Soil Sampling The primary objectives of soil sampling at OU-2 are to define the nature and distribution of contaminants in surface and subsurface soils, to obtain information for assessing risks to human health and the environment, and to provide information for potential remedial measures. Samples will be analyzed by an on-site field analytical laboratory and at a CLP laboratory. Field screening samples will identify the nature and distribution of contaminants at OU-2. Confirmation of field screening results at a CLP laboratory will provide Level III data for the risk assessment.

Soil samples will be collected from all suspected source areas (i.e., PSCs 2, 3, 4, 41, 42, and 43). Samples will be collected from the perimeter of the Polishing Pond to determine the possible migration of contaminants from the pond. Sludge drying bed soil will be sampled to identify contaminants and to evaluate remediation options. Grid sampling at the sludge disposal areas and the former fire training area (PSCs 2, 3 and 4) will identify potential hot spots.

OU-2 soil sampling will focus initially on the surface soil to locate hot spots. Subsurface soil samples will be collected in areas where contaminants are found in the surface soils to determine the depth of the contaminants. The sampling approach at OU-2 was developed based on the following assumptions:

- Contaminants were introduced to the soil at OU-2 by disposal of wastewater treatment sludge and the burning of waste fuels.
- None of the potential source areas at OU-2 have been covered by clean fill material.
- The inorganics associated with wastewater treatment plant activities and the petroleum hydrocarbons (PHCs) associated with fire fighter training are pervasive and are good indicators of potential hot spots in surface soil.
- Potential subsurface soil contamination results from contaminants leaching from, or percolating through, the surface soil.

5.2.2.1 Development of Sampling Grids Grid sampling will be conducted at the sludge disposal areas and the former fire training area (PSCs 2, 3 and 4). Grid node spacing will be determined by the procedure in *Statistical Methods for Environmental Pollution Monitoring* by Richard O. Gilbert (Gilbert, 1987). The initial grid will be expanded if screening results suggest that the entire spill is not contained within the bounds of the grid.

This procedure requires that a specific shape and size of the target area (i.e., hot spot) be known or assumed and that a confidence level be established for the grid space calculation. Because the true shape of the spills/sludge spreading are unknown and will be defined by the screening, target areas are assumed to be elliptical to provide a basis for establishing the initial grid node spacing. Sizes of target areas will be based on historical data about site activities or disposal practices. The following procedure will be used to establish the grid spacing:

1. Determine the shape(s) of the elliptical target area, where

$$s = \frac{\text{Length of the short axis of the ellipse}}{\text{Length of the long axis of the ellipse}}$$

If the shape of the target area is not known, a conservative approach is to assume a long narrow ellipse, such as $s=0.5$.

2. Specify L as one-half the length of the long axis of the ellipse.

3. Establish an acceptable confidence level (i.e., acceptable probability [β]). Acceptable probability is the percentage chance of not finding a small spill. For this project a β value of 0.10 will be used. That is a 90 percent confidence level that a spill area does not exist if no detections are made during sampling.
4. For elliptical target areas ($s < 1$) and a square grid pattern Figure 5-3 (after Zirchky and Gilbert, 1984; in Gilbert, 1987) presents curves that relate L/G to acceptable probability, β .

Example of Grid Calculation (after Gilbert, 1987):

If a square grid is used and we want to take no more than a 10 percent chance of missing an elliptical target 56 by 80 feet in area, the grid spacing is calculated

where: $\beta = 0.10$

$$s = \frac{50}{80} = 0.7$$

$$L = \frac{80}{2} = 40$$

Using the curve in Figure 5-3 for $s = 0.7$, we find $L/G = 0.67$ corresponds to $\beta = 0.10$. Solving for G yields $G = L/0.67 = 40 \text{ feet}/0.67$, which is equal to 59.7. Therefore, the node spacing will be 60 feet.

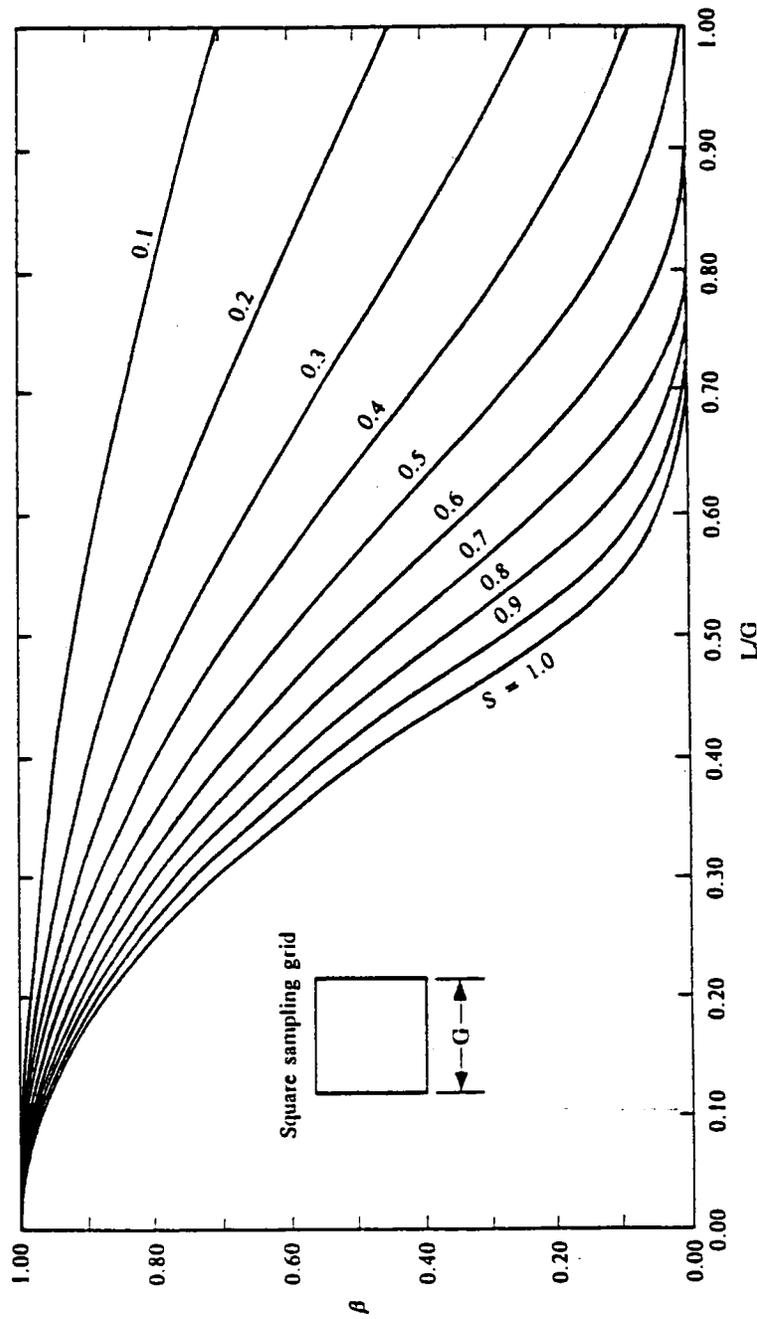


Figure 3-4 Curves relating L/G , β , for different target shapes when sampling is on a square grid pattern (after Zirschky and Gilbert, 1984, Fig. 3).

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SQUARE GRID SAMPLING NOMOGRAPH
FIGURE 5-3

The calculated grid spacing may be modified based on a topographic surface that suggests a preferred migratory pathway and/or physical barriers affecting sampling and/or contaminant migration. Grids for OU-2 are calculated in Section 4.0 of the Field Sampling Plan (Appendix A-2).

Grid reference points will be established for each grid. The sampling grid will be oriented north/south unless field conditions warrant another orientation. All grid nodes will be mapped and staked (whenever possible) for future identification. The grid reference points and selected control points at each established grid location will be surveyed.

5.2.2.2 Collection of Field Screening Samples Surface soil samples for field screening will be collected by hand from zero to 12 inches bgs, (using a stainless steel spoon, trowel, spade, and hand augers). While collecting composite samples speeds the evaluation of the nature of contaminants in an area, the elevated detection limits increase the risk assessment values associated with composite samples. Therefore, all soil samples will be discrete.

Where sampling grids are established, samples will be collected at the grid nodes. In areas with visible waste deposits, additional grab samples will be collected.

As samples are analyzed in the field laboratory, a map of contaminant distribution will be assembled. To further define the locations of hot spots, additional samples will be collected between sample locations identified as having contaminants and areas where contaminants are not detected. In addition, subsurface samples will be collected in hot spot areas to determine the depth of the hot spot. Repetitive field screening to identify hot spot locations will not be conducted within the sludge drying beds because of their small areas.

Field-screened surface soil samples will be analyzed in the field laboratory for TAL inorganics and TCL VOCs. Duplicate soil samples will be collected at a rate of 10 percent of the total surface and subsurface samples. Ten percent of the samples collected for field screening will be split and sent to a CLP laboratory for TAL inorganics and TCL VOC analysis to confirm field laboratory results.

5.2.2.3 Collection of CLP Samples Ten percent of the samples collected for field screening will be split and sent to a CLP laboratory to confirm field screening results. In addition to samples collected for field screening, soil samples will be collected for CLP laboratory analysis for TCL SVOCs and pesticide/PCBs. TOC samples will be collected from every sampling grid area, the Polishing Pond and the sludge drying beds. Toxicity Characteristic Leaching Procedure (TCLP) samples will be collected from the bricks in the sludge drying beds. Samples will also be collected from the Pine Tree Planting Area

for asbestos analysis. All CLP laboratory samples will be collected using the procedures outlined in Section 4.0 of the Field Sampling Plan (Appendix A-2).

5.2.2.4 Background Soil Sampling and Analysis A database of inorganic and anion concentrations in representative background soils (that is, soils remote from known contaminant sources) is critical in evaluating elevated inorganic concentrations in soil collected from potential source areas and to assess migration within the OU-2 AOC. To develop this database, the following background soil sampling and analysis program will be conducted:

- At each background sampling location, one surface (from zero to 12 inches) and one subsurface soil sample will be collected.
- Each sample will be analyzed at a CLP laboratory for TAL inorganics.
- The geometric mean TAL inorganic concentration for surface and subsurface soil samples will be computed.
- To verify the sampler's observations, grain-size analysis will be conducted on one surface and one subsurface soil sample to confirm that the observations conform to the Unified Soil Classification System.

5.2.3 Surface Water and Sediment Sampling The primary objectives of collecting surface water and sediment samples are to define the nature and extent of contaminants in the Polishing Pond, evaluate potential migration pathways in the drainages, obtain information for assessing the threat to human health and the environment, and to provide information for potential remedial measures. Surface water and sediment sampling will be conducted at OU-2 for field screening and CLP laboratory analysis. See Section 2.0 of the Field Sampling Plan (Appendix A-2) for specific locations.

Other than during storm occurrences, the bulk of surface water at OU-2 is in the Polishing Pond and the western end of the east/west drainage ditch, which is directly next to the southern fence of the Timuquana Country Club Golf Course (See Figure 2-2). At the Polishing Pond, surface water samples will be collected from mid-depth levels in the water column. In the east/west drainage ditch, surface water samples will be collected from each inlet and outlet from OU-2. Surface water samples will be analyzed by a CLP laboratory for TCL VOCs, SVOCs, pesticides, and PCBs, and TAL inorganics. To evaluate the contribution to total contaminants from suspended particulates, both filtered and unfiltered inorganic samples will be collected.

During storms, sediments may be transported from OU-2 via drainage ditches south of the golf course and along both sides of the Patrol Road. Storm water is also carried off

OU-2 by drainage pipes with drop box openings on the eastern side of OU-2 next to the taxiway (See Figures 2-1 and 2-2). Sediment samples will be collected for field screening from each drainage ditch at points where storm water flows onto or off OU-2 and in the depression around each drop box. Field screening samples will be analyzed for inorganics and PHCs. Field screening results will be used to map out the distribution of contaminants in the sediments at OU-2. CLP samples will also be collected for TCL VOCs, SVOCs, pesticides, and PCBs, and TAL inorganics analyses.

Sediment from wastewater treatment plant effluent has been deposited in the Polishing Pond. Sediment samples will be collected from the bottom of the pond and field screened for inorganics and VOCs. Samples will be collected for CLP analysis to confirm field screening results and to evaluate the additional presence of SVOCs, pesticides, and PCBs.

Sediment samples will be collected using a stainless steel split-spoon sampler. If appropriate, sediment samples will be collected from the drainage ditches using a trowel, as minimal water depth is expected.

When possible, sediment samples will be collected at the same location as surface water samples. Collecting a surface water/sediment pair helps define partitioning of chemicals between the soil and water fractions.

5.2.4 Groundwater and Hydrogeologic Investigations The primary objectives of the groundwater study at OU-2 are to evaluate the subsurface geology, the direction of groundwater flow, define the nature and extent of contaminants in groundwater, obtain information for assessing the threat to human health and the environment, and provide information for potential remedial measures. To more accurately define the subsurface geology and extent of groundwater contamination at OU-2, and to avoid a many-staged investigation, the Navy has selected field screening using a PCPT survey coupled with field laboratory analysis, followed by installation of monitoring wells and piezometers.

5.2.4.1 Piezometric Cone Penetrometer Testing The PCPT rig is a 20-ton truck with a self-contained hydraulic ram, data recording computer, and decontamination unit. The hydraulic ram is used to advance small diameter steel rods (either a penetrometer or groundwater sampling device) into the ground at a constant rate to depths greater than 100 feet (Figure 5-4). The PCPT survey will characterize the nature and extent of groundwater contaminants in the Surficial Aquifer and further define the subsurface hydrogeology at OU-2.

Geotechnical Testing To provide information about aquifer geology, a penetrometer equipped with sensors for pore pressure, tip resistance, and sleeve resistance will be pushed down to the top of the Hawthorn Group. Sensor readings are relayed to the

onboard computer system as continuous functions of depth and time (Figure 5-5). The soil types encountered by the cone being pushed through the subsurface will be interpreted from the instrument readings. Groundwater elevation is established when pore pressure is zero.

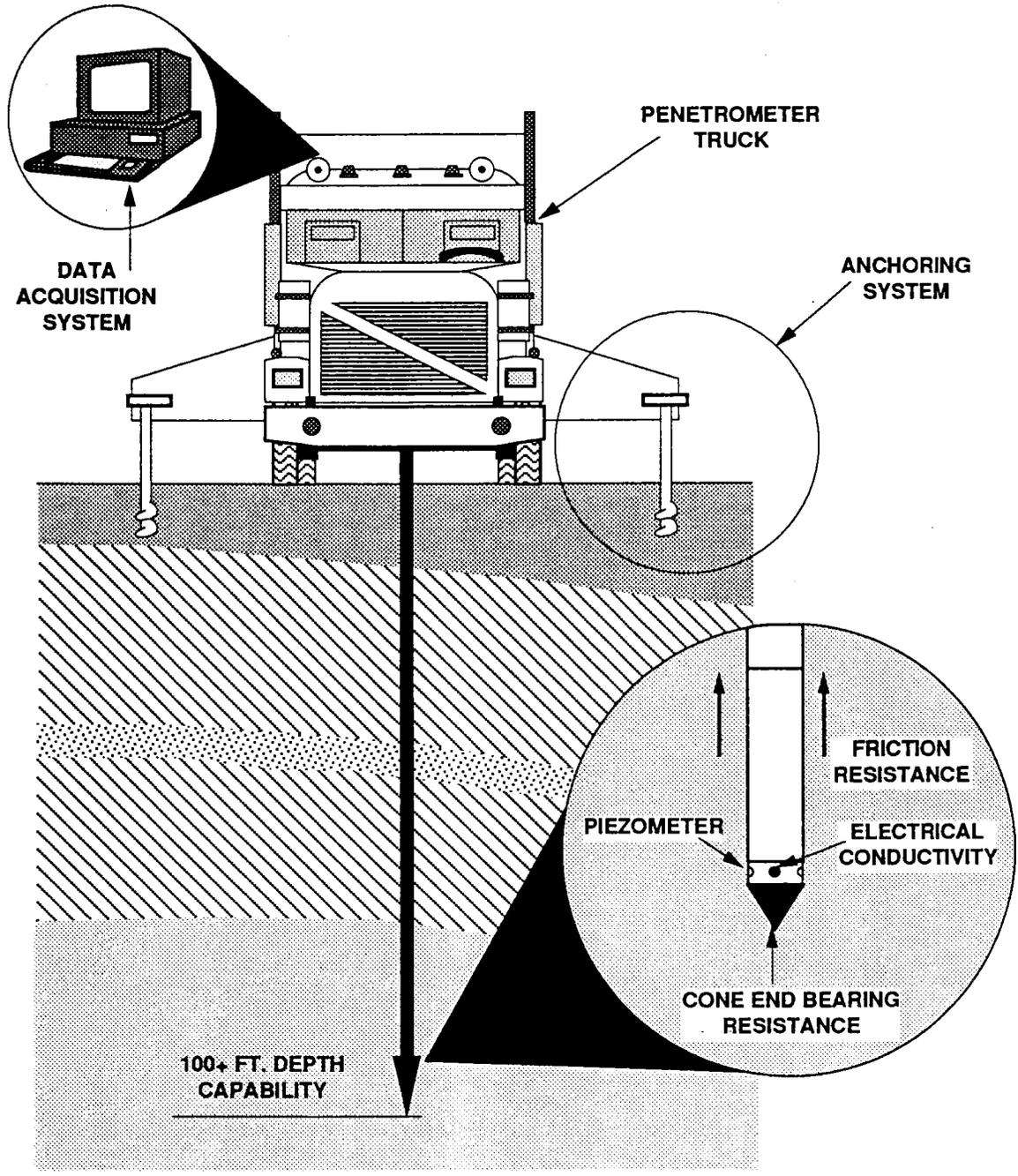
The PCPT survey will consist of a series of borings in and around OU-2. Information from these borings will be evaluated to develop a thorough understanding of the stratigraphy of the Surficial Aquifer at OU-2. The nature and extent of the clayey sand/sandy clay identified in the Surficial Aquifer during previous investigations will be evaluated using this technique.

Groundwater Sampling The PCPT, in combination with the field laboratory, will also help map groundwater contaminant plumes. A telescoping sampling device that can be opened at selected depths will be pushed into the aquifer by the PCPT truck to collect groundwater samples.

Geological information from previous PCPT borings will be used to select sample locations and depths. Groundwater will be sampled at various depths at each location. Groundwater samples collected by the PCPT will be analyzed on site in the field laboratory for TCL VOCs and TAL inorganics. Ten percent of the samples collected will be split and sent to a CLP laboratory for confirmatory analysis.

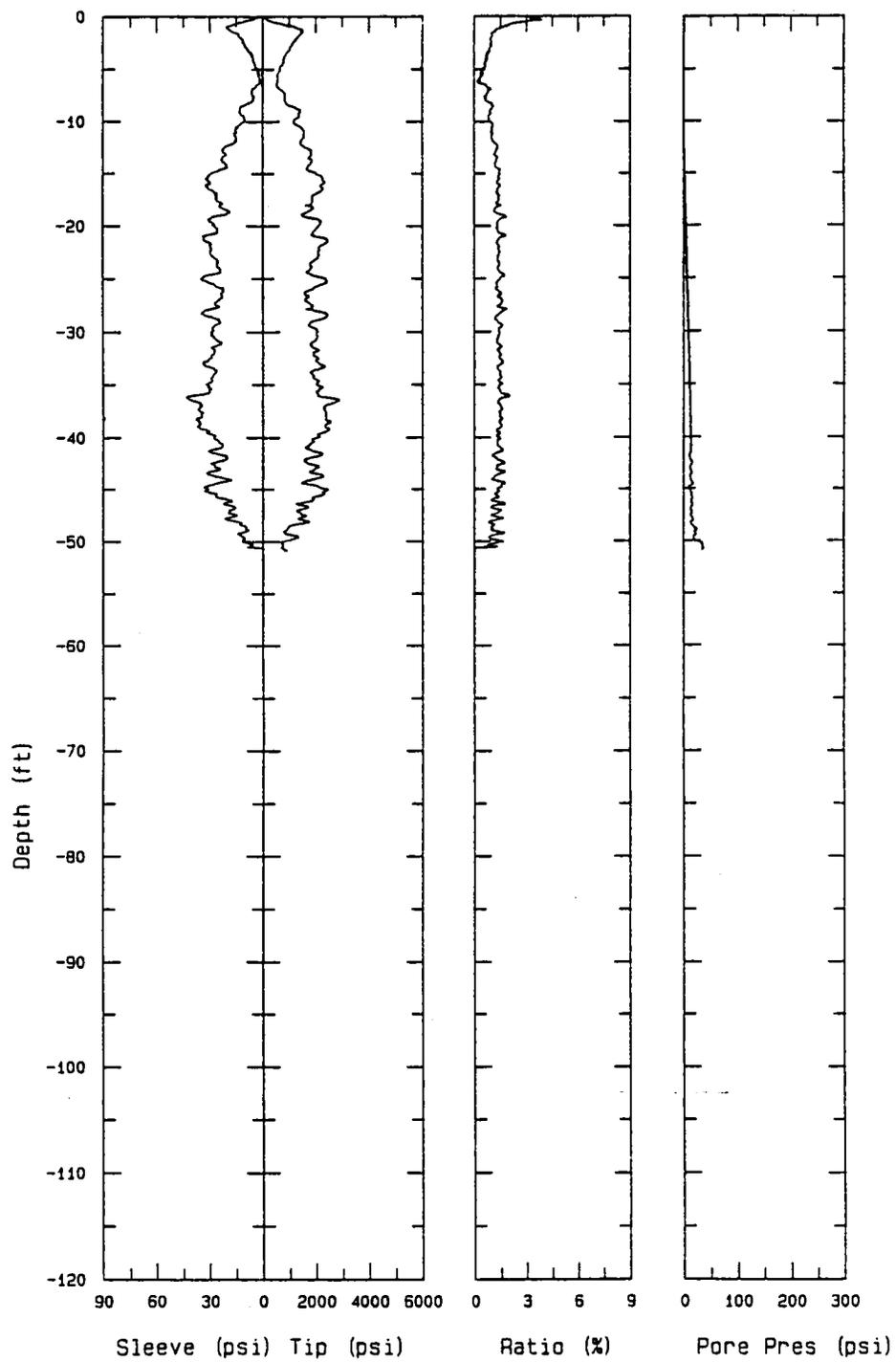
The Field Sampling Plan (Appendix A-2) contains a detailed presentation of the proposed PCPT boring locations.

5.2.4.2 Monitoring Well/Piezometer Installation and Development Information from field-screened groundwater samples collected during the PCPT survey will be used to guide the installation of monitoring wells. Wells will be positioned to confirm the location and distribution of contaminant plumes. Because final well locations will be determined based on field data, these locations are not known prior to beginning the



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PIEZOMETRIC CONE PENETROMETER
TECHNOLOGY
FIGURE 5-4



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EXAMPLE OF PCPT DATA OUTPUT
 FIGURE 5-5

investigation. Therefore, on-site meetings will be held with regulatory agencies to discuss proposed well locations.

Geologic information from the PCPT survey will be used to guide the installation of piezometers. Piezometers will be positioned to provide information on groundwater elevation in areas outside contaminant plumes. Proposed piezometer locations also will be discussed during on-site regulatory meetings.

Specific requirements for equipment decontamination (at each piezometer/well and between borings), piezometer/monitoring well construction, backfilling requirements, and disposal of cutting and drilling fluids, are also described in the OU-2 Field Sampling Plan (Appendix A-2).

Piezometer and well development will proceed as soon as practicable after installation, but no sooner than 48 hours and not later than seven days following placement of the mortar collar.

5.2.4.3 Monitoring Well Groundwater Sampling Groundwater samples will be collected from all new monitoring wells installed at OU-2, and from selected existing wells in the current monitoring network. Groundwater sampling will be conducted in accordance with the OU-2 Field Sampling Plan (Appendix A-2). All samples collected from monitoring wells will be analyzed for the constituents listed in the Quality Assurance Project Plan (Appendix A-1), that is, TCL VOCs, SVOCs, pesticides, and PCBs, TAL inorganics, and gross alpha and beta activity. See the Field Sampling Plan (Appendix A-2) for sampling locations.

5.2.4.4 Groundwater Elevation Measurement Groundwater and surface water levels will be measured to prepare a water table contour map and to establish the direction of groundwater flow, and surface water/groundwater hydraulic relationships. Staff gauges will be installed at two locations within the east-west ditch at OU-2 if sampling determines that surface water is connected to groundwater. A staff gauge will also be installed at the Polishing Pond. Water levels will be read from the staff gauges during each groundwater sampling event. Groundwater levels will be measured in each new piezometer and monitoring well and in selected existing monitoring wells at least twice during each sampling event. Water level measurements in monitoring wells and piezometers will be obtained in accordance with the OU-2 Field Sampling Plan (Appendix A-2), as will surface water measurements.

5.2.4.5 Hydraulic Conductivity Testing In situ permeability testing will be conducted in all new monitoring wells and in selected existing monitoring wells. The tests will evaluate a range of hydraulic conductivity values in the Surficial Aquifer and to confirm the results of previous hydraulic conductivity testing. Subsection 3.2.4.5 of the Basic Site

Work Plan (Volume 4) presents the methodology and calculations for in situ permeability testing.

5.2.4.6 Additional Groundwater Investigations An investigation into the locations of area irrigation and residential well will be conducted to aid in groundwater modeling and assessing potential risk exposure scenarios.

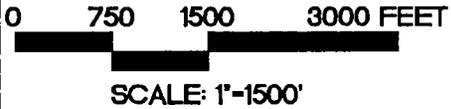
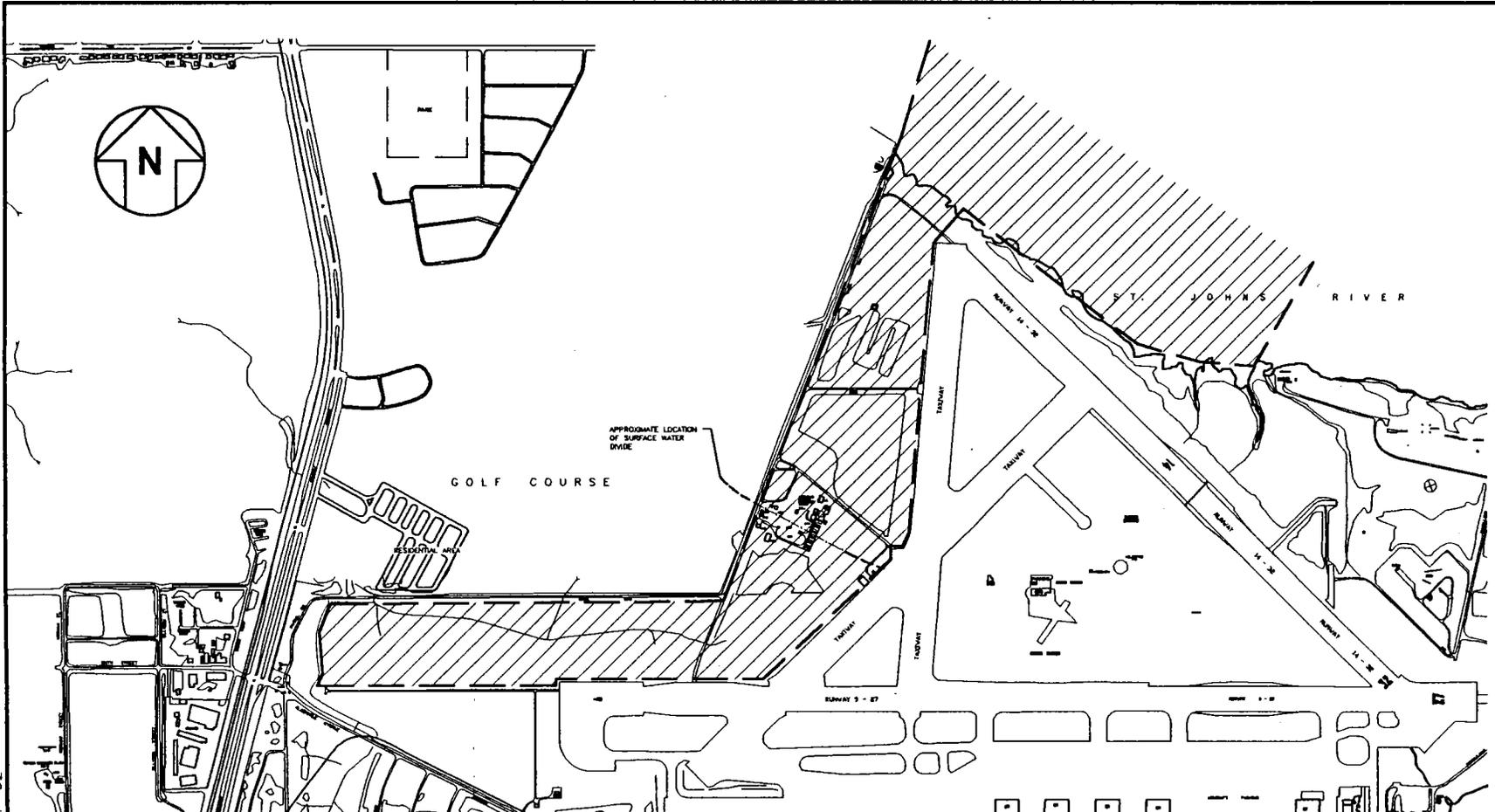
5.2.5 Survey Vertical and horizontal controls at OU-2 will be established from survey monuments. Location coordinates and elevations will be established for each PCPT boring, piezometer, staff gauge, and monitoring well by a professional land surveyor registered in the State of Florida. Location coordinates and elevations for soil samples and surface water and sediment sampling locations will be measured by the field crew based on the grid.

Elevations will be referenced to the North American Datum of 1983. Elevations to the nearest 0.01 foot will be established for the top of the casing (measuring point) at each monitoring well, piezometer, PCPT boring, and staff gauge. Ground surface elevations to the nearest 0.1 foot will be established on the ground surface for each surface soil sampling site.

5.2.6 Risk Assessment Risk assessment personnel will interview Jacksonville personnel and community officials to ascertain potential receptors and exposure scenarios for OU-2 contaminants.

5.2.7 Ecological Inventory The ecological inventory will consist of a qualitative assessment of the major biotic communities or habitats present and adjacent to OU-2. The aerial extent of this investigation will include the portion of the St. Johns River close to OU-2, extending from the northern facility boundary to the cove area located upriver approximately halfway to Piney Point (Figure 5-6). Biotic communities will be characterized by the type and relative abundance of the flora and fauna identified in each habitat. When necessary, reference areas representing undisturbed habitats with similar biotic potential will also be identified and used for comparison with the identified resources within and adjacent to OU-2. All signs of biological stress will be noted and evaluated. In addition, state and federal rare, threatened, or endangered species and/or sensitive communities will be documented.

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FIGURE 5-6
 HABITATS OF ECOLOGICAL CONCERN

Data gathered during the ecological inventory will identify the following site-specific ecological characteristics:

- Potential terrestrial, semi-aquatic, and aquatic receptors and the general distribution of flora and fauna at OU-2, terrestrial habitats in adjoining areas, and the adjacent segment of the St. Johns River.
- Inventory of major vegetative communities at OU-2 and the immediate areas surrounding it, including the submerged macrophyte community in the adjacent segment of the St. Johns River.
- The macroinvertebrate community composition associated with the Polishing Pond and the various substratum in the adjacent segment of the St. Johns River.
- The occurrence of potentially sensitive and important ecological resources at OU-2 and the immediate areas surrounding it.
- Identification and characterization of selected aquatic reference areas which are not known to be impacted by contaminants or other stressors found at OU-2.
- Preliminary identification and assessment of apparent stresses to the biotic communities within and adjacent to OU-2.
- Select appropriate biomonitoring methods that could be applied to further characterize the extent and magnitude of adverse impacts to potentially-affected habitats and resources.

During the ecological inventory, a number of investigative methods will be utilized to document field conditions and observations. The majority of the observations will be recorded using a hand-held tape recorder, to be transcribed after the field work has been completed. However, significant observations will be documented by written notation in a bound field notebook. Photographs documenting conditions at OU-2 will be taken throughout the inventory.

The data obtained from this inventory will provide baseline information that will be used to prepare the baseline ecological risk assessment (Subsection 5.5.2) and subsequently determine the need for additional biomonitoring activities. The various tasks and procedures that will be employed in the ecological inventory of OU-2 are discussed in the Field Sampling Plan (Appendix A-2).

5.3 TASK 3 - SAMPLE ANALYSIS AND DATA MANAGEMENT. Both field screening and CLP laboratory analyses will be used to evaluate the nature and distribution of contaminants at OU-2.

5.3.1 Field Screening Analysis ABB-ES personnel will mobilize and operate a field laboratory at OU-2 Jacksonville to deliver real-time data for the decision-making process on site. The following instrumentation will be used.

5.3.1.1 Atomic Absorption AA will be used to analyze for inorganic compounds. Samples will be brought to the field office, prepared that day, and analyzed the following day. Samples will be analyzed with a Perkin-Elmer 3100 AA or equivalent. The following elements will be tested for: arsenic, chromium, lead, cadmium, and nickel. Detection limits will be determined on site and are expected in the low ppm range.

5.3.1.2 Gas Chromatograph Samples will be analyzed for a select group of VOCs using a Hewlett Packard 5890 GC in conjunction with a LSC-2000 purge-and-trap system. This system detects VOCs in soil or water in the low parts per billion. The following organic compounds will be calibrated and analyzed for: methylene chloride, vinyl chloride, trans-1,2-dichloroethylene, cis-1,2-dichloroethylene, 1,1-dichloroethane, 1,1,1-trichloroethane, trichloroethylene and tetrachloroethylene. These compounds will all be detected by an electron capture detector.

5.3.1.3 Infrared Spectroscopy IR screening will be used for SVOC testing. A modified USEPA Method 418.1 will be used with a fixed filter IR detection unit to detect TPHs. Some compounds detectable in this screen include: jet fuel, No. 2 fuel oil, gasoline, and kerosene. IR methods are used to determine gross contamination; because of the large number of compounds that are measured by this technique, the results may not correlate to standard TCL analysis such as volatile and semivolatile analyses.

5.3.2 CLP Laboratory Sample Analyses Soil and water samples will be selected for CLP laboratory analysis to identify and quantify chemical contaminants in the various media at OU-2 and to confirm field screening sample results. These samples will be sent to an ABB-ES contracted laboratory that meets all applicable USEPA standards. A general guide to methods and the standardized parameter list is in the *Navy Installation Restoration Program Plan, Basic Site Work Plan Volume 4* (Geraghty & Miller, Inc., 1991c; updated 1992).

5.3.3 Data Management Sampling locations and analytical data will be entered into NAS Jacksonville's IRP Plan Database: JAXFACTS.

5.3.4 Data Validation Field and CLP laboratory analytical data will be validated systematically following guidance in USEPA's *Functional Guidelines for Evaluating*

Organic Analyses (USEPA, 1988a) and *Functional Guidelines for Evaluating Inorganic Analyses* (USEPA, 1988f). These guidelines provide a systematic procedure for evaluating laboratory quality assurance/quality control measures such as holding times, blank analyses, surrogate recoveries, matrix spike results, GC/mass spectrometry tuning, instrument calibration, compound identification, and method performance. All data will be evaluated according to the quality assurance/quality control requirements for each method used. Data will also be evaluated by comparing field screening data with the CLP confirmation samples.

Validated data will be prepared in three initial formats: raw laboratory data, data marked with validation qualifiers or annotations, and corrected or validated data. Validated data can then be used for site contaminant characterization and assessment. Data validation will be performed by ABB-ES.

5.3.4.1 Calculation of Precision, Accuracy, Representativeness, Completeness, and Comparability (PARCC) Parameters PARCC parameters are defined and explained in the *Navy Installation Restoration Program Plan, Naval Air Station, Jacksonville, Florida; Volume 4, The Basic Site Work Plan* (Gerhaghty & Miller, 1991c, updated 1992). Acceptance criteria for field and CLP laboratory PARCC parameters are outlined in the Quality Assurance Plan (Appendix A-1).

5.4 TASK 4 - DATA EVALUATION AND MODELING. Chemical and physical data collected during the RI/FS will be used to characterize the site and to evaluate the potential levels of risk posed to human health and the environment. Physical data (groundwater and surface water elevations and flow, soil composition, and hydraulic conductivity) and chemical data (laboratory analyses and field screening data) will be integrated to form a conceptual overview of the site. The chemical data will be evaluated according to the following steps:

1. Sort data by medium (all chemicals detected in at least one sample in each medium will be identified).
2. Evaluate the analytical methods used.
3. Evaluate the quality of the data with respect to sample quantitation limits, qualifiers, and blanks.
4. Qualitatively evaluate tentatively identified compounds.

The chemical data evaluation, with regards to the Risk Assessment, will follow USEPA guidelines as described in Section 5 of the *Risk Assessment Guidance for Superfund, Vol 1: Human Health Evaluations Manual, Part A* (USEPA, 1989b) and *Data Useability for Risk Assessment* (USEPA, 1992c).

Data will be summarized and plotted on scaled maps to facilitate the analysis of contaminant distribution and potential mechanisms of transport. Field-screened data will be plotted in the field to provide near real-time interpretation of contaminant locations. Chemicals considered contaminants will be determined by comparison with various criteria, including:

- comparison of chemical data to ARARs;
- comparison of potential site-related contamination with background levels; and
- comparison of site-related compounds to USEPA Region III risk-based concentrations (USEPA, 1992a).

The history of the site will be considered when there are no ARARs for specific chemicals.

As a result of this process, two data sets are identified - contaminants that are site-attributable, and contaminants or chemicals that are present but not related to site activities. Physical and chemical data will be used to evaluate the distribution of contaminants, contaminant interactions, transport mechanisms, and potential fate. The mobility, persistence, bioaccumulation potential, and potential significant exposure routes of the chemicals will be evaluated. This evaluation will include factors such as groundwater transport, groundwater-surface water interactions, surface water transport, vadose zone transport, volatilization and advection, soil erosion, retardation, degradation, and transformation. As a result of the contamination assessment, the distribution of contaminants for risk and engineering studies will be evaluated.

Models will be used, as appropriate, to identify and quantify potential migration pathways for contaminants and changes in concentration and distribution over time. The times during which these changes can occur are 25 and 70 years. The evaluation of the factors listed above will be subject to the availability of sufficient experimental and empirical reference data and appropriate models. The Navy has contracted with the USGS for groundwater numerical modeling. Groundwater models will be based on the U.S. Geological Survey Modular Three-dimensional Finite-difference Groundwater Flow Model (MODFLOW) (McDonald and Harbaugh, 1988).

Screening techniques will be employed to estimate air concentrations for use in the risk assessment. Air dispersion models will be used to simulate the movement of airborne contaminants after release. Air emissions modeling may be performed to estimate emission rates for input to the dispersion models. Models will be selected from the National Technical Guidance Series (USEPA, 1989d), the Superfund Exposure

Assessment Manual (USEPA, 1988c), the Risk Assessment Guidance for Superfund (USEPA, 1989b), or current literature. Air monitoring conducted on the site can provide a direct measurement of actual air emission rates for dispersion analyses. The dispersion modeling results will be analyzed and summarized in the RI report.

5.5 TASK 5 - BASELINE RISK ASSESSMENT. The objectives of the baseline risk assessment are to evaluate the potential current and future human health and environmental risks associated with contaminants at OU-2. A review of preliminary investigative data has identified contaminants in soils and groundwater. The analysis of baseline risk identifies potential risks that exist if no remedial actions or institutional controls are implemented at OU-2. Due to the accelerated investigation for the former Firefighter Training Area and the sludge drying beds, these areas will undergo a baseline risk assessment after a removal action, or if contaminants are detected, but not above the USEPA Region III suggested guidelines. The tasks involved in conducting the risk assessment are similar for both human and ecological assessments and will include:

- Identifying contaminants of potential concern (different contaminants of potential concern could be identified for the human health and ecological assessments).
- Assessing the concentrations of the chemicals of potential concern in the relevant media.
- Characterizing potential human and environmental receptors and evaluating potential exposure routes and the extent of actual or potential exposures.
- Providing dose-response information and a summary of toxicity data.
- Evaluating the extent and likelihood of adverse effects to human health or the environment.
- Qualitatively identifying the level of uncertainty associated with the estimated risks.

In accordance with the *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Parts A and B), Interim Final* (USEPA, 1989b) and supplemental USEPA Region IV guidance (USEPA, 1991b), a quantitative risk assessment will be produced that incorporates the results of these efforts. The environmental assessment portion of this risk assessment will follow guidelines in the *Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual, Interim Final* (USEPA, 1989a).

5.5.1 Human Health Risk Assessment The objective of this human health risk assessment is to evaluate whether or not human health or welfare is potentially at risk from exposure to contamination at, or migrating from, OU-2. The baseline risk assessment will evaluate possible exposure under both current and potential future land uses. Of greatest concern is potential human exposure to contaminated soils at known or suspected waste disposal areas at OU-2. Other concerns include possible impacts to the St. Johns River.

5.5.1.1 Identification of Chemicals of Potential Concern Potential OU-2-related chemicals for which data of sufficient quality are available for use in the risk assessment are defined as chemicals of potential concern. The process by which chemicals of concern will be identified considers the following activities: (1) sampling design strategy (data needs, DQOs, data collection methods), (2) sample analyses selection processes (including quantitation limits), and (3) data validation and evaluation methods (see Subsections 5.2, 5.3, and 5.4). The steps followed to identify chemicals of potential concern are presented in Appendix A-1.

A preliminary list of chemicals currently expected to be included in the baseline risk assessment was developed based on those compounds detected in groundwater at OU-2 during previous studies. The chemicals detected, maximum concentrations, and compound-specific state and federal ARARs are presented in Table 5-1.

General Data Uncertainty A discussion of uncertainties associated with the quality of either the collection or the analyses of data is in Subsection 5.4. Potential effects of these uncertainties on later sections of the risk assessment will be qualitatively evaluated and tabulated.

TABLE 5-1 COMPARISON OF GROUNDWATER TO STANDARDS, NAS JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

Compound	Maximum Detected Concentration (mg/L)	MCL (mg/L)	Standards	
			USEPA MCLG (mg/L)	Florida MCL (mg/L)
Arsenic	0.051	0.01/0.05	0.003	0.05
Barium	0.819	2	2	1
Beryllium	0.023	0.001	0	-
Cadmium	0.04	0.005	0.005	0.01
Chromium	0.3	0.1	0.1	0.05
Cyanide	0.28	0.2	0.2	-
Fluoride	4.1	4	4	4
Lead	0.103	0.015*	0	0.05
Manganese	0.52	-	-	-
Mercury	0.014	0.002	0.002	0.002
Nickel	5.4	0.1	0.1	-
Nitrate	73	10	10	10
Selenium	0.002	0.05	0.05	0.01
Silver	0.072	-	-	0.05
Sodium	985	-	-	160
Sulfate	1900	400/500	400/500	-
Vanadium	0.44	-	-	-
Zinc	0.23	-	-	-
Acetone	0.12	-	-	-
BEHP	0.12	-	-	-
Benzene	0.0038	0.005	0	0.001
Chloroform	0.013	0.1	-	0.1
Chloromethane	0.0016	-	-	-
o-Cresol	0.063	-	-	-
p-Cresol	0.427	-	-	-
1,1-Dichloroethane	0.187	-	-	-
trans-1,2-Dichloroethene	0.0091	0.1	0.1	0.007
Dichloromethane	1.25	0.005	0	-
Methyl Ethyl Ketone	0.016	-	-	-
Phenol	2	-	-	-
Tetrachloroethene	0.0011	0.005	0	0.003
Toluene	0.054	1	1	-
1,1,1-Trichloroethane	0.015	0.2	0.2	0.2
Trichloroethene	0.045	0.005	0	0.003
Vinyl Chloride	0.005	0.002	0	0.001
Xylenes	0.0014	10	10	-

- = No standard available

* - Action Level

Summary As part of the baseline risk assessment, all identified chemicals of concern will be summarized in tabular form as outlined in the *Risk Assessment Guidance for Superfund* (USEPA, 1989a).

5.5.1.2 Exposure Assessment The exposure assessment is conducted to establish pathways by which humans could potentially be exposed, the magnitude of potential human exposure, and the frequency and duration of the exposure. Reasonable maximum estimates of exposure will be developed for current and potential future land uses. The steps involved in conducting an exposure assessment include:

- characterizing the exposure setting and analyzing contaminant releases
- identifying exposed populations
- determining potential exposure pathways
- estimating the exposure concentrations for each pathway
- estimating the dose of contaminants for each pathway
- identifying uncertainties

Characterization of the Exposure Setting and Analysis of Contaminant Releases OU-2 characteristics are described in Section 2.0. During the investigation, additional information will be collected (that is, field logs, record reviews, and documentation of activities) to further describe the physical setting and human populations on or near OU-2. A qualitative evaluation of those characteristics that influence exposure also will be provided.

Identification of Potentially Exposed Populations The baseline risk assessment will characterize and identify: (1) the populations on or near OU-2; (2) the activity patterns of local residents; and (3) the locations of sensitive subgroups (such as day-care centers and hospitals). This information will be obtained from the base Housing Authority, the Marina Manager, Occupational Health and Safety personnel, the Planning Supervisor, and the land management plan for the base. For off-base populations, information will be obtained from city records.

Determination of Potential Exposure Pathways and Scenarios A conceptual model for OU-2 is presented in Figure 3-6. As the RI progresses, other applicable exposure parameters will be incorporated into the risk assessment exposure scenarios.

Based on existing knowledge of the area exposures to soil, surface water, and sediments will be quantified based on occupational land use at OU-2. Future land use may also include the two functions cited above. The exposure assumptions are based on current occupational activities and projected future occupational scenarios, and current and projected future recreational uses of the Station and surrounding area.

Occupational Exposure Scenarios Current occupational exposures include exposure of employees to contaminated surface soils (zero to 12 inches deep) during outdoor activities. In addition, exposure to subsurface soils (12 inches to the water table) during construction will be evaluated as a current and future scenario. Both scenarios involve inhalation of particulates and volatiles and dermal contact with and incidental ingestion of soils.

The current water ingestion exposure route will be evaluated using data collected from the aquifer (no contaminants have been detected in the base groundwater supply wells).

A golf course and country club are located west of OU-2. The west side of OU-2 is fenced and the east side is bordered by the airport runways. OU-2 is in a restricted area and an is unlikely area for trespassers; therefore, no trespassing scenarios will be evaluated.

Residential Exposure Scenarios Currently, there are no residences on OU-2. A functional wastewater treatment plant at OU-2 has been recently upgraded. NAS Jacksonville is not scheduled to close. Even under a conservative scenario projecting future closure, it is doubtful that the land use will change from that of a wastewater treatment plant. As noted, west of OU-2 (beyond the Station boundaries) is a golf course and country club. Two residences are northwest of and adjacent to the Station, overlooking the St. Johns River. The wastewater treatment plant sludge disposal area abuts the runways to the east (see Figures 1-1 and 1-2). No buildings are allowed within 750 feet on either side of the center line of the runway (according to the NAS Jacksonville Planning Supervisor, Fred Farrell, during a June 4, 1992, meeting). Also, explosives are loaded on planes east of the wastewater sludge drying beds. Because of this activity, a temporary safety arc (that is, no buildings where personnel live or work are allowed) incorporates much of the available land space around OU-2. because of the proximity of the runways and the current and projected future use of OU-2 (i.e., as a wastewater treatment plant), no future residential scenarios will be evaluated for soils at this time. A five year review will be required for OU-2; if there is a proposed change in the status of the OU-2 area, risks can be re-evaluated at that time.

Following USEPA Region IV guidance for evaluating Class G-1 groundwater, future scenarios will use the analytical groundwater data to determine the "worst case" estimates of risk (USEPA 1991b). These estimates will aid in establishing risk-driven cleanup

goals for the FS. Exposure pathways will include ingestion, dermal contact, and inhalation of volatiles from household water use (USEPA, 1991b).

Table 5-2 is a matrix of exposure pathways to be evaluated at OU-2.

Quantification of Exposure For each identified exposure pathway, estimates of the magnitude, frequency, and duration of exposure will be quantified. The quantification of exposure will be conducted in two stages: (1) estimation of exposure concentrations, and (2) calculation of chemical intakes.

Exposure Concentrations Exposure concentration refers to the average concentration contacted at the exposure point or points over an exposure period. Exposure concentrations for all media and pathways will be calculated using the monitoring data obtained during the RI of OU-2. Analytical data from surface soil samples will be used to model exposure concentrations from fugitive dust emissions. Reasonable maximum exposure, defined as the highest exposure that is reasonably expected to occur at OU-2, will be established.

The procedures and assumptions that will be used to estimate exposure concentrations at various exposure points are listed in Appendix C.

Calculations of Chemical Intake The methods for calculating chemical-specific intakes for populations and exposure pathways selected for quantitative evaluation will be based on the *Risk Assessment Guidance for Superfund*, Section 6.6 equations (USEPA, 1989a). The equations used to estimate chemical intake and standard USEPA default parameters (USEPA, 1989c and 1991c) are provided in Appendix C. Non-standard exposure parameters (such as dermal relative absorption factors) will possibly be determined with the guidance of USEPA Region IV.

Summary The summary exposure assessment results presented in the report will include estimated chemical-specific intakes for each pathway in tabular format; selected exposure pathways grouped by population; and summary information grouped by current and

TABLE 5-2 MATRIX OF POTENTIAL CURRENT AND FUTURE EXPOSURE PATHWAYS,
 NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

Exposure Medium and Exposure Route	Exposure Point	Residential Population	Occupational Population	Recreational
Groundwater	PSC 2,3,4,41,42,43			
Ingestion		A		
Dermal contact		A		
Inhalation of volatiles		A		
Surface soil	PSC 2,3,4,41,42,43			
Ingestion			W	
Dermal contact			W	
Inhalation of volatiles			W	
Inhalation of particulates			W	
Subsurface soil	PSC 2,3,4,41,42,43			
Ingestion			W	
Dermal contact			W	
Inhalation of volatiles			W	
Inhalation of particulates			W	
Surface water	St. John's River			
Ingestion				A/C
Dermal contact				A/C
Inhalation of volatiles				A/C
Sediment	St. John's River			
Ingestion				A/C
Dermal contact				A/C
Shellfish	St. John's River			
Ingestion				A/C

Notes:

PSCs = potential source of contamination
 A = Adult (30 year exposure)
 C = Child
 W = Adult worker

future use categories, with chronic and subchronic daily intakes summarized separately. In addition to the summary tables, sample equations for each pathway will be provided, either in the text or appendices, to aid in review of the calculations.

5.5.1.3 Toxicity Assessment The purpose of the toxicity assessment is to determine the severity of adverse effects based on the extent of exposure to a contaminant. The toxicity assessment for contaminants found at OU-2 will be accomplished in two steps: hazard identification and dose-response assessment.

Hazard identification is the process of establishing whether exposure to a chemical agent can cause an increase in the incidence of an adverse health effect (such as lung cancer or birth defects). In the dose-response assessment, the relationship between the dose of the contaminant and the incidence of adverse health effects in the exposed population is quantified. Toxicity values (RfDs and CSFs) derived from the quantitative dose-response relationship are used in the risk characterization to estimate the likelihood of adverse effects occurring in humans at different exposure levels.

Sources for Toxicological Data Sources for toxicological data include epidemiological studies, clinical studies, animal studies, and supporting data. Toxicity values for the preliminary list of chemicals at OU-2 will be determined from the USEPA Integrated Risk Information System (IRIS) database or Health Effects Assessment Summary Tables; these are presented in Appendix C. These two sources will be used to provide toxicity information for any other contaminants detected at OU-2 during the subsequent investigations. Methods used to estimate risk if no toxicity values are available will possibly be determined with USEPA Region IV risk assessment guidance.

Uncertainty Evaluation Toxicity information for many chemicals is limited, leading to varying degrees of uncertainty associated with calculated toxicity values. The evaluation of uncertainty for the toxicity assessment will provide information regarding sources of uncertainty (that is, extrapolation from short-term to long-term exposures); degree of uncertainty associated with toxicity values (that is, the weight of evidence supporting the toxicity factor); and the consistency of different studies for the same chemical (that is, responses of various species to equivalent doses).

Summary The toxicity assessment will be summarized, and a description of the toxic effects of each contaminant of potential concern in non-technical language provided. Information on the effects associated with exposure to each chemical of concern and the concentrations at which the adverse effects are expected to occur in humans will be included. The following information will be included in tabular form: toxicity values with a brief description of the source (including uncertainty factors); the degree of confidence for RfDs obtained from IRIS; absorption efficiencies; and toxicity values for appropriate exposure averaging periods (that is, acute and chronic).

5.5.1.4 Risk Characterization The risk characterization process is the final step in the baseline risk assessment. This section of the baseline risk assessment report will integrate the exposure and toxicity assessments into quantitative and qualitative expressions of risk. The following activities will be performed as part of the risk characterization process:

- review of toxicity and exposure assessment outputs
- quantification of risks from individual chemicals
- quantification of risks from multiple chemicals
- combination of risks across exposure pathways
- evaluation of the uncertainties associated with the entire risk assessment process
- presentation (in tabular form) of the results of baseline risk characterization

Review of Toxicity and Exposure Assessment Outputs The information generated from the toxicity and exposure data will be reviewed. The assumptions for exposure and toxicity will be compared for consistency and validity.

Quantification of Risks from Individual Chemicals Equations for risk calculations will be based on USEPA guidance (USEPA, 1989b). Applicable equations from the *Risk Assessment Guidance for Superfund* include:

Quantification of Risks from Multiple Chemicals To determine the risk presented by multiple chemicals over the same exposure pathway, the following procedures will be used (USEPA, 1989b): calculate the total cancer risk for each exposure pathway; determine the chronic noncancer Hazard Index for each pathway; determine the applicable subchronic or shorter term noncancer Hazard Indices; and segregate the Hazard Indices by effect if combined Hazard Indices exceed unity (by qualified toxicologist only).

Uncertainty Evaluation Given the considerable number of assumptions and estimates used during the exposure and toxicity assessments, it is important to determine the uncertainty inherent in the final assessment of risk. A qualitative uncertainty evaluation will be presented in the baseline risk assessment report. The following steps will be taken to determine the uncertainties affecting the risk assessment.

Linear low-dose cancer risk equation:

$$\text{Risk} = \text{CDI} \times \text{SF}$$

where:

Risk = unitless probability of an individual developing cancer

CDI = chronic daily intake averaged over 70 years (milligrams per kilogram per day [mg/kg/day])

SF = slope factor (cancer potency factor) expressed in (mg/kg/day)⁻¹

Noncancer hazard quotient expressed as the exposure level (or intake) per RfD (reference dose):

$$E/\text{RfD} = \text{noncancer hazard quotient}$$

where:

E = the exposure level

RfD = reference dose (expressed in the same units and represent the same exposure period)

- Define the physical setting (that is, current and future land use, exposure pathways, and selection of substances for the risk assessment).
- Determine the applicability of the models and assumptions used, including their potential to over- or underestimate risk.
- Summarize the uncertainties associated with the parameters selected for intake calculations.
- Discuss the uncertainties associated with the final risk estimate (use checklist on page 8-22 of the *Risk Assessment Guidance for Superfund* (USEPA, 1989b)).

Discussion and Tabulation of the Risk Characterization Results of the risk characterization will be presented in the baseline risk assessment report, including:

- confidence in the identification of OU-2-related chemicals of potential concern

- relationship of contaminant concentrations to background levels
- potential health risks at and in the near vicinity of OU-2
- confidence in toxicity information and exposure pathways and assumptions
- magnitude of the calculated risks relative to the remediation goals of the National Contingency Plan (cancer risk range of 10^{-4} to 10^{-6} and noncancer Hazard Index of 1.0)
- major factors driving the risk calculations (that is, routes of exposure to chemicals)
- significance and magnitude of uncertainties
- exposed population characteristics
- comparison with other OU-2-specific health studies if available

In addition, a tabular summary of the cancer risks and noncancer Hazard Indices for all exposure pathways, land uses, and chemicals will accompany the explanatory text. Examples of table formats are available in the *Risk Assessment Guidance for Superfund* (USEPA, 1989b).

Summary A summary will be included as the final section of the baseline human health risk assessment. The following major topics will be discussed (with appropriate summary tables included for each topic):

- Chemicals of potential concern
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization

5.5.2 Baseline Ecological Risk Assessment A Baseline Ecological Risk Assessment will be performed for OU-2 (PSCs 2, 3, 4, 41, 42, and 43) in accordance with the *Risk Assessment Guidance for Superfund: Environmental Evaluation Manual* (USEPA, 1989a). The purpose of the ecological risk assessment for OU-2 is to define baseline biological effects associated with exposure to chemical constituents in environmental media. The following five elements comprise the ecological risk assessment: biological

characterization, selection of contaminants of concern, ecological exposure assessment, ecological toxicity assessment, and ecological risk characterization.

5.5.2.1 Contaminant Identification To make the assessment process a more manageable one, environmental sampling results will be screened and a list of contaminants of concern developed. The selection of indicator chemicals will be based on the measured chemical concentrations and frequency of detection in various media at OU-2; the inherent toxicity of each chemical to biological organisms; and finally, the likelihood of exposure to ecological receptors.

5.5.2.2 Ecological Characterization A characterization of the ecological receptors that may be affected by contamination associated with OU-2 will be conducted. This characterization provides a description of the different biological habitats located at NAS Jacksonville and the PSCs that comprise OU-2, and of the animal life expected to be found associated with these habitats. The biological characterization will be based on a physical reconnaissance; background information available for OU-2; literature information on the range and distribution of wildlife species; and interviews with local, state, and/or federal wildlife officials. Particular emphasis will be placed on the following: assessing habitat suitability for aquatic and terrestrial organisms; assessing the potential occurrence of rare, threatened, or endangered species; and identifying wetland or other aquatic areas that may be receptors of OU-2-related contaminants. Additionally, plant communities will be described and observations of aquatic and terrestrial species will be recorded. The results of the receptor analysis will be used in developing the ecological exposure assessment.

5.5.2.3 Ecological Exposure Assessment The purpose of the ecological exposure assessment is to evaluate the potential for ecological exposure to OU-2-related chemicals. This involves identification of potential receptors, identification of potential exposure routes, and evaluation of the magnitude of exposure.

Potential receptor areas and associated receptor species will be described for each PSC at OU-2. Aquatic receptors are considered as the broad class of fish and aquatic invertebrates. Particular species of aquatic organisms are not identified because protective biological criteria are available for aquatic systems as a group (such as in Ambient Water Quality Criteria and Sediment Quality Criteria).

Exposures to different terrestrial species will vary depending on feeding preferences, habitat requirements, home range, and other parameters affecting exposure. For this reason, particular species of terrestrial organisms may be chosen to represent groups of organisms and exposure modeling will be performed for those representative organisms. The represented groups include the major elements of terrestrial food webs (that is,

mammals, birds, reptiles, and amphibians). Plants and decomposers are included in the exposure models as food sources for these groups.

In selecting receptors, an effort will be made to select species that are (1) documented at each PSC in question, (2) herbivorous, omnivorous, or carnivorous, and (3) likely to be exposed to chemicals in surficial media (for example, birds that prey solely on flying insects would not be selected). Exposure pathways for each medium will be identified based on information generated in the receptor analysis. These pathways describe the transport of compounds from source locations to the point of receptor contact and identify the expected exposure route (such as ingestion, dermal absorption, or inhalation). An overview of potential exposure pathways based on preliminary data is presented in Table 5-3. There are several potential routes of exposure for ecological receptors.

Aquatic organisms potentially exposed to chemicals in surface waters and sediments (such as at the pond.) include freshwater aquatic invertebrates. Aquatic organisms may also be exposed to chemicals transported to surface water through groundwater discharge. Species most likely exposed to chemicals in sediments are macroinvertebrates occurring in the sediments or benthic feeding organisms. The presence of fish in the Polishing Pond will be determined as part of the biological characterization.

The second component is the estimation of probable exposure concentrations. For each OU-2 PSC where analytical results indicate that chemicals in surficial media may pose a risk to aquatic or terrestrial organisms, the magnitude of exposure via each pathway will be estimated. To evaluate exposure to aquatic organisms, the reported concentrations of

TABLE 5-3 OVERVIEW OF EXPOSURE PATHWAYS, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

SITE	MEDIUM	ROUTE OF EXPOSURE	POPULATION EXPOSED
PSC-2	soil	incidental ingestion of contaminated soil	birds, mammals, reptiles, invertebrates
		consumption of contaminated prey items	seed-eating birds and mammals, and predatory and omnivorous mammals, birds, reptiles
PSC-3	surface water, sediment	dermal contact with contaminated water and sediment	fish, aquatic invertebrates, amphibians, aquatic reptiles, mammals
		ingestion of contaminated water and sediment	birds, mammals, reptiles, amphibians
	soil	incidental ingestion of contaminated soil	birds, mammals, reptiles, invertebrates
		consumption of contaminated prey items	seed-eating birds and mammals, and predatory and omnivorous mammals, birds, reptiles
PSC-4	soil	incidental ingestion of contaminated soil	birds, mammals, reptiles, invertebrates
		consumption of contaminated prey items	seed-eating birds and mammals, and predatory and omnivorous mammals, birds, reptiles
PSC-41	soil	incidental ingestion of contaminated soil	birds, mammals, reptiles, invertebrates
PSC-42	surface water, sediment	dermal contact with contaminated water and sediment	fish, aquatic invertebrates, amphibians, aquatic reptiles, mammals
		ingestion of contaminated water and sediment	birds, mammals, reptiles, amphibians
	soil	incidental ingestion of contaminated soil	birds, mammals, reptiles, invertebrates
		consumption of contaminated prey items	seed-eating birds and mammals, and predatory and omnivorous mammals, birds, reptiles
PSC-43	soil	incidental ingestion of contaminated soil	birds, mammals, reptiles, invertebrates
		consumption of contaminated prey items	seed-eating birds and mammals, and predatory and omnivorous mammals, birds, reptiles

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OU-2-related chemicals in surface water and sediment will serve as representative exposure concentrations. Average and maximum values will be used to represent chronic and acute exposures, respectively.

Incidental ingestion of contaminated surface soil by environmental receptors associated with foraging and preening activities may result in exposure. The consumption of prey items that have bioaccumulated chemicals in their tissues is another potentially significant exposure pathway.

Potential exposures to terrestrial organisms are expected to vary considerably among species because of differences in feeding behavior, habitat preferences, and other factors affecting exposure. Because of this variability, indicator species will be selected as part of the exposure assessment to best represent the species of terrestrial wildlife potentially exposed.

To evaluate exposure to terrestrial organisms, exposure models will be developed that incorporate OU-2-specific data and various parameters affecting exposure (Appendix C). Exposure concentrations will be modeled for a subset of the wildlife species present; these model species are assumed to be representative of the overall ecological community. For each modeled receptor species, calculated exposure doses from each identified route will be summed to estimate the likely body dose of an average individual. These results will be compared with the toxicity values identified in the toxicity assessment to estimate risk.

5.5.2.4 Ecotoxicity Assessment The ecological toxicity assessment consists of describing the potential consequences of exposure by ecological receptors to the identified contaminants of potential concern. Computer databases (such as IRIS, AQUIRE, DIALOG) will be accessed for recent toxicological information on the identified contaminants of potential concern. Additional sources of relevant information include primary literature, compilations of toxicological data, and various government publications. These data will be used to evaluate the potential toxicity of the predicted terrestrial and aquatic dietary exposure levels and to develop protective reference doses (Reference Toxicity Values) for each contaminant.

Information available to evaluate the toxicity of chemicals of concern in surface water includes FSWQS, AWQC, laboratory-derived toxicity data, and toxicity threshold values developed using extrapolation techniques. These sources will be used to generate Reference Toxicity Values for the chemicals of concern in surface water. Aquatic organisms will not be exposed to chemicals in groundwater unless they are discharged to a surface water body. If FSWQC or AWQC are not available for certain chemicals, USEPA Lowest Observed Adverse Effect Levels will be used. The Lowest Observed Adverse Effect Level values, which are the lowest concentrations causing toxicity

reported in the literature, are used instead of AWQC when insufficient data exist for USEPA to develop a national criterion.

Sediment Quality Criteria are available to evaluate the effects of certain chemicals of concern in sediment on aquatic life (USEPA, 1988d). Sediment Quality Criteria have been developed for a number of hydrophobic organic compounds based on their expected partitioning between sediment organic matter and interstitial water, and are dependent on the TOC present in the sediment. Sediment Quality Criteria will be calculated for chemicals of concern in sediment where possible. However, Sediment Quality Criteria are not available for inorganic chemicals. In lieu of Sediment Quality Criteria, laboratory data available for background samples at OU-2 and in other published or peer-reviewed literature will be used to develop benchmark values for comparison with OU-2 conditions.

Toxicity data for terrestrial receptors consist of laboratory acute and chronic exposure studies. Based on these data, Reference Toxicity Values (RTVs) will be developed for terrestrial organisms that represent a threshold concentration for effects to terrestrial organisms. A preliminary listing of RTVs for OU-2 media is presented in Appendix C. RTVs are expressed in milligrams per kilogram (mg/kg) of body weight/day.

5.5.2.5 Ecological Risk Characterization The degree of risk to aquatic and terrestrial organisms will be evaluated based on results of the ecological exposure assessment and ecotoxicity data for chemicals present at OU-2. Exposure levels will be compared to either criteria or reference doses. For aquatic species, a tabular comparison of available water quality criteria and estimated exposure from sampling data will be used to evaluate risk. To estimate risk to terrestrial organisms, RfDs will be compared with the estimated dietary exposure levels. A narrative discussing the results will accompany the risk evaluation tables.

Risk Assessment Uncertainties Because the prediction of risk involves several uncertainties, a discussion of uncertainties will be included in each subsection of the risk assessment (for example, exposure and toxicity). A summary of the uncertainties will also be included in the evaluation.

5.5.3 Development of Remediation Goals In the baseline risk assessment, USEPA toxicity values and exposure information will be used to derive the quantitative risks associated with OU-2. Results of the baseline risk assessment will indicate whether human or ecological receptors may potentially be at risk if exposed to chemicals detected at OU-2. In addition, comparison of chemical-specific ARARs with concentrations detected in the various media at OU-2 will yield additional information for deriving cleanup standards.

Risk-based goals consider only risks to human health and the environment. Remedial alternatives must also attain action-specific ARARs (such as technology or performance-based standards) and location-specific ARARs.

5.5.3.1 Human Health Remediation Goals Risk-based remediation goals are derived using carcinogenic and/or noncarcinogenic toxicity values and specific exposure conditions specified in the baseline risk assessment (USEPA, 1991d). USEPA Region IV (1991b) has identified target risk levels that must be calculated for the contaminants of concern:

- For carcinogenic effects, concentrations are calculated that correspond to the 10^{-4} , 10^{-5} , and 10^{-6} incremental risk of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen from all significant exposure pathways for a given medium.
- For noncarcinogenic effects, concentrations are calculated that correspond to Hazard Indices of 1 and 10.

Total risk refers to the combined risk for a single chemical from all exposure pathways for a given medium (such as water ingestion and inhalation of volatiles from water). By setting the total risk for carcinogenic effects at the target risk levels of 10^{-4} , 10^{-5} , and 10^{-6} , it is possible to solve for the concentration term (that is, the risk-based remediation goals). In a similar manner, a Hazard Index of 1 or 10 for each chemical is used to derive a concentration range for noncarcinogens. Sample calculations for developing remediation goals for carcinogenic and noncarcinogenic contaminants are provided in Appendix C.

The derivation of several risk levels yields a range of concentrations for which remediation goals may be determined. During the decision-making process for evaluating remediation technologies, a realistic target risk level will be determined that falls within this range. Thus, a single remediation goal will be used in the remediation calculations (such as the volume of waste to be removed).

In many cases, one or two chemicals may drive the cleanup at a site. These limiting chemicals will generally be either responsible for much of the baseline risk or are the least amenable to the selected treatment method. By remediating these chemicals to their respective goals, the other chemicals will typically be remediated to concentrations at or below their goals.

In the development of soil remediation goals, the potential for contaminants to leach to groundwater must also be evaluated. Frequently, the leaching potential of contaminants will drive the remediation goals rather than the direct contact exposure pathway.

5.5.3.2 Ecological Remediation Goals Results of the baseline risk assessment will indicate whether ecological receptors may be at risk if exposed to chemicals detected at OU-2. Aquatic and/or terrestrial organisms may be at risk because of exposure to chemicals in surface water, sediments, or surface soil.

To guide remedial measures, soil, sediment, and surface water remediation goals will be developed as required. The contaminants for which target risk levels will be determined are those chemicals responsible for risks above a Hazard Index of 1. The target risk levels will represent the residual concentrations of contaminants that may remain in environmental media following a remedial action.

Aquatic criteria, designed to be protective of most species of aquatic organisms (such as Reference Toxicity Values developed for aquatic organisms), are available. Because exposure concentrations are equivalent to the measured environmental concentrations for aquatic organisms, the criteria can be used directly as target risk levels for those organisms.

Surface water remediation goals cannot be achieved by direct remediation of surface water. Rather, they will be achieved via remediation of source areas (such as sediment and groundwater) and post-remediation levels determined by monitoring of surface water quality.

For terrestrial organisms, identification of chemicals to be evaluated involves ranking the chemicals in decreasing order to their percentage contribution to the total risk to each receptor. As a result of this selection process, contaminants of concern and the affected media will be identified for development of target risk levels.

The target values will be apportioned equally among the number of chemicals to yield chemical-specific target Hazard Indices. In the case where two chemicals result in Hazard Index values above 1, the maximum acceptable Hazard Index for each chemical is apportioned as 0.5, yielding a total target risk of 1. Where both aquatic and terrestrial organisms are at risk because of exposure to a given medium (such as sediment), the lower of the two target levels will be chosen as the final ecological target level.

Areas near a site may represent a source of chemical contamination. Therefore, prevention of erosion of contaminants in surface soils via containment, treatment, or excavation will also be considered remedial alternative objectives.

5.6 TASK 6 - REMEDIAL INVESTIGATION REPORT. The RI report will be prepared using the most current USEPA RI guidance. After internal review, the document will be prepared for submission to the NAS Jacksonville Technical Review Committee for

review. A final RI document will include a responsiveness summary based on comments received.

6.0 FEASIBILITY STUDY TASKS

6.1 TASK 7 - DEVELOPMENT/SCREENING OF REMEDIAL ALTERNATIVES. Task 7 consists of three subtasks: (1) development of remedial action objectives, (2) identification of applicable remedial technologies, and (3) development and screening of remedial alternatives. These subtasks are described in the following paragraphs.

6.1.1 Development of Remedial Action Objectives Remedial action objectives will be developed as medium-specific or operable unit-specific goals for protecting human health and the environment. They will specify: (1) the contaminant(s) of concern; (2) the exposure route(s) and receptor(s); and (3) an acceptable remediation goal (or range) for each exposure route. Remedial action objectives for protecting human receptors should express both a contaminant level or goal and an exposure route, rather than contaminant levels alone, because protectiveness may be achieved by reducing exposure (USEPA, 1988b).

Examples of remedial action objectives that may be developed for the FS are listed below:

- prevent ingestion of water having carcinogens in excess of their respective MCLs and/or
- prevent ingestion of water with a total excess cancer risk (for all contaminants) of greater than 1×10^{-4} and/or
- prevent ingestion of water having noncarcinogens in excess of their respective MCLs, and/or
- prevent ingestion of water with a noncarcinogenic Hazard Index greater than 1 for any one specific target organ.

More or fewer remedial action objectives may be developed depending on the results of the RI. The remedial action objectives developed in the FS will list the specific contaminants and could refine the total excess cancer risk and Hazard Index.

6.1.2 Identification of Applicable Remedial Technologies Potential general response actions, technologies, and processes will be identified that address the remedial action objectives. General response actions (for example, prevent exposure or groundwater extraction and treatment) are those that when combined, or individually, satisfy the remedial action objective. A general response action can include several technologies or processes. Technologies can be treatment technologies such as air stripping or

solidification or groundwater extraction techniques. Processes can include, for example, discharge options, disposal options, or monitoring. The potential technologies and processes will be presented in tabular format and may be screened to produce a viable inventory to assemble into remedial alternatives that address contamination at OU-2. A preliminary list of technologies was discussed in Subsection 4.4.

The technology screening process may reduce the number of potentially applicable technologies and processes by evaluating the overall advantages and disadvantages of each considering effectiveness, implementability, and cost. Technologies and/or processes judged ineffective or unimplementable at a reasonable cost (if any) will be eliminated from further consideration. The retained technologies and processes will represent the ideal inventory to be assembled into remedial alternatives.

6.1.3 Development and Screening of Remedial Alternatives The technically feasible technologies and processes will be combined to form remedial alternatives to attain the remedial action objectives. Normally, several alternatives are developed that range from no action to complete source and/or groundwater treatment. However, circumstances specific to the operable unit or contaminants may limit the number of options applicable to the site, and the screening step may be curtailed (USEPA, 1990b). In addition, the developed alternatives may represent the most suitable alternatives to take to detailed analysis. Therefore, alternative screening may not be conducted.

6.2 TASK 8 - TREATABILITY STUDIES. Treatability studies may be conducted to achieve the following objectives:

1. Provide sufficient data to allow treatment alternatives to be fully developed and evaluated using the detailed analysis and to support the remedial design of a selected alternative.
2. Reduce cost and performance uncertainties for treatment alternatives to acceptable levels so that a remedy can be selected (USEPA, 1988b).

If removing inorganics from groundwater becomes the primary concern, oxidation/precipitation and/or ion exchange treatability studies may be desirable. Information gained from the treatability studies should reduce cost and performance uncertainties for those two treatment technologies.

Groundwater technologies for organics removal are not being considered for treatability studies at this time. The data from previous site investigations indicate that inorganics would be the primary concern, and organics secondary. If the RI data suggests otherwise, then organics removal treatability testing may be considered.

Soil/sludge treatment technologies are not considered for treatability studies at this time. Consideration will be reserved until the RI is complete and possible hot spots identified. If these hot spots are adversely affecting the groundwater to such a magnitude that treatment may be required, the necessity of treatability studies will be considered.

Treatability testing can be performed using bench- or pilot-scale techniques. Generally, treatability testing may include the following steps: (1) preparation of a treatability testing work plan, (2) performance of treatability testing, (3) evaluation of the data, and (4) preparation of a summary report.

A Treatability Testing Study Work Plan will be prepared after the remedial alternatives are developed if additional data from treatability studies are needed to evaluate a remedial technology. The Treatability Testing Study Work Plan will outline the steps necessary to execute and evaluate the treatability study, including the scope, schedule, and budget. After the treatability testing study is complete, a summary report will be prepared.

6.3 TASK 9 - DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES. The detailed analysis section will include a conceptual design description for each alternative. The conceptual design may include site plans, process flow diagrams, general arrangement diagrams, cross-sections, and/or other aids in communicating the conceptual design. A conceptual design allows for a more detailed cost estimate to be performed. The conceptual design and the detailed cost estimate will constitute most of the detailed analysis section.

A sensitivity analysis may be performed on an alternative(s) if there is sufficient uncertainty concerning specific assumptions. Use of sensitivity analyses should be considered for the factors that can significantly change overall costs of an alternative with only small changes in their values, especially if the factors have a high degree of uncertainty associated with them (USEPA, 1988b).

Each alternative will then be assessed against the nine evaluation criteria recommended in USEPA's RI/FS guidance (USEPA, 1988b). The detailed analysis will be presented in a table format. The nine criteria are described in Table 6-1.

TABLE 6-1 CRITERIA FOR DETAILED ANALYSIS OF ALTERNATIVES, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

CRITERIA	DESCRIPTION
Overall protection of human health and environment	Describes how each alternative satisfies the remedial action objectives; protects human health and environment.
Compliance with ARARs	Describes how the alternative complies with ARARs, or if a waiver is required and how it is justified.
Long-term effectiveness and permanence	Evaluates the effectiveness in protecting human health and environment after response objectives have been met.
Reduction of toxicity, mobility, or volume through treatment	Evaluates the anticipated performance of the specific treatment technologies.
Short-term effectiveness	Examines the effectiveness of alternative in protecting human health and environment during the construction and implementation period until response objectives are met.
Implementability	Assesses the technical and administrative feasibility of alternative and the availability of required resources.
Cost	Evaluates the capital, operation and maintenance costs of each alternative.
State acceptance*	Evaluates the technical and administrative issues and concerns the state may have.
Community Acceptance*	Evaluates the issues and concerns the public may have.

Notes:

* This criterion will be addressed once comments on the Feasibility study have been received.

ARARs Applicable or Relevant and Appropriate Requirements

6.4 TASK 10 - FEASIBILITY STUDY REPORT. Preparation of the FS report will follow the latest USEPA FS guidance. After internal review, the document will be prepared for submission to the NAS Jacksonville Technical Review Committee for review. A final FS document(s) will include a responsiveness summary based upon comments received.

7.0 PROJECT ORGANIZATION AND RESPONSIBILITY

This section describes the organizational structure of personnel to be employed for the RI/FS at OU-2. This illustrates the lines of authority and identifies the key personnel assigned to various activities for the project. A proposed organizational structure chart for the investigation is shown in Figure 7-1. Project management for the OU-2 investigations will be performed in accordance with the procedures outlined in the Project Management Plan in Section 2, Volume 1, Organization and Planning.

7.1 AUTHORITY AND RESPONSIBILITIES. The responsibilities of individual positions for this project are described in the following subsections.

7.1.1 U.S. Navy Remedial Project Manager (RPM)

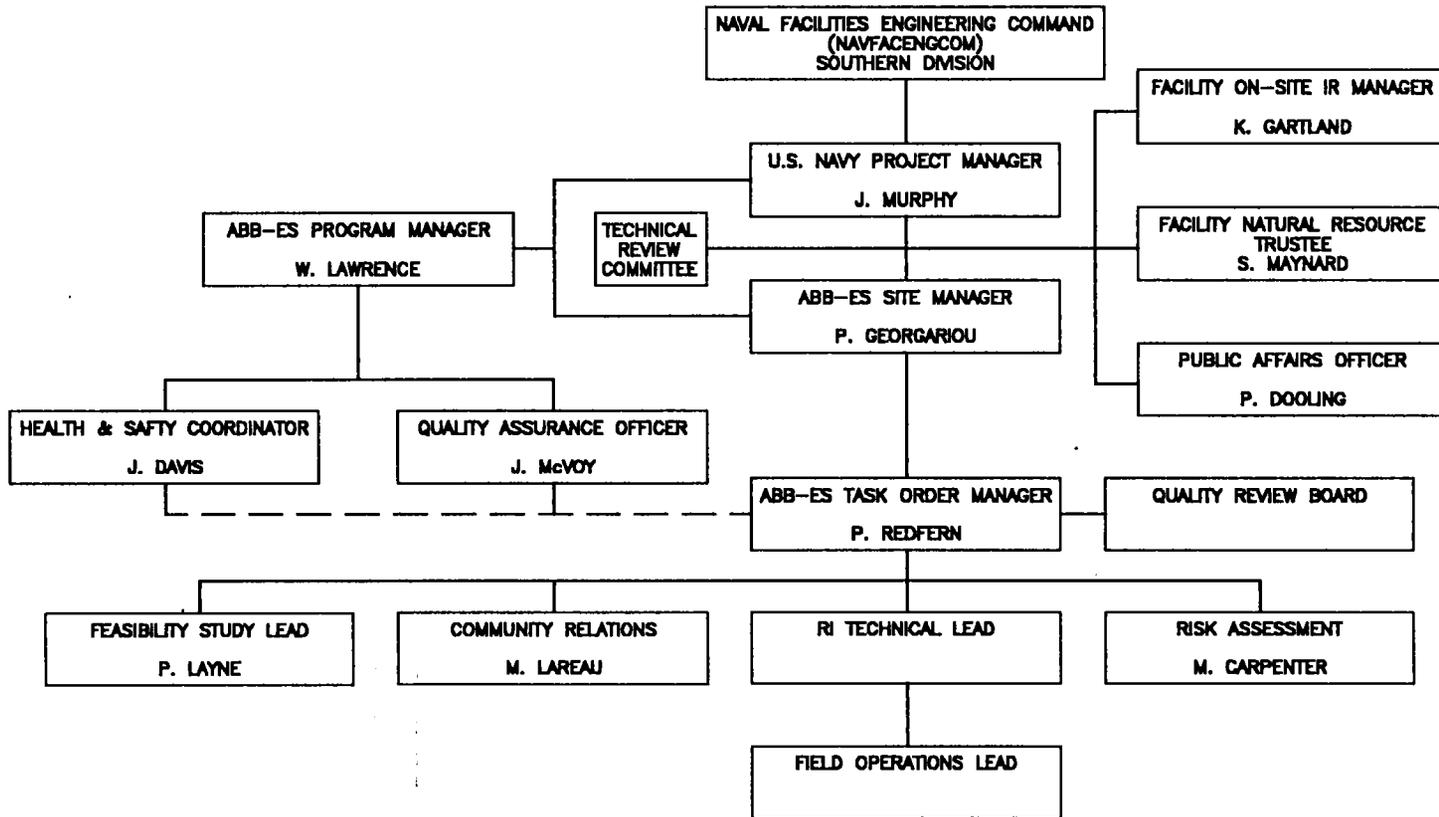
Joel Murphy
Southern Division [Code 1853],
Naval Facilities Engineering Command
2155 Eagle Drive, P.O. Box 10068
Charleston, South Carolina 89411-0068

The U.S. Navy RPM will review and approve the Work Plans and work activities for the duration of the project and direct the coordination of U.S. Navy policy and environmental objectives. He will be responsible for assuring that all site activities conducted by the Contractor and its subcontractors are in agreement with the policies of the Navy and NAS Jacksonville.

7.1.2 Facility Installation Restoration Manager (FIRM)

Kevin Gartland
Naval Air Station
Public Works Department, Engineering Division
Box 5, Code 184, 1841R Building 902
Jacksonville, Florida 32212-5000

The FIRM will be the primary contact at the site. He will be responsible for the day-to-day Navy coordination of on-site activities described in the Work Plan. He will assist the Navy RPM with assuring that all site activities conducted by the Contractor and its subcontractors are in agreement with the policies of the Navy and NAS Jacksonville.



Z:\7559-25\FIG\7559F007\12-22-92

RI/FS
 WORK PLAN OU-2
 N.A.S. JACKSONVILLE
 DECEMBER 1992



FIGURE 7-1
 PROJECT ORGANIZATION

7.1.3 Program Manager

William Lawrence
ABB Environmental Services, Inc.
2590 Executive Center Circle East
Berkeley Building
Tallahassee, Florida 32301

The Program Manager is responsible for ABB-ES' overall implementation of the NIRP within SOUTHNAVFACENGCOM. As an officer of ABB-ES, he has authority to commit the necessary resources to ensure timely completion of project tasks.

7.1.4 Site Manager

Philip Georgariou
ABB Environmental Services, Inc.
2590 Executive Center Circle East
Berkeley Building
Tallahassee, Florida 32301

The Site Manager is responsible for coordinating all of ABB-ES' RI/FS activities at NAS Jacksonville. This administrative function provides a single point of contact for the Navy RPM and the FIRM concerning global administrative issues at NAS Jacksonville. Other duties, as required, may include:

1. Coordinating with the OU-2 Task Order Manager concerning scheduling equipment and manpower
2. Reviewing OU-2 project progress
3. Final review of all OU-2 documents, plans, and drawings
4. Approving project-specific procedures
5. Ensuring that the technical, schedule, and control requirements established by the Quality Assurance Officer are enforced on the project
6. Serving as the "collection point" for the Task Order Managers reporting changes and deviations from the project Work Plan

7. Evaluating the significance of these changes or deviations to the Work Plan, and the appropriateness for reporting such items to the appropriate regulatory and Navy representatives

7.1.5 Task Order Manager

Peter Redfern
ABB Environmental Services, Inc.
2590 Executive Center Circle, East
Berkeley Bldg.
Tallahassee, Florida 32301-5001

The Task Order Manager for the OU-2 RI/FS will have day-to-day responsibility for conducting the work in accordance with the requirements established by the Contract Task Order. The Task Order Manager will be responsible for:

1. Assembling the project team, assigning tasks to the team, and orienting the team to the project's requirements
2. Arranging for subcontractor services
3. Developing the technical requirements and level of effort required to address each element of a specific task
4. Evaluating the appropriateness and adequacy of the technical and engineering services provided
5. Developing and monitoring of task scope, schedule, and budget
6. Integrating the efforts of all supporting disciplines and subcontractors
7. Preparing OU-2 status update reports on behalf of the Site Manager
8. Representing ABB-ES at Technical Review Committee meetings and at project review meetings with the Navy Project Manager

7.1.6 Field Coordinator

ABB Environmental Services, Inc.
2590 Executive Center Circle, East
Berkeley Bldg.
Tallahassee, Florida 32301-5001

The Field Coordinator or Field Operations Leader will be designated to be responsible for interacting with the on-site FIRM to schedule the day-to-day field activities. Other duties may include:

1. Reviewing on-site activities for compliance with the site Work Plan
2. Preparing of daily/weekly status report
3. Monitoring ABB-ES' field team and subcontractor progress
4. Ensuring that recordkeeping meets requirements of the Contract Task Order

7.1.7 Remedial Investigation Technical Leader

ABB Environmental Services, Inc.
2590 Executive Center Circle, East
Berkeley Bldg.
Tallahassee, Florida 32301-5001

The RI Technical Leader will be responsible for:

1. Coordinating with the Field Operations Leader to implement the RI field activities per the requirements of the Work Plan
2. Preparing of the RI report
3. Maintaining the RI project files
4. Representing ABB-ES at Technical Review Committee meetings

7.1.8 Risk Assessment

Marguerite Carpenter, PhD
ABB Environmental Services, Inc.
110 Free Street
Portland, Maine 04112-7050

Dr. Carpenter will be responsible for planning and coordinating the public health and ecological risk assessments, supported by the RI data, to identify remediation goals for the site that are within acceptable risk ranges.

7.1.9 Feasibility Study Leader

Peggy Layne
ABB Environmental Services, Inc.
2590 Executive Center Circle, East
Berkeley Bldg.
Tallahassee, Florida 32301-5001

The FS Leader will be for coordinating FS activities and for ensuring that the FS progresses in accordance with the Work Plan scope and schedule.

7.2 SUPPORT ROLES.

7.2.1 Quality Assurance Officer

John C. McVoy
ABB Environmental Services, Inc.
2590 Executive Circle East
Berkeley Building
Tallahassee, Florida 32301

The Task Order Manager is supported by the Quality Assurance Officer, who will report directly to the Program Manager. The Quality Assurance Officer will be the liaison among the laboratories, ABB-ES, and the U.S. Navy. The Quality Assurance Officer will ensure the accuracy of the collected data through the performance of the following tasks:

1. Field and laboratory performance audits
2. Quality assurance program design for field sample collection and analytical testing
3. Field and analytical data validation audits
4. Selection of the analytical laboratory
5. Preparation of laboratory contracts

7.2.2 Health and Safety Coordinator

Jack Davis
ABB Environmental Services, Inc.
2590 Executive Circle East

Berkeley Building
Tallahassee, Florida 32301

The Health and Safety Coordinator is responsible for OU-2 project compliance with ABB-ES' corporate requirements and the NAS Jacksonville Health and Safety Plan. Conformance with health and safety protocols will be assessed through periodic site visits by the Health and Safety Coordinator and by daily supervision by the Field Operations Leader.

7.2.3 Quality Review Board

Willard Murray, PhD.
ABB Environmental Services, Inc.
107 Audubon Road
P.O. Box 264
Wakefield, Massachusetts 01880

A Quality Review Board, consisting of ABB-ES senior technical staff, will support the Task Order Manager by reviewing technical aspects of the project so that services: (1) reflect the accumulated experience of the firm, (2) are produced according to ABB-ES and Navy policy, and (3) meet the requirements of the project. The primary function of the Quality Review Board will be to support the application of technically sound methodologies and the development of technically defensible data, interpretations, and conclusions. Dr. Willard Murray will act as the coordinator of Quality Review Board activities and will be responsible for identifying the reviewers needed during project execution.

7.3 COMMUNITY RELATIONS.

Robinson & St. John Advertising & Public Relations, Inc., will be responsible for coordinating ABB-ES' community relations support activities at the direction of SOUTHNAVFACENGCOM and the NAS Jacksonville Public Affairs Officer. Community relations activities are detailed in the Community Relations Plan provided in Appendix 1.4, Volume 1, Organization and Planning. Implementation of the plan is the responsibility of NAS Jacksonville. The plan's objectives are to inform the public of the NIRP and its results and also to facilitate public involvement and input in the process. During the RI/FS at OU-2, ABB-ES estimates that its support to the NAS Jacksonville Public Affairs Office will be to:

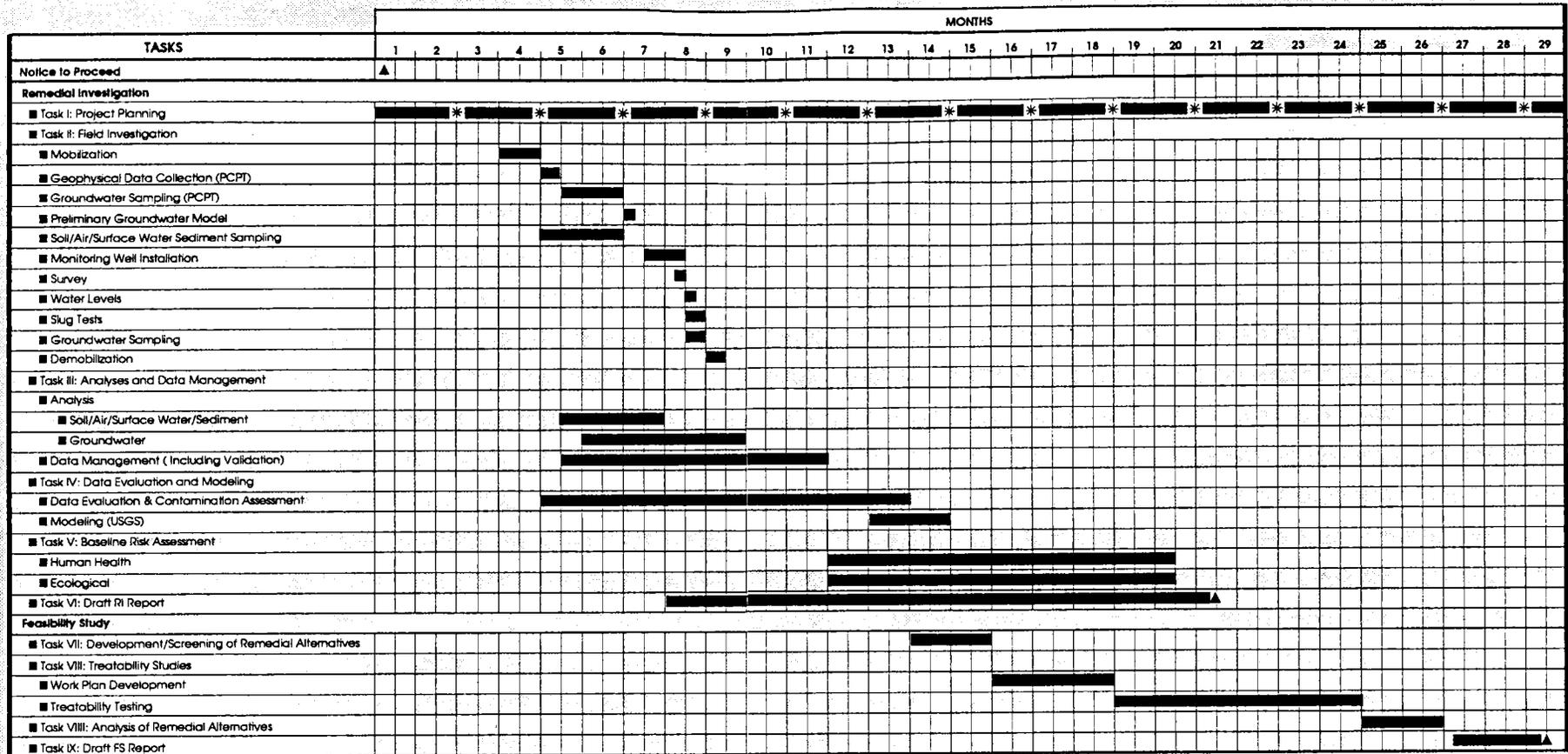
- Develop press releases and fact sheets regarding the onset of the investigation, its progress, and findings.

- Attend Technical Review Committee meeting near the completion of the RI/FS to discuss community involvement activities that will follow this stage.

The following activities are not expected to require ABB-ES support:

- Developing or maintaining the mailing list
- Contacting local officials
- Participating in informal, local community meetings

7.4 SCHEDULE. The schedule for the RI/FS events for OU-2 through the Record of Decision is contained in the Site Management Plan (Volume 1, Appendix 1.6). The sequence of events and duration in calendar days for RI field investigations at OU-2 is presented in Figure 7-2.



KEY

- * MEETING
- ▲ MILESTONE

RI/FS
 WORK PLAN FOR OU2

 NAS JACKSONVILLE
 DECEMBER 1992



PROJECT SCHEDULE
 FIGURE 7-2

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APPENDIX A

SAMPLING AND ANALYSIS PLAN

APPENDIX A-1

**QUALITY ASSURANCE PROJECT PLAN
(QAPjP)**

OU-2 QUALITY ASSURANCE PROJECT PLAN

FOR

NAVAL AIR STATION
JACKSONVILLE, FLORIDA

APPENDIX A-1
OF THE OU-2 PROJECT WORK PLAN

DECEMBER 1992

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SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SOUTH CAROLINA

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GLOSSARY OF ACRONYMS

ABB-ES	ABB Environmental Services, Inc.
DQCR	Daily Quality Control Report
FDER	Florida Department of Environmental REgulation
FFA	Federal Facilities Agreement
FOL	field operations leader
FS	Feasibility Study
FSP	Field Sampling Plan
NEESA	
OU-2	Operable Unit 2
PSC	potential sources of contamination
QAP	Quality Assurance Plan
QAPP	Quality Assurance Program Plan
QAPjP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RI	Remedial Investigation
SOP	Standard Operating Procedure
U.S. DOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency

1.0 INTRODUCTION

In accordance with the Federal Facilities Agreement (FFA), the Navy through the Southern Division of the Naval Facilities Engineering Command, has agreed to prepare and implement a Remedial Investigation/Feasibility Study (RI/FS) Work Plan for potential sources of contamination (PSC) at the Naval Air Station in Jacksonville, Florida. Operable Unit 2 (OU-2), will be investigated during the RI/FS implementation process.

1.1 PROJECT BACKGROUND. The purpose of the RI/FS is to: (1) establish the presence of constituents of concern; (2) determine the areal and vertical distribution of constituents of concern in the soil, sediment, surface water, and groundwater; (3) evaluate the potential for migration of constituents of concern to surrounding environments; (4) assess the risks to human health and the environment of constituents detected at OU-2; (5) establish remedial action objectives; (6) identify potential alternatives to meet the remedial action objectives; and (7) determine the scope of additional investigations or actions necessary to meet the goals of the RI/FS.

To accomplish these objectives, the Navy will be required to conduct several data collection tasks, which include drilling soil borings, installing monitoring wells, determining the elevation of groundwater, and collecting environmental samples of soil and groundwater for chemical and physical analysis parameters.

To ensure the quality of the field and laboratory data produced during the implementation of the RI/FS at OU-2, an OU-2 Quality Assurance Project Plan (QAPjP) has been prepared. The QAPjP has been prepared according to the guidelines set forth by the U.S. Environmental Protection Agency (USEPA) in *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans*, (QAMS-005/80) and by the Navy in *Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program*, (NEESA 20.2-047B). This QAPjP follows the format of the OU-1 QAPjP (Geraghty & Miller, Inc., 1991) and the Quality Assurance Program Plan (QAPP) included as Appendix 4.4.1 of the Basic Site Work Plan (Volume 4). When possible, sections of the OU-1 QAPjP have been incorporated verbatim and sections of the Site QAPP have been incorporated by reference into this OU-2 QAPjP. The QAPjP will be available to the field and laboratory personnel to provide guidance concerning methodologies of data collection, proper recordkeeping protocols, data quality objectives, and procedures for data review.

1.2 SITE BACKGROUND. The site background is described in Section 2.0 of the OU-2 Project Work Plan.

1.3 FIELD QUALITY CONTROL AND QUALITY ASSURANCE SAMPLING. Quality assurance information related to specific sample handling and analysis

procedures is presented in the respective Generic Quality Assurance Plans (QAPs), included as Attachments A, B, and C of the Basic Site Work Plan QAPP (Appendix 4.4.1, Book 2 of Volume 4 of the Naval Installation Restoration Program Plan for Naval Air Station Jacksonville).

During implementation of the field sampling program described in the Field Sampling Plan (FSP) of the OU-2 Project Work Plan, field quality control and field quality assurance samples will be collected to assess the reproducibility of the field collection techniques, the quality of preservation reagents and sample bottles, and the adequacy of field decontamination procedures.

1.4 DATA ANALYSIS AND REPORT PREPARATION. After the completion of each sampling and analysis program, the field and analytical data will be reviewed. Field laboratory results will be evaluated and on-site laboratory data will be validated. The data will be classified for usability as described in Section 9.0 of the QAPP (Appendix 4.4.1, Volume 4) and summarized in appropriate tables, charts, and figures in accordance with data management procedures described in Volume 1 of the Naval Installation Restoration Program Plan, Organization and Planning. Reporting will be in accordance with Appendix 4.3, Final Product/Report Quality Assurance Quality Control (QA/QC) Plan, in the Basic Site Work Plan, Volume 4.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The overall project organization and the responsibilities associated with the job functions required to implement the OU-2 RI/FS Work Plan are described in Section 7.0 of the OU-2 Project Work Plan. The primary and secondary analytical laboratories are described in Section 2.0 of the Basic Site Work Plan QAPP (Appendix 4.4.1 of Volume 4).

3.0 QUALITY ASSURANCE OBJECTIVES

The quality assurance objectives that will apply to data generated during this investigation are presented in Tables 3-1, 3-2, and 3-3.

Table 3-1. Analytical Methods, Data Precision, Accuracy and Completeness Objectives for the Remedial Investigation at OU-2, NAS Jacksonville

Parameter	Matrix	Method	Precision %	Accuracy %	Completeness	Practical Quantitation Limit
		Analysis	Percent RPD of Duplicate %	Spike Percent Recovery Range %	Z	Water = µg/L % Soil = mg/kg %
<u>Metals</u>						
Aluminum	Water	200.7 CLP-M	0-20	75-125	96	50
	Soil/Sediment	200.7 CLP-M	0-35	75-125	96	5
Antimony	Water	200.7 CLP-M	0-20	75-125	96	50
	Soil/Sediment	200.7 CLP-M	0-30	75-125	96	5
Arsenic	Water	206.2 CLP-M	0-20	75-125	96	10
	Soil/Sediment	206.2 CLP-M	0-30	75-125	96	1
Barium	Water	200.7 CLP-M	0-20	75-125	96	10
	Soil/Sediment	200.7 CLP-M	0-30	75-125	96	1
Beryllium	Water	200.7 CLP-M	0-20	75-125	96	5
	Soil/Sediment	200.7 CLP-M	0-30	75-125	96	0.5
Cadmium	Ground Water	200.7 CLP-M	0-20	75-125	96	5
	Surface Water	213.2 CLP-M	0-20	75-125	96	1
Calcium	Water	200.7 CLP-M	0-20	75-125	96	10
	Soil/Sediment	200.7 CLP-M	0-35	75-125	96	5
Chromium	Water	200.7 CLP-M	0-20	75-125	96	10
	Soil/Sediment	200.7 CLP-M	0-30	75-125	96	1
Cobalt	Water	200.7 CLP-M	0-20	75-125	96	10
	Soil/Sediment	200.7 CLP-M	0-35	75-125	96	5
Copper	Water	200.7 CLP-M	0-20	75-125	96	25
	Soil/Sediment	200.7 CLP-M	0-30	75-125	96	2.5
Iron	Water	200.7 CLP-M	0-20	75-125	96	10
	Soil/Sediment	200.7 CLP-M	0-35	75-125	96	5
Lead	Water	239.2 CLP-M	0-20	75-125	96	5
	Soil/Sediment	239.2 CLP-M	0-30	75-125	96	0.5
Magnesium	Water	200.7 CLP-M	0-20	75-125	96	50
	Soil/Sediment	200.7 CLP-M	0-35	75-125	96	5
Manganese	Water	200.7 CLP-M	0-20	75-125	96	10
	Soil/Sediment	200.7 CLP-M	0-35	75-125	96	5
Mercury	Water (all)	245.1 CLP-M	0-20	75-125	96	0.2
	Soil/Sediment	245.5 CLP-M	0-30	75-125	96	0.03
Nickel	Water	200.7 CLP-M	0-20	75-125	96	40
	Soil/Sediment	200.7 CLP-M	0-30	75-125	96	4
Potassium	Water	200.7 CLP-M	0-20	75-125	96	Dependent on ICP conditions
	Soil/Sediment	200.7 CLP-M	0-35	75-125	96	
Selenium	Water	270.2 CLP-M	0-20	75-125	96	5
	Soil/Sediment	270.2 CLP-M	0-30	75-125	96	1
Silver	Ground Water	200.7 CLP-M	0-20	75-125	96	10
	Surface Water	272.2 CLP-M	0-20	75-125	96	1
Sodium	Soil/Sediment	200.7 CLP-M	0-30	75-125	96	1
	Water	200.7 CLP-M	0-20	75-125	96	50
Thallium	Soil/Sediment	200.7 CLP-M	0-35	75-125	96	5
	Water	279.2 CLP-M	0-20	75-125	96	10
	Soil/Sediment	279.2 CLP-M	0-30	75-125	96	1

Table 3-1. Analytical Methods, Data Precision, Accuracy and Completeness Objectives for the Remedial Investigation at OU-2, NAS Jacksonville

		Method	Precision ^v	Accuracy ^v	Completeness	Practical Quantitation Limit
Parameter	Matrix	Analysis	Percent RPD of Duplicate ^v	Spike Percent Recovery Range ^v	%	Water = $\mu\text{g/L}$ ^w Soil = mg/kg ^w
Vanadium	Water	200.7 CLP-M	0-20	75-125	96	10
	Soil/Sediment	200.7 CLP-M	0-35	75-125	96	5
Zinc	Water	200.7 CLP-M	0-20	75-125	96	20
	Soil/Sediment	200.7 CLP-M	0-30	75-125	96	2

Table 3-1. Analytical Methods, Data Precision, Accuracy and Completeness Objectives for the Remedial Investigation at OU-2, NAS Jacksonville

		Method	Precision ^v	Accuracy ^v	Completeness	Practical Quantitation Limit
Parameter	Matrix	Analysis	Percent RPD of Duplicate ^w	Spike Percent Recovery Range ^y	Z	Water = µg/L ^v Soil = mg/kg ^v
<u>Other</u>						
Cyanide	Water	335.2 CLP-M	0-20	75-125	96	10
	Soil/Sediment	335.2 CLP-M	0-35	75-125	96	5
<u>Radiological</u>	Water	See Table 3-2	See Table 3-2	See Table 3-2	See Table 3-2	See Table 3-2
	Soil/Sediment	See Table 3-2	See Table 3-2	See Table 3-2	See Table 3-2	See Table 3-2
<u>Organics</u>						
Volatiles	Water	624 CLP-M	See Table 3-2	See Table 3-2	See Table 3-2	See Table 3-2
	Soil/Sediment	624 CLP-M	See Table 3-2	See Table 3-2	See Table 3-2	See Table 3-2
Base-Neutral Acid Extractables	Water	625 CLP-M	See Table 3-2	See Table 3-2	See Table 3-2	See Table 3-2
	Soil/Sediment	625 CLP-M	See Table 3-2	See Table 3-2	See Table 3-2	See Table 3-2
PCBs	Water	608 CLP-M	See Table 3-2	See Table 3-2	See Table 3-2	See Table 3-2
PCBs	Soil/Sediment	608 CLP-M	See Table 3-2	See Table 3-2	See Table 3-2	See Table 3-2
Dioxin	Soil	8280	See Table 3-2	See Table 3-2	See Table 3-2	See Table 3-2

Notes:

- ^v Precision and accuracy where applicable will be evaluated according to procedures in U.S. EPA Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. Revised March 1983, and in the EPA CLP statement of work (most current version).
- ^w $ORPD = [(S-D)/(S+D)/2] \times 100$ for samples > 5x RDL
 ORPD not calculated (NC), result < DL
 oFor results < 5x DL, values must agree within ± DL as specified by EPA-CLP. Inorganics, SOW (most current version).
- ^y ZRelative Standard Deviation.
- ^z Detection limit will vary depending on matrix differences that result in sample dilution and for soils, detection limit will also vary depending on moisture content of sample if results are reported as dry weight.

Table 3-2. Practical Quantitation Limits, Accuracy, Precision, and Completeness Objectives of Organics Analyses for the Remedial Investigation at OU-2, NAS Jacksonville

Parameters	Precision ^{1/}		Accuracy ^{1,2/}		Completeness (%)	Practical Quantitation Limit ^{3/}	
	Water	Soils	Water	Soils		Water ug/L	Soils ug/kg
<u>Volatile Organics (TCL 624 CLP-M)</u>							
Acetone	0-40	0-47	47-143	32-163	96	25	25
Benzene	0-11	0-21	76-127	66-142	96	5	5
Bromodichloromethane	0-40	0-42	35-155	37-160	96	5	5
Bromoform	0-40	0-33	46-169	48-152	96	5	5
Bromomethane	0-65	0-61	10-170	10-160	96	10	10
2-Butanone	0-40	0-38	46-153	37-161	96	10	10
Carbon Disulfide	0-40	0-40	53-148	43-169	96	5	5
Carbon Tetrachloride	0-40	0-36	71-140	67-138	96	5	5
Chlorobenzene	0-13	0-21	75-130	60-133	96	5	5
Chloroethane	0-80	0-72	10-160	12-147	96	10	10
2-Chloroethylvinyl ether	0-94	0-83	10-199	10-184	96	10	10
Chloroform	0-40	0-43	60-140	51-139	96	5	5
Chloromethane	0-60	0-87	10-140	10-130	96	10	10
Dibromochloromethane	0-40	0-49	56-142	53-140	96	5	5
1,1-Dichloroethane	0-43	0-38	10-169	58-161	96	5	5
1,2-Dichloroethane	0-40	0-37	56-146	47-143	96	5	5
1,1-Dichloroethene	0-14	0-22	61-145	59-172	96	5	5
trans-1,2-Dichloroethene	0-40	0-40	56-146	56-146	96	5	5
1,2-Dichloropropane	0-55	0-46	10-162	10-178	96	5	5
cis-1,3-Dichloropropene	0-62	0-53	10-162	10-163	96	5	5
trans-1,3-Dichloropropene	0-45	0-49	26-160	21-139	96	5	5
2-Hexanone	0-40	0-38	49-151	47-153	96	10	10
Ethyl Benzene	0-40	0-40	38-152	27-161	96	5	5
4-Methyl-2-pentanone	0-40	0-49	46-152	40-163	96	10	10
Methylene Chloride	0-40	0-39	41-177	40-162	96	5	5
Styrene	0-42	0-40	34-176	37-163	96	5	5
1,1,2,2-Tetrachloroethane	0-40	0-38	54-142	47-138	96	5	5

Table 3-2. Practical Quantitation Limits, Accuracy, Precision, and Completeness Objectives of Organics Analyses for the Remedial Investigation at OU-2, NAS Jacksonville

Parameters	Precision ^{1/}		Accuracy ^{1,2/}		Completeness (%)	Practical Quantitation Limit ^{3/}	
	Percent RPD of Duplicates Water	Soils	Spike Recovery Water	Percent Recovery Soils		Water ug/L	Soils ug/kg
<u>Volatile Organics (TCL) (624 CLP-M) (Continued)</u>							
Tetrachloroethene	0-40	0-29	70-140	52-139	96	5	5
Toluene	0-13	0-21	76-125	59-139	96	5	5
1,1,1-Trichloroethane	0-40	0-28	55-150	42-147	96	5	5
1,1,2-Trichloroethane	0-40	0-34	53-152	41-183	96	5	5
Trichloroethene	0-14	0-24	71-120	62-137	96	5	5
Vinyl Acetate	0-50	0-54	39-151	36-173	96	10	10
Vinyl Chloride	0-87	0-69	10-181	10-168	96	10	10
Xylenes (Total)	0-40	0-39	50-150	38-137	96	5	5
<u>Misc. Volatile Organics (624 CLP-M)</u>							
n-Butyl Acetate	0-40	0-50	50-140	40-160	96	50	50
Ethyl Acetate	0-40	0-50	40-150	35-170	96	50	50
<u>Base/Neutral Extractables (TCL) (625 CLP-M)</u>							
Acenaphthene	0-31	0-19	46-118	31-137	96	10	330
Acenaphthylene	0-40	0-40	36-140	36-140	96	10	330
Anthracene	0-40	0-25	40-140	40-125	96	10	330
Benzo(a)anthracene	0-40	0-32	29-140	29-112	96	10	330
Benzo(b)fluoranthene	0-40	0-40	20-140	20-118	96	10	330
Benzo(k)fluoranthene	0-42	0-42	25-140	25-130	96	10	330
Benzo(ghi)perylene	0-56	0-56	10-140	10-102	96	10	330
Benzo(a)pyrene	0-40	0-38	25-160	25-160	96	10	330
Benzyl Alcohol	0-50	0-50	15-140	15-112	96	10	330
Butyl benzyl phthalate	0-40	0-20	10-140	10-118	96	10	330
Bis(2-chloroethoxy)methane	0-43	0-43	36-160	36-160	96	10	330

Table 3-2. Practical Quantitation Limits, Accuracy, Precision, and Completeness Objectives of Organics Analyses for the Remedial Investigation at OU-2, NAS Jacksonville

Parameters	Precision ^{1/}		Accuracy ^{1,2/}		Completeness (%)	Practical Quantitation Limit ^{3/}	
	Water	Soils	Water	Soils		Water ug/L	Soils ug/kg
<u>Base/Neutral Extractables (TCL) (625 GLP-M) (Continued)</u>							
Bis(2-chloroethyl)ether	0-40	0-33	34-168	34-168	96	10	330
Bis(2-chloroisopropyl)ether	0-46	0-46	14-153	14-153	96	10	330
Bis(e-ethylhexyl)phthalate	0-40	0-40	10-153	10-153	96	10	330
4-Bromophenyl phenyl ether	0-40	0-23	53-140	53-126	96	10	330
4-Chloroaniline	0-50	0-50	10-150	10-150	96	10	330
2-Chloronaphthalene	0-40	0-20	60-140	66-118	96	10	330
4-Chlorophenyl phenyl ether	0-33	0-33	25-158	25-158	96	10	330
Chrysene	0-48	0-48	17-168	17-168	96	10	330
Dibenz(a,h)anthracene	0-70	0-70	10-227	10-227	96	10	330
Dibenzofuran	0-40	0-25	25-140	25-120	96	10	330
Di-n-butyl phthalate	0-50	0-50	10-140	10-120	96	10	330
1,2-Dichlorobenzene	0-40	0-31	32-140	32-129	96	10	330
1,3-Dichlorobenzene	0-41	0-41	25-140	25-115	96	10	330
1,4-Dichlorobenzene	0-28	0-27	36-97	28-104	96	10	330
3,3-Dichlorobenzidine	0-80	0-80	10-260	10-260	96	20	670
Diethylphthalate	0-40	0-30	10-140	10-114	96	10	330
Dimethylphthalate	0-40	0-27	10-140	10-112	96	10	330
2,4-Dinitrotoluene	0-38	0-47	24-96	28-89	96	10	330
2,6-Dinitrotoluene	0-40	0-29	50-158	50-158	96	10	330
Di-n-octylphthalate	0-50	0-50	10-150	10-150	96	10	330
Fluoranthene	0-40	0-33	26-140	26-137	96	10	330
Fluorene	0-40	0-21	59-140	59-121	96	10	330
Hexachlorobenzene	0-40	0-25	10-152	10-152	96	10	330
Hexachlorobutadiene	0-40	0-26	24-140	24-116	96	10	330
Hexachlorocyclopentadiene	0-50	0-50	10-150	10-150	96	10	330
Hexachloroethane	0-40	0-25	40-140	40-113	96	10	330
Indeno(1,2,3-cd)pyrene	0-45	0-45	10-171	10-171	96	10	330

Table 3-2. Practical Quantitation Limits, Accuracy, Precision, and Completeness Objectives of Organics Analyses for the Remedial Investigation at OU-2, NAS Jacksonville

Parameters	Precision ^{1/}		Accuracy ^{1,2/}		Completeness (%)	Practical Quantitation Limit ^{3/}	
	Water	Soils	Water	Soils		Water ug/L	Soils ug/kg
<u>Base/Neutral Extractables (TCL) (625 CLP-M) (Continued)</u>							
Isophorone	0-60	0-60	21-196	21-196	96	10	330
2-Methylnaphthalene	0-40	0-30	35-140	35-125	96	10	330
Naphthalene	0-40	0-32	39-140	39-127	96	10	330
2-Nitroaniline	0-50	0-50	10-150	10-150	96	50	1700
3-Nitroaniline	0-50	0-50	10-150	10-150	96	50	1700
4-Nitroaniline	0-50	0-50	10-150	10-150	96	50	1700
Nitrobenzene	0-40	0-39	35-180	35-180	96	10	330
N-Nitrosodi-n-propylamine	0-50	0-38	10-150	41-126	96	10	330
N-Nitroso-diphenylamine	0-50	0-50	10-150	10-150	96	10	330
Phenanthrene	0-40	0-21	54-140	54-120	96	10	330
Pyrene	0-31	0-36	26-127	35-142	96	10	330
1,2,4-Trichlorobenzene	0-28	0.23	39-98	38-107	96	10	330
<u>Acid Extractables (TCL) (625 CLP-M)</u>							
Benzoic Acid	0-50	0-50	10-150	10-150	96	50	1700
4-Chloro-3-methylphenol	0-42	0-33	23-97	26-103	96	10	330
2-Chlorophenol	0-40	0-50	27-123	25-102	96	10	330
2,4-Dichlorophenol	0-40	0-26	39-140	39-135	96	10	330
2,4-Dimethylphenol	0-40	0-26	32-140	32-119	96	10	330
2,4-Dinitrophenol	0-49	0-49	24-140	24-96	96	50	1700
4,6-Dinitro-2-methylphenol	0-93	0-93	10-181	10-181	96	50	1700
2-Methylphenol	0-50	0-50	10-150	10-150	96	10	330
4-Methylphenol	0-50	0-50	10-150	10-150	96	10	330
4-Nitrophenol	0-50	0-50	10-80	11-114	96	50	1700
2-Nitrophenol	0-40	0-35	29-182	29-182	96	10	330
Pentachlorophenol	0-50	0-47	9-103	17-109	96	50	1700
Phenol	0-42	0-35	12-89	26-90	96	10	330

Table 3-2. Practical Quantitation Limits, Accuracy, Precision, and Completeness Objectives of Organics Analyses for the Remedial Investigation at OU-2, NAS Jacksonville

Parameters	Precision ^{1/}		Accuracy ^{1,2/}		Completeness (%)	Practical Quantitation Limit ^{3/}	
	Percent RPD of Duplicates Water	Soils	Spike Recovery Water	Soils		Water ug/L	Soils ug/kg
2,4,5-Trichlorophenol	0-40	0-35	25-137	25-137	96	10	330
2,4,6-Trichlorophenol	0-40	0-32	37-144	37-144	96	10	330

Table 3-2. Practical Quantitation Limits, Accuracy, Precision, and Completeness Objectives of Organics Analyses for the Remedial Investigation at OU-2, NAS Jacksonville

Parameters	Precision ^{1/}		Accuracy ^{1,2/}		Completeness (%)	Practical Quantitation Limit ^{3/}	
	Water	Soils	Water	Soils		Water ug/L	Soils ug/kg
PCBs (608 CLP-M)							
PCB-1016	0-40	0-50	50-120	50-130	96	0.5	80
PCB-1221	0-40	0-50	50-120	50-130	96	0.5	80
PCB-1232	0-40	0-50	50-120	50-130	96	0.5	80
PCB-1242	0-40	0-50	50-120	50-130	96	0.5	80
PCB-1248	0-40	0-50	50-120	50-130	96	0.5	80
PCB-1254	0-40	0-50	50-120	50-130	96	0.5	80
PCB-1260	0-40	0-50	50-120	50-130	96	0.5	80
Polychlorinated Dibenzo-P-Dioxins and Polychlorinated Dibenzofurans-8280							
1 2,3,7,8-Tetrachlorodibenzo-P-Dioxin (2,3,7,8-TCDD)	0-50	0-50	60-140	60-140	80	0.01	1
2 Polychlorinated Dibenzofurans (PCDFs)	0-50	0-50	60-140	60-140	80	0.01	1
3 Polychlorinated Dibenzo-P-Dioxins (PCDDs)	0-50	0-50	60-140	60-140	80	0.01	1
Radiological Parameters							
Gross alpha	0-17	0-17	77-111	77-111	95	0.1 pCi/L	0.5 pCi/kg
Gross beta	0-24	0-24	73-121	73-121	95	0.3 pCi/L	0.5 pCi/kg
Radium-226	0-40	0-40	55-135	55-135	95	0.5 pCi/L	0.5 pCi/kg
Radium-228	0-23	0-23	76-122	76-122	95	0.5 pCi/L	0.5 pCi/kg

Notes:

^{1/} As applied to project methods specified in Table 1-1.

Table 3-2. Practical Quantitation Limits, Accuracy, Precision, and Completeness Objectives of Organics Analyses for the Remedial Investigation at OU-2, NAS Jacksonville

Parameters	Precision ^{1/}		Accuracy ^{1,2/}		Completeness (%)	Practical Quantitation Limit ^{3/}	
	Water	Soils	Water	Soils		Water ug/L	Soils ug/kg

^{2/} As determined from spiking actual sample matrix, these objectives are very near to those specified by EPA in SW-846, 3rd Edition, September 1986.

^{3/} Practical quantitation limits will vary depending on matrix differences that result in sample dilution and for soils, practical quantitation limit will also very depending on moisture content of sample if results are reported as dry weight. Instrument detection limits are approximately 10 times less than the practical quantitation limits. Any compound detected between the detection limit and practical quantitation limit will be reported and qualified as estimated (J flag).

Table 3-3. QA Frequency and Objectives for Field Measurements Conducted at OU-2, NAS Jacksonville

Parameter	Analyses ^{1/} Method	Precision	Accuracy (Recovery)	Completeness %
pH	150.1	0.05 units	±0.2 units	95
Conductivity (COND)	120.1	+/-10%	±2%	95
Temperature (TEMP)	170.1, 2550B ^{2/}	0.1°C 0.1°C	±0.2°C ±0.5°C	95 95
Dissolved oxygen (DO)	360.1	0.1 mg/l	±1%	95
Salinity	2520B ^{2/}	+/-10% ^{3/}	±6.5%	95
Volatile Organics (VOCs) in soil gas	^{4/}	30% RPD	±30%	90

QA Sample Frequency Analysis	Initial Calibration	Calibration Check	Matrix Reagent Blank	Matrix Spike	Spike Duplicate
pH, COND, TEMP DO, Salinity	Daily	Every 4 hrs	----	----	----
VOCs	Weekly ^{5/}	Daily	Daily	5%	5%

Parameter	Reagent Water Spike	Reagent Water Spike Duplicate	Sample Duplicate
pH, COND, DO, Salinity	----	----	Daily
VOCs	Not applicable	Not applicable	5%

^{1/} Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-200, revised March 1983.

^{2/} Standard Methods for the Examination of Water and Wastewater, 17th Edition.

^{3/} For salinity measurement between 0 and 20 parts per thousand.

^{4/} Soil gas samples will be analyzed using a Photovac 10S50 Gaschromatograph equipped with a photoionization detector.

^{5/} An initial calibration will be run at the beginning of each week. If the continuing calibration check sample exceeds ±25% of the expected value, a new initial calibration is performed.

4.0 SAMPLING PROCEDURES

The sampling equipment, sampling procedures, general equipment decontamination, and recordkeeping procedures that will be utilized during this investigation are described in the FSP Section 5.0 of the OU-2 Project Work Plan.

4.1 SAMPLE CONTAINERS. Sample containers utilized for the collection of all samples will be new containers that have been pre-cleaned and pre-baked according to the procedures specified in the analytical methods.

Table 4-1 summarizes the sample containers, handling, and preservation procedures required for each type of sample or parameter. Sample containers will be kept closed until use.

Containers for geotechnical samples may be undisturbed sample tubes or soil sampling jars provided by the contracted soils laboratory. The type of soil sample containers employed will be in accordance with the requirements established for the geotechnical analysis method.

4.2 SAMPLE LABELS AND SAMPLING LOGS. Samples collected for chemical analysis will be labeled prior to sample collection. At a minimum, the sample label will include the sample identification number, the date and time of collection, the sample matrix, the analyses requested, the preservatives used, and the initials of the personnel collecting the sample; samples collected for field analysis do not need to have preservatives or sample matrix specified on the label. Sample collection data, including information contained on the labels, will be recorded in the bound field log book as the samples are collected. All recorded entries will be made in indelible ink. No erasures will be made. If an error is made, a correction will be made by drawing one line through the error, initialing the error, and starting a new entry on the next line. Sample containers will be placed on ice in coolers immediately after sampling.

A soil/sediment sampling log as presented in the FSP will be completed for the collection of every soil, sediment, and solid waste sample. A water sampling log will be completed during the collection of groundwater and surface water samples. These logs will be completed as samples are collected. Field QC samples will be clearly identified on the appropriate field sampling log and in the field log book.

Further details regarding sampling procedures can be found in the Basic Site Work Plan QAPP (Appendix 4.4.1 of Volume 4) and the FSP.

**Table 4-1. Sample Container, Preservative, and Holding Time Specifications
OU-2, NAS Jacksonville**

Parameter	Container	Sample Preservative	Holding Time
<u>Ground Water/Surface Water</u>			
Volatile Organics	Three 40-mL glass VOC vials, no headspace	1:1 HCL to pH <2, cool to 4°C	14 days
Base/Neutral/Acid Extractables	Two 1-liter amber glass bottle	Cool to 4°C	Extract in 7 days, analyze within 40 days of extraction
PCBs	Two 1-liter amber glass bottle	Cool to 4°C	Extract in 7 days, analyze within 40 days of extraction
Dioxin	2-liter amber glass bottle	Cool to 4°C	Extract in 7 days, analyze within 40 days of extraction
Metals	1-liter poly-ethylene bottle	HNO ₃ to pH <2	6 months, mercury 28 days
Cyanide	500 mL poly-ethylene bottle	NaOH pH >12, cool to 4°C	14 days
Radiochemistry	1-gallon cubitainer	HNO ₃ to pH <2	6 months
<u>Soils/Sediment</u>			
Volatile Organics	8-ounce glass	none	14 days
Base/Neutral/Acid Extractables and PCBs	8-ounce glass	none	Extract in 7 days, analyze within 40 days of extraction
Dioxin	8-ounce glass	none	Extract in 7 days, analyze within 40 days of extraction
Metals/cyanide	8-ounce glass	none	6 months, mercury 28 days
Radiochemistry	8-ounce glass	none	6 months

5.0 SAMPLE CUSTODY

Sample custody is a vital aspect of remedial investigations as the generated data may be used as evidence in a court of law. The samples must be traceable from the time of sample collection until the time the data are introduced as evidence in enforcement proceedings.

5.1 FIELD RECORD LOG BOOK. The key aspect of documenting sample custody is through recordkeeping. Bound field log books with sequentially numbered pages will be maintained during the duration of the field work to document the collection of each sample. In addition, logs for sample/core (geologic logs), monitoring well completion, and soil/sediment and water sampling will be completed for each well drilled and each sample collected. Loose-leaf log sheets will be arranged in sequential order and bound together upon completion of each sampling event. Logs and documentation will be completed in indelible ink, dated, and signed by the field person conducting the work.

5.2 SAMPLE LABELING. Sample containers will be labeled at the time of sampling with the information specified in Section 4.2 of the QAPjP. At the time of sampling the identification number assigned to each sample will be recorded on the appropriate sample log form or similar (see Figures 4-2, 4-3, and 4-4 of the QAPP, Appendix 4.4.1). After each bottle is filled and before it is placed in the cooler for temporary storage, the sampling personnel will initial the label to document proper sample handling. The sample numbering system incorporates identifiers for the PSC, sample matrix, and the sample location and is described in Section 5.0 of the FSP.

5.3 SAMPLE CONTAINER CUSTODY. The sample containers provided by the subcontracted laboratories for this project will be prepared in accordance with each analytical method. The containers will be shipped from the laboratory to the site by common carrier in sealed cartons. The laboratory will include a shipping form listing containers shipped and the purpose of each container. This list will become part of the chain-of-custody record.

5.4 SAMPLE CUSTODY, SHIPMENT, AND LABORATORY RECEIPT. Samples are considered "in custody" if one of the following conditions are not violated:

1. The responsible person maintains possession;
2. After the samples are received, they remain in the view of, or in the physical possession of, responsible persons;
3. Samples are maintained in sealed/locked containers so that no unauthorized person can tamper with them; **or**

4. Samples are maintained in a secured area, restricted from unauthorized personnel.

The field samples will be handled according to three classifications: (1) field measurements, (2) field laboratory analysis, and (3) off-site laboratory analyses.

5.4.1 Field Measurements. Field measurements are made immediately after the sample has been collected. The data will be recorded directly in bound field logbooks along with identifying information on sampling conditions and location. Field measurements will include, but are not limited to, the following: pH, temperature, conductivity, and turbidity. Custody of samples collected for analysis on-site will be transferred to the field personnel.

5.4.2 Field Laboratory Measurements. These measurements refer to samples collected and preserved in the field and analyzed in an on-site laboratory. Identifying information on sampling conditions and locations will be recorded as indicated in Section 5.1 of this QAPjP. Samples will remain in the custody of the field personnel until delivered to the on-site laboratory.

5.4.3 Laboratory Measurements. These measurements refer to samples collected and preserved in the field, and shipped to the appropriate off-site laboratory for chemical analysis. Identifying information on sampling conditions and location will be recorded as indicated in Section 5.1 of this QAPjP, together with a record of the required analyses for each of the samples collected.

Sample custody will be maintained by sampling personnel. At the end of each sampling day and prior to the transfer of the samples off-site, chain-of-custody entries will be made for the samples using the standard chain-of-custody form. The information on the chain-of-custody form and the sample container labels will be checked on the sample field log entries, and samples will be recounted before leaving the sampling site. Upon transfer of custody, the chain-of-custody form will be signed and dated by the sample team leader. Because common overnight carriers (e.g., Federal Express, Purolator Courier, etc.) will not sign chain-of-custody forms, the forms will be placed in the cooler prior to shipping.

A signed, dated, custody seal will be placed over the lid opening of the sample cooler to indicate if the cooler has been opened during shipment or prior to receipt by the laboratory.

Laboratory custody procedures are outlined in the laboratory QAPs provided as Appendices C, D, and E of the Site QAPP (Volume 4, Appendix 4.4.1).

5.5 SHIPMENT OF SAMPLES. Samples collected during field investigations or in response to a hazardous materials incident will be classified by the field operations leader (FOL) prior to shipment, as either environmental or hazardous material samples.

In general, environmental samples include drinking water, groundwater and surface water, background/control soils, sediment, municipal and industrial wastewater effluents, biological specimens, or any samples that are not expected to be contaminated with high levels of hazardous materials. Environmental samples shall be packed prior to shipment using the following procedures:

1. Select a sturdy cooler in good repair. Secure and tape the drain plug with fiber tape. Line the cooler with a large heavy duty plastic trash bag.
2. Allow sufficient room in all bottles (except VOCs) to compensate for any pressure and temperature changes (approximately 10 percent of the volume of the container).
3. Be sure the lids on all bottles are tight (will not leak).
4. Wrap all glass bottles in separate polyethylene bubble pack and seal with tape.
5. Wrap paired 40-ml VOC vials into separate polyethylene bubble pack and seal with tape.
6. Pack the sample containers in the cooler securely so they do not shift during shipment. Leave space in the top of the cooler for bags of ice.
7. Securely fasten the top of the large garbage bag with tape.
8. Place bags of ice on top of the samples.
9. Place completed chain-of-custody forms into a plastic bag, seal the bag and tape it inside the top of the cooler. Close the cooler and securely tape (preferably with fiber tape) the top of the cooler shut. Chain-of-custody seals will be affixed to the top and sides of the cooler so that the cooler cannot be opened without breaking the seal.
10. The shipping containers will be marked "THIS END UP," and arrow labels, which indicate the proper upward position of the container, will be affixed to the container. A label containing the name and address of the shipper shall be placed on the outside of the container. Labels used in the shipment of hazardous materials (e.g., Cargo Only Aircraft, Flammable Solids, etc.) will not be permitted on the outside of the container used to transport environmental samples and will not be used.

Samples collected from bulk storage tanks, or soil, sediment, or water samples from areas suspected of being highly contaminated will be shipped as a hazardous material

according to U.S. Department of Transportation (DOT) regulations described in the Code of Federal Regulations (40 CFR 171 through 177).

6.0 CALIBRATION PROCEDURES AND FREQUENCY

Calibration procedures for field instruments are summarized in the Equipment Maintenance and Calibration Procedures presented in Attachment G of the Basic Site Work Plan (Attachment G, in Book 2 of Volume 4). Other field equipment used for analyzing samples in the field or conducting geophysical surveys, that are not described in Attachment G, will be calibrated and operated in accordance with the manufacturer's recommendations. A log will be kept on calibration and maintenance procedures for each instrument used during field operations at OU-2.

7.0 ANALYTICAL PROCEDURES

7.1 LABORATORY ANALYTICAL PROCEDURES. Analysis of samples collected will be performed by the selected laboratories in accordance with protocols and quality assurance procedures established by the USEPA and the Navy. Navy Level D quality control and data deliverable requirements, which are equivalent to USEPA Level IV analytical support, will be performed on samples collected at OU-2. Quality control requirements for Navy Level D are described in "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program" (NEESA 20.2-047B).

7.2 FIELD ANALYTICAL PROCEDURES. Field analysis of samples will be performed in accordance with protocols and quality assurance procedures established in the FSP and ABB-ES Standard Operating Procedures (SOPs) (provided as appendices to the FSP). The field analysis methods are based on USEPA laboratory methods. At a minimum, Navy Level B (equivalent of USEPA Level II quality control and data deliverable requirements) will be performed on samples collected at OU-2 for field analysis. Quality Control requirements for Navy Level B data are described in "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program" (NEESA 20.2-047B).

7.3 FIELD MEASUREMENTS. Field measurements will be made according to methods specified in Table 3-3.

8.0 INTERNAL QUALITY CONTROL CHECKS

Internal QC checks are those procedures used during the phases of the work that are designed to control the individual processes involved in data generating activities. Internal QC checks of sampling procedures and laboratory analyses will be conducted periodically throughout the investigation at pre-determined intervals. The following discussion describes the required QC checks to be performed for both the field and laboratory activities.

8.1 INTERNAL FIELD SAMPLING QUALITY CONTROL CHECKS. Internal QC checks for field sampling (i.e., field QC samples) will consist of the preparation and submittal of equipment blanks, field blanks, trip (travel) blanks, and field replicates (i.e., field duplicates), at frequencies described in Table 8-1. Although the number of QC samples changes, the types of field QC samples remain the same regardless of the level of QC implemented. Descriptions of each type of QC sample can be found in Section 8.0 of the Basic Site Work Plan QAPP (Appendix 4.4.1 of Volume 4)

8.2 INTERNAL FIELD LABORATORY QUALITY CONTROL CHECKS. Internal laboratory control check used in field analyses are described in the FSP and ABB-ES SOP.

8.3 INTERNAL LABORATORY QUALITY CONTROL CHECKS. Internal laboratory control checks used by the contracted laboratories are described in the appropriate reference for each analytical method performed.

Table 8-1. Field QC Samples Required
for Each Matrix per Sampling Event
(OU-2 Quality Assurance Project Plan
NAS Jacksonville)

Type of Sample	Inorganics	Organics
Trip Blank (for Volatile Organic Analysis only)	NA ^{1/}	1 per cooler
Equipment Rinseate	1 per day	1 per day
Field Blank	1 per source/event	1 per source/event
Material Blanks ^{2/}	1 per source/event	1 per source/event
Drilling Water and Decontamination Water	1 at beginning and end of field work	1 at beginning and end of field work
Field Replicates ^{3/}	10 percent of the samples	10 percent of the sample
Collocated (air)	1 per day	1 per day
Breakthrough	NA	1 per day

^{1/} NA = Not applicable

^{2/} Bentonite grout and filter sand

^{3/} The replicate must be taken from the same sample which will become the laboratory matrix/matrix spike duplicate for organics or for the sample used as a laboratory duplicate in inorganic analysis.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

The data reduction, validation, and reporting procedures that will be used during this investigation are described in the Data Analysis Plan (Appendix 4.2, Volume 4), and in Section 9.0 of the QAPP (Appendix 4.4.1, Volume 4).

The data reduction, validation, and reporting procedures, used by the laboratories are described in the laboratory Generic QAPs presented as Attachments A, B, and C of the QAPP (Book 2 of Volume 4).

At a minimum, Level B Quality Control will be performed on field laboratory analyses. Level D Quality Control will be performed on off-site laboratory analyses; however, only Level C validation will be performed on off-site data results unless circumstances require full Level D validation. Level B and D requirements are described in "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program" (NEESA 20.2-047B) and in Attachment A of the Data Analysis Plan in Appendix 4.2 of Volume 4 of the Basic Site Work Plan.

10.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits for sampling and analysis operations consist of on-site review of field and laboratory quality assurance systems and on-site review of equipment for sampling, calibration, and measurement.

10.1 FIELD SYSTEM AUDIT. The QA Officer will make non-scheduled visits to the site to evaluate the performance of field personnel and general field operations in progress. The QA Officer will observe the performance of the field operations team during each activity, such as water-level readings and sampling rounds. The field laboratory will also be audited by the QA Officer or a representative familiar with analytical procedures. A systems audit of field operations personnel by the project QA officer will be performed during each field event, and a field audit report of the sampling event and team will be maintained on file and will be included in monthly progress reports.

10.2 LABORATORY PERFORMANCE AND SYSTEM AUDITS. The performance and system audits performed by the laboratories are described in the Laboratory General QAPs (Attachments A, B, and C Book 2 of Volume 4).

10.3 REGULATORY AUDITS. It is understood that field personnel and subcontractor laboratories also are subject to quality assurance audits by the Navy, Florida Department of Environmental Regulation (FDER), and USEPA.

11.0 PREVENTIVE MAINTENANCE

11.1 FIELD EQUIPMENT. Preventive Maintenance Procedures are described in Attachment G of the Basic Site Work Plan QAPP. Records of calibration and maintenance activities for each piece of equipment will be maintained in log books assigned to that instrument.

11.2 LABORATORY EQUIPMENT. The preventive maintenance procedures used by the laboratories are described in the laboratory Generic QAPs which are included as Attachments A, B, and C of the QAPP (Book 2 of Volume 4).

12.0 ASSESSMENT OF DATA PRECISION, ACCURACY, AND COMPLETENESS

The assessment of data precision, accuracy, and completeness that will be used during the investigation is described in Section 12.0 of the site QAPP (Appendix 4.4.1 of Volume 4).

The procedures used by the labs to assess data precision, accuracy, and completeness are described in the laboratory Generic QAPs which are presented as Attachments A, B, and C of the QAPP (Book 2 of Volume 4).

13.0 CORRECTIVE ACTION

13.1 FIELD CONDITIONS. During implementation of the OU-2 FSP, the field personnel will be responsible for the proper operation of field instruments, of satisfactory work progression, and the compliance with the QAPjP for work performed.

If a problem is detected by the field personnel, the Navy Project Manager and the ABB-ES Project Manager shall be notified concurrently by the Field Operations Leader (FOL) at which time the problem will be further investigated and corrective action will begin. Similarly, if a problem is identified during a routine audit by the project QA officer or the USEPA/FDER Project Manager or QA Officer, an immediate investigation will be undertaken and the corrective measures deemed necessary will be implemented as quickly as possible.

13.2 LABORATORY CORRECTIVE ACTION. The corrective action procedures by the laboratories are described in the laboratory Generic QAPs (Attachments A, B, and C Book 2 of Volume 4).

13.3 REPORTING OF CORRECTIVE ACTIONS. In the cases where corrective actions of field procedures were required, a written report describing the nature of the problem, an evaluation of the cause, if known, and the action taken, will be prepared by the ABB-ES FOL or the Project QA Officer, and submitted to the ABB-ES Project Manager, Project QA Officer (if not the author of the report), and Project Officer.

Reports of corrective actions taken during the implementation of the OU-2 RI/FS Work Plan will be provided to the Navy according to the frequency and procedures specified in the Data Analysis Plan (Appendix 5.2 of Volume 4, Basic Site Work Plan).

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Each day that field activities are conducted on-site, a representative of the field team will complete a Daily Quality Control Report (DQCR) (Figure 14-1). These reports will be transmitted weekly to the Project QA Officer for review and inclusion into the project file. These DQCRs, along with associated field records and laboratory data, form the basis of the Quality Control Report.

DAILY QUALITY CONTROL REPORT
NAS JACKSONVILLE

Date: _____

A. Weather (temperature, wind speed and direction, precipitation, etc.): _____

B. Work Performed: _____

C. Sampling Performed (location/number, sample type, etc.): _____

D. Field Analyses Performed (including instrument checks, calibration, etc.): _____

E. Problems Encountered and Corrective Actions Taken (sampling problems, alternate methods/locations, etc.): _____

F. Quality-Control Activities Initiated: _____

Signature of Reporter: _____
Geraghty & Miller, Inc.

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A-E DATA QUALITY CONTROL
REPORT

FIGURE 14-1



REMEDIAL INVESTIGATION/
FEASIBILITY STUDY
QUALITY ASSURANCE
PROGRAM PLAN

NAS JACKSONVILLE
SEPTEMBER 1991

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APPENDIX A-2
FIELD SAMPLING PLAN

OU-2 SITE-SPECIFIC
FIELD SAMPLING PLAN

FOR

NAVAL AIR STATION
JACKSONVILLE, FLORIDA

APPENDIX A-2
OF THE OU-2 PROJECT WORK PLAN

CONTRACT NO. N62467-89-D-0317

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Prepared by:

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PORTLAND, MAINE

Prepared for:

U.S. DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SOUTH CAROLINA

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FIELD SAMPLING PLAN**

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GLOSSARY OF ACRONYMS

AA	atomic absorption
ASTM	American Society for Testing and Materials
BESD	Bio-Environmental Services Department
BFSP	Basic Field Sampling Plan
bgs	below ground surface
BOD	biochemical oxygen demand
Btu	British thermal unit
CLP	Contract Laboratory Program
COD	chemical oxygen demand
FSP	Field Sampling Plan
ft	feet
GC	gas chromatography
ICP	inductively coupled plasma
ID	inside diameter
IDL	instrument detection limit
IDW	investigative-derived waste
Lpm	liters per minute
m ³	cubic meter
mg/kg	milligrams per kilogram
mL	milliliter
MS	mass spectrometry
ng/m	nanograms per cubic meter
OD	outside diameter
OU-2	Operable Unit Number 2
PCB	polychlorinated biphenyl
PCPT	piezometric cone penetrometer testing
PHCs	petroleum hydrocarbons
PI	photoionization
PSC	
PUF	polyurethane foam
PVC	polyvinyl chloride
QA	Quality Assurance
QAM	Quality Assurance Manual

QC	Quality Control
SAV	submerged aquatic vegetation
SOP	Standard Operating Procedures
SVOC	semivolatile organic compound
TAL	Target Analyte List
TCL	Target Compound List
TCLP	toxicity characteristic leachate procedure
TOC	total organic carbon
TPH	Total Petroleum Hydrocarbons
TSP	total suspended particulates
$\mu\text{g}/\text{f}$	micrograms per filter
$\mu\text{g}/\text{m}^3$	micrograms per cubic meter

1.0 INTRODUCTION

The sample quantities, locations, and collection procedures for the RI/FS field investigations at Naval Air Station Jacksonville Operable Unit 2 (OU-2) are described in this Field Sampling Plan (FSP). The OU-2 FSP parallels the format of the Basic Field Sampling Plan (BFSP) included as Appendix 4.4.2 of the Basic Site Work Plan, which is Volume 4 of the Naval Air Station Jacksonville Naval Installation Restoration Program Plan. Where practical, sections of the BFSP have been incorporated by reference into this OU-2 FSP. This sampling plan should be used in conjunction with the BFSP and the U.S. Environmental Protection Agency (USEPA) Region IV Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual.

1.1 PURPOSE. The purpose of the RI field sampling is to (1) identify sources, (2) evaluate the nature and distribution of contaminants, (3) obtain information for assessing human health and ecological risks, and (4) obtain information for evaluating potential remedial alternatives.

The FSP is organized into the following six sections:

- Section 1.0 describes the purpose of the sampling and organization of the report.
- Section 2.0 discusses the sample quantities, locations, and steps for conducting the investigation.
- Section 3.0 describes sample designation.
- Section 4.0 describes new or modified sampling procedures not contained in the Basic Site Sampling Plan.
- Section 5.0 discusses the handling of investigative-derived waste (IDW).
- Section 6.0 describes sample handling procedures.

1.2 GENERAL TECHNICAL APPROACH. OU-2 is located on the northern portion of the Naval Air Station bordering the St. Johns River to the north and the Timuquana Country Club Golf Course to the west. Wastewater treatment and fire fighting training activities have introduced contaminants to the environment. Waste materials previously disposed of at OU-2 include aviation fuels and spent oils at the Fire Fighting Training Area and sludge from the former Domestic Wastewater Sludge Drying Beds. Previous investigations conducted at OU-2 and their results are summarized in the Sections 2.0 and 3.0 of the OU-2 Project Work Plan.

The nature and distribution of contaminants in the soil, sediment, surface water, and groundwater at OU-2 need to be evaluated. To minimize the number of field investigations required to collect the appropriate data, samples will be analyzed in the field for Volatile Organic Compounds (VOCs), inorganics, and Petroleum Hydrocarbon Compounds (PHCs). The technical approach for each media is summarized in the following paragraphs.

Soil sampling grids will be established at most of the potential source areas. Samples will be collected from the grids and analyzed in the field. In areas where contaminants are detected, further field screening samples will be collected to evaluate the distribution of contaminants. Ten percent of the field screening samples will be split for Contract Laboratory Program (CLP) analysis. The CLP samples will be used to confirm field screening results and provide CLP quality data for risk assessment and the feasibility study. If there is a good comparison between field screening and CLP results, field screening data may be used in the risk assessment.

Surface water and sediment samples will be collected from the Polishing Pond and the drainage ditches/swales at OU-2 to evaluate the Polishing Pond as a potential source area and drainage ditches/swales as potential migration pathways. Field screening with CLP confirmatory sampling will be used to evaluate the nature and distribution of contaminants in Polishing Pond. However, field screening will not be used as the primary tool for evaluating the nature and distribution of contaminants in surface water or sediment in the drainage ditches. At most of the drainage ditch surface water and sediment sample locations, both field screening and CLP samples will be collected. If contaminants are detected in the field screening samples, the nature and distribution of the contaminants will be further evaluated. As with the soil sampling data, if there is a good comparison between field screening and CLP results, field screening data may be used in the risk assessment.

The characterization of groundwater will require a four-staged approach. Because little is known about the stratigraphy of the surficial aquifer at OU-2, especially at depths greater than 35 feet below ground surface (bgs), piezometric cone penetrometer testing (PCPT) equipment will be used during the first stage to provide geotechnical information. During the second stage, guided by the PCPT geotechnical information, field crews will collect groundwater samples with the PCPT equipment for field screening and confirmatory CLP analysis. The field screening results will be used to guide further sample collection and map any groundwater contaminant plumes detected. Based on the field screening results, monitoring well and piezometer locations and depths will be selected. The piezometers and wells will be installed during the third stage. During the fourth and final stage, monitoring wells will be sampled for CLP analysis.

The methods for sample collection and the investigative steps are defined in more detail in the remainder of this FSP. The Field Operations Leader, Technical Lead, or Project Manager will be responsible for approving changes to these procedures. If the changes

impact scope, schedule, or budget, or adversely impact data quality, the Navy will be consulted before the changes are implemented.

2.0 SITE-SPECIFIC SAMPLING AND ANALYTICAL PROGRAMS

The sample quantities, locations, and steps for conducting the investigation are described, by medium, in the following subsections. Laboratory analytical methods and detection limits for the specific analytes are presented in Appendix A.

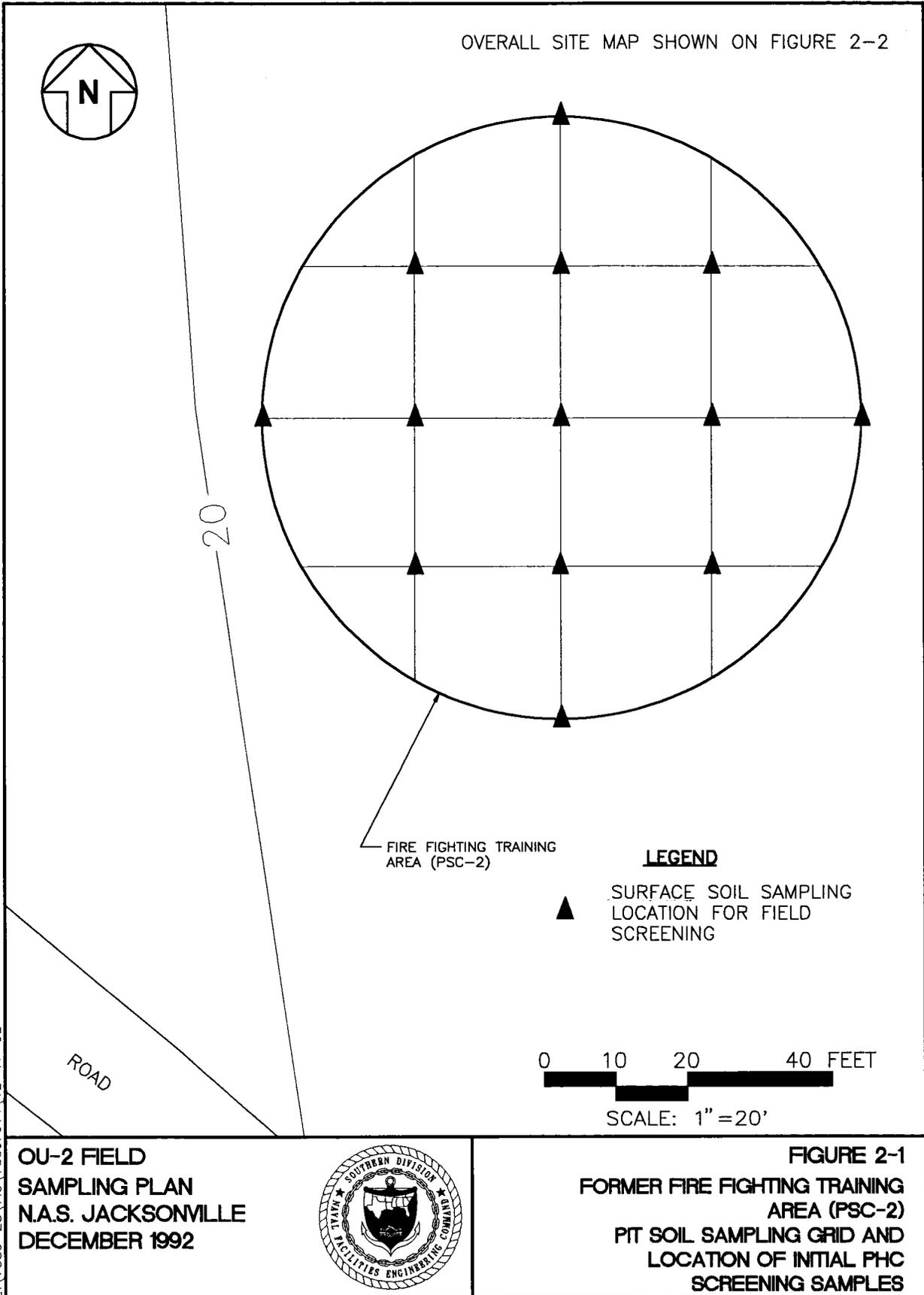
2.1 SOIL. Soil samples will be collected from several suspected source areas or potential migration pathways associated with OU-2. The following subsections describe the numbers and locations of samples to be collected, by sampling area.

2.1.1 Former Fire Fighting Training Area Samples will be collected from the pit at the former Fire Fighter Training Area to evaluate the nature and distribution of contaminants. The sampling methodology for the pit was developed based on the following background information and assumptions.

- The primary contaminants at the former Fire Fighting Training Area are fuel-related compounds.
- PHCs are a good indicator of residual fuel compounds and can be used to define the size of the contaminated area.
- The vertical and horizontal boundaries of the source area will be defined by samples where PHC screening results are below detection limits (approximately 50 milligrams per kilogram [mg/kg]). (Assumption)

The soil within the pit will be investigated using the following steps:

1. Establish a north-aligned grid with 20-foot node spacing (Figure 2-1).
2. Collect initial surface soil samples for PHC screening from 13 grid nodes (see Figure 2-1). During the entire source delineation process, split 10 percent of the PHC field-screening samples for PHC analysis by an off-site CLP laboratory. When possible, the split samples should be collected every tenth sample and be representative of areas where contaminants are and are not detected by field screening.
3. Map the results of the PHC screening.
4. If the horizontal extent of the source area has not been delineated by samples with concentrations below the detection limit, extend the grid and collect additional surface soil samples for PHC screening.



Z:\7559-25\FIG\7559F014\12-17-92

5. Continue the previous two steps until the outer boundaries of the PHC contamination are defined by samples with PHC concentrations that are below detection limits.
6. At a depth of 2 to 3 feet, collect a minimum of four soil samples evenly spaced around the perimeter of the source area and a minimum of two randomly selected from the middle for PHC screening.
7. In areas where PHCs were detected above the detection limit in subsurface soil samples, collect soil samples from a depth of 4 to 5 feet for PHC screening
8. When the vertical and horizontal extent of the source area are defined, collect six randomly selected soil samples from locations and depths where PHCs were detected at concentrations greater than or equal to 500 mg/kg. Field screen these samples for VOCs and inorganics and randomly select three to be split for target compound list (TCL) VOC, semivolatile organic compound (SVOC), pesticide, and polychlorinated biphenyl (PCB), and target analyte list (TAL) inorganic analysis using CLP methodology. Submit one randomly selected sample for British thermal unit (BTU) content and grain size analysis.
9. Collect four randomly selected soil samples from locations and depths where PHCs were detected at concentrations greater than 50 mg/kg and less than 500 mg/kg. Field screen these samples for VOCs and inorganics and randomly select two to be split for TCL VOC, SVOC, pesticide, and PCB, and TAL inorganic analysis using CLP methodology. Submit one randomly selected sample for BTU content, total organic carbon (TOC), and grain size analysis.

It is possible that contaminants have migrated from the pit by sediment transport. In addition, old aerial photographs indicate that there may have been other pits for fire fighter training exercises that were located east and west of the known site. Therefore, the area around the former fire fighting training pit will be investigated. The sampling methodology for the area around the pit was developed based on the same background information and assumptions used for the pit with the following additions/exceptions:

- Any previously unidentified pits are assumed to be the same size as the known pit, a circle approximately 80 feet in diameter. (Assumption)
- Analyses for specific compounds will not be required unless a new potential source area is identified by PHC field screening.

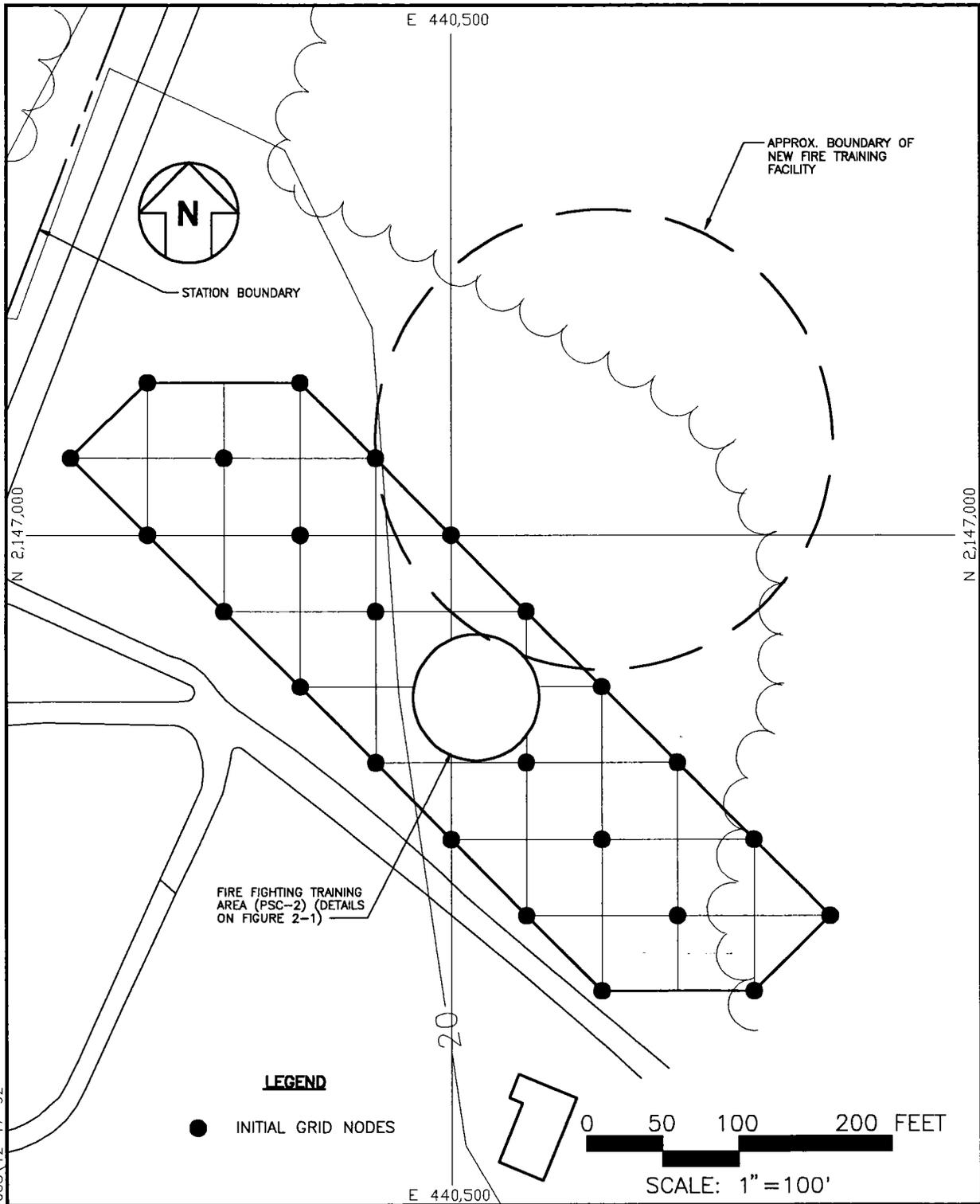
Using the potential source area size assumption, the procedures described in the RI/FS work plan were used to determine the node spacing for a sampling grid. Grid size and

configuration are described in Subsection 4.2.1. The following steps will be used to investigate the area around the former fire fighting training area:

1. Establish a north-aligned sampling grid covering the area shown in Figure 2-2.
2. Collect PHC field-screening samples from each node. During the source delineation process, 10 percent of the PHC samples should be split for analysis by an off-site CLP laboratory. When possible, the split samples should be collected every tenth sample and be representative of areas where contaminants are and are not detected by field screening.
3. If no PHCs are detected, no further investigation is necessary. If PHCs are detected above the detection limit, map out the sampling results.
4. In areas where PHCs were detected, collect PHC screening samples from halfway between the grid nodes to better define the perimeter of the potential source area.
5. At a depth of 2 to 3 feet, collect a minimum of four soil samples from the perimeter of each potential source area and one from the middle for PHC screening.
6. In areas where PHCs were detected above the detection limit in soil samples during the previous step, collect soil samples from a depth of 4 to 5 feet for PHC screening.
7. From each potential source area, collect one surface soil sample where the highest PHC concentrations were detected, and submit for VOC and inorganic screening and CLP TCL VOC, SVOC, pesticide, and PCB, and TAL inorganic analysis. Submit one randomly selected sample from each potential source area for BTU content, TOC, and grain size analysis.

2.1.2 Former Sludge Disposal Areas The former sludge disposal areas include the Pine Tree Planting Area (PSC-4) and the Former Sludge Disposal Area (PSC-3), which consists of two areas, Parcels 1 and 2). Soil samples will be collected from the sludge disposal areas to evaluate the nature and distribution of contaminants from sludge disposal and other activities. The sampling program for the sludge disposal areas was developed based on the following background information and assumptions:

- Because the industrial sludge drying beds were constructed after sludge disposal at OU-2 stopped, the source of the sludge is assumed to be the domestic sludge drying beds. Although sludge from the industrial beds were reportedly not disposed of on-site, industrial sludge was sometimes blown onto PSC-3, Parcel 2 while clogged lines were cleared.



Z:\7559-25\FIG\7559F008\12-17-92

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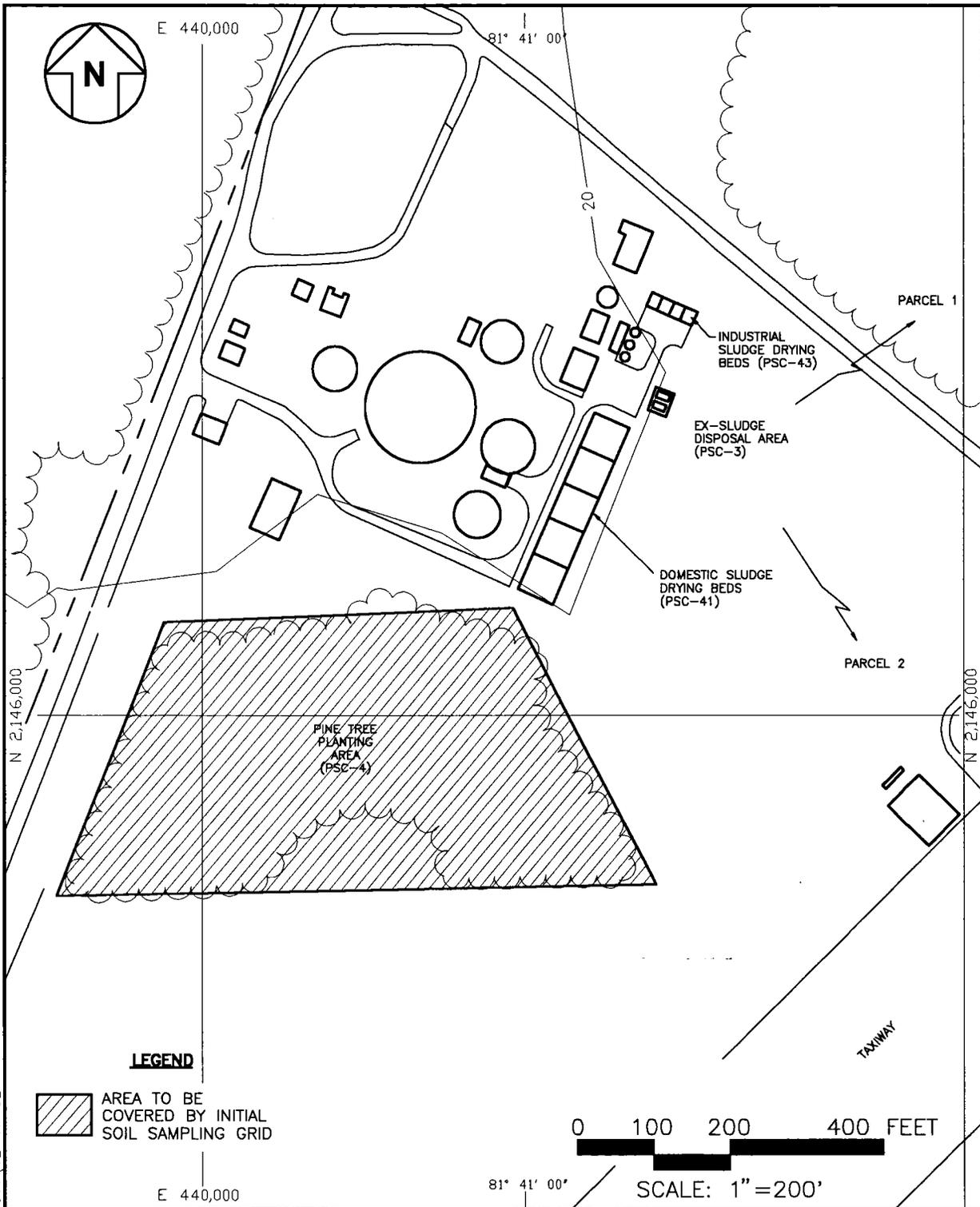


**FIGURE 2-2
FORMER FIRE FIGHTING TRAINING
AREA (PSC-2)
SOIL SAMPLING GRID FOR AREA
SURROUNDING THE PIT**

- The contents of one 50-foot square domestic sludge drying bed was spread over a minimum area of 50 feet by 100 feet. (Assumption)
- The primary contaminants of concern in the sludge are inorganics; however, petroleum products may have been disposed off at the Pine Tree Planting Area.
- The likely size for a hot spot corresponds to the area covered by the contents of one bed which is supported by an observation of stressed vegetation within PSC-3 Parcel 2 on a 1983 aerial photograph of the site. (Assumption)
- During the history of sludge disposal, only one layer of sludge has been spread over the area. (Assumption)
- Sludge has not been covered by clean soil. (Assumption)

The soil at the sludge disposal areas will be investigated using the following steps:

1. Establish a grid at each of the three disposal areas. The grid will be oriented north-south unless site conditions (e.g., trees at PSC-3 Parcel 1 and PSC-4) require a different orientation (Figures 2-3 and 2-4). (The grid node spacing is described in Subsection 4.2.1).
2. To support the assumptions that sludge was disposed in one layer and clean soil was not deposited on top of the sludge, randomly select five grid nodes at each of the three disposal areas and dig small trenches (approximately 2 feet square and 1.5 feet deep).
3. Collect surface soil samples from each grid node for inorganic field screening. Samples from the Pine Tree Planting Area will also be screened for VOCs because trichloroethene (TCE) has been detected in downgradient groundwater and PHCs because of the reported past disposal of petroleum products. During the course of the entire field screening effort, split 10 percent of the field screening samples for CLP TCL VOC, SVOC, pesticide, and PCB, and TAL inorganic analysis. Samples from the Pine Tree Planting Area will also be analyzed by an off-site laboratory for PHCs. When possible, the split samples should be collected every tenth sample and be representative of areas where contaminants are and are not detected by field screening.
4. Collect sludge/soil samples for field screening samples from areas where sludge is visible.
5. Map the field screening results.

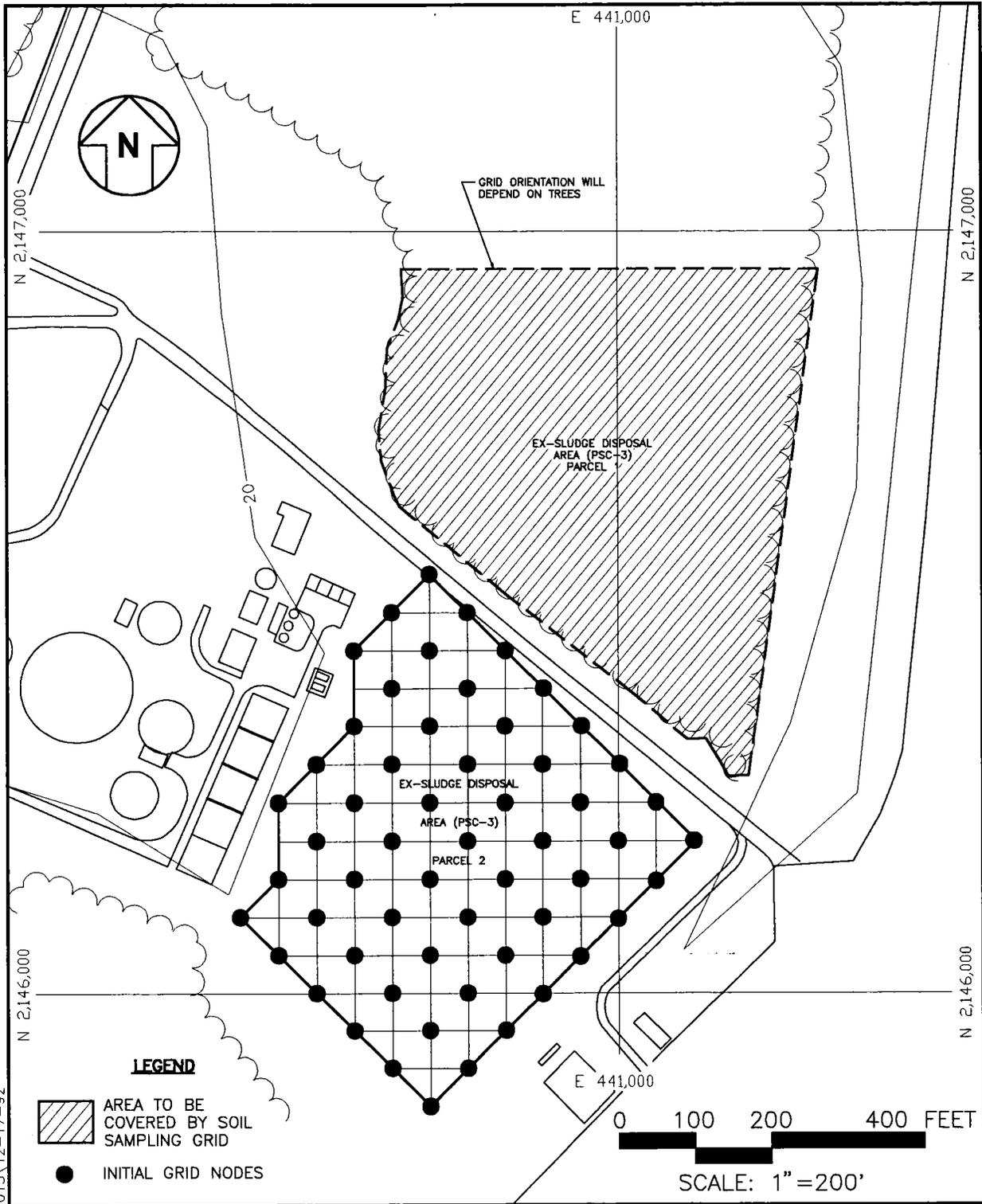


Z:\7559-25\FIG\7559F011\12-17-92

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**FIGURE 2-3
PINE TREE PLANTING AREA (PSC-4)
SOIL SAMPLING GRID LOCATION**



Z:\7559-25\FIG\7559F013\12-17-92

**OU-2 FIELD SAMPLING PLAN
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**FIGURE 2-4
WASTE WATER TREATMENT PLANT
EX-SLUDGE DISPOSAL AREA (PSC-3)
SOIL SAMPLING GRID LOCATION**

6. In areas where potential hot spots are detected, collect screening samples from halfway between the grid nodes to better define the perimeter of the potential source area.
7. Collect a minimum of two subsurface soil samples from each potential source area at a depth of 2 to 3 feet for field screening. Collect one of the samples from each potential source area from the location where the highest concentrations were detected in surface soil samples. Collect the other sample from randomly selected grid nodes within each potential source area.
8. In areas where contaminants were detected in soil samples during the previous step, collect soil samples from a depth of 4 to 5 feet for field screening.
9. Collect two soil samples from each of three disposal areas (i.e., from randomly selected grid nodes within identified hot spots if possible) for TOC and grain size analysis.
10. At the Pine Tree Planting Area, collect nine samples of waste or debris for asbestos analysis (using ASTM D4240) from different locations where waste or debris were observed during grid sampling. If waste or debris were not identified during grid sampling, collect the samples from randomly selected grid nodes.

2.1.3 Former Sludge Drying Beds Samples will be collected from the Former Domestic and Industrial Wastewater Sludge Drying Beds to evaluate the nature and distribution of contaminants in soil and evaluate disposal options. The sampling program for the sludge drying beds was developed based on (1) background information, (2) the assumption that the primary contaminants are VOCs, SVOCs, and inorganics, and (3) the assumption that the contaminants are distributed relatively even within the soil in each bed. The sludge drying beds will be investigated using the following steps:

1. Collect three surface soil samples from each domestic bed and two surface soil samples from each industrial bed for VOC and inorganic screening.
2. From each domestic bed, collect 3 soil samples at a depth of 2 to 3 ft and 3 soil samples at a depth of 4 to 5 ft for VOC and inorganic screening (collect these samples from the same locations as the surface soil samples). From each industrial bed collect one sample at a depth of 2 to 3 feet and one sample at a depth of 4 to 5 feet.
3. Compare field screening results to USEPA Region III risk-based soil guidance values.

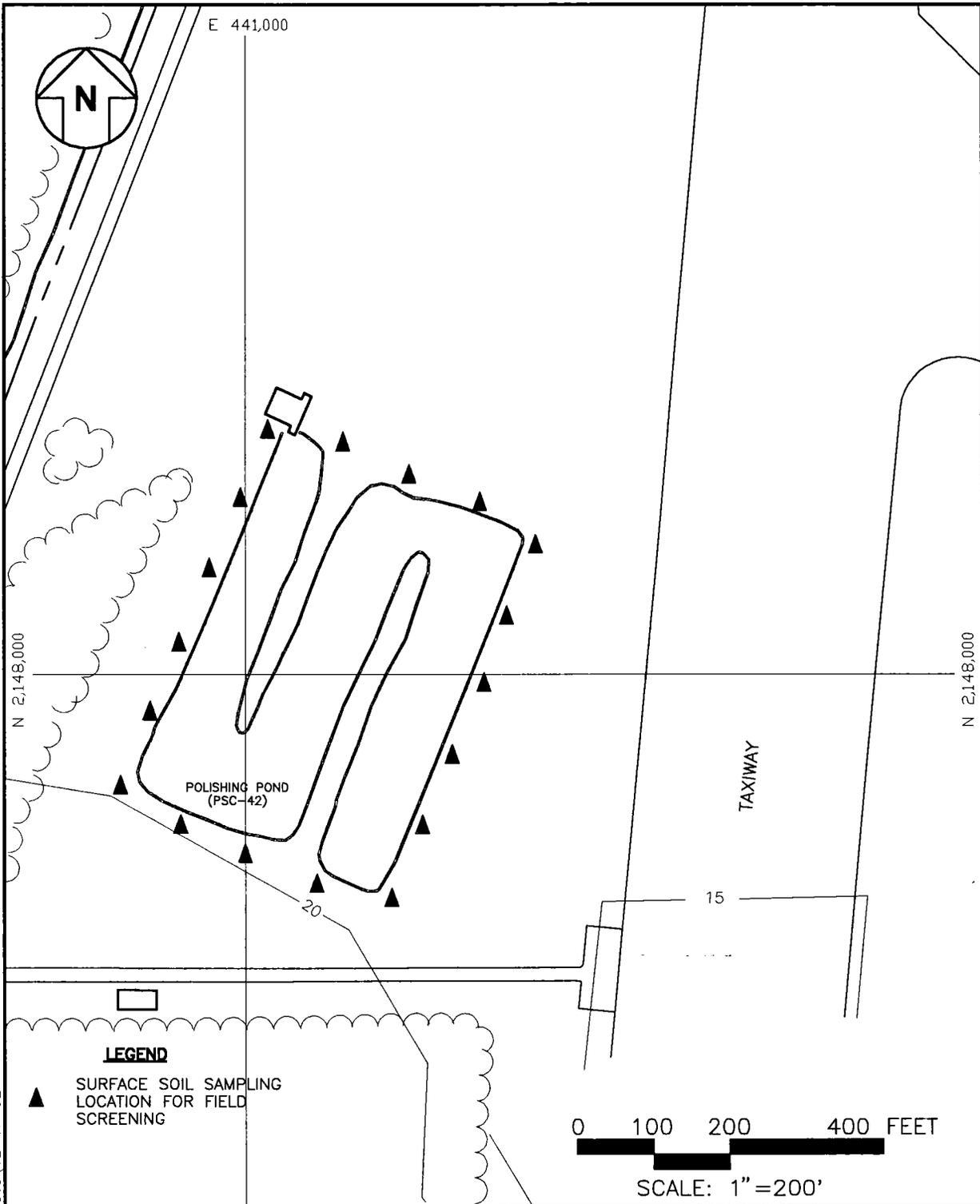
4. In beds where no contaminants are detected above USEPA Region III guidance values, collect one surface soil sample for CLP TCL VOC, SVOC, pesticide, and PCB, and TAL inorganic analysis. Split these CLP samples for VOCs and inorganics field screening.
5. In beds where contaminants are detected above USEPA Region III guidance values, collect one TCLP sample where the highest concentrations were detected in Step 3. Collect one randomly selected sample for TOC and grain size analysis.
6. Randomly select two domestic and two industrial sludge drying beds. For each of the selected beds, collect chips from the four walls for toxicity characteristic leachate procedure (TCLP) analysis.

2.1.4 Polishing Pond Surface soil samples will be collected from the perimeter of the Polishing Pond to investigate the possible migration of contaminants from the pond. It was assumed that inorganics would be the most likely contaminants to be detected on the banks of the pond. The soil around the Polishing Pond will be investigated using the following steps:

1. Collect approximately 18 surface soil samples at 100-foot intervals from the top of the bank of the Polishing Pond for inorganic screening (Figure 2-5). (The spits that separate each leg of the Pond will not be sampled). During the entire field screening process, split 10 percent of the samples for CLP TCL VOC, SVOC, pesticide, and PCB, and TAL inorganic analysis. When possible, the split samples should be collected every tenth sample and be representative of areas where contaminants are and are not detected by field screening.
2. If contaminants are detected by field screening, collect additional field screening samples to define the potential migration pathways.

2.1.5 Other Areas Surface soil samples will be collected from areas outside of the known and suspected source areas to identify previously unknown areas of contamination. These areas will be investigated using the following steps:

1. Establish a north-south oriented grid with 200-foot node spacing in the areas shown in Figures 2-6 and 2-7.
2. To assess shallow subsurface stratigraphy and help assess if sludge was deposited in these areas, randomly select eight grid nodes from the area around the drainage and south of the Pine Tree Planting Area and dig small trenches (approximately 2 square feet and 1.5-feet deep). Dig four trenches at randomly selected grid nodes in the area north of the Polishing Pond.

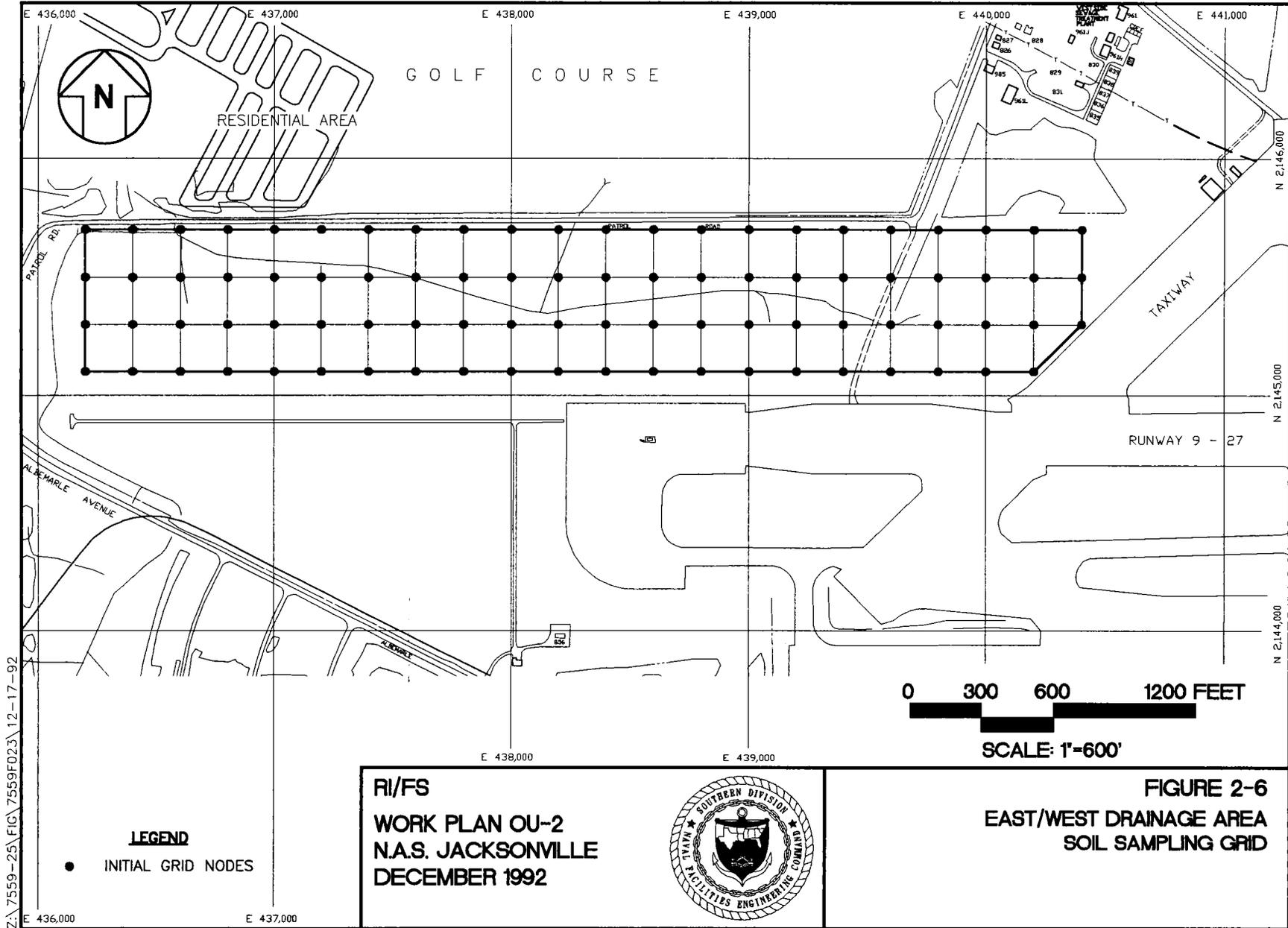


Z:\7559-25\FIG\7559F010\12-17-92

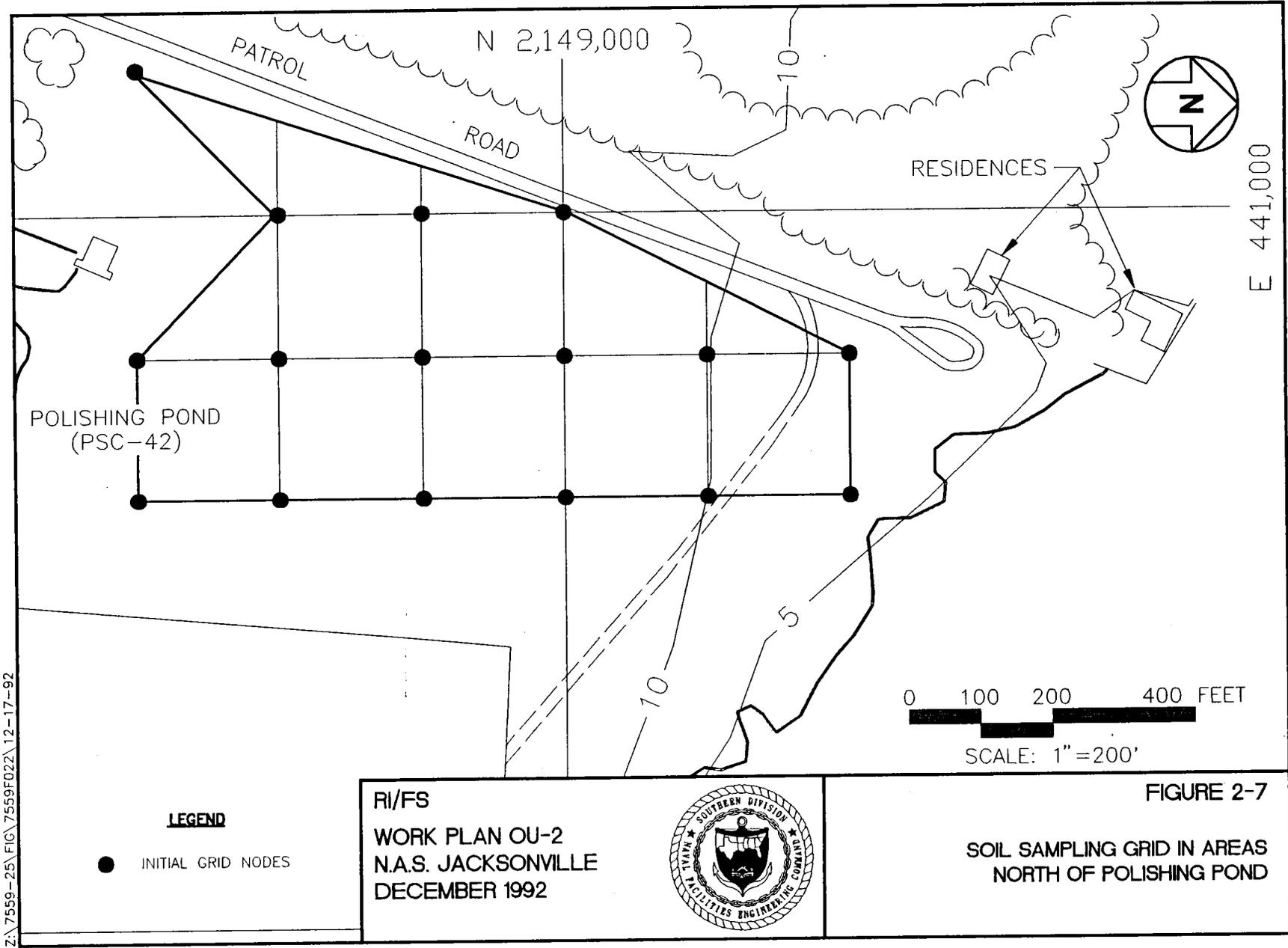
**OU-2 FIELD
SAMPLING PLAN
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**FIGURE 2-5
POLISHING POND FOR WASTE WATER
TREATMENT PLANT EFFLUENT (PSC-42)
SURFACE SOIL FIELD SCREENING
SAMPLE LOCATIONS**



Z:\7559-25\FIG\7559FD23\12-17-92



Z:\7559-25\FIG\7559F022\12-17-92

LEGEND

● INITIAL GRID NODES

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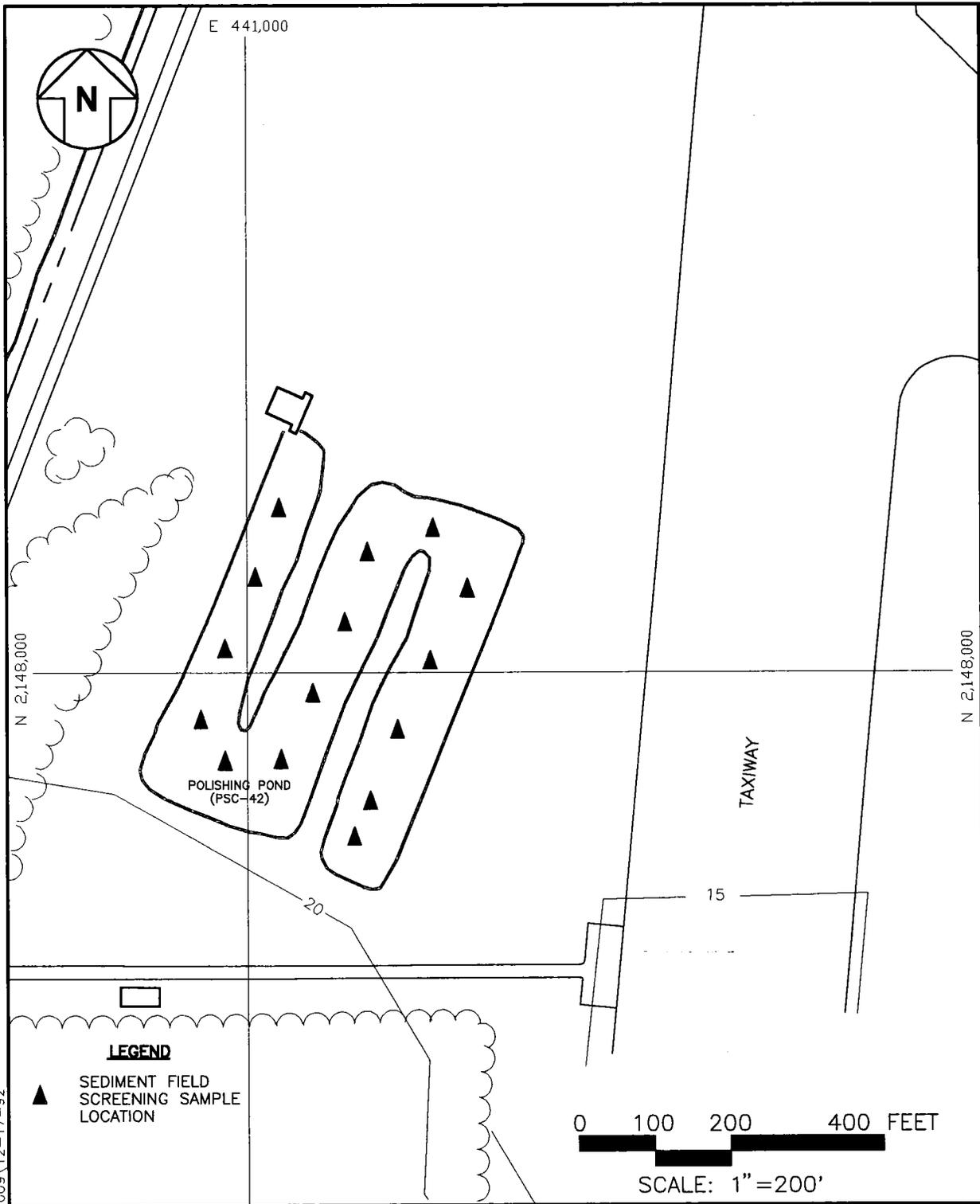
FIGURE 2-7
SOIL SAMPLING GRID IN AREAS
NORTH OF POLISHING POND

3. Collect surface soil samples from each grid node for VOC, inorganic, and PHC field screening. During the field screening effort, split 10 percent of the field screening samples for CLP TCL VOC, SVOC, pesticide, and PCB, and TAL inorganic analysis. In addition, collect samples for PHC analysis by an off-site laboratory when CLP samples are collected. When possible, the split samples should be collected every tenth sample and be representative of areas where contaminants are and are not detected by field screening.
4. Collect sludge/soil samples for field screening samples from areas where sludge is visible.
5. Map the field screening results.
6. In areas where potential source areas are detected, collect screening samples from halfway between the grid nodes to better define the perimeter of the potential source area.
7. Collect a minimum of two subsurface soil samples from each potential source area at a depth of 2 to 3 feet for field screening. Collect one of the samples from each potential source area from the location where the highest concentrations were detected in surface soil samples. Collect the other samples from randomly selected grid nodes within each potential source area.
8. In areas where contaminants were detected in soil samples during the previous step, collect soil samples from a depth of 4 to 5 feet for field screening.

2.1.6 Background Soil Sampling and Analysis Background soil samples will be collected from a minimum of five locations. One surface and one subsurface soil sample (i.e., 2 to 3 feet deep) will be collected from each location. Each sample will be analyzed for TAL inorganics. Grain size analysis will be conducted on one randomly selected surface and one subsurface soil sample.

2.2 SEDIMENT. Sediment samples will be collected to evaluate the nature and distribution of contaminants in the Polishing Pond sediment and to investigate the potential migration of contaminants along the OU-2 drainage ditches.

Fifteen sediment samples will be collected from the Polishing Pond and field screened for VOCs and inorganics (Figure 2-8). Three additional samples will be collected from the locations where the highest concentrations of contaminants are detected. These samples will be submitted for CLP, TCL VOC, SVOC, pesticide, and PCB, and TAL inorganic analysis, and split for VOC and inorganic field screening. The additional samples will also be analyzed for TOC and grain size.



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**FIGURE 2-8
 POLISHING POND FOR WASTE WATER
 TREATMENT PLANT EFFLUENT (PSC-42)
 SEDIMENT SAMPLE LOCATIONS**

Eight sediment samples will be collected from the east/west drainage area at locations where water in the ditch flows off base, on base, or from other portions of the base (Figure 2-9). These samples will be submitted for CLP, TCL VOC, SVOC, pesticide, and PCB, and TAL inorganic analysis, TOC, grain size, and split for VOC, inorganic, and PHC field screening.

One sediment sample will be collected from the drainage ditches on either side of the Patrol Road turnaround (Figure 2-10). These samples will be submitted for TCL VOC, SVOC, pesticide, and PCB and TAL inorganic analysis, TOC, grain size, and split for VOC, inorganic, and PHC field screening.

Twenty-four samples will be collected from the sediment around the drop boxes associated with the drain pipes that run north along the east side of OU-2 (see Figure 2-10). Two samples will be collected adjacent to each drop box, one on the "upstream" side and the other on the "downstream" side. These samples will be field screened for VOCs, PHCs, and inorganics. Based on field-screening results, additional samples will be collected from the four locations with the highest concentrations of contaminants. These additional samples will be submitted for CLP, TCL VOC, SVOC, pesticide, and PCB, and TAL inorganic analysis, TOC, grain size, and split for VOC, inorganic, and PHC field screening. If no contaminants are detected by field screening, the additional samples will be collected adjacent to drop boxes 1, 2, 5, and 9.

2.3 SURFACE WATER. Surface water samples will be collected from the Polishing Pond to evaluate water quality. A sample will be collected from each leg of the Polishing Pond. If possible, these sample will be collected at the same approximate locations as CLP sediment samples. To evaluate potential contaminant migration through the east/west drainage ditch, surface water samples will be collected from each place where water enters or exits the base in the drainage ditch (see Figure 2-9). Surface water samples will be analyzed using CLP methodology for TCL VOCs, SVOCs, pesticides, and PCBs, and TAL inorganics. These samples will also be analyzed for TOC and split for VOC, PHC, and inorganic field screening. One surface water sample from the Polishing Pond and all the drainage ditch samples will also be analyzed for pH, temperature (field measurements), and submitted for total dissolved solids, total suspended solids, alkalinity, biochemical oxygen demand (BOD)/chemical oxygen demand (COD).

2.4 GROUNDWATER. The groundwater at OU-2 will be investigated to evaluate the impact of the various source areas on the groundwater quality. The groundwater sampling program was developed based on the following assumptions:

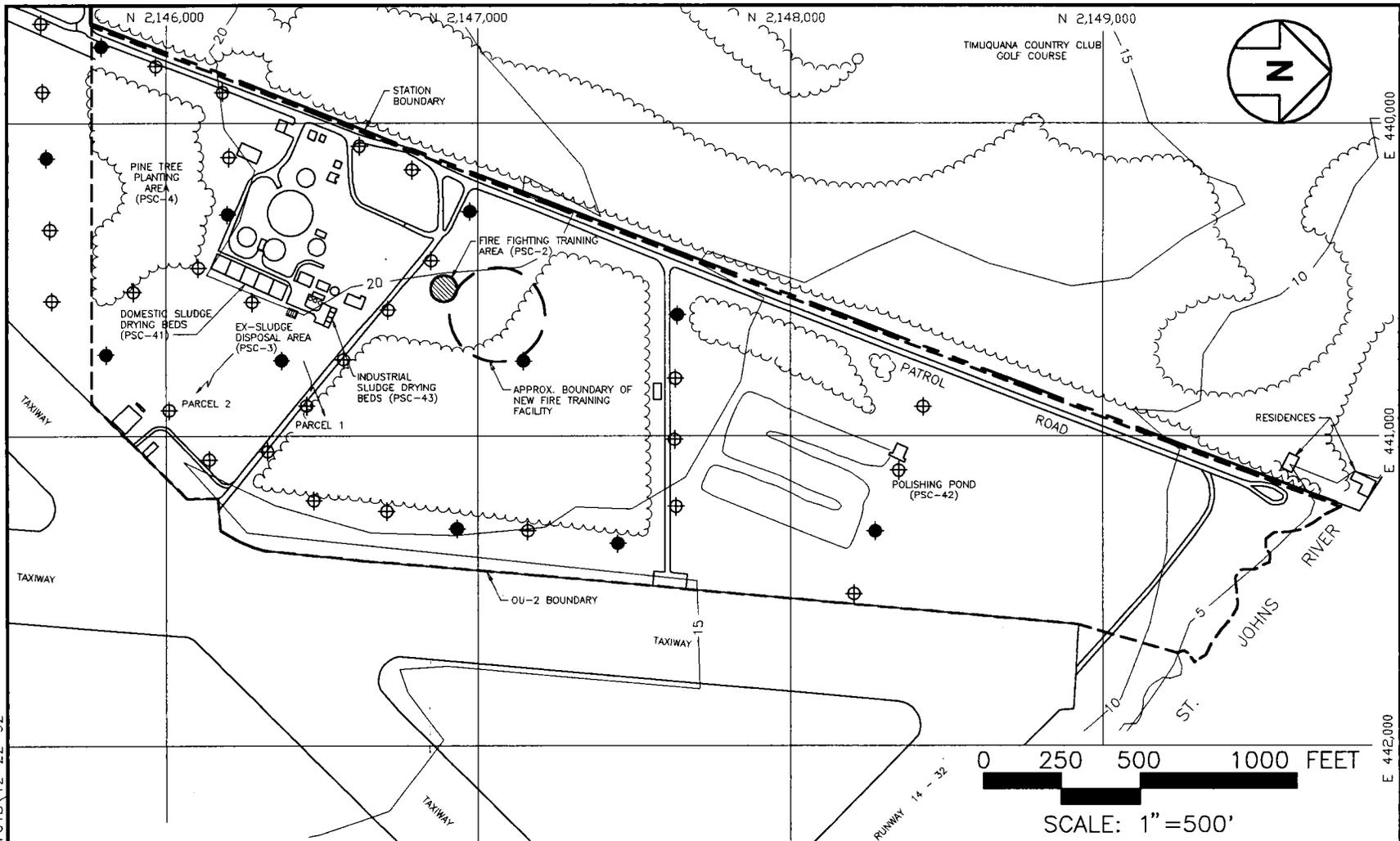
- Each identified potential source at OU-2 may be impacting groundwater quality.
- Based on previous groundwater sampling results, the primary contaminants in groundwater are VOCs and inorganics.

- Contaminants may potentially be detected at any depth in the surficial aquifer.

The groundwater at OU-2 will be investigated using the following steps:

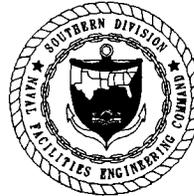
1. Collect groundwater samples from existing wells for VOC and inorganic field screening. No split samples are required for CLP analysis.
2. Calibrate the PCPT equipment by pressing a PCPT boring adjacent to an existing boring with known stratigraphy.
3. Obtain subsurface geological information with the PCPT equipment at the locations shown in Figure 2-11.
4. Map PCPT geological information and identify depths in the aquifer where permeability is highest.
5. From the higher permeability zones, collect groundwater VOC and inorganic screening samples using a groundwater sampling device attached the PCPT equipment. PCPT boring locations are shown in Figure 2-11. Throughout the field screening process, split 10 percent of the samples for CLP TCL VOC and TAL inorganic analysis. When possible, the split samples should be collected every tenth sample and be representative of areas where contaminants are and are not detected by field screening.
6. Map the field screening results.
7. If contaminant plumes are detected, use the field screening results, geological data, and knowledge of groundwater flow to select additional groundwater sampling locations.
8. Repeat steps 5 through 7 until the horizontal and vertical distribution of the plumes are delineated. The lowest chemical-specific ARAR for detected contaminants will be used to identify the edges of the plumes.
9. Based on the results of the groundwater screening, select locations and depths for piezometers and monitoring wells. The piezometers should be positioned to provide groundwater contour data needed to define groundwater flow at OU-2. The monitoring wells should be positioned to provide contaminant concentration gradients within each plume and confirm interpreted edges of the plumes. Preliminary monitoring well and piezometer locations are shown in Figure 2-12.
10. Discuss proposed monitoring well and piezometer locations with representatives from regulatory agencies.

Z:\7559-25\FIG\7559FF01B\12-22-92



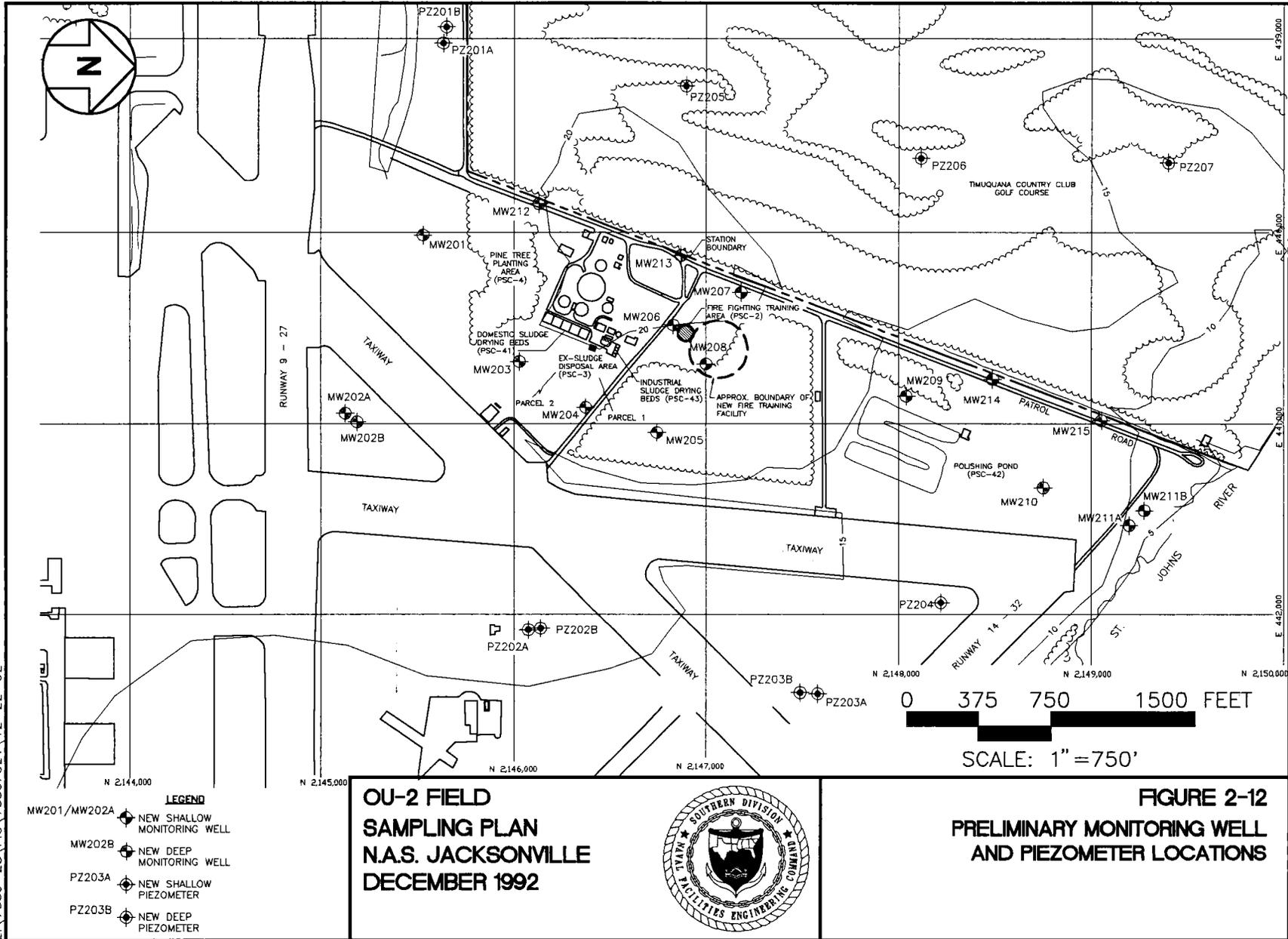
- LEGEND**
- ⊕ PCPT GROUNDWATER SAMPLING LOCATION
 - ◆ PCPT GEOTECHNICAL AND GROUNDWATER SAMPLING LOCATION

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**FIGURE 2-11
INITIAL PCPT SAMPLING LOCATIONS**

Z:\7559-25\FIG\7559F021\12-22-92



- LEGEND**
- MW201/MW202A NEW SHALLOW MONITORING WELL
 - MW202B NEW DEEP MONITORING WELL
 - PZ203A NEW SHALLOW PIEZOMETER
 - PZ203B NEW DEEP PIEZOMETER

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**FIGURE 2-12
PRELIMINARY MONITORING WELL
AND PIEZOMETER LOCATIONS**

11. Install monitoring wells and piezometers.
12. Measure the groundwater elevation in the monitoring wells and piezometers. Sample new and selected existing monitoring wells and analyze for TCL VOC, SVOC, pesticide, and PCB, and TAL inorganics using CLP methodology. In addition to CLP analyses, measure pH, temperature, and conductivity in the field and submit samples for total dissolved solids, total suspended solids, BOD, and COD.

2.5 ANALYTICAL PROGRAM SUMMARY. A summary of the Analytical Program for OU-2 is provided in Table 2-1. This table presents the total number of samples and duplicate samples to be collected per matrix for each analysis type at OU-2. Table 2-2 presents the number of associated blank samples (trip, field, equipment, matrix spikes) that will be submitted for analysis based on the expected number of field events (i.e., 10-day shifts).

TABLE 2-1 ANALYTICAL PROGRAM SUMMARY, NAS JACSONVILLE, FLORIDA, OPERABLE UNIT 2

OU-2 SOIL								
SITE	FIELD LABORATORY ANALYSES			OFF-SITE LABORATORY ANALYSES				
	VOC	PHC	INORG	CLP ¹	PHC	TOC	BTU	GRAIN SIZE
Former Fire Fighting Training Area (PSC-2)	10	49	10	5	5	1	1	1
Area around PSC-2	2	39	2	2	4	2	2	2
Former Sludge Disposal area Parcel 1 (PSC-3-1)	9		90	9		2		2
Former Sludge Disposal area Parcel 2 (PSC-3-2)	9		90	9		2		2
Pine Tree Planting Area (PSC-4)	90	90	90	9	9	2		2
Polishing Pond Bank			27	3				
Domestic Sludge Drying Beds	30		45	5		5		5
Industrial Sludge Drying Beds	8		16	4		4		4
Areas outside of known potential source areas	125	125	125	13	13			
TOTAL SAMPLES⁴	283	303	495	59	31	18	3	18
NAVY DQL	B	B¹	B	C	C	Other	Other	Other
PRIMARY USES								
Confirmation				X	X			
Characterization	X	X	X	X	X			
Risk Assessment	X ²		X ²	X				
Feasibility Studies	X	X	X	X	X	X	X	X

2-23

TABLE 2-1 (Continued) ANALYTICAL PROGRAM SUMMARY, NAS JACSONVILLE, FLORIDA, OPERABLE UNIT 2

OU-2 SEDIMENT							
SITE	FIELD LABORATORY ANALYSES			OFF-SITE LABORATORY ANALYSES			
	VOC	PHC	INORG	CLP ¹	PHC	TOC	GRAIN SIZE
Patrol Road Turnaround	2	2	2	2		2	2
East/West Drainage	8	8	8	8	1	8	8
Drain Pipes Along Taxiway	28	28	28	4	4	4	4
Polishing Pond	18		18	3	3	3	3
TOTAL SAMPLES⁴	56	38	56	17	8	17	17
NAVY DQL	B	B	B	C	C	Other	Other
PRIMARY USES							
Confirmation				X	X		
Characterization	X	X	X	X	X		
Risk Assessment	X ²		X ²	X			
Feasibility Studies	X	X	X	X	X	X	X

TABLE 2-1 (Continued) ANALYTICAL PROGRAM SUMMARY, NAS JACSONVILLE, FLORIDA, OPERABLE UNIT 2

OU-2 SURFACE WATER AND GROUNDWATER										
SITE	FIELD LABORATORY ANALYSES				OFF-SITE LABORATORY ANALYSES					
	VOC	PHC	INORG	CLP ¹	PHC	BOD	COD	ALK	TDS	TSP
East/West Drainage	4	4	4	4		4	4	4	4	4
Polishing Pond	3	3	3	3	1	3	3	3	3	3
PCPT borings	150		150	15 ³						
Monitoring Wells				13		13	13	13	13	13
TOTAL SAMPLES ⁴	157	7	157	35	1	20	20	20	20	20
NAVY DQL	B	B	B	C	C	Other	Other	Other	Other	Other
PRIMARY USES										
Confirmation				X	X					
Characterization	X	X	X	X	X					
Risk Assessment	X ²		X ²	X						
Feasibility Studies	X	X	X	X	X	X	X	X	X	X

NOTES:

1 Includes Target Compound List volatile organics, semivolatile organics, pesticides, and polychlorinated biphenyls, and Target Analyte List inorganics

2 If there is a satisfactory comparison between field and laboratory analysis, field screening may be used for risk assessment

3 Target Compound List volatile organic and Target Analyte List inorganic analyses only

4 Because field screening is being used, numbers of samples are estimates and may change as the field program progresses

ALK - alkalinity

DQL - data quality level

TOC - total organic carbon

BOD - biochemical oxygen demand

INORG - inorganics

TSP - total suspended particulates

BTU - British thermal units

PCPT - piezometric cone penetrometer testing

VOC - volatile organic compounds

COD - chemical oxygen demand

PHC - petroleum hydrocarbons (Method 418.1 equivalent)

CLP - Contract Laboratory Program

TDS - total dissolved solids

TABLE 2-2 SUMMARY OF QUALITY CONTROL SAMPLES, NAS JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

SAMPLE TYPE	ANALYSES				
	VOC	SVOC	PEST/PCB	INORG	PHC
Trip Blanks ¹	40				
Equipment Blanks ²	40/20	40/20	40/20	40/20	40/20
Field Blanks ³	8	8	8	8	8
Duplicates (soil) ⁴	8	8	8	8	4
Duplicates (water) ⁴	4	2	2	4	1
MS/MSD (soil) ⁵	4	4	4	4	2
MS/MSD (water) ⁵	2	1	1	2	1
TOTAL SAMPLES	86	43	43	46	36

NOTES:

- 1 Estimated at one per day for four ten-day shifts
- 2 Number collected/number sent for analysis. One per day, shipped every other day (four ten-day shifts)
- 3 One per source per event, two sources
- 4 Ten percent of total off-site laboratory samples collected, by media
- 5 Twenty percent of the total off-site laboratory samples collected, by media

CLP - Contract Laboratory Program
 INORG - CLP TAL inorganics
 MS - Matrix spike
 MSD - Matrix Spike Duplicate
 PCB - CLP TCL polychlorinated biphenyls
 PEST - CLP TCL pesticides
 PHC - Petroleum hydrocarbons (USEPA Method 418.1)
 SVOC - CLP TCL semivolatile organics
 TAL - Target Analyte List
 TCL - Target Compound List
 VOC - CLP TCL volatile organics

3.0 SAMPLE DESIGNATION

Each sample collected during the field program needs a unique sample identifier. Separate but similar systems will be used for field screening samples and samples sent to an off-site CLP laboratory.

3.1 SAMPLES FOR OFF-SITE ANALYSIS. A sample identification system was developed for the OU-1 Field Sampling Plan to enable field personnel to establish unique and appropriate identifications for each sample collected. The system incorporates identifiers for each PSC, the sample matrix, and the sample location. The identification system is designed to give reference to previously existing sample location identification numbers. The identification number will consist of a Site code, PSC code for both new or old PSC numbers, date code, sample matrix code, sample number, and sequence number. Each of these codes is described below and also in Section 3.0 of the BFSP (Appendix 4.4.2 of Volume 4).

Site Code The Site code for all samples will be "J" for Naval Air Station, Jacksonville, Florida.

PSC Code The PSC code is the location code, for example, "04", for PSC-4, the Pine Tree Planting Area. Samples outside of designated PSCs (e.g., drainage areas), and quality control samples will use the PSC code "00."

Date Code The date code will consist of a four digit number. The first two digits refer to the month and the last two digits refer to the year.

Sample Matrix Code This code includes Field Quality Control Samples. The sample matrix code will be a two letter (alphabetic) code that describes the type of sample matrix. The following codes will be used:

- | | |
|----------------------------------|----|
| • Soil: | SL |
| • Sludge/Waste | WT |
| • Sediment: | SD |
| • Surface Water: | SW |
| • Groundwater (PCPT sample): | CW |
| • Groundwater (Monitoring Well): | MW |
| • Field blank (water): | FB |
| • Equipment blank: | EB |
| • Trip blank: | TB |
| • Duplicate: | RP |

Sample Number Code The sample number code will be a three digit number starting with 001 and proceeding sequentially — 002, 003, and so forth.

Sample Sequence Code The sample sequence code will be a single digit letter starting with A and proceeding sequentially — B, C, etc. The sample sequence code is used for samples collected at multiple depths at the same sample location and will be assigned sequentially with depth. If only one depth is sampled during a sample event, then the sample sequence number will not be used.

Examples. The following numbers are provided as examples to illustrate how the sample coding will work for each matrix. Assume samples were collected in January 1991.

Soil Samples (single depth):
J260191SL001 (single depth)

Soil Samples (multiple depth, 0 to 12 inches bgs and 2 to 3 feet bgs):
J260191SL001A (0 to 12 inches bgs)
J260191SL001B (2 to 3 feet bgs)

Sediment Samples: J260191SD001

Surface Water Samples: J260191SW001

Field Quality Control Samples:
Field Blanks: J000191FB004

Equipment Blanks: J000191EB005

3.2 FIELD SCREENING SAMPLES. The sample designation system for field screening samples is an abbreviated form of the system used for off-site analytical samples. Only the PSC, sample matrix, sample number, and sample sequence codes will be used. These codes will have the same use as described in the previous subsection with the exception of the sample number code. For soil samples collected from grids, the sample number code will be replaced by an eight digit grid location code (i.e., a four digit north coordinate and a four digit east coordinate). For groundwater samples collected with the PCPT equipment, the sample number will correspond to the PCPT boring number.

4.0 SAMPLING PROCEDURES

Field sampling procedures that will be conducted at OU-2 are described by media in this section. The sampling protocols conform to and reference methods presented in the *U.S. Navy Installation Restoration Program Plan, Naval Air Station, Jacksonville, Florida; Volume 4, The Basic Site Work Plan, Appendix 4.4.2, The Basic Field Sampling Plan* (September, 1991; updated 1992) unless otherwise noted. Sample containers, preservatives and holding times are provided in the Quality Assurance Project Plan (QAPjP) (Included as Appendix A-1 of the OU-2 Project Work Plan).

4.1 AIR SAMPLING. The in-depth air sampling program at the Fire Fighting Training Area (PSC-2) will consist of collecting air samples for total suspended particulates (TSP), TAL metals, and TCL VOC, SVOC, pesticide, and PCB analysis using CLP methodology from an upwind/downwind sampling network that will be set up based on daily micrometeorological conditions. Air samples will be collected over three days.

In addition, air screening will be conducted at the polishing pond (PSC-42), sludge drying beds (PSC-41, PSC-43), and sludge disposal area (PSC-3) for a total of three days with favorable weather conditions. Air screening will be done using two screening techniques, head space sampling for VOCs and upwind/downwind monitoring for fugitive dust (particulate).

4.1.1 Meteorological Monitoring Throughout the air monitoring program, on-site meteorological conditions will be monitored with a portable meteorological system. The system will be capable of continuously recording temperature, wind speed, and wind direction. In addition, soil temperature, barometric pressure, and general weather conditions will be recorded on the days of sampling. Barometric pressure will also be monitored daily and recorded three or four times during each test period. The meteorological station will remain in place throughout the duration of the field investigation and provide a continuous record of meteorological data.

Before performing field measurements at the fire training area (PSC-2), upwind and downwind sampling locations will be determined each day based on the local wind directions.

Sustained wind shift can affect sample collection; however, because moving the sampling locations could take many hours and the potential for sample contamination increases with handling, samplers will not be moved. Samplers will be shut off in the event that a sustained wind shift occurs. The systems will be restarted when the wind returns to its original direction.

4.1.2 Sampling Methodologies Specific ambient air sampling methodologies have been selected to determine concentrations of TSPs, TAL metals, and TCL VOCs, SVOCs, pesticides, and PCBs at PSC-2. Three individual sampling methodologies (in-depth

techniques) will be used to capture these suspected air contaminant groups at PSC-2. In addition, air screening will be conducted at PSC-41, 42, 43 using two screening techniques, head space sampling for VOCs and upwind/downwind monitoring for fugitive dust (particulate). The sampling procedures for each are briefly discussed in the following subsections.

4.1.2.1 Total Suspended Particulates and Metals TSPs and metals will be collected in accordance with USEPA's "Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High-Volume Method)" found in Clean Act regulations 40 CFR Part 50, Appendix B.

During sampling, the high-volume air samplers will be maintained at a flow rate of approximately 42 cubic feet per minute (cfm) for a period of four hours. A normal sample volume of 286 cubic meters (m³) will be collected through a glass fiber filter.

The analytical method detection limit for TSPs will be 100 micrograms per filter ($\mu\text{g}/\text{f}$) and the instrument detection limits (IDL) for TAL metals range from 0.03 to 213 $\mu\text{g}/\text{f}$, depending on the analyte. Based on the 286 m³ sample, this will yield detection limits from 0.001 to 0.74 nanograms per cubic meter (ng/m³) for the metals species.

Sampling Locations. Sampling will be conducted on three consecutive days at the Fire Fighting Training Area (PSC-2). On each day, samples will be collected under general ambient conditions at one upwind and two downwind site locations. In addition, the downwind sampling location will be sampled in duplicate using a collocated sampler. The sampling location will be selected on the morning of each day of testing using a portable meteorological station that is set up on-site before the start of the air monitoring program.

Each day, one unused, stamped glass fiber filter will be selected in the field to serve as a sampler blank. The blank sample will be analyzed for target metals to determine the presence of background levels of metals in the filter media, either initially present or through field contamination.

Analytical Procedures. After completion of the sampling, the filters will be analyzed gravimetrically for total suspended particulates. The filters will be equilibrated for 24 hours at a relative humidity of less than 50 percent and at 15 to 30 degrees Celsius. The equilibrated filter will be weighed to the nearest microgram and the weight recorded. Duplicate weighings will be performed until the measurement becomes constant.

After completion of the gravimetric analysis, the filters will be prepared for TAL metal analyses (the detection limit ranges in air for TAL metals are listed in Appendix A-2.1 of this FSP). Each sample filter will be cut into five equal strips by the laboratory. Two strips will be submitted for preparation and analysis by the USEPA Method 3010/6010. One strip will be submitted for preparation and analysis by USEPA Method 3020/7000;

one will be submitted for the analysis of mercury; and one will be maintained as a backup. The TAL metals analysis performed in these USEPA methods use three different analytical techniques. Mercury analysis will be performed by the manual cold vapor method; an atomic absorption (AA) furnace is used to analyze arsenic, lead, selenium, and thallium. All other metal species will be analyzed by inductively coupled plasma (ICP) spectrometry. The metal analytes will be reported by the laboratory in total $\mu\text{g}/\text{f}$.

For each sample, the concentration in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) of total suspended particulates will be calculated by dividing the difference in final and initial weight (in micrograms) by the total volume sampled, as corrected to standard conditions of 77 degrees Fahrenheit and 29.94 inches of mercury. Based on the volume of air sampled and the results of the metals analyses, the concentration of metals in the air for each sample will be calculated and reported in $\mu\text{g}/\text{m}^3$.

4.1.2.2 Volatile Organic Compounds TCL VOCs will be sampled in general accordance with USEPA Method TO-14 as found in "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air". This method involves the collection of whole air samples in six liter, Summa sampling canisters. The TCL VOCs are subsequently separated by gas chromatography (GC) and measured by mass spectrometry (MS).

The sampling method that will be used is a subatmospheric sampling system which is a collection of air in an evacuated canister at a (final) canister pressure below atmospheric pressure, without assistance of a sampling pump. The canister is filled as the internal canister pressure increases to ambient or near ambient pressure. This technique will be used to collect an integrated sample for a duration of 24-hours. The sample flow rate will be controlled with a critical orifice flow restrictor pre-calibrated by the analytical laboratory.

On each day, samples will be collected under general ambient conditions at one upwind and two downwind site locations. In addition, the downwind sampling location will be sampled in duplicate using a collocated sampler.

One trip blank canister sample will be collected on each day of sampling for a total of three trip blanks. The trip blanks will be analyzed identically to the field samples to determine background VOC quantities. Sample canisters will be shipped to the laboratory on a daily basis, at the end of each 24-hour event.

Analytical Procedures. The VOC analysis will be performed using the analytical procedures specified in USEPA Method TO-14, from the USEPA "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air". This analytical procedure for Method TO-14 involves using a high-resolution GC coupled with a MS operating in the selection mode (SIM) which provides quantification of a "target compound list" of VOCs.

The minimum analytical detection limit of 0.1 to 1.0 ppbv per sample can be achieved for VOCs, depending on the compounds and the concentration found in the ambient air.

The VOCs will be reported by the laboratory in total micrograms per sample. Based on the volume of air sampled, and the results of the VOCs analyses, the concentration of each analyte per sample will be calculated and reported in $\mu\text{g}/\text{m}^3$.

4.1.2.3 Semivolatile Organic Compounds, Pesticides, and PCBs SVOCs, pesticides, and PCBs will be collected in general accordance with USEPA Methods TO-13 and TO-4 from the *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, using General Metal Works PS-1 foam polyurethane (PUF) high-volume air samplers. This method will be modified to include a dual sorbent module composed of PUF and XAD-2 resins.

To determine the field bias and matrix effects of the sampling, the PUF/XAD-2 cartridge will be spiked with known quantities of surrogate standards following the cleanup extraction and before field use. The quantity of surrogate recovered during analysis is compared with the known amount added to the sample to determine if bias has been introduced during sampling.

The sampling media and system are designed for the collection of particulate-phase SVOCs, pesticides, and PCBs on the filter, and the collection of the gaseous-phase compounds in the PUF/XAD-2 sorbent media.

The high-volume air samplers will be maintained at a maximum flow rate of approximately 226 liters per minute (Lpm) for a period of 24 hours. A sample volume of approximately 320 m^3 of air will be pulled through the sampling module.

The minimum analytical detection limit of 1 to 10 micrograms per sample can be achieved for SVOCs, pesticides, and PCBs. Based on a 400 m^3 sample, this will yield detection limits of 2.5 to 25 ng/m^3 .

Sample Locations. On each day, samples will be collected under general ambient conditions at one upwind and two downwind site locations. In addition, the downwind sampling locations will be sampled in duplicate using a collocated sampler.

One filter and dual sorbent module will be selected at random for each 24-hour sampling period and sent with the field samples to serve as a trip blank. The trip blank samples will be extracted identically to the field samples to determine background quantities of SVOCs, pesticides, and PCBs.

Analytical Procedures. The SVOCs analysis will be performed using the analytical procedures specified in USEPA Methods TO-13 and TO-4, from the USEPA *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*. The sorbent media and filters will be Soxhlet extracted and analyzed for USEPA

CLP TCL SVOCs, pesticides, and PCBs by gas chromatography/mass spectrometry (GC/MS).

To verify the desorption efficiency and overall accuracy of the analytical procedure for SVOCs, pesticides, and PCBs, known quantities of surrogate standards will be added to the PUF/XAD-2 cartridges after sampling and prior to extraction. These will be reported as standard spike recoveries and used to determine the overall efficiency of the analytical technique.

The SVOCs, pesticides, and PCBs will be reported by the laboratory in total micrograms per sample. Based on the volume of air sampled, and the results of the SVOC analyses, the concentration of each analyte per sample will be calculated and reported in $\mu\text{g}/\text{m}^3$.

4.1.2.4 Head Space Screening Technique Sampling for Volatile Organic Compounds

Head space sampling will be used to measure the concentration of VOCs emitted from the surface over a period of time. The head space sampling will be operated in the static mode in which the sampling enclosure is placed over the surface for a given amount of time before the sample collection.

The concentrations of the target VOCs will be used to calculate a time-integrated emission flux rate for use in the subsequent air emission modeling described in Section ????. The time-integrated flux rate is calculated as:

$$E_i = (C_i V_e)/(t A)$$

where

E = emission flux for component i (ug/m^2 - sec);

C = concentration of component i (ug/m^3);

V = volume of the enclosure (m^3);

t = length of time enclosure is in place (sec); and

A = surface area enclosed by chamber (m^2).

Head space sampling will be conducted within PSC- 41, 42, 43 at three site selected locations each. In addition, to the three locations duplicate samples will also be collected, one at each location.

The samples will be collected from the head space sampling system after a given period of time by pumping the surface emissions into a clean Tedlar bag. The analysis of the Tedlar bag will be conducted by on-site field GC for selected target VOCs.

4.1.2.5 Upwind/Downwind Screening Technique for Particulate The upwind/downwind technique used in this approach will be a screening technique for fugitive dust or particulate matter from PSC- 41, 42, 43. The method will be used for emission flux measurement for use in the subsequent air emission modeling.

The upwind/downwind technique will have one particulate monitor located upwind of the area source and a second monitor located downwind. The upwind monitor will serve as a blank or background sampling location. The monitoring device will be a MIE PPM-3 Miniram Particulate monitor. This instrument is a real-time direct reading monitor for dust, smoke, and mists. It is capable of measuring aerosol concentrations over a range of 10 to 10,00 ug/m³. The unit is powered by nickel-cadmium batteries and is MSHA approved.

The average surface emission flux for a particulate trajectory is equal to the increase in the column concentration (downwind minus upwind) divided by the transit time across the source. Transit time is a function of the distance between the source and downwind location, and the average wind speed.

$$E.R.i = (C_D - C_u)\pi\sigma_y\sigma_z U$$

where

- E.R.i = emission flux of species (ug/m² - sec);
- C_D = downwind concentration of species (ug/m³);
- C_u = upwind concentration of species (ug/m³);
- π = 3.141...
- σ_y = lateral extent of Gaussian plume;
- σ_z = vertical extent of Gaussian plume; and
- U = mean wind speed (m/sec).

Upwind/downwind sampling will be conducted within PSC- 41, 42, 43 at site selected locations. In addition, to the selected locations duplicate sampling will also be conducted, once at each location. The particulate concentration will be measured along the downwind axis determined on-site based upon current daily wind direction. Upwind/downwind also requires that meteorological conditions be monitored and this will be done with the meteorological system described previously. The sampling locations will be monitored on the approximate plume centerline.

4.2 SURFACE AND SUBSURFACE SOIL SAMPLING. The soil sampling program is designed to evaluate the presence of contaminants in the surface and subsurface soil. Soil samples will be collected using a variety of techniques depending on the depth from which the sample will be collected and the subsurface conditions anticipated and/or encountered. The Surface/Subsurface Soil Sampling Record (Figure 4-1) will be used to record field-generated information for surface (i.e., 0 to 12 inches bgs) and subsurface (i.e., greater than 1 foot bgs) soil samples collected. A brief description of the soil sample which includes the Unified Soil Classification System designation will be included on the sampling record.

4.2.1 Soil Sampling Grids Soil sampling grids will be established at the Pine Tree Planting Area, the Sludge Disposal Areas (i.e., Parcels 1 and 2), the area surrounding the Former Fire Fighting Training Area, between the Polishing Pond and the St. Johns

River, south of the Pine Tree Planting Area, and along the east/west drainage ditch south of the Timuquana Country Club Golf Course.

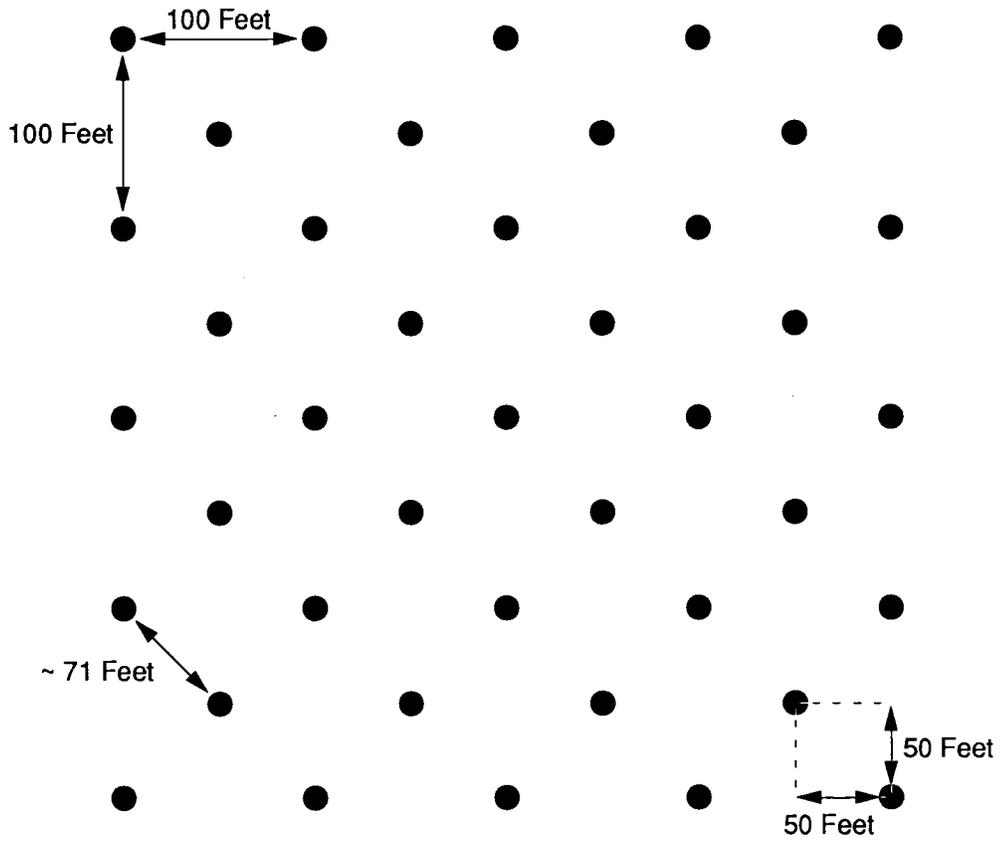
Grids will be oriented north-south except when field conditions require a different orientation. To provide a correlation between the different north-south oriented grids, common gridlines will be used throughout the site when practical. If contaminants are found at the edge of an established grid, the grid will be expanded by one row in the area of concern using the same grid node spacing; samples will be collected from the new row and field screened for the appropriate compounds. The grid will be expanded, one row at a time, until the distribution of contaminants is determined by field screening results.

Grid size was established based on the data requirements for each area and by using the methodology described in Section 5.0 of the OU-2 Project Work Plan. The selection of grid sizes for each area is described in the following subsections.

4.2.1.1 Sludge Disposal Areas The primary potential source of contaminants in the sludge disposal areas is sludge from the domestic sludge drying beds. Because there is evidence that contaminants are present in the sludge/soil at the disposal areas (i.e., stressed vegetation, contaminants in groundwater), the minimum acceptable confidence level for detecting a hotspot was set at 85 percent. This goal and the assumptions about potential hotspot size listed in Section 2.0 of this FSP were used to determine the grid size for the sludge disposal areas. However, before grid size could be determined, some calculations were required to fit the estimated size of the source area into the Gilbert method.

The sludge drying bed hot spot was developed based on the area of a 50 foot by 100 foot rectangle measuring a total of 5000 square feet. However, the Gilbert method assumes a hot spot has an elliptical shape. The area of a 50 foot by 100 foot ellipse is not the same as the area of a rectangle with the same length axes. To calculate the axes used in the Gilbert method, the 5000-foot target area size was substituted into the equation for the area of an ellipse or $K = \pi ab$ (where a and b represent half the length of the major and minor axes, respectively and L is the total area). It was assumed that $a = 2b$ so $K = \pi 2b^2$ (This assumption was made to be conservative and have $s = 0.5$). Solving for b in this equation, $b = 28.2$ feet; the length of the ellipse axes are 56.4 feet and 112.8 feet, respectively. Using the previously calculated axes lengths and the confidence level of 85 percent in the Gilbert model, $s = 56.4/112.8 = 0.5$; " L " = $112.8/2 = 56.4$; and $\beta = 15$. The calculated grid size was approximately 72 feet, which is impractical for field use.

To create a grid that could be easily setup in the field and provide a satisfactory confidence level, an additional node was placed in the middle of each square of a 100-foot-square grid (Figure 4-2). When this grid is viewed diagonally, there is a square grid with approximately 71-foot node spacing. This pattern is easy to setup in the field since it is based on 100 foot and 50 foot spacings. The approximate 71-foot node spacing provides a better than 85 percent confidence level for finding hot spots.



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EXAMPLE OF MODIFIED 100-FOOT
GRID SPACING
FIGURE 4-2

4.2.1.2 Area Surrounding the Former Fire Fighting Training Pit Because of features observed on a 1961 aerial photograph of the base, grid sampling is required around the Former Fire Fighting Training Pit to investigate the possibility of unknown pits which were may have been used for fire fighting training in the past. Using the assumption that the target area is a 80-foot-diameter circle, the Gilbert model was used to calculate grid size. In the model, $s=80/80=1$, $L=80/2=40$, and $\beta=15$. With this input the calculated grid size is approximately 76 feet. Because this grid size is impractical for use in the field, the grid arrangement established for the sludge disposal areas will be used in the area around the Former Fire Fighting Training Pit. The approximate 71-foot node spacing provides a greater than 90 percent confidence level for finding an old training area.

4.2.1.3 Areas outside of the Known Potential Source Areas There are no known areas of soil contamination outside of the PSCs that have been identified at OU-2. However, because there is little historical information about the disposal practices for wastewater treatment plant sludge, soil sampling outside of the known PSCs is warranted. Because contamination is not suspected, a low level of confidence (i.e., 10 percent or greater) was selected for finding the same size target area used for the sludge disposal areas (i.e., 5000-square feet). Using the same "s" and "L" as for the sludge disposal areas and a β equal to 90, the grid node spacing calculated using the Gilbert method is approximately 217 feet. A 200-foot grid node spacing will be used in these areas to make the node spacing more practical. The level of confidence provided by the 200-foot spacing is approximately 13 percent.

4.2.2 Surface Soil Sampling Prior to sampling, leaves, grass, and surface debris will be removed from the area to be sampled using a pre-cleaned stainless steel trowel or spoon. Each surface sample will be collected from 0 to 12 inches bgs using a dedicated pre-cleaned stainless steel trowel or spoon. A sufficient amount of material should be collected to fill the sample bottles. Filled field screening sample containers will be labeled and taken to the on-site field laboratory and refrigerated at 4° degrees Celsius (°C) until analyzed. Samples collected for analysis at a CLP laboratory will be labeled and placed into coolers containing ice until they can be repackaged and shipped.

Samples collected for VOC analysis will be placed immediately into the appropriate sample containers without mixing. Soil samples collected for chemical analysis other than VOCs will be thoroughly mixed before being placed in the appropriate sample containers.

4.2.3 Subsurface Soil Sampling Subsurface soil samples will be collected at OU-2 using hand augers. Filled field screening sample containers will be labeled and taken to the on-site field laboratory and refrigerated at 4°C until analyzed. Samples collected for analysis at a CLP laboratory will be labeled and placed into coolers containing ice until they can be repackaged and shipped.

Before drilling each borehole, leaves, grass, and surface debris will be removed from the area using a pre-cleaned stainless steel scoop or spoon. Samples collected for VOC analysis will be placed immediately into the appropriate sample containers without mixing. Soil samples collected for chemical analysis other than VOCs will be thoroughly mixed before being placed in the appropriate sample containers.

4.3 PIEZOMETRIC CONE PENETROMETER TESTING. A PCPT survey will be conducted to identify the surficial aquifer stratigraphy and to identify the nature and distribution of the OU-2 groundwater contaminant plumes.

4.3.1 Geophysical Sampling A PCPT tip containing transducers will be set to record tip pressure, sleeve pressure, and pore pressure, will be advanced until the tip reaches either refusal or the maximum depth of the PCPT equipment. Data collected from the sensors will be stored on electronic media (i.e., diskettes) and printed out in hardcopy form. The PCPT rods will be decontaminated between borings using the procedures described in Subsection 4.9 of this FSP.

4.3.2 Groundwater Samples Groundwater samples will be collected using a groundwater sampling device attached to the PCPT equipment. The groundwater sampler will be pushed to the appropriate depth by the PCPT truck and a sampling port will be exposed to the aquifer, allowing the rod to fill with groundwater. Groundwater samples will be collected as described in Section 4.5.3 Groundwater Sampling, using a small bailer lowered down the PCPT rods. Using the procedures described in Subsection 4.9 of this FSP, the bailer and the PCPT rods will be decontaminated after each sample to prevent cross-contamination. Samples will be taken to the on-site field laboratory and refrigerated at 4°C until analyzed. A separate boring will be used for each groundwater sample.

4.4 MONITORING WELLS AND PIEZOMETERS. Approximately 23 piezometers and monitoring wells will be installed during the OU-2 field investigation, according to the procedures described in the following subsections.

4.4.1 Monitoring Well and Piezometer Installation Monitoring well and piezometer construction and installation are covered in the following subsections. The Completion Checklist (Figure 4-3) and the Field Boring Log (Figure 4-4) will be filled out after each of the installation tasks described in the following subsections are completed. In addition, before final demobilization of the drill rig, a slug that is approximately the same diameter and length as the submersible pumps used during groundwater sampling will be lowered into each new well to confirm that the wells are properly installed and there are no obstructions.

4.4.1.1 Piezometer/Well Construction Material ASTM Schedule 40 polyvinyl chloride (PVC) threaded risers and screens that meet National Sanitation Foundation (NSF) Standard 14 have been determined to be the most appropriate well construction material for piezometers and monitoring wells installed at OU-2.

4.4.1.2 Shallow Piezometer and Monitoring Well Installation Piezometers and monitoring wells with screens that straddle the water table will be drilled using 7.25-inch outside diameter (OD), 4.25-inch inside diameter (ID) cast iron hollow-stem auger. The hollow-stem augers will be used as temporary surface casing. The piezometers and monitoring wells will be installed to a depth of approximately 7 feet below the water table. The total depth of the shallow piezometers and monitoring wells will be approximately 12 feet. Because of the shallow depth of the water table (i.e., approximately 5 feet), well construction may have to be modified to accommodate a 2-foot-thick bentonite seal.

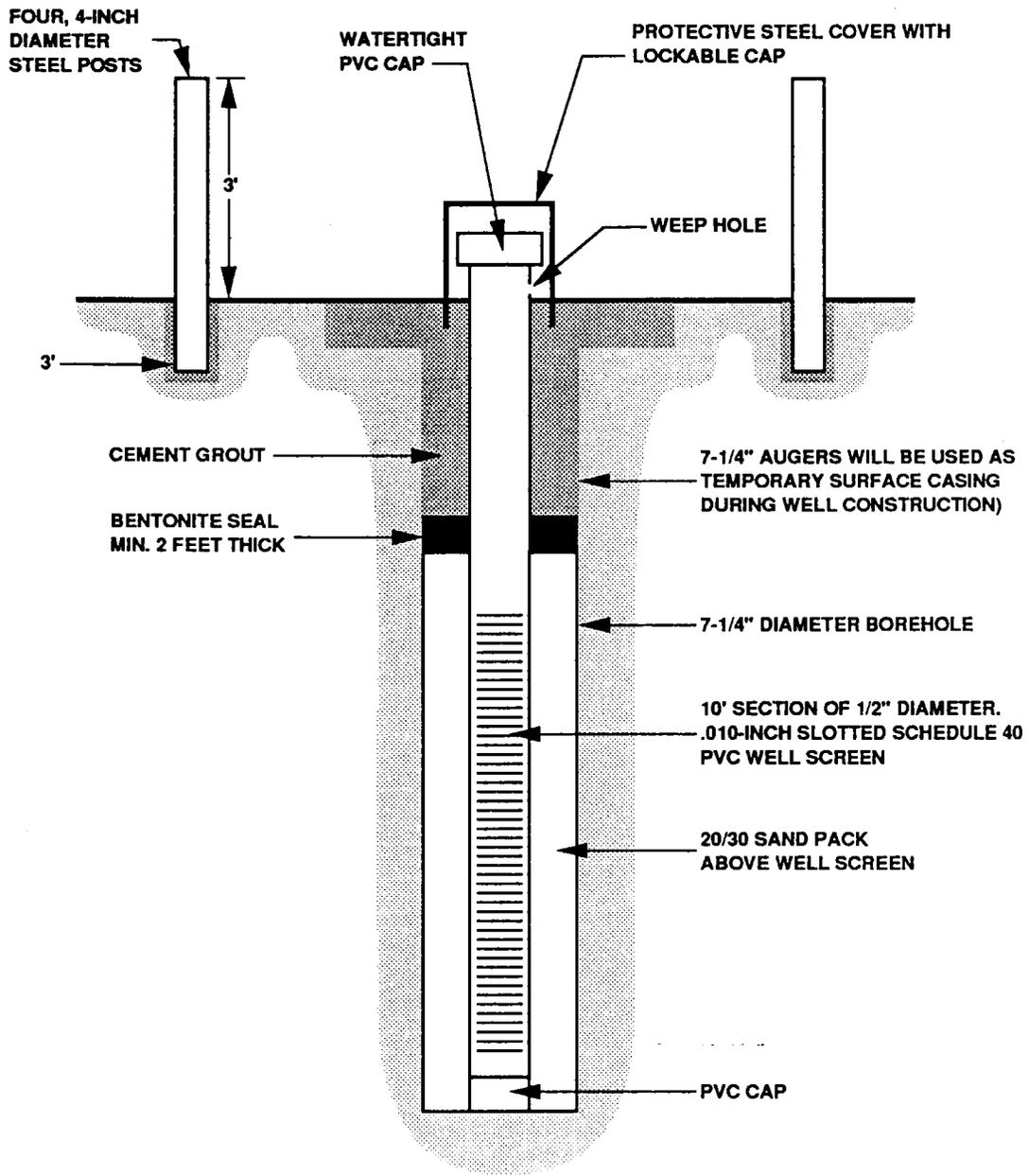
Shallow piezometers and monitoring wells will be constructed of a 10-foot section of 2-inch ID, 0.010-inch slotted, PVC well screen attached to PVC casing extending 3 feet above the land surface. The base of the screen will be set 5 feet below the water table, leaving 5 feet above the water table to allow for seasonally and tidally influenced groundwater fluctuations. A diagram of a typical shallow piezometer and monitoring well are shown in Figure 4-5. As-built piezometer and monitoring well installation data will be recorded on a Monitoring Well/Piezometer Installation Data Record, shown in Figure 4-6.

With the 7.25-inch outside diameter, 4.25-inch inside diameter hollow-stem auger serving as a temporary casing, the annular space between the piezometer or well screen and the auger will be filled with graded 20/30 silica sandpack from the bottom of the borehole to 2 feet above the top of the piezometer or well screen using a tremie tube and continuously measured with a tape measure. As the sand is introduced into the borehole, the augers will be pulled from the bottom of the borehole at a pace to allow proper deposition of the sandpack within the 7.25-inch borehole.

A 2-foot-thick bentonite seal will be placed above the sandpack in each piezometer or well to prevent downward migration of the surface seal (i.e., the cement grout). The seal will consist of bentonite pellets and will be installed by a tremie tube. After hydrating to the manufacturer's specifications, the remaining annular space above the bentonite seal will be filled with a high-solids bentonite grout. As the bentonite seal and grout are added, the augers will be pulled from the borehole at a pace to allow proper deposition within the 7.25-inch borehole and prevent downward migration of potential contamination.

The piezometer or well casing will extend to 3 feet above grade and a larger diameter steel casing will be placed over the PVC casing and set into a concrete pad. The steel casing will have a small weephole at its base, and a lockable cap. The concrete pad will be 4-feet by 4-feet and 6-inches thick and will be installed to slope away from the well to

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TYPICAL PIEZOMETER / MONITORING
WELL CONSTRUCTION DIAGRAM
FIGURE 4-5

promote surface water runoff. Four 4-inch ID steel posts will be cemented into the ground to a depth of 3 feet around each piezometer or well.

4.4.1.3 Deep Piezometer and Deep Monitoring Well Installation Deep piezometers and monitoring wells will be constructed of a 5-foot section of 2-inch ID, 0.010-inch slotted, PVC well screen attached to Schedule 40 threaded PVC casing extending 3 feet above land surface.

Deep wells and piezometers will be installed using the same procedures as for shallow explorations, except where a confining soil layer will be penetrated. In areas where piezometers and monitoring wells will be installed below a confining layer, hollow-stem augers with 15-inch OD, 10.25-inch ID cast iron augers will be used. The 15-inch borehole will be advanced and pressure grouted into the confining layer. The 15-inch OD, 10.25-inch ID augers will then serve as temporary surface casing to prevent potential vertical migration of contamination. The borehole will be advanced with 7.25-inch OD, 4.25-inch ID cast iron augers drilling through the temporary surface casing.

Backfilling requirements for deep monitoring wells and piezometers are identical to these specified for shallow monitoring wells and piezometers, except backfilling material must accommodate the borehole made by the 15-inch OD hollow-stem augers. Additionally, because of the potential problems with installing a pellet seal below the water table, the sand pack in deep wells will be installed to a depth three feet above the top of the well screen and the remainder of the borehole will be filled with a high-solids bentonite grout using the tremie method. Protective casing requirements and finishing details are also identical to these described in the previous subsection.

4.4.2 Piezometer and Well Development Each of the piezometers and monitoring wells will be developed after completion of the installation. The piezometers and wells will be developed by air surge, pumping, or bailing until the pH, temperature, and conductivity have stabilized or until it is determined that further development will not decrease turbidity. If pumping is used for development, the pump will be cycled on and off several times during the development to provide water movement back and forth across the well screen. If the piezometer or well is air surged, pumped, or bailed dry, it will be allowed to recharge to continue development. The Well Development Record (Figure 4-7) will be used to record field information. The disposal of the development water is discussed in Section 5.0

4.4.3 Hydraulic Conductivity Testing In-situ permeability testing will be performed in all new monitoring wells. The tests will be conducted to determine a range of hydraulic conductivity values in the surficial aquifer and to confirm the results of previous hydraulic conductivity testing at OU-2. Subsection 3.2.4.5 of the Basic Site Work Plan (Volume 4) describes the methodology and calculations for in-situ permeability testing.

4.5 GROUNDWATER SAMPLING. Groundwater samples will be collected from all new monitoring wells installed at OU-2. Sampling of groundwater wells will proceed

Project:	Well Installation Date:	Project No.	
Client:	Well Development Date:	Logged by:	Checked by:
Well/Site I.D.:	Weather:	Start Date:	Finish Date:
Initial Water Level (ft):		Start Time:	Finish Time:
Water Level during Initial Pumping/Purging (ft):			
Water Level at Termination of Pumping/Purging (ft):			

	TIME	TEMP.	pH	Conductivity	Approximate Pumping Rate (gal/min)
BEGINING OF WELL DEVELOPMENT	_____	_____	_____	_____	_____
MIDDLE OF WELL DEVELOPMENT	_____	_____	_____	_____	_____
END OF WELL DEVELOPMENT	_____	_____	_____	_____	_____
NOTES:					
WELL DEVELOPER'S SIGNATURE _____					

OU-2 FIELD SAMPLING PLAN NAS JACKSONVILLE DECEMBER 1992		WELL DEVELOPMENT RECORD FIGURE 4-7
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from the upgradient (background) wells to the downgradient (contaminated) wells as best as can be determined, based on existing data. When sampling monitoring wells, water level measurements and sample collection will be conducted no sooner than 48 hours after well installation and development. Upon arriving at the well, the well will be checked for aboveground damage and the concrete collar will be checked for structural integrity. The well will be unlocked and the well cap will be removed (a wrench may be required), new plastic sheeting placed around the well, and the top of the well casing cleaned with a Kimwipe™ or equivalent prior to purging and sampling. Groundwater sampling equipment will be decontaminated prior to use in accordance with the procedures outlined in the QAPjP. Calibration of the sampling equipment will be in accordance with the manufacturer's suggested procedures and will be completed prior to each day's sampling activities. Daily instrument calibration data will be recorded on the Field Instrumentation Quality and Material Quality Assurance Record (Figure 4-8) and the Equipment Calibration Log (Figure 4-9). Data generated during groundwater sampling will be recorded on the Sample Groundwater Field Data Record (Figure 4-10).

4.5.1 Groundwater Level and Total Sounded Depth Measurements Groundwater levels will be measured in each new monitoring well and in selected existing monitoring wells at least twice during the investigation. The static water level and the total sounded depth of the well will be measured prior to purging and sampling well water. An electronic water-level meter will be used for the water-level measurement. Measurements will be made to the nearest 0.01 foot and referenced to the survey point (top of well casing).

The total depth of the well will be measured to the nearest 0.1 foot from the top of the casing and the datum recorded. If the construction specifications are available, this datum will be used to determine if the proper well has been identified, whether the well has filled with silt, and the volume of standing well water in the well. Measurements will be recorded in the field log book and on the water sampling log (see Figure 4-10). Before measuring another well, the tape will be decontaminated with a detergent solution and then rinsed with deionized water.

4.5.2 Purging the Well After a water level measurement has been taken, the well will be purged to remove the standing water. Well purging will be accomplished by using either a peristaltic, centrifugal, or submersible pump, depending on depth to water, well depth, and well diameter. When pumping is not practical, a Teflon™ closed top bailer also may be used for purging. If a pump will be used, the pump intake will be placed at the top of the water column. As the water level drops, the pump or suction tube intake will be lowered so that the water column in the well casing will be completely and efficiently removed. The intake tube will be removed before suction has been discontinued. Bailing the well will also be acceptable; however, if a bailer will be employed, the bailer will be slowly lowered into the well to avoid "surging" the water in the casing, which could disturb deposits at the bottom of the well.

Project _____ Site _____

Project No. _____ Sampler Signature _____

Date _____

Field Instrumentation Calibration Data

Equipment Type/I.D.

Battery
Condition

Calibration Information

_____	_____	pH 4 _____	pH 7 _____	pH 10 _____
_____	_____	pH 4 _____	pH 7 _____	pH 10 _____
_____	_____	pH 4 _____	pH 7 _____	pH 10 _____
_____	_____	Cond. Std. _____/ _____	Cond. Std. _____/ _____	
_____	_____	Cond. Std. _____/ _____	Cond. Std. _____/ _____	
_____	_____	Cond. Std. _____/ _____	Cond. Std. _____/ _____	

Dissolved Oxygen

Avg. Winkler Value _____ ppm Meter Value _____ ppm

Redox

Zobell Sol. Value _____ Meter Value _____

Photoionization Meter

Zero/Zero Air? Yes No Span Gas Value _____ ppm Equiv.
Meter Value _____ ppm Equiv.

Zero/Zero Air? Yes No Span Gas Value _____ ppm Equiv.
Meter Value _____ ppm Equiv.

Other

Fluids/Materials Record

Deionized Water Source: _____ ABB Staging Portable System Other

Trip Blank Water Source: _____ ABB Lab; Lot No. _____
_____ Other; Type _____ ID _____

Decontamination Fluids: _____ Methyl Hydrate; Lot No. _____
_____ Other; Type _____ ID _____

HNO₃/DI Rinse Solution: _____ ABB Staging; Lot No. _____

Filtration Paper ID: (In Line) Manuf/Type _____ Lot No. _____ / _____
(Vacuum) Manuf/Type _____ Lot No. _____ / _____

Chemicals Used: HNO₃ Lot No. _____ ZnAOC Lot No. _____
H₂SO₄ Lot No. _____ Other Lot No. _____
HCL Lot No. _____ Other Lot No. _____
NaOH Lot No. _____

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FIELD INSTRUMENTATION AND
MATERIAL QUALITY ASSURANCE
RECORD
FIGURE 4-8

A minimum of three volumes of water will be removed from the well. Temperature, pH, and specific conductance will be measured after each volume is removed. If the readings taken during the removal of the first three volumes are stable, purging will be considered complete; otherwise, purging will continue until there are three successive stable readings, five volumes have been removed, or the well is pumped dry. Prior to obtaining the measurements, the field instrumentation will be properly calibrated with reference standards in accordance with the manufacturer's recommendations. Temperature, pH, and conductivity are considered stabilized when the temperature is within 0.5°C, the pH is reproducible to 0.1 pH units, and the conductivity is within 10 percent of successive measurements. Well purging information will be recorded in the field log book and on the water sampling logs. The volume of water in the well (in gallons) will be calculated using the following equation:

$$V = (7.48 \text{ gallons/cubic foot}) \pi r^2 h$$

where,

v = volume of standing water (gallons)

r = radius of well casing (ft)

h = height of standing water (ft)

π = constant

Wells that recharge slowly (i.e., do not return to static level within eight hours), should be purged completely at least once and then sampled after the water level has recovered sufficiently to fill the necessary sample containers. The rate of recharge for all wells should be recorded for each sampling interval.

Deciding when the required volume of water has been purged can be determined by directly measuring the amount of water pumped or bailed from the well with a container of known volume, or by purging with a calibrated pump and calculating the operating time required to remove five well volumes. A purge pump (peristaltic or submersible) may be calibrated by measuring the time required to fill a container of known volume. However, purge rates vary with drawdown and should be checked during purging. Once the required volume to be purged and the pumping rate are known, the time necessary to pump the required amount may be calculated by the following formula:

$$T = V/R$$

where,

T = time (minutes)

V = volume of standing water (gallons)

R = rate of flow (gallons/minute)

4.5.3 Collecting Groundwater Samples Teflon™ bailers and peristaltic pumps will be used for sample collection. Bottom-entry Teflon™ bailers will be used to collect samples for TCL VOC, SVOC, pesticide, and PCB analysis using CLP methodology. Bailers will

be fitted with Teflon™-coated, stainless-steel cable, or disposable cables of nylon or large-diameter monofilament fishing line. If a Teflon™-coated, stainless-steel cable will be used instead of a disposable cable, the cable will be decontaminated between each use using the procedures in Section 4.9 of this FSP. A peristaltic pump fitted with a Teflon™ intake hose will not be acceptable for collection of CLP TCL, VOC, SVOC, pesticide and PCB samples.

Once the groundwater sample is brought to ground surface, the water will be placed immediately in the appropriate container. Bottle caps will not be removed until the bottle is to be filled.

When sampling for VOCs, extreme care will be taken to minimize aeration of the sample. This will be achieved by pouring the sample from the bailer down the inner-side of the container until the vial is full and a meniscus is present. The Teflon™ lining from the cap used to seal the bottle will not be removed. After filling, the vial will be inverted and tapped to be sure there are no bubbles. If there are bubbles, the cap will be removed and the procedure repeated. If bubbles persist, the vial may be defective. Containers for other analyses should be filled to about 90 percent capacity and sealed.

When samples require preservation, care will be taken not to overfill the sample container. The sample will be preserved with the appropriate preservative immediately after the sample is collected. The pH of all preserved samples (except VOCs) will be checked in the field by pouring small aliquots of the preserved sample into the sample bottle cap and then onto pH paper having a minimum resolution of one pH unit. Prepreserved bottles will be used to collect VOC samples because preservation after collection is not possible.

If a sample will be filtered, the filtration will be performed as the sample is being pumped from the well using an in-line flow-through filter. Water samples for dissolved inorganic analyses will be filtered through a 0.45-micrometer disposable filter; fiber filters will not be used.

When bottle filling is complete, each sample container will be identified with a label. Labels will be filled out completely with date, time, sample identification number, matrix, parameters to be analyzed, method number, preservative added, and the sampler's initials. The labels will be affixed to the containers prior to sampling. Paired VOC vials for each sample will be placed in two resealable plastic bags (one bag inside the other) to avoid cross-contamination. Samples will be stored in coolers packed with ice until they are repackaged and shipped to the laboratory.

4.5 SURFACE WATER AND SEDIMENT SAMPLING. Surface water and sediment samples will be collected from the Polishing Pond, the drainage ditch south of the Timuquana Country Club Golf Course, the drainage ditches on either side of the Patrol Road turnaround, and near the drop boxes associated with the drainage pipes that run along the east side of OU-2 parallel to the taxiway. Upon collection, surface water and

sediment sample information will be recorded on the Surface Water and Sediment Field Data Record (Figure 4-11).

4.5.1 Surface Water Sampling Surface water samples will be collected using several different techniques. It is anticipated that the Polishing Pond samples will be collected from a boat whereas the drainage area samples will be collected by wading into the streams.

When the depth and width of the ditch or pond allow, the sampling personnel will wade from downstream to upstream to minimize the presence of disturbed bottom sediments in the sample to be collected. Also, in the case of a water body with minimal flow, after reaching the sampling location, the sampling personnel will wait for disturbed sediments to settle.

All samples will be collected using either a precleaned bottom filling Teflon™ bailer, a precleaned beaker, or by directly dipping the sample bottle into the surface water body. Following sample collection, samples will be placed into coolers containing ice until they are repackaged and shipped to the appropriate laboratories.

4.5.2 Sediment Sampling The sampling strategies discussed in the previous subsection will be used for the collection of sediment samples. Sediment samples will be collected using either a ponar dredge or a core sampler. These two techniques are described in the following subsections.

4.5.2.1 Ponar Dredge In waters of sufficient depth where use of a boat is required, the ponar dredge will be used to collect sediment samples. The dredge will be operated by slowly lowering the dredge into the water column. Upon contact with the bottom sediments, a locking mechanism releases, closing the dredge. The dredge will then be returned to the surface; water captured in the top of the sampler will gently be drained to minimize the loss of organic flocks and fines that may be present. The dredge will then be opened and the contents placed into a glass bowl.

Samples for VOC analysis will be immediately removed from the sampler and placed into the appropriate containers without mixing. The remainder of the sample will be thoroughly mixed prior to placement into the appropriate sample containers. Following sample collection, samples will be stored in coolers packed with ice until they are repackaged and shipped to the appropriate laboratories.

4.5.2.2 Core Sampler In shallow waters, a stainless-steel core tube will be used for sediment collection. When sampling personnel are wading through the water body, caution will be exercised not to disturb the area to be sampled. A collar-type device constructed of stainless steel, with a circular recess to accept the top of the corer, will be used to push the tube. The recess will have a hole in it to allow water to pass through while pushing the corer in to the sediment. The core tube will be pushed into the sediment until approximately 4 inches of the tube is above the sediment/surface water

interface. If hard or coarse substrates are encountered, the tube will be gently rotated while it is pushed into the sediment to facilitate greater penetration and to minimize core compaction. After the tube is driven in, a wide, circular motion will be used to help loosen the core for removal. The collar device will be removed from the top of the capped corer, as described previously, before removing it from the water. The top of the corer will then be capped with a Teflon™ plug or a sheet of Teflon™ held in place by a rubber stopper or cork. After capping, the core sampler will be slowly extracted. The negative pressure and adherence of the sediment to the core tube should keep the sample in the tube. The bottom part of the core will be capped with a sheet of Teflon™ while the bottom of the tube is still in the water and as close to the sediment/surface water interface as possible. Upon removing the core from the water, the core will be opened and extruded and the contents will be placed in a glass bowl.

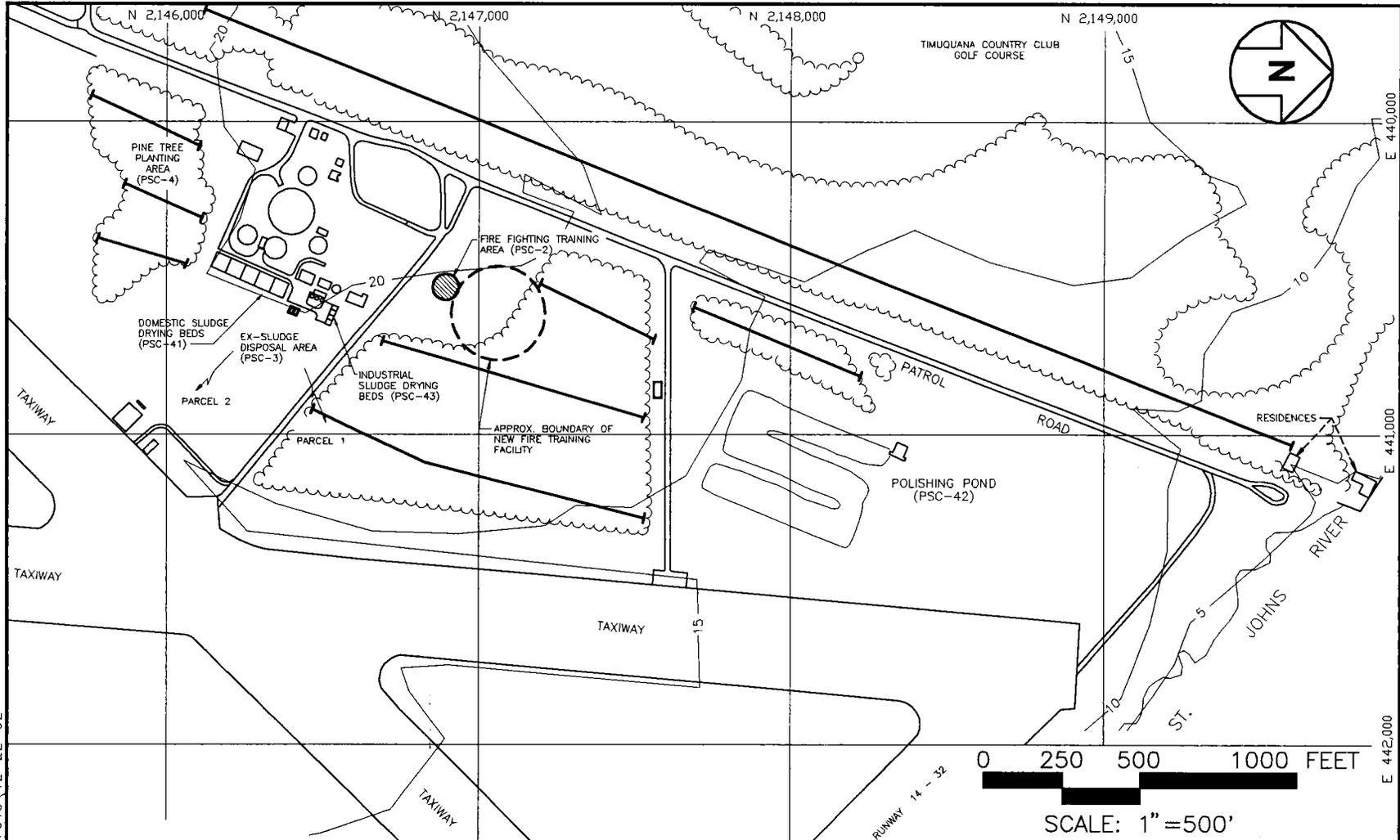
Samples for VOC analysis will be immediately removed from the sampler and placed into the appropriate containers. The remainder of the samples will be thoroughly mixed prior to placement into the appropriate sample containers. Following sample collection, samples will be stored in coolers containing ice until they are repackaged and shipped to the appropriate laboratories.

4.6 ECOLOGICAL INVENTORY. The procedures to conduct the ecological inventory at OU-2 are described in the following subsections.

4.6.1 Characterization of major floral communities and identification of plant species within each community at, and in the vicinity of, OU-2 Prior to the initiation of site field work, a literature review will be conducted to determine floral and faunal communities expected to be found at the site. This step will include a review of existing maps, soil surveys, and available reports to identify soil types, drainage patterns, and mapped topographic features. Major community types will be identified from recent aerial photography. The location and extent of coverage of each habitat will be described. Interviews will also be held with the St. Johns Water Management District, the Florida Department of Natural Resources, the Jacksonville Bio-Environmental Services Department (BESD) and regional specialists to obtain additional information on the indigenous flora and fauna. Information collected as part of the ongoing ecological activities at other locations at the Station will also be evaluated for applicability to the OU-2 ecological investigation.

Field evaluations will be conducted to verify the nature, location, and composition of vegetative communities. This will include a qualitative walkover survey to confirm ecological habitat types, flora, and fauna at and in the vicinity of OU-2. Belt and/or line transect surveys of vegetative types in the forested areas associated with OU-2 will be conducted. Based on available information, only one or two transects will be necessary to characterize the relatively homogeneous environments associated with the forested pine habitats (i.e., PSCs 3 and 4) (Figure 4-12). In addition, the forested area located between OU-2 and the Timuquana Golf Course will be described. Observations and identification of vegetative species within each defined community and an estimate of the

Z:\7559-25\FIG\7559FF019\12-22-92



LEGEND

 ECOLOGICAL INVENTORY
 TRANSECT LINE

**OU-2 FIELD
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**FIGURE 4-12
 PRELIMINARY TRANSECT LINES FOR
 ECOLOGICAL INVENTORY**

relative abundance of plant species within each strata, including percent cover, will be recorded. Strata will consist of the canopy (i.e., trees) and understory (i.e., saplings, shrubs, herbs).

An estimate of the relative size and age distribution of representative trees will be made by either consulting with appropriate facility personnel or by measuring tree bole diameters using a diameter tape. Age would be estimated by taking small diameter cores using a tree-corer and enumerating the growth rings. The potential use of these habitats by animal species will be described. This will include a qualitative description of the forage value of the dominant plant species observed at the various PSCs. This information will be used to evaluate the forage base and other functions (e.g., nesting areas, shelter) that these habitats provide to various animal species that may occur at OU-2.

4.6.2 Characterization of animal species utilizing OU-2 and adjacent areas as habitat

A literature review will be conducted to identify the potential animal receptor species at, or adjacent to, OU-2. Several recent references including the Fish and Wildlife Section of the Long Range Natural Field Natural Resources Master Plan, the Naval Air Station Jacksonville, Florida (USFWS, 1988) and the Draft Environmental Impact Statement of a Proposed Expansion of the Marina at the Naval Air Station, Jacksonville, Florida (Water and Air Research, 1990) will be reviewed.

Field observation of animal species, including indirect evidence from nests, tracks, songs, and runways will be noted and photographed by biologists during the field investigation. Small mammal traps (approximately 75 to 100 trap nights) will be used to evaluate the presence of small mammal receptors at the site. Prior to any trapping activities, a scientific trapping permit will be obtained from the State of Florida Game and Fresh Water Fish Commission. Bird species observed during dawn and dusk surveys, as well as during the course of other phases of the ecological field investigation, will be documented. Finally, observations of the presence or absence of soil flora and fauna and measured litter-layer depth at each of the various PSCs associated with OU-2 will be recorded.

4.6.3 Characterization of aquatic habitats at OU-2 and in the adjacent section of the St

Johns River Aquatic habitats, including the Polishing Pond, the adjacent segment of the St. Johns River, and at selected reference stations, will be sampled to characterize the river flora and fauna that may be exposed to OU-2-related constituents. This information may also provide the basis for justifying a more quantitative biomonitoring investigation as well as in sampling design development for such activities. This characterization will consist of a qualitative mapping of the aquatic habitat (e.g., substrate characteristics, depth, nature and coverage of submerged macrophytes) and the sampling of the benthic macroinvertebrate fauna associated with the various substrate types identified during this initial survey.

4.6.3.1 Mapping of Aquatic Habitats In the St. Johns River, a series of approximately five transects roughly perpendicular to the shore will be established along the section of the river under investigation (see Figure 5-6 of the Project Work). At various intervals along each transect, a sediment corer or Ponar grab sampler will be used to collect a sediment sample to qualitatively evaluate sediment composition (i.e., grain size fractions, relative amounts of organic matter, sands, and silts). To the extent possible, all sampling proposed for the St. Johns River will be conducted from a boat to minimize disturbance to the sediment. In addition, the presence, coverage, and composition of submerged aquatic macrophytes will be assessed at each location either visually or by using the Ponar grab sampler. Brody suggests that light penetration probably restricts plant growth to the shallow portions of the river (maximum 1.5 -2.0 meters depth) in the submerged aquatic vegetation (SAV) zone (Brody, 1990). Sampling along each transect will continue beyond the SAV zone to collect two to three sediment samples for substrate characterization in the deeper demersal zone. This information will be used to develop a qualitative description of the nature and extent of each significant habitat type within the section of the river under investigation, and will be used to establish a sampling plan for aquatic fauna.

The aquatic substrate types and submerged macrophytes associated with the Polishing Pond will be characterized in a similar fashion by sampling across each channel of the polishing pond.

4.6.3.2 Characterization of Aquatic Fauna Aquatic fauna that may be potentially exposed to OU-2-related constituents will be characterized by sample collection as well as a review of available reports, unpublished literature, and discussion with local experts on the fauna of the St. Johns River. Due to the high variability in mobile fish and shellfish (i.e., crabs) populations, and the availability of literature sources describing fish and shellfish, this effort will focus on benthic macroinvertebrates.

Benthic macroinvertebrates associated with each of the major substrate types (e.g., in shore, SAV, and demersal zones) identified during the habitat mapping activity will be sampled at three sampling stations per substrate type in the St. Johns River adjacent to OU-2 and at two reference stations on the St. Johns River. Using the information from the habitat mapping study, benthic macroinvertebrate sampling locations will be selected to provide a range of physical characteristics (e.g., depth, flow rates), habitat type (e.g., vegetation, substrate type), and proximity to potential releases. Reference stations will be selected based on a review of available literature and historic data from the BESD, consultation with local biologists, and a preliminary site inspection. Due to the highly-variable nature of the environment in the St. Johns River in the vicinity of OU-2 and the proximity of OU-2 to the mouth of the Ortega River, the Golf Course, and other sources of adverse impact, it may not be possible to locate reference sites in close proximity to OU-2 sampling stations.

To the extent possible, the sampling gear and techniques will be chosen to be consistent with ongoing studies, such as the Florida Benthic Invertebrate database, to provide data

suitable for regional comparisons. A Ponar grab sampler will be used to qualitatively sample benthic macroinvertebrates at the nine selected sampling locations in the St. Johns River. The Ponar grab sampler will be lowered by rope to the sediments and allowed to rest momentarily on the bottom. The grab will be triggered by a sharp pull on the rope; the sampler will be slowly raised through the water column to the surface and its contents placed in a wash pail. The contents of the pail will be transferred to a U.S. Standard No. 35 (0.5m mesh opening) sieve and then be placed in sample jars containing 70 percent ethanol. Sample jars will be labeled to identify location, date and time of collection, and its collector, and sent to a professional invertebrate taxonomist for identification.

Three sampling stations will be established at the Polishing Pond and sampled in a similar fashion.

The benthic macroinvertebrate data will be summarized to provide baseline information on the species composition present at the Polishing Pond (PSC-42), in adjacent habitats in the St. Johns River, and at selected reference sites. Specifically, species abundance, taxa richness and species composition within each habitat type will be compared among sampling locations. Reduced abundance or taxa richness, or a shift to more pollution-tolerant families may be indicative of impacts, and these results will be interpreted in the baseline ecological risk assessment in conjunction with the toxicological assessment of analytical data. Analysis and presentation of the data derived from identified organisms will include abundance tables, species richness or number of taxa, a diversity index (Shannon-Weiner), and an evenness index (Heip) (Boesch, 1977, Cairns and Dickson 1971; Kaesler and Herricks, 1977; Schaeffer et al., 1985; Godfrey, 1978).

Concurrently with the benthic macroinvertebrate sample collection activities, selected water quality parameters will be measured at each sampling location. Measured parameters will include dissolved oxygen, temperature, salinity, pH, and specific conductance. These parameters will be measured at the top and bottom of the water column and recorded on data sheets.

The characterization of the fish fauna that may occur in the study areas will be based on a review of available literature for the St. Johns River (USFWS, 1988; SJRMD, 1992), discussions with local experts, and results of a planned electroshocking study to be conducted at PSC 42. In addition, minnow or small fish traps will be placed in the inshore areas along the St. Johns River and in the three Polishing Pond channels. The minnow trap data will provide information on the available forage base for wading birds such as herons and egrets.

4.6.4 Documentation of signs of apparent stress observed at OU-2 and in adjacent ecological communities Field observations of physical site conditions (i.e., topography, man-made features), associated impacts, and a review of historical information including aerial photographs, climatic data, and information provided by facility personnel, will be documented. Evidence of ecological stress in plant species (e.g., yellowing, wilting, insect

infestations) and animal species (e.g., disease, parasitism, death, reduced diversity or abundance) will be noted.

The information collected during the ecological inventory will be summarized in a brief (i.e., 4 to 5 page) field investigation report and will be incorporated into the baseline ecological risk assessment. If the data indicate that impacts have occurred, additional field studies may be proposed.

4.7 TOPOGRAPHIC SURVEY. Vertical and horizontal controls at OU-2 will be established from existing survey monuments. Location coordinates and elevations will be established for each piezometer, staff gauge, and monitoring well by a registered professional surveyor. Location coordinates and elevations for soil borings, and surface water and sediment sampling locations will be surveyed. A minimum of two points from every soil sampling grid will be surveyed. The horizontal coordinates for all sampling locations shall be to the nearest 0.1 foot and referenced to the Florida East Zone Rectangular Coordinate System. Elevations will be referenced to the North American Datum of 1983. Elevations to the nearest 0.01 foot will be established for the top of the casing (measuring point) at each monitoring well, piezometer, and staff gauge. Elevations to the nearest 0.1 foot will be established on the ground surface for each boring and surface water/sediment sampling site.

4.8 ON-SITE FIELD LABORATORY SCREENING. The procedures that will be used for on-site VOC, inorganic, and PHC analysis are described in the following subsections. Methods are described in more detail in ABB-ES standard operating procedures, which will be available at the site during the investigation.

4.8.1 Inorganic Screening Inorganic compounds will be analyzed with the use of an AA unit. A three-point calibration will be entered bracketing the working range of the instrument. Absorbance, stability, and linear range will dictate the standards limits of the instrument.

4.8.1.1 Sample Preparation All aqueous samples must be preserved immediately after collection by adding nitric acid until the pH is less than 2. The aqueous sample will be prepared using the following steps.

1. Transfer 8.0 mL of sample into a test tube.
2. Add 0.5 mL of concentrated nitric acid.
3. Vortex.
4. Place samples in a cool water bath of less than 40°C.
5. Increase both temperature samples to 90°C and digest for 45 minutes.
6. Add 1.5 mL of 50 percent hydrochloric acid solution.
7. Repeat steps 4 and 5.
8. Allow sample to cool to room temperature and analyze.

Soil samples must be stored at 4 degrees Centigrade, then prepared as follows:

1. Samples must be dried at 85°C for 4 hours.
2. Blend and homogenize samples.
3. Transfer 0.5 grams of the sample into test tube, place in a rack, start the cool-water bath.
4. Add 0.5 mL of concentrated nitric acid, agitate samples.
5. Increase bath temperature to 90 degrees Centigrade and digest for 45 minutes.
6. Place samples in a cool water bath.
7. Add 1.5 mL of concentrated hydrochloric acid solution, agitate sample.
8. Repeat steps 6 and 7.
9. Add 8.0 mL of ASTM Type II deionized water to samples, shake the test tube and place in the centrifuge.

4.8.1.2 Continuing Calibration A continuing calibration standard will be run every 20 samples to confirm machine stability. If the continuing calibration exceeds criteria, a new calibration will be established.

4.8.1.3 Method Blank Blanking or zeroing will be done before sample analysis and at any time the operator questions drift of baseline.

4.8.2 Volatile Organic Compound Screening This methodology involves purging samples at ambient temperature with helium gas and concentrating the VOCs on a polymer trap. VOCs are then desorbed onto the GC for compound separation and identification. Retention time windows based on calibration runs generated at the field site will be compared to sample retention times for identification. Compounds will be quantified using a three-point calibration curve with one point at or near the detection limit.

4.8.2.1 Sample Preparation For surface water or groundwater samples, a 5.0 mL aliquot of sample, or a portion thereof, is placed in a gas-tight syringe. A known concentration of surrogate is added to the sample, which is then transferred to the sparger vessel, where it is purged and desorbed onto the GC column. For soil samples, 5.0 grams of sample, or a portion thereof, is weighed out and transferred to the sparger vessel. Five mL of organic-free water with a known amount of surrogate sample is added to the vessel and purged.

4.8.2.2 Continuing Calibration Once every day (not to exceed 24 hours between runs), a mid-level continuing calibration standard will be run to ensure machine stability. If the relative standard deviation of the continuing calibration exceeds criteria a new three-point calibration curve will be created.

4.8.2.3 Method Blank Before analyzing any samples and once every day thereafter (not to exceed 24 hours between runs), the field chemist will run a method blank to confirm that the system is free from organic interferences.

4.8.3 Total Petroleum Hydrocarbons This methodology uses a Miran fixed filter infrared spectrophotometer. Samples are prepped by a micro-extraction of soils or sediments. Extracts are placed in the instrument and results are read directly from the meter. Sample results are compared to standards run at the field site. Total Petroleum Hydrocarbons (TPH) results will be quantified using a five-point calibration curve based on a standard reference oil mixture composed of n-hexadecane, isoocatane, and chlorobenzene.

4.8.3.1 Sample Preparation Transfer a 2.0 gram aliquot of soil to a screw cap test tube. Add approximately 2 gram of silica gel as a desiccant and mix thoroughly. Add 10 ml of Freon-113. Vortex, let settle, then decant off the solvent.

4.8.3.2 Continuing Calibration Continuing calibrations are run using a mid-level standard every 24 hours. If the standard exceeds criteria a new calibration curve must be established.

4.8.3.3 Method Blanks Before analyzing any samples and, once every 24 hours after that (not to exceed 24 hours between runs), the chemist will run a method blank to ensure that the machine is free from any interferences.

4.8.4 Quality Assurance/Quality Control The following quality control samples will be run for each field analytical method.

- Duplicate samples will be collected and analyzed at a 10 percent level (when, possible every tenth sample)
- Matrix Spike/Matrix Spike Duplicate samples will be run at a five percent level (when possible, every 20 samples)
- Cleaning blanks will be run at the discretion of the operator
- Equipment blanks will be run, at a minimum, every other day. If contaminants are detected in the blanks, equipment blanks will be run daily.

Additional quality assurance/quality control procedures are described in ABB-ES standard operating procedures which will be available at the site during the investigation, and the QAPjP (Appendix A-1 of the OU-2 Project Work Plan).

4.9 DECONTAMINATION PROCEDURES. To prevent cross contamination, downhole drilling equipment and sampling equipment will be decontaminated before the first use and after completion of each exploration. Sampling and drilling equipment cleaning procedures (i.e., pre- and post-sampling) will be conducted in accordance with procedures specified in the USEPA Region IV Standard Operating Procedure

(SOP)/Quality Assurance Manual (QAM) presented in Attachment A of the BFSP (Appendix 4.4.2, Volume 4).

4.9.1 Decontamination Pad A decontamination pad will be constructed next to the southern end of the east leg of the polishing pond (Figure 4-13). The pad will be large enough to accommodate decontamination of the largest on-site vehicle. The pad will be lined with plastic and constructed so that decontamination fluids will flow off the pad into the Polishing Pond. The impact that runoff contaminants have on the Polishing Pond is expected to be minimal, and will be addressed during the investigation and remediation of Polishing Pond sediment and water.

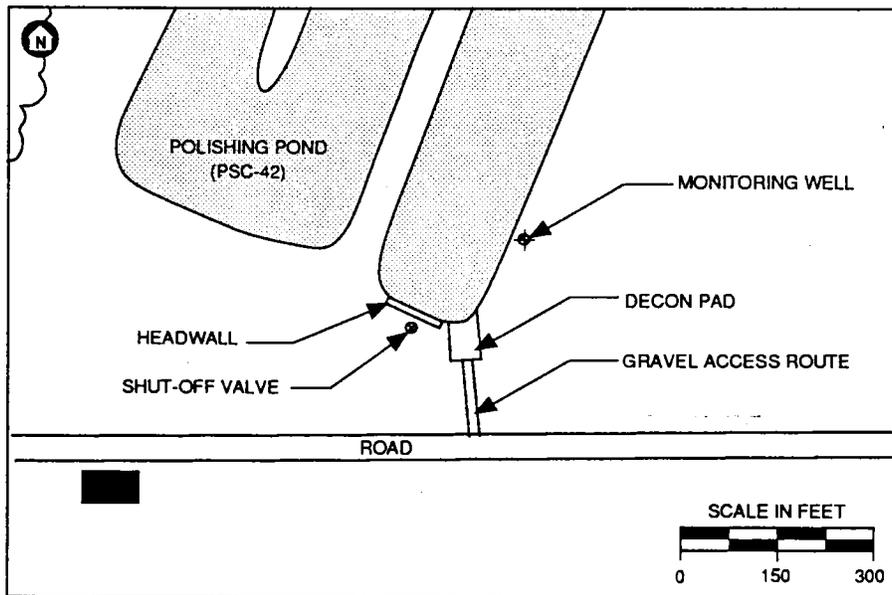
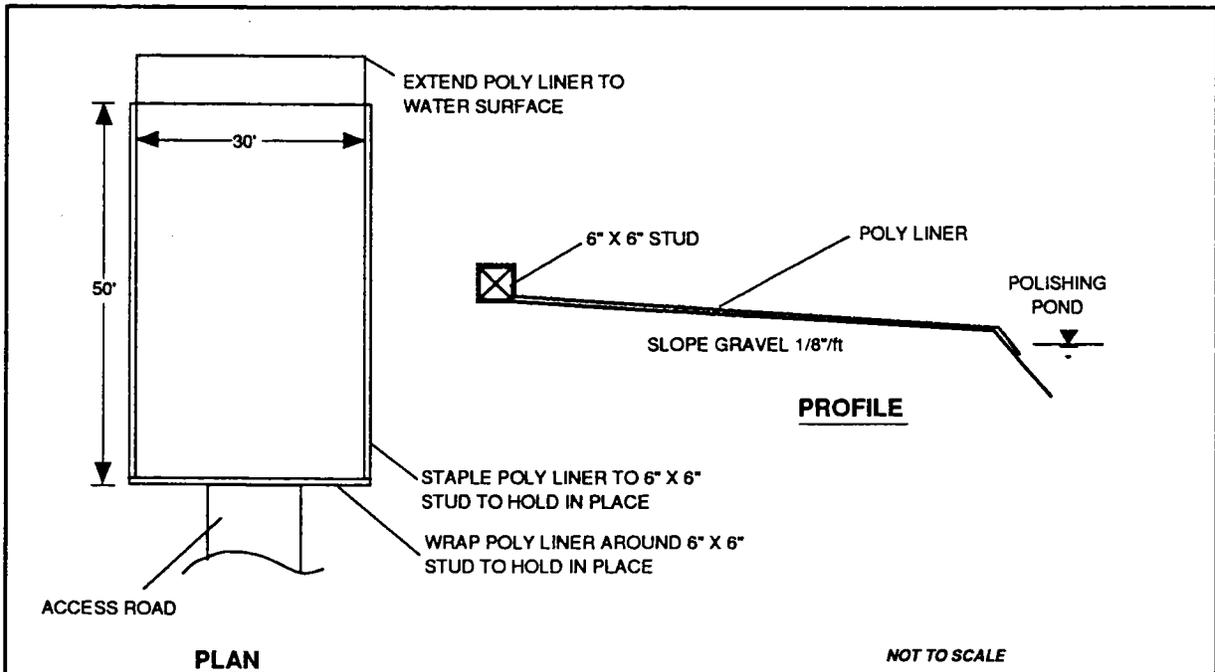
4.9.2 Decontamination Water Source The Wells cargo mobile system for deionized water currently in use at NAS Jacksonville OU-1 will also be employed at OU-2 as a water source for drilling and decontamination.

4.9.3 Sampling Equipment Decontamination The following procedure will be used by sampling personnel to decontaminate sampling and other field equipment before field use:

1. Wash equipment thoroughly with laboratory-grade detergent (e.g., Liquinox®) and tap water using a brush to remove particulate matter or surface film.
2. Rinse equipment thoroughly with tap water.
3. Rinse thoroughly with deionized water.
4. Rinse equipment twice with isopropanol solution (isopropyl alcohol).
5. Rinse equipment thoroughly with deionized/organic-free water and allow to air dry as long as possible before rinse.
6. Wrap equipment completely in aluminum foil to prevent contamination during storage and/or transport to the field.

Under no circumstances should isopropanol or organic-free water be applied from plastic spray bottles and distilled water should not be substituted for deionized water. In addition, if heavily contaminated areas are encountered, equipment can be pre-cleaned using either pesticide-grade acetone or hexane.

4.9.4 Drilling Equipment Decontamination Before drilling begins at OU-2, any portion of the PCPT or drill rigs that will be over the borehole must be steam cleaned before being brought on-site to remove loose rust, soil, and other materials that may have come from other sites. The drill rig should then be inspected to check that no seals or gaskets are leaking, and that any grease, oil, and hydraulic fluid from leaks are cleaned. When



SOURCE: ESE, 1992

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DECONTAMINATION PAD DETAILS
FIGURE 4-13

work is completed at OU-2, the drill rig will be decontaminated at the decontamination pad before it leaves the site.

In addition to the initial cleaning, the drill rig will be steam cleaned before drilling each borehole. Downhole drilling, sampling, and associated equipment that comes into contact with the downhole equipment and sample medium will be decontaminated using the procedures described in Subsection 4.9.3 of this FSP before drilling each borehole.

4.9.5 Decontamination of Sample Containers Exterior surfaces of sample bottles will be decontaminated before packing for transportation to the analytical laboratory to prevent uncontainerized, potentially contaminated residues from leaving the site. Sample containers will be wiped clean with a paper towel at the sample site, and then taken to the decontamination area for more thorough cleaning with approved or reagent water. The samples will then be transferred to a clean cooler and the sample identities will be noted and checked on a Chain-of-Custody Record. The samples, now in a clean cooler, will be stored in the sample staging area prior to shipment.

4.9.6 Monitoring Equipment Monitoring equipment will be protected from contamination by draping, masking, or otherwise covering the instruments with plastic without hindering the operation of the unit. Photoionization detectors (PIDs), for example, can be placed in a clear plastic bag that allows reading of the scale and operation of the controls. PIDs can be partially wrapped, keeping the sensor tip and discharge port clear. Protective coverings will be removed and disposed of in appropriate containers.

If contamination has penetrated the monitoring equipment's protective covering, the field equipment will be decontaminated. Any direct or obvious contamination will be brushed or wiped with a disposable paper wipe, wiped off with damp disposable wipes (i.e., baby wipes, if this will not harm the equipment), and air dried. The field equipment will be checked, recalibrated, and recharged as necessary for the next day's operation. They will then be wrapped with new protective coverings prior to reuse.

4.9.7 Respirators Contaminated respirator masks will be stored in plastic bags or buckets until they can be decontaminated. Respirator masks will be decontaminated daily when used. The masks will be disassembled, the cartridges set aside, and the rest placed in a cleansing solution. Parts will be pre-coded (for example, "#1" on all parts of mask no. 1). After an appropriate time within the solution, the parts will be removed and rinsed with tap water. The old cartridges will be marked to indicate length of usage (if means to evaluate the cartridges' remaining utility are available) or will be discarded into the container for contaminated trash disposal. In the morning, the masks will be reassembled and new cartridges installed if appropriate. Personnel will inspect their own masks and will readjust the straps for proper fit.

4.9.8 Laboratory Equipment Sample handling areas and field laboratory equipment will be cleaned and wiped daily. Disposable wipes will be used and discarded in a plastic

trash bag. These will subsequently be taken to and placed in the disposal drum for final disposition. For demobilization equipment will be disassembled and decontaminated. Any equipment that cannot be satisfactorily decontaminated will be disposed of (e.g., glassware, disposal surface covers), as previously indicated.

5.0 HANDLING IDW

5.1 SOIL. Soil from the installation of monitoring wells and piezometers will be piled next to the boring. After each monitoring well or piezometer is installed, the soil from the exploration will be spread on the ground in the immediate vicinity of the exploration.

5.2 GROUNDWATER. Groundwater removed from monitoring wells or piezometers during development or purging prior to sampling, will be discharged to the ground surface in the immediate vicinity of the monitoring well or piezometer.

6.0 SAMPLE HANDLING

Procedures for sample container selection and labeling, chain of custody, shipping procedures, and recordkeeping procedures are described the QAPjP. An example chain of custody record is presented in Figure 6-1.

PROJECT NO.		PROJECT NAME				NUMBER OF CONTAINERS	SAMPLE CONTAINER TYPE										REMARKS INDICATE SOIL/WATER/AIR SEDIMENT/SLUDGE						
SAMPLERS (SIGNATURE)																							
STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION																		
RELINQUISHED BY: (SIGNATURE)		DATE/TIME		RECEIVED BY: (SIGNATURE)		RELINQUISHED BY: (SIGNATURE)		DATE/TIME		RECEIVED BY: (SIGNATURE)		RELINQUISHED BY: (SIGNATURE)		DATE/TIME		RECEIVED BY: (SIGNATURE)		RELINQUISHED BY: (SIGNATURE)		DATE/TIME		RECEIVED BY: (SIGNATURE)	
RELINQUISHED BY: (SIGNATURE)		DATE/TIME		RECEIVED BY: (SIGNATURE)		RELINQUISHED BY: (SIGNATURE)		DATE/TIME		RECEIVED BY: (SIGNATURE)		RELINQUISHED BY: (SIGNATURE)		DATE/TIME		RECEIVED BY: (SIGNATURE)		RELINQUISHED BY: (SIGNATURE)		DATE/TIME		RECEIVED BY: (SIGNATURE)	
RELINQUISHED BY: (SIGNATURE)		DATE/TIME		RECEIVED FOR DISPOSAL BY: (SIGNATURE)		DATE/TIME		REMARKS															

6-2

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EXAMPLE OF CHAIN OF CUSTODY RECORD
FIGURE 6-1

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APPENDIX A-2.1

LABORATORY ANALYTICAL METHODS AND DETECTION LIMITS

TABLE A-1

LABORATORY ANALYTICAL METHODS

MEDIA	PARAMETER	METHOD	REFERENCE
Soils	TCL Volatiles	P+T GC/MS	CLP-COP
Soils	TCL Semivolatiles	GC/MS	CLP-COP
Soils	TAL Metals	AAS/PES	CLP-CIP
Soils	TOC	Combustion	ASA/SSA
Soils	Cyanide	Colorimetric	CLP-CIP
Soils	TCLP	AAS/PES	CLP-CIP
Groundwater	TCL Volatiles	P+T GC/MS	CLP-COP
Groundwater	TCL Semivolatiles	GC/MS	CLP-COP
Groundwater	TAL Metals	AAS/PES	CLP-CIP
Groundwater	Cyanide	Colorimetric	CLP-CIP
Air	TSP	Gravimetric	
Air	TAL Metals	AAS/PES	USEPA 3010/6010
Air	TCL Semivolatiles	GC/MS	USEPA TO-13/ CLP-COP

NOTES:

GC/MS	Gas Chromatograph/Mass Spectrometry
CLP-COP	Contract Laboratory Program - Caucus Organic Protocol
CLP-CIP	Contract Laboratory Program - Caucus Inorganic Protocol
PES	Plasma Emission Spectroscopy
TCL	Target Compound List
AAS	Atomic Adsorption Spectroscopy
P+T	Purge and Trap
TSP	Total Suspended Particulate
ASA/SSSA	Method of soil analysis, Part 2 ASA-SSSA, 2nd Ed., 1982
TAL	Target Analyte List
TCLP	Toxicity Characteristics Leaching Procedure

TABLE A-2
DETECTION LIMITS FOR TCL ORGANICS

Parameter no.	TCL VOC Analytes	LDL (water) ug/L	CRQL (soil) ug/kg
100	Chloromethane	1	10
101	Bromomethane	1	10
102	Vinyl Chloride	1	10
103	Chloroethane	1	10
104	Methylene Chloride	2	10
105	Acetone	5	10
106	Carbon Disulfide	1	10
107	1,1-Dichloroethylene	1	10
108	1,1-Dichloroethane	1	10
109	1,2-Dichloroethylene (total)	1	10
110	Chloroform	1	10
111	1,2-Dichloroethane	1	10
112	2-Butanone	5	10
113	1,1,1-Trichloroethane	1	10
114	Carbon Tetrachloride	1	10
116	Bromodichloromethane	1	10
117	1,2-Dichloropropane	1	10
118	cis-1,3-Dichloropropene	1	10
119	Trichloroethylene	1	10
120	Dibromochloromethane	1	10
121	1,1,2-Trichloroethane	1	10
122	Benzene	1	10
123	trans-1,3-Dichloropropene	1	10
125	Bromoform	1	10
126	4-Methyl-2-Pentanone	5	10
127	2-Hexanone	5	10
128	Tetrachloroethylene	1	10
129	1,1,2,2-Tetrachloroethane	1	10
130	Toluene	1	10
131	Chlorobenzene	1	10
132	Ethylbenzene	1	10
133	Styrene	1	10
134	Total Xylenes	1	10
135	1,2-Dichloroethylene (trans)	1	
136	1,2-Dichloroethylene (cis)	1	
137	1,2-Dichlorobenzene	1	
138	1,3-Dichlorobenzene	1	
139	1,4-Dichlorobenzene	1	
140	1,2-Dibromo-3-Chloropropane	1	

TABLE A-3

DETECTION LIMITS FOR TCL SEMIVOLATILE ORGANIC COMPOUNDS

Param. No.	TCL SVOC Analytes	CRQL (water) ug/L	CRQL (soil) ug/kg	Param. No.	TCL SVOC Analytes	CRQL (water) ug/L	CRQL (soil) ug/kg
200	Phenol	10	300	235	2,4-Dinitrophenol	25	800
201	bis(2-Chloroethyl)ether	10	300	236	4-Nitrophenol	25	800
202	2-Chlorophenol	10	300	237	Dibenzofuran	10	330
203	1,3-Dichlorobenzene	10	300	238	2,4-Dinitrotoluene	10	330
204	1,4-Dichlorobenzene	10	300	239	Diethylphthalate	10	330
206	1,2-Dichlorobenzene	10	300	240	4-Chlorophenyl-phenylether	10	330
207	2-Methylphenol	10	300	241	Fluorene	10	330
208	2,2-oxybis(1-chloropropane)	10	300	242	4-Nitroaniline	25	800
209	4-Methylphenol	10	300	243	4,6-Dinitro-2-methylphenol	25	800
210	N-Nitroso-di-n-propylamir	10	300	244	N-Nitrosodiphenylamine	10	330
211	Hexachloroethane	10	300	245	4-Bromophenyl-phenylether	10	330
212	Nitrobenzene	10	300	246	Hexachlorobenzene	10	330
213	Isophorone	10	300	247	Pentachlorophenol	25	800
214	2-Nitrophenol	10	300	248	Phenanthrene	10	330
215	2,4-Dimethylphenol	10	300	249	Anthracene	10	330
217	bis(2-Chloroethoxy)methane	10	300	250	Di-n-butylphthalate	10	330
218	2,4-Dichlorophenol	10	300	251	Fluoranthrene	10	330
219	1,2,4-Trichlorobenzene	10	300	252	Pyrene	10	330
220	Naphthalene	10	300	253	Butylbenzylphthalate	10	330
221	4-Chloroaniline	10	300	254	3,3-Dichlorobenzidine	10	330
222	Hexachlorobutadiene	10	300	255	Benzo(a)Anthracene	10	330
223	4-Chloro-3-Methylphenol	10	300	256	Chrysene	10	330
224	2-Methylnaphthalene	10	300	257	bis(2-Ethylhexyl)phthalate	10	330
225	Hexachlorocyclopentadiene	10	300	258	Di-n-octylphthalate	10	330
226	2,4,6-Trichlorophenol	10	300	259	Benzo(b)Fluoranthene	10	330
227	2,4,5-Trichlorophenol	25	800	260	Benzo(k)Fluoranthene	10	330
228	2-Chloronaphthalene	10	300	261	Benzo(a)Pyrene	10	330
229	2-Nitroaniline	25	800	262	'Indeno(1,2,3-cd)Pyrene	10	330
230	Dimethylphthalate	10	300	263	Dibenz(a,h)Anthracene	10	330
231	Acenaphthylene	10	300	264	Benzo(g,h,i)perylene	10	330
232	2,6-Dinitrotoluene	10	300	267	Carbazole	10	330
233	3-Nitroaniline	25	800				
234	Acenaphthene	10	300				

TABLE A-4

DETECTION LIMITS FOR TAL METALS, CYANIDE, AND TOC

Param. No.	TAL Metals Cyanide & TOC	CRDL (water) ug/L	CRDL (soil) mg/kg	Param. No.	TAL Metals Cyanide & TOC	CRDL (water) ug/L	CRDL (soil) mg/kg
400	Aluminum	200	40	413	Manganese	15	3
401	Antimony	60	12	414	Mercury	0.2	0.1
402	Arsenic	10	2	415	Nickel	40	8
403	Barium	200	40	416	Potassium	5000	1000
404	Beryllium	5	1	417	Selenium	5	1
405	Cadmium	5	1	418	Silver	10	2
406	Calcium	5000	1000	419	Sodium	5000	1000
407	Chromium	10	2	420	Thallium	10	2
408	Cobalt	50	10	421	Vanadium	50	10
409	Copper	25	5	422	Zinc	20	4
410	Iron	100	20	423	Cyanide	10	1
411	Lead	3	0.6		TOC	-	10
412	Magnesium	5000	1000				

DETECTION LIMITS FOR TCLP ANALYSES

USEPA HW No.	TCLP Elements	DL (ug/L)
D004	Arsenic	5
D005	Barium	100
D006	Cadmium	1
D007	Chromium	5
D008	Lead	5
D009	Mercury	0.2
D010	Selenium	1
D011	Silver	5

DETECTION LIMITS FOR AIR ANALYSES

Method	DL(Air)
TSP	100 ug/f
TAL Metals	.001-0.74 ng/m3
TCL SVOC	2.5-25 ng/m3

NOTES:

- CRQL Contract Required Quantitation Limits
- CRDL Contract Required Detection Limit
- DL Detection limit
- LDL Low detection limit
- ug/L Micrograms per liter
- ug/kg Micrograms per kilogram
- ug/f Micrograms per filter
- ng/m3 Nanograms per cubic meter
- TOC Total Organic Carbon
- TSP Total Suspended Particulates

TABLE A-5
DETECTION LIMITS FOR AIR ANALYSES

METHOD	DL (AIR)
TSP	100 ug/f
TAL METALS	.001–0.74 ng/m ³ –analyte specific
TCL SVOC	2.5–25 ng/m ³ –compound specific

NOTES:

- CRQL Contract Required Quantitation Limit
- DL Detection limit
- TCL Target Compound List
- TAL Target Analyte List
- ug/l Micrograms per liter
- ug/kg Micrograms per kilogram
- mg/kg Milligrams per kilograms
- ug/f Micrograms per filter
- ng/m³ Nanograms per cubic meter
- LDL Low detection limit achieved for TCL VOC analysis

APPENDIX B

**SITE-SPECIFIC
HEALTH AND SAFETY PLAN**

**OU-2 SITE SPECIFIC
HEALTH AND SAFETY PLAN**

FOR

**NAVAL AIR STATION
JACKSONVILLE, FLORIDA**

**APPENDIX B
OF THE OU-2 PROJECT WORK PLAN**

DECEMBER 1992

Prepared by:

**ABB ENVIRONMENTAL SERVICES, INC.
PORTLAND, MAINE**

Prepared for:

**U.S. DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SOUTH CAROLINA**

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<u>x</u>	4.0	MEDICAL SURVEILLANCE PROGRAM
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1.0 GENERAL

1.1 SCOPE AND PURPOSE. This Health and Safety Plan (HASP) has been prepared in conformance with the ABB Environmental Services Inc. (ABB-ES) Generic HASP developed under the Comprehensive Long-Term Environmental Action - Navy (CLEAN) District I Contract (CLEAN HASP) and is intended to meet the requirements of 29 Code of Federal Regulations (CFR) 1910.120. As such, the HASP addresses those activities associated with field operations for this project. Compliance with this HASP is required for all ABB-ES personnel, contractor personnel, or third parties entering the Site.

1.2 PROJECT PERSONNEL.

1.2.1 Task Order Manager The Task Order Manager (TOM), is the individual with overall project management responsibilities. Those responsibilities as they relate to health and safety include provision for the development of this site-specific HASP, the necessary resources to meet requirements of this HASP, the coordination of staff assignments to ensure that personnel assigned to the project meet medical and training requirements, and the means and materials necessary to resolve any health and safety issues that are identified or that develop on the project.

1.2.2 Field Operations Leader The Field Operations Leader has vested authority from the TOM to carry out day-to-day site operations.

1.2.3 Health and Safety Officer The Health and Safety Officer (HSO) will have at least an indirect line of reporting to the Health and Safety Manager (HSM) through the Health and Safety Supervisor (HSS) for the duration of his assignment as project HSO. The HSO is responsible for developing and implementing this site-specific HASP in accordance with the CLEAN HASP. The HSO will investigate all accidents, illnesses, and incidents occurring on site. The HSO will also conduct safety briefings and site-specific training for on-site personnel. As necessary, the HSO will accompany all USEPA, Occupational Safety and Health Administration (OSHA), or other governmental agency personnel visiting an ABB-ES site in response to health and safety issues. The HSO, in consultation with the HSS or HSM, is responsible for updating and modifying this HASP as site or environmental conditions change. Additional description of the duties of the HSM, HSS and HSO are provided in Part II of the HASP in Appendix A.

1.2.4 Field Engineer/Scientist This category includes engineers, scientist, and technicians who will perform site reconnaissance, geophysical/seismic surveys, surface water and sediment sampling, soil sampling, groundwater sampling and air sampling.

1.3 TRAINING. Training is defined in Chapter 3.0 of the CLEAN HASP. All personnel entering potentially contaminated areas at this site must meet the requirements of 29 CFR 1910.120. Personnel without the required training **will not be permitted** in any area with potential for exposure to toxic substances or harmful physical agents (i.e., downrange). The ABB-ES training program is described in Section 3.0 of the ABB-ES generic HASP.

1.4 MEDICAL SURVEILLANCE. All personnel entering potentially contaminated areas of this site will be medically qualified for site assignment through a medical surveillance program outlined in the ABB-ES Generic HASP. Personnel who have not received medical clearance **will not be permitted** in any area with potential for exposure to toxic substances or harmful physical agents (i.e., downrange). Chapter 4.0 of the CLEAN HASP contains further information on Medical Surveillance Programs. ABB-ES' Medical Surveillance Program is described in Section 2.0 of the ABB-ES generic HASP.

2.0 TASK ANALYSIS

Field work at OU-2 will include the following tasks:

- site walkovers
- topographic surveys
- ecological inventories
- surface soil sampling
- subsurface soil sampling
- sediment and surface water sampling
- collection of geotechnical information with piezometric cone penetrometer testing (PCPT) equipment
- groundwater sampling using PCPT equipment
- monitoring well installation
- collection of groundwater samples from monitoring wells

The hazardous substances, risks, and protective measures identified and described in the following subsections apply to all these tasks.

2.1 HAZARDOUS SUBSTANCES. Based on the available data the contaminants of concern known or suspected to be present on site, along with any established exposure limits for those substances, are listed in Table 2-1.

2.2 SITE RISKS. The following are the health hazards and safety hazards that are anticipated to be encountered at the site.

2.2.1 Health Hazards Personnel may be exposed to volatile and/or semi-volatile contaminants. Hazardous substance information forms (Material Safety Data Sheets, MSDS) for the contaminants of concern are contained in Appendix B.1 of this HASP. All activities at this site will be conducted in unconfined areas. This will help minimize the chances of exposure of on-site personnel to high vapor concentrations of any contaminants.

2.2.2 Safety Hazards Safety Hazards include those hazards that personnel may be exposed to that are unrelated to hazardous wastes. These include hazards such as heat stress, operation and presence around heavy equipment, lifting of objects, vehicle traffic, and snake bites. Extreme caution should be exhibited by all personnel while conducting work around drill rigs, backhoes, and other heavy equipment. During hot days, personnel should take time to drink fluids and cool off to avoid overheating and symptoms related to heat stress. Listing of heavy objects should be done with caution. Personnel should assist one another with moving heavy objects or use the appropriate equipment to

accomplish these tasks. During all site activities, personnel should be aware of the possibility of an encounter with poisonous snakes.

Power substations, powerlines, underground utilities, and underground pipelines are to be avoided during drilling operations. Necessary work permits for activities will be obtained from the Public Works Department or the appropriate department (e.g., fire department, etc.). Safety hazards and methods to reduce employee/contamination exposure to hazardous substances is addressed in the ABB-ES generic HASP in Appendix 6.0, Personal Protective Equipment; Section 12.5, Monitoring Equipment; Section 6.0, Section 7.0, Work Practices; Appendix G, Confined Space Entry Procedures (not planned for this work); Section 10.0, Temperature Extremes; Section 8.0, Decontamination, and Section 9.0, Emergency Planning.

2.2.3 Health and Safety Assessment Based on the available information (nature of the work, potential on-site chemicals and their properties, exposure limits, etc.), hazards associated with conducting the described field work are considered to be low, assuming appropriate health and safety practices are maintained.

**TABLE 2-1
CONTAMINANTS OF CONCERN**

**SITE SPECIFIC
HEALTH AND SAFETY PLAN**

CONSTITUENT	MAX. ¹ REP. CONC.	PEL/TLV ²	MEDIA ³
<u>Volatiles</u>			
Benzene		1	GW
1,1-Dichloroethane	0.187	100	GW
1,1,1-Trichloroethane	0.014	350	GW
Tetrachloroethane	0.001	1	GW
Trichloroethene	0.045	50	GW
Tetrachloroethene	0.015	25	GW
Toluene	0.054	100	GW
Methylene Chloride	1.3	50	GW
Methyl Ethyl Ketone	0.016	200	GW
Vinyl Chloride		1	GW
Xylene		100	GW
<u>Semi-Volatiles</u>			
Phenol	1.5	5	GW
Cresol	0.4	5	GW

Notes:

1. Maximum reported concentration mg/l (water).
2. Permissible exposure limit/threshold limit value (parts per million).
3. Ground water, surface, water, soil, or air.

2.3 PROTECTIVE MEASURES. The following are the protective measures that will be used at the site.

2.3.1 Engineering Controls Whenever needed, engineering controls (i.e., fans to blow volatilized chemicals away from the work area) will be used. Engineering controls are described in more detail in Section 7.4 of the ABB-ES generic HASP, however it is anticipated that engineering controls will not be necessary.

2.3.2 Levels of Protection Level D Protection will only be used when the atmosphere contains no known hazard, all potential airborne contaminants can be monitored for, and work functions preclude splash, immersion, or the potential for unexpected inhalation or contact with hazardous levels of any chemical. It is anticipated that work at OU-2 may require modified Level D protection. Modified Level D is Level D protection with the addition of chemical protective clothing. Modified Level D does not include respiratory protection.

Higher levels of personal protection will be used as dictated by conditions discovered in the field and as directed by the HSO. Guidance on selection of the level of personal protection is provided in Subsection 2.4.1 of this HASP and Section 6.0 of the ABB-ES generic HASP.

2.4 MONITORING. It is intended that real time monitoring instrumentation will be used to monitor the work environment in order to ensure the appropriate level of protection for the site team.

2.4.1 Air Sampling To the extent feasible, the presence of airborne contaminants will be evaluated through the use of direct reading instrumentation. Information gathered will be used to ensure the adequacy of the levels of protection being used at the site, and may be used as the basis for upgrading or downgrading the levels of protection in conformance with action levels provided in this HASP and at the direction of the site HSO.

A respirable dust monitor will be used at the site in areas where semivolatile contamination and dry dusty conditions exists. If the monitor reads $\geq 5 \text{ mg/m}^3$, the field team will withdraw from the site.

Level D or (modified) is acceptable if:

- FID < 10 ppm, and
- Benzene and vinyl chloride 0.5/a tubes < 0.5 ppm

Level C required if:

- FID reads between 10 and 700 ppm, and/or
- Benzene 5/b between 0.5 and 50 ppm
- vinyl chloride 0.5/a < 0.5 ppm

Level B required if:

- FID ≥ 70 ppm, or

- Benzene 5/b \geq 50 ppm
- Vinyl chloride 0.5/a \geq 0.5 ppm

Refer to Chapter 7.0 of the CLEAN HASP for information on the calibration and maintenance of the equipment.

A Foxboro Organic Vapor Analyzer 128 (OVA) and draeger tubes will be used at the Site. If the OVA detects a steady measurable quantity of organic vapors above background in the breathing zone, monitor with a benzene 6.5/a and vinyl chloride 0.5/a draeger tube. If benzene reads \geq 0.5 ppm, upgrade to Level C. If vinyl chloride reads \geq 0.5 ppm, upgrade to Level B. If benzene or vinyl chloride levels are $<$ 0.5 ppm, continue work at modified Level D till the FID reads 10 ppm, monitor with benzene 5/b tube. If benzene levels exceed 50 ppm, upgrade to Level B. Otherwise continue working at Level C till FID reads 700 ppm, then upgrade to Level B.

Additional monitoring equipment that may be utilized at the site are described in Section 7.3 of the ABB-ES generic HASP.

2.4.2 Personal Monitoring Personal monitoring will be undertaken to characterize the personal exposure of high risk employees to the hazardous substances they may encounter on-site. Personal monitoring will be conducted on a representative basis. Personnel who conduct a high risk work task will be noted in field logs. Thermoluminescent Dosimetry Body Badges will be used by all workers at the site.

Refer to Chapter 7.0 of the CLEAN HASP for information on the maintenance and calibration of the equipment. Additional information concerning personal monitoring, if required, is provided in Section 7.3.2 of the ABB-ES generic HASP.

3.0 SITE CONTROL

3.1 ZONATION. The general zonation protocols that should be employed at hazardous waste sites are described in Chapter 8.0 of the CLEAN HASP. The site-specific zonation that will be used for this project is described as follows:

Due to the nature of the work (multiple soil borings and monitoring well sampling throughout the study area) and the properties of the potential chemicals found on-site, typical exclusion, contamination reduction, and support zones are not necessary or practical at all locations. Therefore, where appropriate, a "floating" exclusion zone in the perimeter of the sampling site will be established to eliminate access to the area by individuals not working on the project or involved in the assessment work. The perimeter will be at least 30 feet in radius and moved accordingly as the assessment points are moved.

Zonation of waste sites and "floating" decontamination stations are described in the ABB-ES generic HASP in Section 5.0 Site Control and Section 8.0 Decontamination. A decontamination area will be established adjacent to the Polishing Pond OU-2. A diagram of the decontamination pad is provided in Section 4.0 of the OU-2 Field Sampling Plan (Appendix A-2 of the OU-2 Project Work Plan). The purpose of the decontamination pad is to provide a central area for the decon of field sampling and equipment, vehicles and large field equipment (tractors, drill rigs, trucks, etc).

3.2 COMMUNICATIONS. When radio communication is not used, the following air horn signals will be employed:

HELP	three short blasts	(. . .)
EVACUATION	three long blasts	(_ _ _)
ALL CLEAR	alternating long and short blasts	(_ _ .)

The air horn will be kept in the Exclusion Zone or Support Zone. Site communication and work practices are discussed in more detail in Part II of the HASP in Appendix H.

3.3 WORK PRACTICES. General work practices to be used during ABB-ES projects are described in Chapter 9.0 of the CLEAN HASP. Work at the Site will be conducted according to these established protocol and guidelines for the safety and health of all involved. Specific work practices necessary for this project or those that are of significant concern are described as follows.

- Work and sampling will be conducted in Level D clothing and equipment, unless site specific conditions are discovered that require a higher level of personal protection. Zonation of site work areas, typical work practices and levels of personal protection are discussed in the ABB-ES generic HASP in Section 5.0 Site Control Section 7.0 Work Practices and Section 8.0 Decontamination.

4.0 DECONTAMINATION AND DISPOSAL

All personnel and/or equipment leaving contaminated areas of the Site will be subject to decontamination, which will take place in the contamination reduction zone. The decontamination areas will consist of either the "fixed" decontamination station (Figure 3-1) located on-site for work conducted at OU-2 and "floating" decontamination stations for work conducted off-site. General decontamination practices are described in Chapter 13.0 of the CLEAN HASP and in Part II of the Site Specific HASP in Appendix L.

4.1 PERSONNEL DECONTAMINATION. All personnel leaving the study area are subject to decontamination (as necessary). The decontamination procedure required will be determined by the nature and level of contamination found at the sites. At a minimum, site personnel will remove loose soils from boots and clothing before leaving the site. More thorough decontamination procedures will be observed as dictated by site conditions.

4.1.1 Small Equipment Decontamination Small equipment will be protected from contamination as much as possible by keeping the equipment covered when at the site and placing the equipment on plastic sheeting, not the ground. Sampling equipment used at the site will be used only once or will be field cleaned between samples. Small equipment decontamination is described in more detail Section 8.3 of the HASP.

4.1.2 Heavy Equipment Decontamination Drilling equipment will be protected from contamination as much as possible by placing the equipment on plastic sheeting, not the ground. The drill rig and associated drilling equipment will be cleaned with high pressure water or high pressure steam followed by a soap and water wash and rinse. Loose material will be removed by brush. The person performing this activity will be at the level of protection used during the field investigation. Heavy equipment decontamination is described in more detail in Section 8.4 of the ABB-ES generic HASP.

4.2 COLLECTION AND DISPOSAL OF DECONTAMINATION PRODUCTS. All disposable protective gear, decontamination fluids (for both personnel and equipment), other disposable materials will be disposed at the site. Disposable material (e.g., gloves and Tyveks) will be bagged and disposed of properly. Collection and disposal of decontamination products is described in more detail Section 8.5 of the ABB-ES generic HASP.

5.0 EMERGENCY AND CONTINGENCY PLAN

This section identifies emergency and contingency planning that has been undertaken for operations at this site. Most sections of the HASP provide information that would be used under emergency conditions. General emergency planning information is addressed in Chapter 14.0 of the CLEAN HASP and in Part II of the Site Specific HASP in Appendix M. The following subsections present site-specific emergency and contingency planning information.

5.1 PERSONNEL ROLES, LINES OF AUTHORITY, AND COMMUNICATION. The site HSO or the Health and Safety designee is the primary authority for directing operations at the site under emergency conditions. All communications both on- and off-site will be directed through the HSO or designee.

5.2 EVACUATION. Evacuation procedures at the site will follow those procedures discussed in Chapter 14.5 of the CLEAN HASP for upwind withdrawal, site evacuation, and evacuation of the surrounding area.

Upon determination of conditions warranting site evacuation, the work party will proceed upwind of the work site and notify the security force, HSO, and the field office of site conditions. If the decontamination area is upwind and greater than 500 feet from the work site, the crew will pass quickly through decontamination to remove contaminated outer suits. If the hazard is toxic gas, respirators will be retained. The crew will proceed to the field office, only if upwind, or the designated rally point to assess the situation. There the respirators may be removed (if instrumentation indicates an acceptable condition). As more facts are determined from the field crew, these will be relayed to the appropriate agencies. The advisability and type of further response action will be coordinated and carried out by the HSO.

5.3 EMERGENCY MEDICAL TREATMENT AND FIRST AID. Any personnel injured on-site will be rendered first aid as appropriate and transported to competent medical facilities for further examination and/or treatment. The preferred method of transport would be through professional emergency transportation means; however, when this is not readily available or would result in excessive delay, other transport will be authorized. Under no circumstances will injured persons transport themselves to a medical facility for emergency treatment.

6.0 ADMINISTRATION

6.1 PERSONNEL AUTHORIZED DOWNRANGE. Personnel authorized to participate in downrange activities at this site have been reviewed and certified for site operations by the Project Manager and the HSS. Certification involves the completion of appropriate training, a medical examination, and a review of this site-specific HASP. All persons entering the site must use the buddy system, and check in with the Site Manager and/or HSO before going downrange.

CERTIFIED ABB ENVIRONMENTAL TEAM PERSONNEL:

<u>To Be Determined</u>	

- * FIRST-AID-TRAINED
- + CPR-TRAINED

6.2 HEALTH AND SAFETY PLAN (HASP) APPROVALS. By their signatures, the undersigned certify that this HASP will be used for the protection of the health and safety of all persons entering this site.

Health and Safety Officer

Date

Project Manager

Date

Health and Safety Manager/Supervisor

Date

6.3 FIELD TEAM REVIEW. I have read and reviewed the health and safety information in the HASP. I understand the information and will comply with the requirements of the HASP.

NAME: _____

DATE: _____

SITE/PROJECT: _____

6.4 MEDICAL DATA SHEET. This Medical Data Sheet will be completed by all on-site personnel and kept in the Support Zone during site operations. It is not a substitute for the Medical Surveillance Program requirements consistent with the CLEAN HASP. This data sheet will accompany any personnel when medical assistance or transport to hospital facilities is required. If more space is required, use the back of this sheet.

Project: _____

Name: _____

Address: _____

Home Telephone: Area Code () _____

Age: _____ Height: _____ Weight: _____

In case of emergency, contact: _____

Address: _____

Telephone: Area Code () _____

Do you wear contact lenses? Yes () No ()

Allergies: _____

List medication(s) taken regularly: _____

Particular sensitivities: _____

Previous/current medical conditions or exposures to hazardous chemicals:

Name of Personal Physician: _____

Telephone: Area Code () _____

6.5 EMERGENCY TELEPHONE NUMBERS.

NAS Jacksonville

Police Department	911
Rescue Service	911
St. Vincents Hospital	(904) 387-7395
Riverside Hospital	(904) 387-7070

Other Contacts

National Poison Control Center	(800) 492-2414
Maine Poison Control Center	(207) 871-2950
National Response Center	(800) 424-8802
Regional USEPA Emergency Response	(800) 414-8802
Chemical Manufacturers Association	
Chemical Referral Center	(800) 262-8200
Site HSO: To Be Determined	
Task Order Manager: Phil Georgariou	(904) 656-1293
Regional HSS: Jack Davis	(904) 656-1293
ABB Environmental HSM: Cindy Sundquist	(800) 341-0460 ext. 2657

EMERGENCY CONTACTS

Dr. Frank Lawrence	(207) 871-2617
Bruce Campbell, RPh	(207) 871-2449
Florida Poison Control Center	(800) 282-3171
ABB-ES (Maine)	(800) 476-0460
ABB-ES (Florida)	(904) 656-1293
USEPA Emergency Response	(800) 414-8802

6.6 ROUTES TO EMERGENCY MEDICAL FACILITIES. The primary source of medical assistance for the site is:

Facility Name: Saint Vincent's Hospital

Address: 1800 Barrs, Jacksonville, FL

Telephone Number: (904) 387-7395

Directions to primary source of medical assistance: (attach map)

Exit NAS via the main gate and take a right onto Roosevelt Blvd. (Hwy 17)
heading north. Proceed north to Park Street and take a right (east) onto Park
Street. Proceed on Park to Barrs and take a right. At the end of Barrs on the
right is St. Vincent's.

Alternative source of medical assistance:

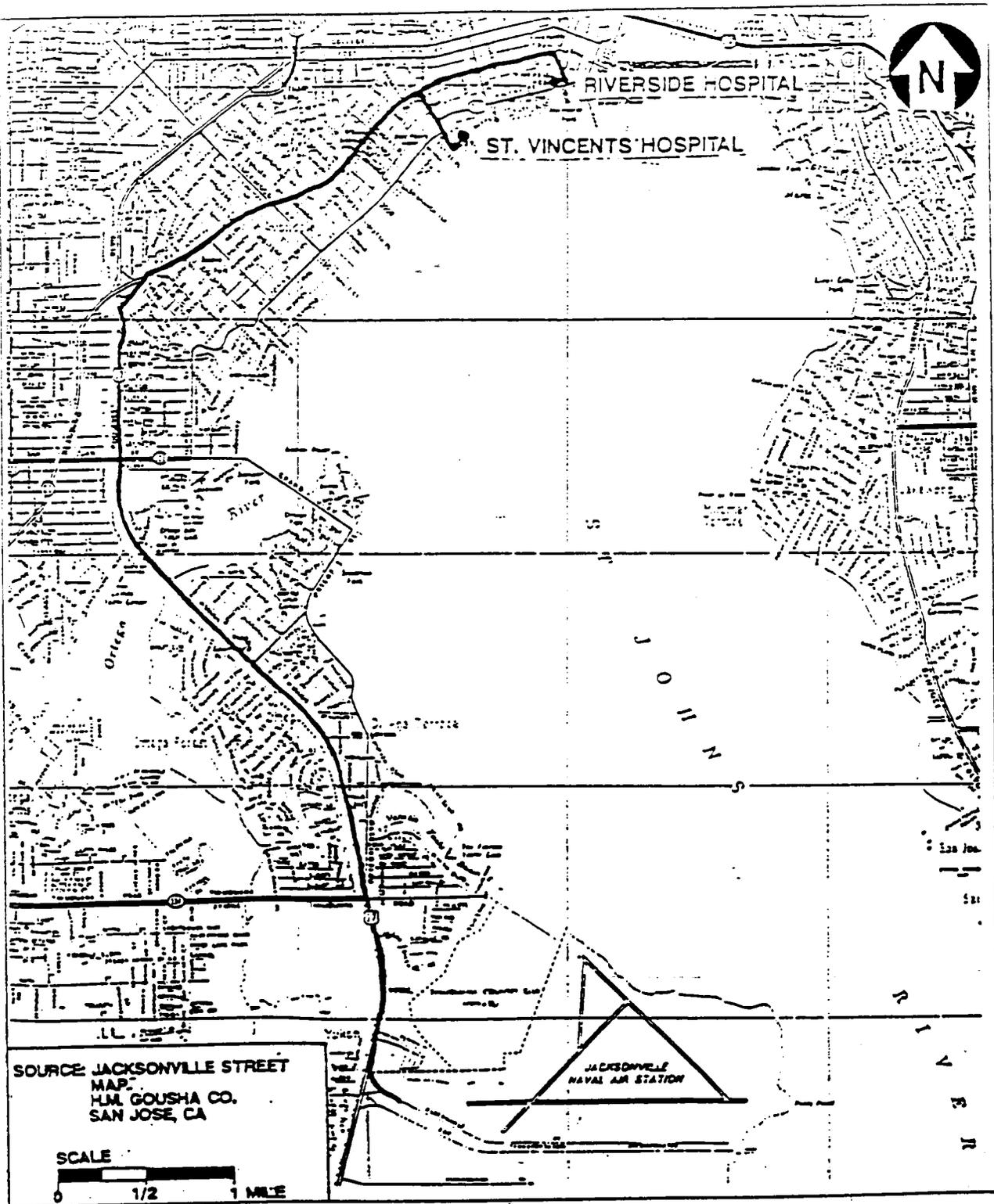
Facility Name: Riverside Hospital

Address: 2033 Riverside Avenue, Jacksonville, FL

Telephone Number: (904) 387-7070

Directions to alternate source of medical assistance: (attach map)

Exit NAS via the main gate and take a right onto Roosevelt Blvd. (Hwy 17)
heading north. Proceed north to Park Street and take a right (east) onto Park
Street. Proceed on Park Street to Margaret Street and take a right. At the corner
of Margaret Street and Riverside is Riverside Hospital on the right.



SOURCE: JACKSONVILLE STREET
MAP
H.M. GOUSHA CO.
SAN JOSE, CA

SCALE
0 1/2 1 MILE

FIGURE 7-1
ROUTE TO HOSPITALS



HEALTH AND SAFETY
PLAN
NAVAL SUPPLY CENTER
JACKSONVILLE, FLORIDA

APPENDIX B.1
MATERIAL SAFETY
DATA SHEETS

ACT

ACETONE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
-120	56.350	34	.507	30	1.193		N
-110	55.980	36	.508	35	1.184		O
-100	55.620	38	.508	40	1.174		T
-90	55.250	40	.509	45	1.164		
-80	54.880	42	.510	50	1.155		P
-70	54.520	44	.511	55	1.145		E
-60	54.150	46	.512	60	1.135		R
-50	53.780	48	.513	65	1.126		T
-40	53.400	50	.514	70	1.116		I
-30	53.030	52	.514	75	1.106		N
-20	52.650	54	.515	80	1.097		E
-10	52.280	56	.516	85	1.087		N
0	51.900	58	.517	90	1.077		T
10	51.520	60	.518	95	1.068		
20	51.140	62	.519	100	1.058		
30	50.760	64	.519	105	1.048		
40	50.380	66	.520				
50	50.000	68	.521				
60	49.610	70	.522				
70	49.230	72	.523				
80	48.840	74	.524				
90	48.450	76	.525				
100	48.070	78	.525				
110	47.680	80	.526				
120	47.280	82	.527				
		84	.528				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	M	-20	.245	-20	.00302	0	.275
	I	-10	.354	-10	.00426	25	.286
	S	0	.501	0	.00590	50	.296
	C	10	.698	10	.00804	75	.307
	I	20	.956	20	.01079	100	.317
	B	30	1.291	30	.01427	125	.327
	L	40	1.719	40	.01862	150	.337
	E	50	2.260	50	.02399	175	.347
		60	2.935	60	.03056	200	.357
		70	3.770	70	.03851	225	.367
		80	4.791	80	.04803	250	.377
		90	6.029	90	.05934	275	.386
		100	7.516	100	.07266	300	.395
		110	9.290	110	.08823	325	.405
		120	11.390	120	.10630	350	.414
		130	13.850	130	.12710	375	.423
		140	16.720	140	.15090	400	.431
		150	20.060	150	.17800	425	.440
		160	23.890	160	.20860	450	.449
		170	28.290	170	.24310	475	.457
		180	33.300	180	.28170	500	.466
		190	38.980	190	.32460	525	.474
						550	.482
						575	.490
						600	.498

ACETONE

ACT

Common Synonyms Dimethyl ketone Propanone 2-Propanone		Watery liquid Colorless Sweet odor
Floats and mixes with water. Flammable, irritating vapor is produced.		
Stay upwind and use water spray to "knock down" vapor. Shut off ignition sources and call fire department. Keep people away. Stop discharge if possible. Isolate and remove discharged material. Avoid contact with liquid and vapor. Notify local health and pollution control agencies.		
Fire	FLAMMABLE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Extinguish with dry chemical, alcohol foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.	
Exposure	CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled, may cause difficult breathing or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Irritating to eyes. Not irritating to skin. IF IN EYES, hold eyelids open and flush with plenty of water.	
Water Pollution	Dangerous to aquatic life in high concentrations. May be dangerous if it enters water intakes. Notify local health and pollution control officials. Notify operators of nearby water intakes.	
1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Issue warning-high flammability Disperse and flush		2. LABEL 2.1 Category: Flammable liquid 2.2 Class: 3
3. CHEMICAL DESIGNATIONS 3.1 CG Compatibility Class: Ketone 3.2 Formula: CH_3COCH_3 3.3 IMO/UN Designation: 3.1/1090 3.4 DOT ID No.: 1090 3.5 CAS Registry No.: 67-64-1		4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Sweetish; pleasant, resembling that of mint or fruit; pungent, sharp, penetrating residual; ketonic, pleasant, non-residual
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Organic vapor canister or air-supplied mask; synthetic rubber gloves; chemical safety goggles or face splash shield. 5.2 Symptoms Following Exposure: INHALATION: vapor irritating to eyes and mucous membranes; acts as an anesthetic in very high concentrations. INGESTION: low order of toxicity but very irritating to mucous membranes. SKIN: prolonged excessive contact causes defatting of the skin, possibly leading to dermatitis. 5.3 Treatment of Exposure: INHALATION: if victim is overcome, remove to fresh air and call a physician; administer artificial respiration if breathing is irregular or stopped. INGESTION: if victim has swallowed large amounts and is conscious and not having convulsions, induce vomiting and get medical help promptly; no specific antidote known. SKIN: wash well with water. EYES: flush with water immediately for at least 15 min. Consult a physician. 5.4 Threshold Limit Value: 750 ppm 5.5 Short Term Inhalation Limits: 1000 ppm for 30 min. 5.6 Toxicity by Ingestion: Grade 1, LD ₅₀ = 5 to 15 g/kg (dog) 5.7 Late Toxicity: Not pertinent 5.8 Vapor (Gas) Irritant Characteristics: If present in high concentrations, vapors cause moderate irritation of the eyes or respiratory system. Effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: No appreciable hazard. Practically harmless to the skin because it is very volatile and evaporates quickly from the skin. 5.10 Odor Threshold: 100 ppm 5.11 IDLH Value: 20000 ppm		

6. FIRE HAZARDS

6.1 Flash Point: 4°F O.C., 0°F C.C.
 6.2 Flammable Limits in Air: 2.6%-12.8%
 6.3 Fire Extinguishing Agents: Alcohol foam, dry chemical, carbon dioxide
 6.4 Fire Extinguishing Agents Not to be Used: Water in straight hose stream will scatter and spread fire and should not be used.
 6.5 Special Hazards of Combustion Products: Not pertinent
 6.6 Behavior in Fire: Not pertinent
 6.7 Ignition Temperature: 869°F
 6.8 Electrical Hazard: Class I, Group D
 6.9 Burning Rate: 3.9 mm/min.
 6.10 Adiabatic Flame Temperature: Data not available
 6.11 Stoichiometric Air to Fuel Ratio: Data not available
 6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
 7.2 Reactivity with Common Materials: No reaction
 7.3 Stability During Transport: Stable
 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
 7.5 Polymerization: Not pertinent
 7.6 Inhibitor of Polymerization: Not pertinent
 7.7 Molar Ratio (Reactant to Product): Data not available
 7.8 Reactivity Group: 18

8. WATER POLLUTION

8.1 Aquatic Toxicity: 14,250 ppm/24 hr/sunfish/killed/tap water
 13,000 ppm/48 hr/mosquito fish/TL₅₀/turbid water
 8.2 Waterfowl Toxicity: Not pertinent
 8.3 Biological Oxygen Demand (BOD): (Theor) 122%, 5 days
 8.4 Food Chain Concentration Potential: None noted

9. SHIPPING INFORMATION

9.1 Grades of Purity: Technical: 99.5% plus 0.5% water Reagent: 99.5% plus 0.5% water
 9.2 Storage Temperature: Ambient
 9.3 Inert Atmosphere: No requirement
 9.4 Venting: Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE
 (See Hazard Assessment Handbook)
A-P-Q-R-S

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
 11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	0
Poisons	0
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	1
Aesthetic Effect	1
Reactivity	
Other Chemicals	1
Water	2
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	1
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
 12.2 Molecular Weight: 58.08
 12.3 Boiling Point at 1 atm: 133°F = 56.1°C = 329.3°K
 12.4 Freezing Point: -138°F = -94.7°C = 178.5°K
 12.5 Critical Temperature: 455°F = 235°C = 508°K
 12.6 Critical Pressure: 682 psia = 46.4 atm = 4.70 MN/m²
 12.7 Specific Gravity: 0.791 at 20°C (liquid)
 12.8 Liquid Surface Tension: Not pertinent
 12.9 Liquid Water Interfacial Tension: Not pertinent
 12.10 Vapor (Gas) Specific Gravity: 2.0
 12.11 Ratio of Specific Heats of Vapor (Gas): 1.127
 12.12 Latent Heat of Vaporization: 220 Btu/lb = 122 cal/g = 5.11 X 10⁵ J/kg
 12.13 Heat of Combustion: -12,250 Btu/lb = -6808 cal/g = -285.0 X 10⁵ J/kg
 12.14 Heat of Decomposition: Not pertinent
 12.15 Heat of Solution: Not pertinent
 12.16 Heat of Polymerization: Not pertinent
 12.25 Heat of Fusion: 23.42 cal/g
 12.26 Limiting Value: Data not available
 12.27 Reid Vapor Pressure: 7.25 psia

NOTES

BNZ

BENZENE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
55	55.330	45	.394	75	.988	55	.724
60	55.140	50	.396	80	.981	60	.693
65	54.960	55	.398	85	.975	65	.665
70	54.770	60	.400	90	.969	70	.638
75	54.580	65	.403	95	.962	75	.612
80	54.400	70	.405	100	.956	80	.588
85	54.210	75	.407	105	.950	85	.566
90	54.030	80	.409	110	.944	90	.544
95	53.840	85	.411	115	.937	95	.524
100	53.660	90	.414	120	.931	100	.505
105	53.470	95	.416	125	.925	105	.487
110	53.290	100	.418	130	.919	110	.470
115	53.100			135	.912	115	.453
120	52.920			140	.906	120	.438
125	52.730			145	.900		
130	52.540			150	.893		
135	52.360			155	.887		
140	52.170			160	.881		
145	51.990			165	.875		
150	51.800			170	.868		
155	51.620						
160	51.430						
165	51.250						
170	51.060						
175	50.870						

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
77.02	.180	50	.881	50	.01258	0	.204
		60	1.171	60	.01639	25	.219
		70	1.535	70	.02109	50	.234
		80	1.989	80	.02681	75	.248
		90	2.547	90	.03371	100	.261
		100	3.227	100	.04196	125	.275
		110	4.049	110	.05172	150	.288
		120	5.033	120	.06317	175	.301
		130	6.201	130	.07652	200	.313
		140	7.577	140	.09194	225	.325
		150	9.187	150	.10960	250	.337
		160	11.060	160	.12980	275	.349
		170	13.220	170	.15270	300	.360
		180	15.700	180	.17850	325	.371
		190	18.520	190	.20750	350	.381
		200	21.740	200	.23970	375	.392
		210	25.360	210	.27560	400	.402
						425	.412
						450	.421
						475	.431
						500	.440
						525	.449
						550	.457
						575	.465
						600	.474

BENZENE

BNZ

Common Synonyms Benzol Benzole	Watery liquid	Colorless	Gasoline-like odor
Floats on water. Flammable, irritating vapor is produced. Freezing point is 42°F.			

Avoid contact with liquid and vapor. Keep people away. Wear goggles and self-contained breathing apparatus. Shut off ignition sources and call fire department. Stop discharge if possible. Stay upwind and use water spray to "knock down" vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.

Fire	<p>FLAMMABLE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Wear goggles and self-contained breathing apparatus. Extinguish with dry chemical, foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.</p>
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Exposure	<p>CALL FOR MEDICAL AID.</p> <p>VAPOR Irritating to eyes, nose and throat. If inhaled, will cause headache, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.</p> <p>LIQUID Irritating to skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.</p>
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Water Pollution	<p>HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>
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<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Issue warning-high flammability Restrict access</p>	<p>2. LABEL 2.1 Category: Flammable liquid 2.2 Class: 3</p>
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<p>3. CHEMICAL DESIGNATIONS 3.1 CG Compatibility Class: Aromatic hydrocarbon 3.2 Formula: C₆H₆ 3.3 IMO/UN Designation: 3.2/1114 3.4 DOT ID No.: 1114 3.5 CAS Registry No.: 71-43-2</p>	<p>4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Aromatic; rather pleasant aromatic odor; characteristic odor</p>
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<p>5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Hydrocarbon vapor canister, supplied air or a hose mask; hydrocarbon-insoluble rubber or plastic gloves; chemical goggles or face splash shield; hydrocarbon-insoluble apron such as neoprene 5.2 Symptoms Following Exposure: Dizziness, excitation, pallor, followed by flushing, weakness, headache, breathlessness, chest constriction. Coma and possible death. 5.3 Treatment of Exposure: 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. 5.4 Threshold Limit Value: 10-ppm 1 ppm 5.5 Short Term Inhalation Limits: 75 ppm for 30 min. 5.6 Toxicity by Ingestion: Grade 3; LD₅₀ = 50 to 500 mg/kg 5.7 Late Toxicity: Leukemia 5.8 Vapor (Gas) Irritant Characteristics: If present in high concentrations, vapors may cause irritation of eyes or respiratory system. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin. 5.10 Odor Threshold: 4.68 ppm 5.11 IDLH Value: 2,000 ppm</p>
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<p>6. FIRE HAZARDS 6.1 Flash Point: 12°F C.C. 6.2 Flammable Limits in Air: 1.3%-7.9% 6.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide 6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective 6.5 Special Hazards of Combustion Products: Not pertinent 6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back 6.7 Ignition Temperature: 1097°F 6.8 Electrical Hazard: Class I, Group D 6.9 Burning Rate: 6.0 mm/min. 6.10 Adiabatic Flame Temperature: Data not available 6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>
--

<p>7. CHEMICAL REACTIVITY 7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: 32</p>
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<p>8. WATER POLLUTION 8.1 Aquatic Toxicity: 5 ppm/6 hr/minnow/lethal/distilled water 20 ppm/24 hr/sunfish/TL₅₀/tap water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 1.2 lb/lb, 10 days 8.4 Food Chain Concentration Potential: None</p>

<p>9. SHIPPING INFORMATION 9.1 Grades of Purity: Industrial pure99+ % Thiophene-free99+ % Nitration90+ % Industrial 90%85+ % Reagent99+ % 9.2 Storage Temperature: Open 9.3 Inert Atmosphere: No requirement 9.4 Venting: Pressure-vacuum</p>
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<p>10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-T-U-V-W</p>

<p>11. HAZARD CLASSIFICATIONS 11.1 Code of Federal Regulations: Flammable liquid 11.2 NAS Hazard Rating for Bulk Water Transportation:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td>3</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>Vapor Irritant</td> <td>1</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td>1</td> </tr> <tr> <td>Poisons</td> <td>3</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>Human Toxicity</td> <td>3</td> </tr> <tr> <td>Aquatic Toxicity</td> <td>1</td> </tr> <tr> <td>Aesthetic Effect</td> <td>3</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>Other Chemicals</td> <td>2</td> </tr> <tr> <td>Water</td> <td>1</td> </tr> <tr> <td>Self Reaction</td> <td>0</td> </tr> </tbody> </table> <p>11.3 NFPA Hazard Classification:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td>2</td> </tr> <tr> <td>Flammability (Red)</td> <td>3</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>0</td> </tr> </tbody> </table>	Category	Rating	Fire	3	Health		Vapor Irritant	1	Liquid or Solid Irritant	1	Poisons	3	Water Pollution		Human Toxicity	3	Aquatic Toxicity	1	Aesthetic Effect	3	Reactivity		Other Chemicals	2	Water	1	Self Reaction	0	Category	Classification	Health Hazard (Blue)	2	Flammability (Red)	3	Reactivity (Yellow)	0
Category	Rating																																			
Fire	3																																			
Health																																				
Vapor Irritant	1																																			
Liquid or Solid Irritant	1																																			
Poisons	3																																			
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Health Hazard (Blue)	2																																			
Flammability (Red)	3																																			
Reactivity (Yellow)	0																																			

<p>12. PHYSICAL AND CHEMICAL PROPERTIES 12.1 Physical State at 15°C and 1 atm: Liquid 12.2 Molecular Weight: 78.11 12.3 Boiling Point at 1 atm: 176°F = 80.1°C = 353.3°K 12.4 Freezing Point: 42.0°F = 5.5°C = 278.7°K 12.5 Critical Temperature: 552.0°F = 288.9°C = 562.1°K 12.6 Critical Pressure: 710 psia = 48.3 atm = 4.89 MN/m² 12.7 Specific Gravity: 0.879 at 20°C (liquid) 12.8 Liquid Surface Tension: 28.9 dynes/cm = 0.0289 N/m at 20°C 12.9 Liquid Water Interfacial Tension: 35.0 dynes/cm = 0.035 N/m at 20°C 12.10 Vapor (Gas) Specific Gravity: 2.7 12.11 Ratio of Specific Heats of Vapor (Gas): 1.061 12.12 Latent Heat of Vaporization: 169 Btu/lb = 94.1 cal/g = 3.94 X 10⁴ J/kg 12.13 Heat of Combustion: -17,460 Btu/lb = -9698 cal/g = -406 X 10⁴ J/kg 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: 30.45 cal/g 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 3.22 psia</p>
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NOTES

CHLOROFORM

CRF

Common Synonyms Trichloromethane	Watery liquid Colorless Sweet odor Sinks in water. Irritating vapor is produced.
Avoid contact with liquid and vapor. Stay upwind. Wear goggles and self-contained breathing apparatus. Stop discharge if possible. Keep people away. Notify local health and pollution control agencies.	
Fire	Not flammable. POISONOUS AND IRRITATING GASES ARE PRODUCED WHEN HEATED. Wear goggles and self-contained breathing apparatus.
Exposure	CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled, will cause headache, nausea, dizziness, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Irritating to skin and eyes. Harmful if swallowed. Remove contaminated clothing. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting. IF SWALLOWED and victim is UNCONSCIOUS AND HAVING CONVULSIONS, do nothing except keep victim warm.
Water Pollution	Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and pollution control officials. Notify operators of nearby water intakes.
1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Issue warning-air contaminant Restrict access Should be removed	2. LABEL 2.1 Category: None 2.2 Class: Not pertinent
3. CHEMICAL DESIGNATIONS 3.1 CG Compatibility Class: Halogenated hydrocarbon 3.2 Formula: CHCl ₃ 3.3 IMO/UN Designation: 9.0/1888 3.4 DOT ID No.: 1888 3.5 CAS Registry No.: 67-66-3	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Pleasant, sweet; ethereal
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Chemical goggles, 50 ppm to 2%; suitable full-face gas mask. Above 2%; suitable self-contained system. 5.2 Symptoms Following Exposure: Headache, nausea, dizziness, drunkenness, narcosis. 5.3 Treatment of Exposure: INHALATION: if ill effects develop, get victim to fresh air, keep him warm and quiet, and get medical attention. If breathing stops, start artificial respiration. INGESTION: induce vomiting and get medical attention. No known antidote; treat symptoms. EYES: flush with plenty of water for at least 15 minutes and get medical attention. SKIN: wash with soap and water, remove contaminated clothing and free of chemical. 5.4 Threshold Limit Value: 10 ppm 5.5 Short Term Inhalation Limits: 50 ppm for 10 min. 5.6 Toxicity by Ingestion: Grade 2; LD ₅₀ = 0.5 to 5 g/kg 5.7 Late Toxicity: None 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin. 5.10 Odor Threshold: 205-307 ppm 5.11 IDLH Value: 1,000 ppm	

6. FIRE HAZARDS 6.1 Flash Point: Not flammable 6.2 Flammable Limits in Air: Not flammable 6.3 Fire Extinguishing Agents: Not pertinent 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion Products: Poisonous and irritating gases are produced when heated. 6.6 Behavior in Fire: Decomposes, producing toxic gases 6.7 Ignition Temperature: Not flammable 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: Not flammable 6.10 Adiabatic Flame Temperature: Data not available 6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available	10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-X																																				
7. CHEMICAL REACTIVITY 7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: 36	11. HAZARD CLASSIFICATIONS 11.1 Code of Federal Regulations: ORM-A 11.2 NAS Hazard Rating for Bulk Water Transportation: <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Category</th> <th style="text-align: right;">Rating</th> </tr> </thead> <tbody> <tr> <td>Fire.....</td> <td style="text-align: right;">1</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>Vapor Irritant.....</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Liquid or Solid Irritant.....</td> <td style="text-align: right;">1</td> </tr> <tr> <td>Poisons.....</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>Human Toxicity.....</td> <td style="text-align: right;">1</td> </tr> <tr> <td>Aquatic Toxicity.....</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Aesthetic Effect.....</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>Other Chemicals.....</td> <td style="text-align: right;">1</td> </tr> <tr> <td>Water.....</td> <td style="text-align: right;">0</td> </tr> <tr> <td>Self Reaction.....</td> <td style="text-align: right;">0</td> </tr> </tbody> </table> 11.3 NFPA Hazard Classification: <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Category</th> <th style="text-align: right;">Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue).....</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Flammability (Red).....</td> <td style="text-align: right;">0</td> </tr> <tr> <td>Reactivity (Yellow).....</td> <td style="text-align: right;">0</td> </tr> </tbody> </table>	Category	Rating	Fire.....	1	Health		Vapor Irritant.....	2	Liquid or Solid Irritant.....	1	Poisons.....	2	Water Pollution		Human Toxicity.....	1	Aquatic Toxicity.....	2	Aesthetic Effect.....	2	Reactivity		Other Chemicals.....	1	Water.....	0	Self Reaction.....	0	Category	Classification	Health Hazard (Blue).....	2	Flammability (Red).....	0	Reactivity (Yellow).....	0
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Reactivity (Yellow).....	0																																				
8. WATER POLLUTION 8.1 Aquatic Toxicity: Data not available 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): None 8.4 Food Chain Concentration Potential: None	12. PHYSICAL AND CHEMICAL PROPERTIES 12.1 Physical State at 15°C and 1 atm: Liquid 12.2 Molecular Weight: 119.39 12.3 Boiling Point at 1 atm: 142°F = 61.2°C = 334.4°K 12.4 Freezing Point: -82.3°F = -63.5°C = 209.7°K 12.5 Critical Temperature: 506°F = 263.2°C = 536.4°K 12.6 Critical Pressure: 790 psia = 54 atm = 5.5 MN/m ² 12.7 Specific Gravity: 1.49 at 20°C (liquid) 12.8 Liquid Surface Tension: 27.1 dynes/cm = 0.0271 N/m at 20°C 12.9 Liquid Water Interfacial Tension: 32.8 dynes/cm = 0.0328 N/m at 20°C 12.10 Vapor (Gas) Specific Gravity: 4.1 12.11 Ratio of Specific Heats of Vapor (Gas): 1.146 12.12 Latent Heat of Vaporization: 106.7 Btu/lb = 59.3 cal/g = 2.483 X 10 ⁶ J/kg 12.13 Heat of Combustion: Not pertinent 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: 17.62 cal/g 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 6.39 psia																																				
9. SHIPPING INFORMATION 9.1 Grades of Purity: Technical, USP 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Open	NOTES																																				

CHLOROFORM

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
-50	100.799	0	.216	-70	.938	0	.847
-40	100.200	10	.217	-60	.929	10	.791
-30	99.549	20	.219	-50	.920	20	.741
-20	98.910	30	.221	-40	.911	30	.697
-10	98.259	40	.222	-30	.902	40	.656
0	97.610	50	.224	-20	.893	50	.620
10	96.950	60	.226	-10	.884	60	.586
20	96.299	70	.227	0	.875	70	.556
30	95.639	80	.229	10	.866	80	.528
40	94.980	90	.231	20	.857	90	.503
50	94.320	100	.232	30	.848	100	.479
60	93.650	110	.234	40	.839	110	.458
70	92.990	120	.236	50	.830	120	.438
80	92.320	130	.237	60	.821	130	.420
90	91.650	140	.239	70	.812	140	.403
100	90.980			80	.804		
110	90.309			90	.795		
120	89.629			100	.786		
130	88.950			110	.777		
140	88.270			120	.768		
				130	.759		
				140	.750		

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
77.02	.800	-30	.150	-30	.00387	0	.123
		-20	.217	-20	.00548	25	.126
		-10	.309	-10	.00763	50	.129
		0	.433	0	.01047	75	.131
		10	.598	10	.01417	100	.134
		20	.816	20	.01892	125	.137
		30	1.099	30	.02496	150	.139
		40	1.462	40	.03255	175	.142
		50	1.924	50	.04198	200	.144
		60	2.505	60	.05361	225	.146
		70	3.229	70	.06781	250	.148
		80	4.124	80	.08499	275	.150
		90	5.220	90	.10560	300	.152
		100	6.551	100	.13020	325	.154
		110	8.157	110	.15930	350	.156
		120	10.080	120	.19340	375	.158
						400	.160
						425	.161
						450	.162
						475	.164
						500	.165
						525	.166
						550	.167
						575	.168
						600	.169

o-CRESOL

CRO

<p>Common Synonyms</p> <p>o-Hydroxytoluene 2-Methylphenol o-Toluid 2-Cresol</p>	<p>Solid crystals or liquid Colorless to yellow Sweet tarry odor</p> <p>Sinks and mixes slowly with water.</p>
<p>Avoid contact with liquid or solid. Keep people away. Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves). Stop discharge if possible. Call fire department. Notify local health and pollution control agencies. Isolate and remove discharged material.</p>	
Fire	<p>COMBUSTIBLE POISONOUS GASES MAY BE PRODUCED IN FIRE. Wear goggles and self-contained breathing apparatus. Extinguish with water fog, dry chemical, foam or carbon dioxide. Cool exposed containers with water.</p>
Exposure	<p>CALL FOR MEDICAL AID.</p> <p>LIQUID OR SOLID Will burn skin and eyes. Poisonous if swallowed, inhaled or if skin is exposed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED, and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.</p>
Water Pollution	<p>HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes.</p> <p>Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook)</p> <p>Issue warning-water contaminant, poison. Restrict access Should be removed. Chemical and physical treatment</p>	<p>2. LABEL</p> <p>2.1 Category: Corrosive 2.2 Class: 8</p>
<p>3. CHEMICAL DESIGNATIONS</p> <p>3.1 CG Compatibility Class: Phenols, cresols 3.2 Formula: C₇H₈O 3.3 IMO/UN Designation: 6.1/2078 3.4 DOT ID No.: 2078 3.5 CAS Registry No.: 95-48-7</p>	<p>4. OBSERVABLE CHARACTERISTICS</p> <p>4.1 Physical State (as shipped): Solid or liquid 4.2 Color: Colorless to yellow. 4.3 Odor: Phenolic, tarry</p>
<p style="text-align: center;">5. HEALTH HAZARDS</p> <p>5.1 Personal Protective Equipment: Chemical goggles or face shields, full protective clothing including boots and gloves, and respiratory protective apparatus. 5.2 Symptoms Following Exposure: INHALATION, INGESTION OR SKIN ABSORPTION: Central nervous system depression, muscular weakness, gastroenteric disturbances, convulsions and death. EYES: can cause burns. SKIN: Corrosive action may produce severe burns. 5.3 Treatment of Exposure: Call a doctor. INHALATION: Move to fresh air. Oxygen inhalation for respiratory distress. If needed, give artificial respiration. EYES: Irrigate with copious quantities of running water for 15 min. Hold eyelids open. If physician not available irrigate for an additional 15 min. SKIN: Remove all contaminated clothing. Wash with soap and water until all odor is gone. Then wash contaminated areas with alcohol or glycerin. Then use more water. INGESTION: Drink large quantities of liquid (salt water, weak sodium bicarbonate solution, milk or gruel) followed by demulcent such as raw egg white or corn starch paste. Induce vomiting, if not spontaneous. Keep up until vomiting is free of Cresol odor. 5.4 Threshold Limit Value: 5 ppm. Skin absorption can contribute to exposure. 5.5 Short Term Inhalation Limits: 10 ppm. 5.6 Toxicity by Ingestion: Grade 3; LD₅₀ = 50 - 500 mg/kg. 5.7 Late Toxicity: May produce neoplasms or act as tumor promoters. Central nervous system damage. Chronic gastritis, possible liver and kidney damage, and lesions of heart and brain. Dermatitis may result. 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Fairly severe skin irritant. May cause pain and second-degree burns after a few minutes contact. 5.10 Odor Threshold: 0.65 ppm detection in water 0.26 ppm recognition in air. 5.11 IDLH Value: 250 ppm</p>	

<p>6. FIRE HAZARDS</p> <p>6.1 Flash Point: 178°F C.C. 6.2 Flammable Limits in Air: 1.35% 6.3 Fire Extinguishing Agents: Water may be used to blanket fire, CO₂, dry chemical, foam, water spray. 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion Products: Emits highly toxic fumes. 6.6 Behavior in Fire: Vapors form explosive mixtures with air. 6.7 Ignition Temperature: 1110°F. 6.8 Electrical Hazard: Data not available 6.9 Burning Rate: Data not available 6.10 Adiabatic Flame Temperature: Data not available 6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>	<p>10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook)</p> <p style="text-align: center;">SS</p>								
<p>7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Will not occur. 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: 21</p>	<p>11. HAZARD CLASSIFICATIONS</p> <p>11.1 Code of Federal Regulations: Corrosive material 11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed 11.3 NFPA Hazard Classification:</p> <table style="width: 100%; border: none;"> <tr> <td style="text-align: right;">Category</td> <td style="text-align: right;">Classification</td> </tr> <tr> <td style="text-align: right;">Health Hazard (Blue).....</td> <td style="text-align: right;">3</td> </tr> <tr> <td style="text-align: right;">Flammability (Red).....</td> <td style="text-align: right;">2</td> </tr> <tr> <td style="text-align: right;">Reactivity (Yellow).....</td> <td style="text-align: right;">0</td> </tr> </table>	Category	Classification	Health Hazard (Blue).....	3	Flammability (Red).....	2	Reactivity (Yellow).....	0
Category	Classification								
Health Hazard (Blue).....	3								
Flammability (Red).....	2								
Reactivity (Yellow).....	0								
<p>8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: 49.1-19 ppm/24-96 hr/goldfish/TL₅₀/soft water 22.2-20.8 ppm/24-96 hr/bluegill/TL₅₀/soft water 18-13.4 ppm/24-96 hr/tathead minnow/TL₅₀/hard water 18-50 ppm/24-96 hr/guppy/TL₅₀/hard water 8.2 Waterfowl Toxicity: Chronic water fowl toxic limit is 25 ppm. 8.3 Biological Oxygen Demand (BOD): 1.64 lb/lb, 5 days. 8.4 Food Chain Concentration Potential: None</p>	<p>12. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>12.1 Physical State at 15°C and 1 atm: Solid 12.2 Molecular Weight: 108.134. 12.3 Boiling Point at 1 atm: 378°F = 191°C = 464.2°K 12.4 Freezing Point: 88°F = 31°C = 304.2°K 12.5 Critical Temperature: 795.9°F = 424.4°C = 697.6°K 12.6 Critical Pressure: 726.0 psia = 49.4 atm = 5.00 MN/m² 12.7 Specific Gravity: 1.05 at 20°C. 12.8 Liquid Surface Tension: 40.3 dynes/cm = 0.0403 N/m at 20°C. 12.9 Liquid Water Interfacial Tension: 32.7 dynes/cm = 0.0327 N/m at 20°C. 12.10 Vapor (Gas) Specific Gravity: 3.72. 12.11 Ratio of Specific Heats of Vapor (Gas): >1. 12.12 Latent Heat of Vaporization: 178.4 Btu/lb = 99.12 cal/g = 4.15 X 10⁵ J/kg. 12.13 Heat of Combustion: -13994 Btu/lb = -7774 cal/g = -325 X 10³ J/kg. 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: Data not available 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: Data not available</p>								
<p>NOTES</p>									

CRO

o - CRESOL

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
70	65.459	20	555	90	1.055	104	4.490
75	65.235			95	1.052	105	4.380
80	65.025			100	1.050	106	4.270
85	64.829			105	1.047	107	4.160
90	64.643			110	1.045	108	4.050
95	64.466			115	1.042	109	3.940
100	64.301			120	1.040	110	3.830
105	64.141			125	1.037	111	3.720
110	63.991			130	1.035	112	3.610
115	63.846			135	1.032	113	3.500
120	63.708			140	1.030		

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot (estimate)	Temperature (degrees F)	British thermal unit per pound-F
M I S C I B L E		100	.020	90	.00024	80	.290
		120	.048	95	.00030	100	.298
		140	.101	100	.00037	120	.306
		160	.192	105	.00044	140	.315
		180	.340	110	.00053	160	.323
		200	.566	115	.00063	180	.331
		220	.899	120	.00074	200	.339
		240	1.370	125	.00087	220	.347
		260	2.018	130	.00101	240	.355
		280	2.890			260	.363
		300	4.036			280	.371
		320	5.518			300	.379
		340	7.401			320	.387
		360	9.761			340	.395
						360	.403
						380	.411
					400	.420	
					420	.428	
					440	.436	

p-CRESOL

CSO

<p>Common Synonyms</p> <p>P-Methylphenol 4-Hydroxytoluene P-Toluid P-Methylhydroxybenzene</p>	<p>Solid</p> <p>Colorless</p> <p>Tarlike odor</p>
<p>Sinks and mixes slowly with water.</p>	
<p>Avoid contact with liquid. Keep people away. Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves). Stop discharge if possible. Call fire department. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>	
<p>Fire</p>	<p>Combustible. POISONOUS GASES MAY BE PRODUCED IN FIRE. Wear goggles and self-contained breathing apparatus. Extinguish with water, dry chemical, foam or carbon dioxide. Cool exposed containers with water.</p>
<p>Exposure</p>	<p>CALL FOR MEDICAL AID.</p> <p>LIQUID Will burn skin and eyes. Poisonous if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk, and have victim induce vomiting.</p>
<p>Water Pollution</p>	<p>HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook)</p> <p>Issue warning - Water contaminant, poison. Restrict access. Should be removed. Chemical and physical treatment.</p>	<p>2. LABEL</p> <p>2.1 Category: Corrosive 2.2 Class: 8</p>
<p>3. CHEMICAL DESIGNATIONS</p> <p>3.1 CG Compatibility Class: Phenols, cresols 3.2 Formula: C₇H₈O 3.3 IMO/UN Designation: 6.1/2076. 3.4 DOT ID No.: 2078. 3.5 CAS Registry No.: 106-44-5</p>	<p>4. OBSERVABLE CHARACTERISTICS</p> <p>4.1 Physical State (as shipped): Liquid or solid 4.2 Color: Colorless 4.3 Odor: Phenolic.</p>
<p>5. HEALTH HAZARDS</p> <p>5.1 Personal Protective Equipment: Chemical goggles, full protective clothing including boots and gloves, self-contained breathing apparatus. 5.2 Symptoms Following Exposure: INHALATION: Irritation of nose or throat. EYES: Intense irritation and pain, swelling of conjunctiva and corneal damage may occur. SKIN: Intense burning, loss of feeling, white discoloration and softening. Gangrene may occur. INGESTION: Burning sensation in mouth and esophagus. Vomiting may result. Absorption by all routes may cause muscular weakness, gastroenteric disturbance, severe depression and collapse. Effects are primarily on central nervous system, edema of lungs, injury of spleen and pancreas may occur. 5.3 Treatment of Exposure: Call a physician. INHALATION: Move to fresh air. Irritation of nose or throat may be relieved to some extent by spraying or gargling with water until odor disappears. For respiratory distress administer oxygen. EYES: Irrigate with copious quantities of running water for at least 15 min. SKIN: Remove contaminated clothing. Wash with soap and water until all cresol odor disappears. Follow with alcohol or glycerin (20% solution) wash. Follow with water. INGESTION: Dilute with large quantities of liquid (salt water, weak sodium bicarbonate solution, milk or gruel). Follow with demulcent such as raw egg white or corn starch paste. Induce vomiting. 5.4 Threshold Limit Value: 5 ppm. Skin absorption can contribute to exposure. 5.5 Short Term Inhalation Limit: 10 ppm. 5.6 Toxicity by Ingestion: Grade 3; LD₅₀ = 50 - 500 mg/kg. 5.7 Late Toxicity: May produce neoplasms or act as tumor promoters. Can cause central nervous system damage and chronic gastritis. Possible liver and kidney damage and lesions of the heart and brain. Can cause dermatitis. 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Fairly severe skin irritant. May cause pain and second-degree burns after a few minutes contact. 5.10 Odor Threshold: 0.2 ppm recognition in air; 0.46 ppb detection in air. 5.11 IDLH Value: 250 ppm</p>	

<p>6. FIRE HAZARDS</p> <p>6.1 Flash Point: 187°F C.C. 6.2 Flammable Limits in Air: 1.06% - 1.4% 6.3 Fire Extinguishing Agents: CO₂, dry chemical, foam, water spray or fog. 6.4 Fire Extinguishing Agents Not to be Used: Water may cause frothing. 6.5 Special Hazards of Combustion Products: Emits highly toxic fumes. 6.6 Behavior in Fire: Flammable toxic vapors may be given off. 6.7 Ignition Temperature: 1038°F. 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: Data not available 6.10 Adiabatic Flame Temperature: Data not available 6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>	<p>10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook)</p> <p>A P Q</p>								
<p>7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: 21</p>	<p>11. HAZARD CLASSIFICATIONS</p> <p>11.1 Code of Federal Regulations: Corrosive material 11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed 11.3 NFPA Hazard Classification:</p> <table border="0"> <tr> <td>Category</td> <td>Classification</td> </tr> <tr> <td>Health Hazard (Blue)</td> <td>3</td> </tr> <tr> <td>Flammability (Red)</td> <td>1</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>0</td> </tr> </table>	Category	Classification	Health Hazard (Blue)	3	Flammability (Red)	1	Reactivity (Yellow)	0
Category	Classification								
Health Hazard (Blue)	3								
Flammability (Red)	1								
Reactivity (Yellow)	0								
<p>8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: 21 ppm/24 hr/crucian carp/LC₅₀ 17 ppm/24 hr/roach/LC₅₀ 16 ppm/24 hr/tench/LC₅₀ 24 ppm/48 hr/mosquito fish/TL₅₀/pond 10 ppm/96 hr/bluegill/TL₅₀/distilled water 8.2 Waterfowl Toxicity: Chronic waterfowl limit is 25 ppm. 8.3 Biological Oxygen Demand (BOD): 1.4-1.48 lb/lb 5 days. 8.4 Food Chain Concentration Potential: None</p>	<p>12. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>12.1 Physical State at 15°C and 1 atm: Solid 12.2 Molecular Weight: 108.134 12.3 Boiling Point at 1 atm: 395.46°F = 201.92°C = 475°K. 12.4 Freezing Point: 94.6°F = 34.78°C = 307.93°K. 12.5 Critical Temperature: 808.5°F = 431.4°C = 704.6°K. 12.6 Critical Pressure: 746.7 psia = 50.8 atm = 5.15 MN/m². 12.7 Specific Gravity: 1.034 at 20°C. 12.8 Liquid Surface Tension: 41.8 dynes/cm = 0.041 N/m at 40°C. 12.9 Liquid Water Interfacial Tension: 31.2 dynes/cm = 0.0312 N/m at 40°C. 12.10 Vapor (Gas) Specific Gravity: 3.72. 12.11 Ratio of Specific Heats of Vapor (Gas): > 1 ≥ 1.05 (est.) 12.12 Latent Heat of Vaporization: 186.7 Btu/lb = 104.85 cal/g = 4.39 X 10⁴ J/kg. 12.13 Heat of Combustion: -14014 Btu/lb = -7786 cal/g = -326 X 10⁴ J/kg 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: 26.28 cal/g 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: Data not available</p>								
<p>9. SHIPPING INFORMATION</p> <p>9.1 Grade of Purity: 92-98% containing m-cresol. 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Open</p>	<p>NOTES</p>								

CSO

p - CRESOL

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
106	63.511	20	.555	20	1.001	104	7.000
108	63.465					105	6.812
110	63.420					106	6.634
112	63.378					107	6.465
114	63.336					108	6.304
116	63.296					109	6.151
118	63.258					110	6.005
120	63.221					111	5.866
122	63.185					112	5.734
						113	5.607

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
105	2.454	105	.013	104	.00022	80	.277
110	2.711	110	.015	105	.00023	100	.286
115	2.945	115	.018	106	.00024	120	.294
120	3.159	120	.022	107	.00025	140	.303
125	3.356	125	.025	108	.00026	160	.311
130	3.539	130	.030	109	.00027	180	.319
135	3.707	135	.035	110	.00028	200	.328
140	3.864	140	.042	111	.00029	220	.336
145	4.010	145	.049	112	.00030	240	.344
150	4.146	150	.058	113	.00031	260	.353
155	4.273	155	.069	114	.00032	280	.361
160	4.392	160	.081	115	.00032	300	.369
165	4.505	165	.096	116	.00033	320	.378
170	4.610	170	.113			340	.386
175	4.710	175	.133			360	.395
180	4.804	180	.157			380	.403
185	4.892	185	.186			400	.411
190	4.977					420	.420
195	5.057					440	.428
200	5.132						
205	5.205						
210	5.273						

1,1-DICHLOROETHANE

DCH

Common Synonyms Ethyldene dichloride Ethyldene dichloride Chlorinated hydrochloric ether	Oily liquid Colorless Chloroform like ethereal Sinks and mixes with water.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves). Stop discharge if possible. Keep people away. Shut off ignition sources and call fire department. Avoid contact with liquid. Isolate and remove discharged material. Notify local health and pollution control agencies.	
Fire	Flammable. POISONOUS GAS MAY BE PRODUCED IN FIRE OR WHEN HEATED. Containers may explode in fire. Wear goggles and self-contained breathing apparatus. Extinguish with alcohol foam, carbon dioxide, or dry chemical. Water may be ineffective on fire.
Exposure	CALL FOR MEDICAL AID. LIQUID If swallowed may cause nausea, vomiting and faintness. Irritating to skin and eyes. Flush affected areas with plenty of water. IF IN EYES, hold eye lids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS have victim drink water or milk and induce vomiting.
Water Pollution	Dangerous to aquatic life in high concentrations. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.
1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Issue warning-high flammability. Restrict access. Chemical and physical treatment.	2. LABEL 2.1 Category: None 2.2 Class: Not pertinent
3. CHEMICAL DESIGNATIONS 3.1 CG Compatibility Class: Halogenated hydrocarbon 3.2 Formula: C ₂ H ₄ Cl ₂ 3.3 IMO/UN Designation: Not listed 3.4 DOT ID No.: 2362 3.5 CAS Registry No.: 75-34-3	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Oily liquid 4.2 Color: Colorless 4.3 Odor: Chloroform
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: In areas of poor ventilation or high concentration, a self-contained breathing apparatus with full face mask should be worn. Chemical workers goggles, rubber gloves, and protective clothing should be worn. 5.2 Symptoms Following Exposure: INHALATION: Irritation of respiratory tract. Salivation, sneezing, coughing, dizziness, nausea, and vomiting. EYES: Irritation, lacrimation, and reddening of conjunctiva. SKIN: Irritation. Prolonged or repeated skin contact can produce a slight burn. INGESTION: Ingestion incidental to industrial handling is not considered to be a problem. Swallowing of substantial amounts could cause nausea, vomiting, faintness, drowsiness, cyanosis, and circulatory failure. 5.3 Treatment of Exposure: Call a doctor. INHALATION: Remove from contaminated area; keep warm and quiet. If breathing has stopped, give artificial respiration. Administer oxygen. EYES: Flush with large amounts of water or weak bicarbonate of soda solution. SKIN: Dilute with large amounts of water. Remove contaminated clothing. INGESTION: Attempt to empty stomach; dilute by administering fluids (tap water, soapy water, salt water, or milk). 5.4 Threshold Limit Value: 200 ppm. 5.5 Short Term Inhalation Limits: 250 ppm. 5.6 Toxicity by Ingestion: Grade 2; LD ₅₀ = 0.5 to 5 g/kg (rat). 5.7 Late Toxicity: Chronic exposure may cause liver damage and dermatitis. Animal experimentation has shown this compound to be slightly embryo-toxic and to retard fetal development. 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of skin. 5.10 Odor Threshold: Data not available 5.11 IDLH Value: 4,000 ppm	

6. FIRE HAZARDS 6.1 Flash Point: 57°F O.C. = 22°F C.C. 6.2 Flammable Limits in Air: 5.6% to 11.4% 6.3 Fire Extinguishing Agents: Alcohol foam, water, foam, CO ₂ , dry chemical, carbon tetrachloride 6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective 6.5 Special Hazards of Combustion Products: When heated to decomposition emits highly toxic fumes to phosgene. 6.6 Behavior in Fire: Explosion hazard 6.7 Ignition Temperature: 856°F 6.8 Electrical Hazard: Data not available 6.9 Burning Rate: Data not available 6.10 Adiabatic Flame Temperature: Data not available 6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available	10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-P-Q-R-S								
7. CHEMICAL REACTIVITY 7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: Data not available 7.3 Stability During Transport: Data not available 7.4 Neutralizing Agents for Acids and Caustics: Data not available 7.5 Polymerization: Data not available 7.6 Inhibitor of Polymerization: labie Data not available 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: 36	11. HAZARD CLASSIFICATIONS 11.1 Code of Federal Regulations: Not listed 11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed 11.3 NFPA Hazard Classification: <table border="0"> <tr> <td>Category</td> <td>Classification</td> </tr> <tr> <td>Health Hazard (Blue)</td> <td>2</td> </tr> <tr> <td>Flammability (Red)</td> <td>3</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>0</td> </tr> </table>	Category	Classification	Health Hazard (Blue)	2	Flammability (Red)	3	Reactivity (Yellow)	0
Category	Classification								
Health Hazard (Blue)	2								
Flammability (Red)	3								
Reactivity (Yellow)	0								
8. WATER POLLUTION 8.1 Aquatic Toxicity: TL ₅₀ (Marine pinperch) 250 to 275 mg/l 24-hour TL ₅₀ Bine shrimp: 320 mg/l 24-hour TL ₅₀ Pinperch: 160 mg/l 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): Percent, 0.05 g/g for 10 days Percent, 0.002 g/g for 5 days 8.4 Food Chain Concentration Potential: Data not available	12. PHYSICAL AND CHEMICAL PROPERTIES 12.1 Physical State at 15°C and 1 atm: Liquid 12.2 Molecular Weight: 98.97 12.3 Boiling Point at 1 atm: 135.14°F = 57.3°C = 330.5°K 12.4 Freezing Point: -143.32°F = -97.4°C = 175.75°K 12.5 Critical Temperature: 502.7°F = 261.5°C = 534.65°K 12.6 Critical Pressure: 734.8 psia = 50 atm = 5.065 MN/m ² 12.7 Specific Gravity: 1.174 at 20°C 12.8 Liquid Surface Tension: 24.75 dynes/cm = 0.02475 N/m at 20°C 12.9 Liquid Water Interfacial Tension: Data not available 12.10 Vapor (Gas) Specific Gravity: 3.42 12.11 Ratio of Specific Heats of Vapor (Gas): 1.136 at 20°C (68°F) 12.12 Latent Heat of Vaporization: 131.6 Btu/lb = 73.1 cal/g = 3.06 X 10 ⁵ J/kg 12.13 Heat of Combustion: -4,774 Btu/lb = -2,652 cal/g = -111 X 10 ³ J/kg 12.14 Heat of Decomposition: Data not available 12.15 Heat of Solution: Data not available 12.16 Heat of Polymerization: Data not available 12.25 Heat of Fusion: Data not available 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 7.35 psia								
9. SHIPPING INFORMATION 9.1 Grades of Purity: Data not available 9.2 Storage Temperature: Cool 9.3 Inert Atmosphere: Data not available 9.4 Venting: Data not available	NOTES								

DCH

DICHLOROETHANE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
35	75.198		D	35	.804	35	.617
40	74.929		A	40	.799	40	.595
45	74.660		T	45	.795	45	.574
50	74.389		A	50	.791	50	.555
55	74.120			55	.786	55	.537
60	73.851		N	60	.782	60	.520
65	73.580		O	65	.778	65	.504
70	73.311		T	70	.773	70	.489
75	73.042			75	.769	75	.475
80	72.771		A	80	.765	80	.462
85	72.502		V	85	.760	85	.449
			A	90	.756	90	.437
			I	95	.752	95	.426
			L	100	.747	100	.415
			A	105	.743	105	.405
			B	110	.739	110	.395
			L			115	.386
			E			120	.377

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68	.500	-70	-1.334	-100	.07407		D
		-60	-1.944	-80	.05000		A
		-50	-.555	-60	.02594		T
		-40	.835	-40	.00187		A
		-30	.225	-20	.02219		
		-20	.386	0	.04626		N
		-10	.996	20	.07032		O
		0	1.607	40	.09439		T
		10	2.217	60	.11845		
		20	2.827	80	.14252		A
		30	3.438	100	.16658		V
		40	4.048	120	.19065		A
		50	4.658	140	.21471		I
		60	5.269	160	.23878		L
		70	5.879				A
		80	6.489				B
		90	7.100				L
		100	7.710				L
		110	8.321				E
		120	8.931				
		130	9.541				

1,2-DICHLOROETHYLENE

DEL

<p>Common Synonyms</p> <p>Acetylene dichloride Dym-chloroethylene Dichlorom cis-1, 2-dichloroethylene trans-1, 2-dichloroethylene</p>	<p>Liquid</p> <p>Colorless</p> <p>Sweet pleasant odor</p> <p>Sinks in water. Flammable, irritating vapor is produced.</p>	
<p>Wear goggles and self-contained breathing apparatus. Shut off ignition sources. Call fire department. Stop discharge if possible. Keep people away. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>		
Fire	<p>FLAMMABLE. POISONOUS GASES MAY BE PRODUCED IN FIRE. Containers may explode in fire. Flammable, strong vapor trail may occur. Vapor may explode if ignited in an enclosed area. Extinguish with dry chemicals, foam or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.</p>	
Exposure	<p>INHALATION FOR MEDICAL AID</p> <p>VAPOR If inhaled will cause dizziness, nausea, vomiting, or difficult breathing. Move victim to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.</p> <p>LIQUID Harmful if swallowed. If SWALLOWED and victim is CONSCIOUS, have victim drink water or tea.</p>	
Water Pollution	<p>Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water masses. Notify local health and wildlife officials. Notify operators of nearby water masses.</p>	
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook)</p> <p>Issue warning-high flammability Restrict access Evacuate area Should be removed Chemical and physical treatment</p>		<p>2. LABEL</p> <p>2.1 Category: Flammable liquid 2.2 Class: 3</p>
<p>3. CHEMICAL DESIGNATIONS</p> <p>3.1 CG Compatibility Class: Not listed 3.2 Formula: C₂H₂Cl₂ 3.3 HSO/UN Designation: 3.2/1150 3.4 DOT ID No.: 1150 3.5 CAS Registry No.: 540-58-0</p>		<p>4. OBSERVABLE CHARACTERISTICS</p> <p>4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Ethereal, slightly sweet, pleasant, chloroform-like</p>
<p>5. HEALTH HAZARDS</p>		
<p>5.1 Personal Protective Equipment: Rubber gloves, safety goggles, or supply mask or self-contained breathing apparatus. 5.2 Symptoms Following Exposure: Inhalation causes nausea, vomiting, weakness, tremor, epigastric distress, central nervous depression. Contact with liquid causes irritation of eyes and (on prolonged contact) skin. Ingestion causes slight depression to deep narcosis. 5.3 Treatment of Exposure: INHALATION: remove from further exposure; if breathing is difficult, give oxygen; if victim is not breathing, give artificial respiration, preferably mouth-to-mouth; give oxygen when breathing is resumed; call a physician. EYES: flush with water for at least 15 min. SKIN: wash well with soap and water. INGESTION: give gastric lavage and cathartics. 5.4 Threshold Limit Value: 200 ppm PEL 5.5 Short Term Inhalation Limits: Data not available 5.6 Toxicity by Ingestion: Grade 2; oral LD₅₀ = 770 mg/kg (rat) 5.7 Lethal Toxicity: Produces liver and kidney injury in experimental animals 5.8 Vapor (Gas) Irritant Characteristics: Data not available 5.9 Liquid or Solid Irritant Characteristics: Data not available 5.10 Odor Threshold: Data not available 5.11 IDLH Value: 4,000 ppm</p>		

<p>6. FIRE HAZARDS</p> <p>6.1 Flash Point: 37°F C.C. 6.2 Flammable Limits in Air: 9.7%-12.8% 6.3 Fire Extinguishing Agents: Dry chemical, foam, carbon dioxide 6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective. 6.5 Special Hazards of Combustion Products: Phosgene and hydrogen chloride fumes may form in fire. 6.6 Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back. 6.7 Ignition Temperature: 860°F 6.8 Electrical Hazard: Data not available 6.9 Burning Rate: 2.6 mm/min. 6.10 Adiabatic Flame Temperature: Data not available</p> <p style="text-align: right;"><i>(Continued)</i></p>	<p>10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-X-Y</p> <p>11. HAZARD CLASSIFICATIONS</p> <p>11.1 Code of Federal Regulations: Flammable liquid 11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed 11.3 NFPA Hazard Classification: Category Classification Health Hazard (Blue) 2 Flammability (Red) 3 Reactivity (Yellow) 2</p>
<p>7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Metallic: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Will not occur under ordinary conditions of shipment. The reaction is not vigorous. 7.6 Inhibitor of Polymerization: None used 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: Data not available</p>	<p>12. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>12.1 Physical State at 15°C and 1 atm: Liquid 12.2 Molecular Weight: 97.0 12.3 Boiling Point at 1 atm: cis: 140°F = 60°C = 333°K trans: 118°F = 48°C = 321°K 12.4 Freezing Point: cis: -114°F = -81°C = 192°K trans: -56°F = -50°C = 223°K 12.5 Critical Temperature: Not pertinent 12.6 Critical Pressure: Not pertinent 12.7 Specific Gravity: 1.27 at 25°C (liquid) 12.8 Liquid Surface Tension: 24 dynes/cm = 0.024 N/m at 20°C 12.9 Liquid Water Interfacial Tension (est.): 30 dynes/cm = 0.030 N/m at 20°C 12.10 Vapor (Gas) Specific Gravity: 1.34 12.11 Ratio of Specific Heats of Vapor (Gas): 1.1468 12.12 Latent Heat of Vaporization: 130 Btu/lb = 72 cal/g = 3.0 X 10⁵ J/kg 12.13 Heat of Combustion: -847.2 Btu/lb = -2,692.9 cal/g = -112.87 X 10⁴ J/kg 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: Data not available 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: Data not available</p>
<p>8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: Data not available 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): Data not available 8.4 Food Chain Concentration Potential: None</p>	<p>9. SHIPPING INFORMATION</p> <p>9.1 Grades of Purity: Commercial 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Pressure-VACUUM</p>
<p>6. FIRE HAZARDS (Continued)</p>	
<p>6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>	

DEL

1,2-DICHLOROETHYLENE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
35	81.020	35	.193	65	.907	40	.478
40	80.820	40	.196	70	.894	50	.454
45	80.610	45	.198	75	.882	60	.432
50	80.400	50	.200	80	.869	70	.411
55	80.190	55	.202	85	.857	80	.393
60	79.980	60	.204	90	.844	90	.376
65	79.780	65	.207	95	.832	100	.360
70	79.570	70	.209	100	.819	110	.345
75	79.360	75	.211	105	.807	120	.331
80	79.150	80	.213	110	.794	130	.319
85	78.940	85	.216	115	.782	140	.307
90	78.740	90	.218	120	.769	150	.296
95	78.530	95	.220	125	.757	160	.286
100	78.320	100	.222	130	.744	170	.276
105	78.110	105	.224			180	.267
110	77.900	110	.227			190	.259
115	77.690	115	.229			200	.251
120	77.490	120	.231			210	.244
125	77.280	125	.233				
130	77.070	130	.236				
135	76.860	135	.238				
140	76.650	140	.240				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68	.830	55	3.009	55	.05284	0	.150
		60	3.396	60	.05908	20	.153
		65	3.824	65	.06587	40	.158
		70	4.297	70	.07330	60	.159
		75	4.817	75	.08141	80	.162
		80	5.389	80	.09023	100	.165
		85	6.016	85	.09980	120	.167
		90	6.702	90	.11020	140	.170
		95	7.453	95	.12140	160	.173
		100	8.272	100	.13360	180	.176
		105	9.164	105	.14660	200	.179
		110	10.130	110	.16070	220	.182
		115	11.190	115	.17590	240	.185
		120	12.330	120	.19220	260	.188
		125	13.560	125	.20960	280	.191
		130	14.900	130	.22830	300	.194
		135	16.340	135	.24820	320	.197
		140	17.890	140	.26960	340	.200
						360	.203
						380	.205
						400	.208
						420	.211
						440	.214

DICHLOROMETHANE

DCM

<p>Common Synonyms Methylene chloride - Methylene dichloride</p>	<p>Watery liquid Colorless Sweet, pleasant odor</p> <p>Sinks in water. Irritating vapor is produced.</p>
<p>Spill discharge if possible. Avoid contact with liquid and vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>	
Fire	<p>Not flammable. POISONOUS GASES ARE PRODUCED WHEN HEATED. Wear goggles and self-contained breathing apparatus. Cool exposed containers with water.</p>
Exposure	<p>CALL FOR MEDICAL AID</p> <p>VAPOR Irritating to eyes, nose and throat. If inhaled, will cause nausea and dizziness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.</p> <p>LIQUID Irritating to skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.</p>
Water Pollution	<p>Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes.</p> <p>Notify local health and pollution control officials. Notify operators of nearby water intakes.</p>
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Disperse and flush</p>	<p>2. LABEL</p> <p>2.1 Category: None 2.2 Class: Not pertinent</p>
<p>3. CHEMICAL DESIGNATIONS</p> <p>3.1 CG Compatibility Class: Halogenated hydrocarbon 3.2 Formula: CH₂Cl₂ 3.3 IMO/UN Designation: 9.0/1593 3.4 DOT ID No.: 1593 3.5 CAS Registry No.: 75-09-2</p>	<p>4. OBSERVABLE CHARACTERISTICS</p> <p>4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Pleasant, aromatic, like chloroform; sweet, ethereal</p>
<p style="text-align: center;">5. HEALTH HAZARDS</p> <p>5.1 Personal Protective Equipment: Organic vapor canister mask, safety glasses, protective clothing. 5.2 Symptoms Following Exposure: INHALATION: anesthetic effects, nausea and drunkenness. CONTACT WITH SKIN AND EYES: skin irritation, irritation of eyes and nose. 5.3 Treatment of Exposure: INHALATION: remove from exposure. Give oxygen if needed. INGESTION: no specific antidote. CONTACT WITH SKIN AND EYES: remove contaminated clothing; wash skin or eyes if affected. 5.4 Threshold Limit Value: 100 ppm 50 ppm 5.5 Short Term Inhalation Limit: 500 ppm for 30 min. 5.6 Toxicity by Ingestion: Grade 2; LD₅₀ = 0.5 to 5 g/kg 5.7 Late Toxicity: None 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smearing and reddening of the skin. 5.10 Odor Threshold: 205-307 ppm 5.11 TLVH Value: 5,000 ppm</p>	

<p style="text-align: center;">6. FIRE HAZARDS</p> <p>6.1 Flash Point: Not flammable under conditions likely to be encountered. 6.2 Flammable Limits in Air: 12%-19% 6.3 Fire Extinguishing Agents: Not pertinent 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion Products: Decomposition products generated in a fire may be irritating or toxic. 6.6 Behavior in Fire: Not pertinent 6.7 Ignition Temperature: 1184°F 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: Not pertinent 6.10 Adiabatic Flame Temperature: Data not available 6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p> <p style="text-align: center;">7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: 36</p>	<p style="text-align: center;">10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-P-X</p> <p style="text-align: center;">11. HAZARD CLASSIFICATIONS</p> <p>11.1 Code of Federal Regulations: ORM-A 11.2 HAS Hazard Rating for Bulk Water Transportation:</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Category</th> <th style="text-align: right;">Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td style="text-align: right;">1</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>Vapor Irritant</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td style="text-align: right;">1</td> </tr> <tr> <td>Poisons</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>Human Toxicity</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Aquatic Toxicity</td> <td style="text-align: right;">1</td> </tr> <tr> <td>Aesthetic Effect</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>Other Chemicals</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Water</td> <td style="text-align: right;">1</td> </tr> <tr> <td>Self Reaction</td> <td style="text-align: right;">0</td> </tr> </tbody> </table> <p>11.3 NFPA Hazard Classification:</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Category</th> <th style="text-align: right;">Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Flammability (Red)</td> <td style="text-align: right;">0</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td style="text-align: right;">1</td> </tr> </tbody> </table>	Category	Rating	Fire	1	Health		Vapor Irritant	2	Liquid or Solid Irritant	1	Poisons	2	Water Pollution		Human Toxicity	2	Aquatic Toxicity	1	Aesthetic Effect	2	Reactivity		Other Chemicals	2	Water	1	Self Reaction	0	Category	Classification	Health Hazard (Blue)	2	Flammability (Red)	0	Reactivity (Yellow)	1
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<p style="text-align: center;">8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: Not pertinent 8.2 Waterway Toxicity: Not pertinent 8.3 Biological Oxygen Demand (BOD): Not pertinent 8.4 Food Chain Concentration Potential: None</p>	<p style="text-align: center;">12. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>12.1 Physical State at 15°C and 1 atm: Liquid 12.2 Molecular Weight: 84.93 12.3 Boiling Point at 1 atm: 104°F = 39.8°C = 313.0°K 12.4 Freezing Point: -142°F = -96.7°C = 176.5°K 12.5 Critical Temperature: 473°F = 245°C = 518°K 12.6 Critical Pressure: 895 psia = 60.9 atm = 6.17 MN/m² 12.7 Specific Gravity: 1.322 at 20°C (liquid) 12.8 Liquid Surface Tension: Not pertinent 12.9 Liquid Water Interfacial Tension: Not pertinent 12.10 Vapor (Gas) Specific Gravity: 2.9 12.11 Ratio of Specific Heats of Vapor (Gas): 1.199 12.12 Latent Heat of Vaporization: 142 Btu/lb = 78.7 cal/g = 3.30 x 10⁴ J/kg 12.13 Heat of Combustion: Not pertinent 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: 16.89 cal/g 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 13.9 psia</p>
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<p style="text-align: center;">9. SHIPPING INFORMATION</p> <p>9.1 Grades of Purity: Aerosol grade; technical grade 9.2 Storage Temperature: Data not available 9.3 Inert Atmosphere: inerted 9.4 Venting: Data not available</p>	<p style="text-align: center;">NOTES</p>
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DCM

DICHLOROMETHANE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
-70	91.320	35	.274	-110	1.205		N O T
-60	90.700	40	.275	-100	1.192		
-50	90.080	45	.276	-90	1.179		
-40	89.450	50	.277	-80	1.166		
-30	88.830	55	.278	-70	1.154		
-20	88.200	60	.279	-60	1.141		
-10	87.580	65	.279	-50	1.128		
0	86.959	70	.280	-40	1.115		
10	86.330	75	.281	-30	1.102		
20	85.709	80	.282	-20	1.090		
30	85.080	85	.283	-10	1.077		
40	84.459	90	.284	0	1.064		
50	83.830	95	.284	10	1.051		
60	83.209	100	.285	20	1.038		
70	82.589			30	1.025		
80	81.959			40	1.013		
90	81.341			50	1.000		
100	80.709			60	.987		
				70	.974		
				80	.961		

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68.02	1.380	-10	.866	-10	.01525	0	.126
		-5	1.013	-5	.01763	10	.129
		0	1.180	0	.02031	20	.131
		5	1.370	5	.02333	30	.133
		10	1.586	10	.02671	40	.135
		15	1.830	15	.03050	50	.137
		20	2.105	20	.03472	60	.139
		25	2.414	25	.03941	70	.142
		30	2.762	30	.04462	80	.144
		35	3.151	35	.05039	90	.145
		40	3.585	40	.05676	100	.147
		45	4.068	45	.06378	110	.149
		50	4.606	50	.07149	120	.151
		55	5.201	55	.07996	130	.153
		60	5.860	60	.08922	140	.155
		65	6.588	65	.09934	150	.156
		70	7.389	70	.11040	160	.158
		75	8.270	75	.12240	170	.159
		80	9.237	80	.13540	180	.161
		85	10.300	85	.14960	190	.163
						200	.164
						210	.165
						220	.167
						230	.168
						240	.169
						250	.171

ETHYLBENZENE

ETB

<p>Common Synonyms Phenylethane EB</p>		<p>Liquid</p>	<p>Colorless</p>	<p>Sweet, gasoline-like odor</p>
<p>Floats on water. Flammable, irritating vapor is produced.</p>				
<p>Avoid contact with liquid and vapor. Keep people away. Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves). Shut off ignition sources and call fire department. Stop discharge if possible. Stay upwind and use water spray to "knock down" vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>				
<p>Fire</p>		<p>FLAMMABLE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves). Extinguish with dry chemical, foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.</p>		
<p>Exposure</p>		<p>CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled, will cause dizziness or difficult breathing. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Will burn skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.</p>		
<p>Water Pollution</p>		<p>HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. Fouling to shorelines. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>		
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Mechanical containment Should be removed Chemical and physical treatment</p>		<p>2. LABEL 2.1 Category: Flammable liquid 2.2 Class: 3</p>		
<p>3. CHEMICAL DESIGNATIONS 3.1 CG Competibility Class: Aromatic hydrocarbon 3.2 Formula: C₈H₁₀ 3.3 IMO/UN Designator: 3.3/1175 3.4 DOT ID No.: 1175 3.5 CAS Registry No.: 100-41-4</p>		<p>4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Aromatic</p>		
<p>5. HEALTH HAZARDS</p> <p>5.1 Personal Protective Equipment: Self-contained breathing apparatus; safety goggles. 5.2 Symptoms Following Exposure: Inhalation may cause irritation of nose, dizziness, depression. Moderate irritation of eye with corneal injury possible. Irritates skin and may cause blisters. 5.3 Treatment of Exposure: 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 lung may cause chemical pneumonia. SKIN AND EYES: promptly flush with plenty of water (15 min. for eyes) and get medical attention; remove and wash contaminated clothing before reuse. 5.4 Threshold Limit Value: 100 ppm 5.5 Short Term Inhalation Limit: 200 ppm for 30 min. 5.6 Toxicity by Ingestion: Grade 2; LD₅₀ = 0.5 to 5 g/kg (rat) 5.7 Late Toxicity: Data not available 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Causes smearing of the skin and first-degree burns on short exposure; may cause secondary burns on long exposure. 5.10 Odor Threshold: 140 ppm 5.11 IDLH Value: 2,000 ppm</p>				

<p>6. FIRE HAZARDS</p> <p>6.1 Flash Point: 80°F O.C.; 59°F C.C. 6.2 Flammable Limits in Air: 1.0%-6.7% 6.3 Fire Extinguishing Agents: Foam (most effective), water fog, carbon dioxide or dry chemical. 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion: Products: irritating vapors are generated when heated. 6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to the source of ignition and flash back. 6.7 Ignition Temperature: 860°F 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: 5.8 mm/min. 6.10 Adiabatic Flame Temperature: Data Not Available</p> <p style="text-align: right;">(Continued)</p>		<p>10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-T-U</p>																																					
<p>7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Molar Ratio (Reactant to Product): Data Not Available 7.8 Reactivity Group: 32</p>		<p>11. HAZARD CLASSIFICATIONS</p> <p>11.1 Code of Federal Regulations: Flammable liquid 11.2 MAS Hazard Rating for Bulk Water Transportation:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td>3</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>Vapor Irritant</td> <td>2</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td>2</td> </tr> <tr> <td>Poisons</td> <td>2</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>Human Toxicity</td> <td>1</td> </tr> <tr> <td>Aquatic Toxicity</td> <td>3</td> </tr> <tr> <td>Aesthetic Effect</td> <td>2</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>Other Chemicals</td> <td>1</td> </tr> <tr> <td>Water</td> <td>0</td> </tr> <tr> <td>Self Reaction</td> <td>0</td> </tr> </tbody> </table> <p>11.3 NFPA Hazard Classification:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td>2</td> </tr> <tr> <td>Flammability (Red)</td> <td>3</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>0</td> </tr> </tbody> </table>		Category	Rating	Fire	3	Health		Vapor Irritant	2	Liquid or Solid Irritant	2	Poisons	2	Water Pollution		Human Toxicity	1	Aquatic Toxicity	3	Aesthetic Effect	2	Reactivity		Other Chemicals	1	Water	0	Self Reaction	0	Category	Classification	Health Hazard (Blue)	2	Flammability (Red)	3	Reactivity (Yellow)	0
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<p>8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: 29 ppm/96 hr/bluegill/TL₅₀/fresh water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 2.6% (theor.); 5 days 8.4 Food Chain Concentration Potential: None</p>		<p>12. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>12.1 Physical State at 15°C and 1 atm: Liquid 12.2 Molecular Weight: 106.17 12.3 Boiling Point at 1 atm: 277.2°F = 136.2°C = 409.4°K 12.4 Freezing Point: -139°F = -95°C = 178°K 12.5 Critical Temperature: 651.0°F = 343.9°C = 617.1°K 12.6 Critical Pressure: 523 psia = 35.6 atm = 3.61 MN/m² 12.7 Specific Gravity: 0.867 at 20°C (liquid) 12.8 Liquid Surface Tension: 29.2 dynes/cm = 0.0292 N/m at 20°C 12.9 Liquid Water Interfacial Tension: 35.48 dynes/cm = 0.03548 N/m at 20°C 12.10 Vapor (Gas) Specific Gravity: Not pertinent 12.11 Ratio of Specific Heats of Vapor (Gas): 1.071 12.12 Latent Heat of Vaporization: 144 Btu/lb = 80.1 cal/g = 3.35 x 10⁴ J/kg 12.13 Heat of Combustion: -17,780 Btu/lb = -9677 cal/g = -413.5 x 10⁴ J/kg 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: Data Not Available 12.26 Limiting Value: Data Not Available 12.27 Reid Vapor Pressure: 0.4 psia</p>																																					
<p>9. SHIPPING INFORMATION</p> <p>9.1 Grades of Purity: Research grade: 99.96%; pure grade: 99.5%; technical grade: 99.0% 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Open (flame arrester) or pressure-vacuum</p>		<p>6. FIRE HAZARDS (Continued)</p> <p>6.11 Stoichiometric Air to Fuel Ratio: Data Not Available 6.12 Flame Temperature: Data Not Available</p>																																					

ETB

ETHYLBENZENE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
40	54.990	40	.402	-90	1.065	40	.835
50	54.680	50	.404	-80	1.056	50	.774
60	54.370	60	.407	-70	1.047	60	.719
70	54.060	70	.409	-60	1.037	70	.670
80	53.750	80	.412	-50	1.028	80	.626
90	53.430	90	.414	-40	1.018	90	.586
100	53.120	100	.417	-30	1.009	100	.550
110	52.810	110	.419	-20	1.000	110	.518
120	52.500	120	.421	-10	.990	120	.488
130	52.190	130	.424	0	.981	130	.461
140	51.870	140	.426	10	.971	140	.436
150	51.560	150	.429	20	.962	150	.414
160	51.250	160	.431	30	.953	160	.393
170	50.940	170	.434	40	.943	170	.374
180	50.620	180	.436	50	.934	180	.356
190	50.310	190	.439	60	.924	190	.340
200	50.000	200	.441	70	.915	200	.325
210	49.690	210	.443	80	.906	210	.311
				90	.896		
				100	.887		
				110	.877		
				120	.868		
				130	.859		
				140	.849		
				150	.840		
				160	.830		

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68.02	.020	80	.202	80	.00370	-400	-.007
		100	.370	100	.00654	-350	.026
		120	.644	120	.01099	-300	.060
		140	1.071	140	.01767	-250	.093
		160	1.713	160	.02734	-200	.125
		180	2.643	180	.04087	-150	.157
		200	3.953	200	.05926	-100	.187
		220	5.747	220	.08363	-50	.217
		240	8.147	240	.11520	0	.248
		260	11.290	260	.15510	50	.274
		280	15.320	280	.20490	100	.301
		300	20.410	300	.26570	150	.327
		320	26.730	320	.33910	200	.353
		340	34.460	340	.42620	250	.377
		360	43.800	360	.52850	300	.401
		380	54.950	380	.64720	350	.424
						400	.446
						450	.467
						500	.487
						550	.507
						600	.525

FREON 113

A CHRIS data sheet is not available for freon 113; the following information was obtained from the seventh edition of N.I. Sax's and R.J. Lewis's "Dangerous Properties of Industrial Materials" (Published 1989 by Van Nostrand Reinhold)

CAS: 76-13-1
NIOSH: KJ 4000000

PHYSICAL AND CHEMICAL PROPERTIES

Molecular formula: $C_2Cl_3F_3$
Molecular weight: 187.37
Melting point: 13.2°F
Boiling point: 45.8°F
Autoignition: 1256°F
Density: 1.5702
Combustible when exposed to heat or flame.
Incompatable with Al, Ba, Li, NaK alloy, and Ti.

HEALTH HAZARDS

Mildly toxic by ingestion and inhalation. Affects the central nervous system in Humans. A skin irritant.

OSHA PEL: TWA 1000 ppm
ACGIH TLV: TWA 1000 ppm; STEL 1250 ppm

HYDROCHLORIC ACID

HCL

Common Synonyms Muriatic Acid	Watery liquid Sinks and mixes with water. Irritating vapor is produced.	Colorless	Sharp, irritating odor
AVOID CONTACT WITH LIQUID AND VAPOR. Keep people away. Wear chemical protective suit with self-contained breathing apparatus. Stop discharge if possible. Stay upwind and use water spray to "knock down" vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.			
Fire	Not flammable. Flammable gas may be produced on contact with metals. Wear chemical protective suit with self-contained breathing apparatus.		
Exposure	CALL FOR MEDICAL AID VAPOR Irritating to eyes, nose and throat. If inhaled, will cause coughing or difficult breathing. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Will burn skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.		
Water Pollution	Dangerous to aquatic life in high concentrations. May be dangerous if it enters water intakes. Notify local health and welfare officials. Notify operators of nearby water intakes.		
1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Issue warning-corrosive Restrict access Disperse and flush		2. LABEL 2.1 Category: Corrosive 2.2 Class: 8	
3. CHEMICAL DESIGNATIONS 3.1 CG Compatibility Class: Non-oxidizing mineral acid 3.2 Formula: HCl-H ₂ O 3.3 IMO/IUN Designation: 8.0/1789 3.4 DOT ID No.: 1789 3.5 CAS Registry No.: 7647-01-0		4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless to light yellow 4.3 Odor: Pungent, sharp, pungent, irritating	
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Self-contained breathing equipment, air-line mask, or industrial canister-type gas mask; rubber or rubber-coated gloves, apron, coat, overalls, shoes. 5.2 Symptoms Following Exposure: Irritation of larynx results in coughing and choking sensation, and irritation of nose and lungs. Liquid causes burns. 5.3 Treatment of Exposure: INHALATION: remove person to fresh air; keep him warm and quiet and get medical attention immediately; start artificial respiration if breathing stops. INGESTION: have person drink water or milk; do NOT induce vomiting. EYES: immediately flush with plenty of water for at least 15 min. and get medical attention; continue flushing for another 15 min. if physician does not arrive promptly. SKIN: immediately flush skin while removing contaminated clothing; get medical attention promptly; use soap and wash area for at least 15 min. 5.4 Threshold Limit Value: 5 ppm (PEL) 5.5 Short Term Inhalation Limit: 5 ppm for 5 min. 5.6 Toxicity by Ingestion: Data not available 5.7 Late Toxicity: None 5.8 Vapor (Gas) Irritant Characteristics: Vapor is moderately irritating such that personnel will not usually tolerate moderate or high vapor concentrations. 5.9 Liquid or Solid Irritant Characteristics: Fairly severe skin irritant; may cause pain and second-degree burns after a few minutes' contact. 5.10 Odor Threshold: 1-5 ppm 5.11 IDLH Value: 100 ppm			

6. FIRE HAZARDS 6.1 Flash Point: Not flammable 6.2 Flammable Limits in Air: Not flammable 6.3 Fire Extinguishing Agents: Not pertinent 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion: Products: Toxic and irritating vapors are generated when heated. 6.6 Behavior in Fire: Not pertinent 6.7 Ignition Temperature: Not flammable 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: Not flammable 6.10 Adiabatic Flame Temperature: Data not available 6.11 Stochiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available	10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-P																																				
7. CHEMICAL REACTIVITY 7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: Corrosive to 10 metals with evolution of hydrogen gas, which may form explosive mixtures with air. 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Flush with water; apply powdered limestone, slaked lime, soda ash, or sodium bicarbonate. 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Oxidation (Reactant to Product): Data not available 7.8 Reactivity Group: 1	11. HAZARD CLASSIFICATIONS 11.1 Code of Federal Regulations: Corrosive materials 11.2 NAS Hazard Rating for Bulk Water Transportation: <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Category</th> <th style="text-align: center;">Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td style="text-align: right;">0</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>Vapor Irritant</td> <td style="text-align: right;">3</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td style="text-align: right;">3</td> </tr> <tr> <td>Poisons</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>Human Toxicity</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Aquatic Toxicity</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Aesthetic Effect</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>Other Chemicals</td> <td style="text-align: right;">3</td> </tr> <tr> <td>Water</td> <td style="text-align: right;">0</td> </tr> <tr> <td>Self Reaction</td> <td style="text-align: right;">0</td> </tr> </tbody> </table> 11.3 NFPA Hazard Classification: <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Category</th> <th style="text-align: center;">Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td style="text-align: right;">3</td> </tr> <tr> <td>Flammability (Red)</td> <td style="text-align: right;">0</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td style="text-align: right;">0</td> </tr> </tbody> </table>	Category	Rating	Fire	0	Health		Vapor Irritant	3	Liquid or Solid Irritant	3	Poisons	2	Water Pollution		Human Toxicity	2	Aquatic Toxicity	2	Aesthetic Effect	2	Reactivity		Other Chemicals	3	Water	0	Self Reaction	0	Category	Classification	Health Hazard (Blue)	3	Flammability (Red)	0	Reactivity (Yellow)	0
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8. WATER POLLUTION 8.1 Aquatic Toxicity: 282 ppm/96 hr/mosquito 160 TL ₅₀ /fresh water 100-330 ppm/48 hr/shrimp/LC ₅₀ /salt water 8.2 Waterway Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): None 8.4 Food Chain Concentration Potential: None	12. PHYSICAL AND CHEMICAL PROPERTIES 12.1 Physical State at 15°C and 1 atm: Liquid 12.2 Molecular Weight: 36.46 12.3 Boiling Point at 1 atm: 123°F = 50.5°C = 323.8°K 12.4 Freezing Point: Not pertinent 12.5 Critical Temperature: Not pertinent 12.6 Critical Pressure: Not pertinent 12.7 Specific Gravity: 1.19 at 20°C (liquid) 12.8 Liquid Surface Tension: Not pertinent 12.9 Liquid Water Interfacial Tension: Not pertinent 12.10 Vapor (Gas) Specific Gravity: Not pertinent 12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent 12.12 Latent Heat of Vaporization: 178 Btu/lb = 98.6 cal/g = 4.13 X 10 ⁶ J/kg 12.13 Heat of Combustion: Not pertinent 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: -860 Btu/lb = -480 cal/g = -20 X 10 ⁶ J/kg 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: 13.0 cal/g 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 6.0 mm *Physical properties apply to 37 % solution.																																				
9. SHIPPING INFORMATION 9.1 Grades of Purity: Food processing or technical: 18° Be-27.9%, 20 Be-31.5%, 22° Be-35.2%; Reagent, ACS, and USP: 23° Be-37.1% 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Open	NOTES																																				

HCL	HYDROCHLORIC ACID
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12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
40	74.770	35	.417		N O T P E R T I N E N T		N O T P E R T I N E N T
50	74.599	40	.429				
60	74.419	45	.441				
70	74.250	50	.453				
80	74.080	55	.465				
90	73.900	60	.477				
100	73.730	65	.489				
110	73.559	70	.501				
120	73.381	75	.513				
		80	.525				
		85	.537				
		90	.548				
		95	.560				
		100	.572				
		105	.584				
		110	.596				
		115	.608				
		120	.620				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	M I S C I B L E	52	1.844		N O T P E R T I N E N T		N O T P E R T I N E N T
		54	1.970				
		56	2.104				
		58	2.248				
		60	2.396				
		62	2.555				
		64	2.723				
		66	2.901				
		68	3.088				
		70	3.287				
		72	3.496				
		74	3.717				
		76	3.951				
		78	4.197				
		80	4.456				
		82	4.730				
		84	5.018				
		86	5.321				
	88	5.640					
	90	5.975					
	92	6.328					
	94	6.699					
	96	7.089					
	98	7.499					
	100	7.929					
	102	8.380					

METHYL ALCOHOL

MAL

Common Synonyms Methanol Wood alcohol Wood spirit Pyroxylic spirit Columbian spirit Columbian spirit		Watery liquid Colorless Alcohol odor	
Floats and mixes with water. Flammable, irritating vapor is produced.			
Stop discharge if possible. Keep people away. Shut off ignition sources and call fire department. Stay upwind and use water spray to "knock down" vapor. Avoid contact with liquid and vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.			
Fire	<p>FLAMMABLE. Vapor may explode if ignited in an enclosed area. Flashback along vapor trail may occur. Extinguish with dry chemical, alcohol foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.</p>		
Exposure	<p>CALL FOR MEDICAL AID</p> <p>VAPOR Irritating to eyes, nose and throat. If inhaled, will cause dizziness, headache, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.</p> <p>LIQUID POISONOUS IF SWALLOWED. Irritating to skin and eyes. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting. IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.</p>		
Water Pollution	<p>Dangerous to aquatic life in high concentrations. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>		
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Issue warning-high flammability Restrict access Evacuate area Disperse and flush</p>		<p>2. LABEL 2.1 Category: Flammable liquid 2.2 Class: 3</p>	
<p>3. CHEMICAL DESIGNATIONS 3.1 CG Compatibility Class: Alcohol, glycol 3.2 Formula: CH₃OH 3.3 IMO/UN Designation: 3.2/1230 3.4 DOT ID No.: 1230 3.5 CAS Registry No.: 67-56-1</p>		<p>4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Faint alcohol; like ethyl alcohol; faintly sweet; characteristic pungent</p>	
<p>5. HEALTH HAZARDS</p> <p>5.1 Personal Protective Equipment: Supplied Air Respirator (Do not use organic canister mask); goggles, rubber gloves; protective clothing</p> <p>5.2 Symptoms Following Exposure: Exposure to excessive vapor causes eye irritation, head-ache, fatigue and drowsiness. High concentrations can produce central nervous system depression and optic nerve damage. 50,000 ppm will probably cause death in 1 to 2 hrs. Can be absorbed through skin. Swallowing may cause death or eye damage.</p> <p>5.3 Treatment of Exposure: Remove victim from exposure and apply artificial respiration if breathing has ceased. INGESTION: induce vomiting, then give 2 teaspoons of baking soda in glass of water; call a physician. SKIN OR EYES: flush with water for 15 min.</p> <p>5.4 Threshold Limit Value: 200 ppm</p> <p>5.5 Short Term Inhalation Limits: 260 mg/m³ for 60 min.</p> <p>5.6 Toxicity by Ingestion: Grade 1; LD₅₀ = 5 to 15 g/kg (rat)</p> <p>5.7 Late Toxicity: None</p> <p>5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.</p> <p>5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.</p> <p>5.10 Odor Threshold: 100 ppm</p> <p>5.11 IDLH Value: 25,000 ppm</p>			

<p>6. FIRE HAZARDS</p> <p>6.1 Flash Point: 54°F C.C.; 61°F O.C. 6.2 Flammable Limits in Air: 6.0%-36.5% 6.3 Fire Extinguishing Agents: Alcohol foam, dry chemical, or carbon dioxide 6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective. 6.5 Special Hazards of Combustion Products: Not pertinent 6.6 Behavior in Fire: Containers may explode. 6.7 Ignition Temperature: 867°F 6.8 Electrical Hazard: Class I, Group D 6.9 Burning Rate: 1.7 mm/min. 6.10 Adiabatic Flame Temperature: Data not available 6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>		<p>10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-P-Q-R-S</p>	
<p>7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: 20</p>		<p>11. HAZARD CLASSIFICATIONS</p> <p>11.1 Code of Federal Regulations: Flammable liquid</p> <p>11.2 NAS Hazard Rating for Bulk Water Transportation: Category Rating Fire 3 Health Vapor Irritant 1 Liquid or Solid Irritant 1 Poisons 2 Water Pollution Human Toxicity 1 Aquatic Toxicity 1 Aesthetic Effect 1 Reactivity Other Chemicals 2 Water 0 Self Reaction 0</p> <p>11.3 NFPA Hazard Classification: Category Classification Health Hazard (Blue) 1 Flammability (Red) 3 Reactivity (Yellow) 0</p>	
<p>8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: 250 ppm/11 hr/goldfish/died/fresh water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 0.6 to 1.12 lb/lb in 5 days 8.4 Food Chain Concentration Potential: None</p>		<p>12. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>12.1 Physical State at 15°C and 1 atm: Liquid 12.2 Molecular Weight: 32.04 12.3 Boiling Point at 1 atm: 148.1°F = 64.5°C = 337.7°K 12.4 Freezing Point: -144.0°F = -97.8°C = 175.4°K 12.5 Critical Temperature: 464°F = 240°C = 513°K 12.6 Critical Pressure: 1142.0 psia = 77.7 atm = 7.87 MN/m² 12.7 Specific Gravity: 0.792 at 20°C (liquid) 12.8 Liquid Surface Tension: Not pertinent 12.9 Liquid Water Interfacial Tension: Not pertinent 12.10 Vapor (Gas) Specific Gravity: 1.1 12.11 Ratio of Specific Heats of Vapor (Gas): 1.254 12.12 Latent Heat of Vaporization: 473.0 Btu/lb = 262.6 cal/g = 11.00 X 10⁴ J/kg 12.13 Heat of Combustion: -8419 Btu/lb = -4677 cal/g = -195.8 X 10⁴ J/kg 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution (est.): -9 Btu/lb = -5 cal/g = -0.2 X 10⁴ J/kg 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: 23.70 cal/g 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 4.5 psia</p>	
<p>9. SHIPPING INFORMATION</p> <p>9.1 Grades of Purity: CP, Crude, ACS: at 99.9% 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Open (flame arrester) or pressure-vacuum</p>			
<p>NOTES</p>			

MAL

METHYL ALCOHOL

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
15	51.110	60	.576	65	1.389		N O T P E R T I N E N T
20	50.950	70	.593	70	1.384		
25	50.790	80	.611	75	1.379		
30	50.630	90	.629	80	1.374		
35	50.470	100	.647	85	1.369		
40	50.310	110	.665	90	1.364		
45	50.150	120	.682	95	1.360		
50	49.990	130	.700	100	1.355		
55	49.830	140	.718	105	1.350		
60	49.670			110	1.345		
65	49.510			115	1.340		
70	49.350			120	1.335		
75	49.190			125	1.330		
80	49.030			130	1.325		
85	48.870						
90	48.710						
95	48.550						
100	48.390						

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	M	20	.377	20	.00235	0	.280
	I	30	.537	30	.00327	25	.289
	S	40	.753	40	.00450	50	.299
	C	50	1.044	50	.00611	75	.309
	I	60	1.428	60	.00820	100	.319
	B	70	1.930	70	.01087	125	.328
	L	80	2.579	80	.01427	150	.338
	E	90	3.412	90	.01852	175	.348
		100	4.467	100	.02383	200	.359
		110	5.795	110	.03036	225	.369
		120	7.450	120	.03836	250	.379
		130	9.496	130	.04807	275	.390
		140	12.010	140	.05976	300	.400
		150	15.070	150	.07376	325	.411
		160	18.770	160	.09039	350	.422
		170	23.210	170	.11000	375	.432
						400	.443
						425	.454
						450	.466
						475	.477
						500	.488
						525	.500
						550	.511
						575	.523
						600	.534

METHYL ETHYL KETONE



MEK

Common Synonyms MEK 2-Butanone Ethyl methyl ketone	Liquid Colorless Sweet odor
Floats and mixes with water. Flammable, irritating vapor is produced.	

Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to "knock down" vapor.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire	<p>FLAMMABLE Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Extinguish with dry chemical, alcohol foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.</p>
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Exposure	<p>CALL FOR MEDICAL AID.</p> <p>VAPOR Irritating to eyes, nose and throat. If inhaled, will cause nausea, vomiting, headache, dizziness, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.</p> <p>LIQUID Will burn eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES: hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.</p>
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Water Pollution	<p>Dangerous to aquatic life in high concentrations. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>
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<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Issue warning-high flammability Disperse and flush</p>	<p>2. LABEL 2.1 Category: Flammable liquid 2.2 Class: 3</p>
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<p>3. CHEMICAL DESIGNATIONS</p> <p>3.1 CG Compatibility Class: Ketone 3.2 Formula: $CH_3COCH_2CH_3$ 3.3 IMO/UN Designation: 3.2/1193 3.4 DOT ID No.: 1193 3.5 CAS Registry No.: 78-93-3</p>	<p>4. OBSERVABLE CHARACTERISTICS</p> <p>4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Like acetone; pleasant; pungent</p>
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<p>5. HEALTH HAZARDS</p> <p>5.1 Personal Protective Equipment: Organic canister or air pack; plastic gloves; goggles or face shield. 5.2 Symptoms Following Exposure: Liquid causes eye burn. Vapor irritates eyes, nose, and throat; can cause headache, dizziness, nausea, weakness, and loss of consciousness. 5.3 Treatment of Exposure: INHALATION: remove victim to fresh air; if breathing is irregular or has stopped, start resuscitation and administer oxygen. EYES: wash with plenty of water for at least 15 min. and call physician. 5.4 Threshold Limit Value: 200 ppm 5.5 Short Term Inhalation Limits: 290 mg/m³ for 60 min. 5.6 Toxicity by Ingestion: Grade 2; LD₅₀ = 0.5 to 5 g/kg (rat) 5.7 Late Toxicity: None 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin. 5.10 Odor Threshold: 10 ppm 5.11 IDLH Value: Data not available</p>
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<p>6. FIRE HAZARDS</p> <p>6.1 Flash Point: 20°F C.C.; 22°F O.C. 6.2 Flammable Limits in Air: 1.8%-11.5% 6.3 Fire Extinguishing Agents: Alcohol foam, dry chemical, or carbon dioxide 6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective 6.5 Special Hazards of Combustion Products: Not pertinent 6.6 Behavior in Fire: Not pertinent 6.7 Ignition Temperature: 981°F 6.8 Electrical Hazard: Class I, Group D 6.9 Burning Rate: 4.1 mm/min. 6.10 Adiabatic Flame Temperature: Data not available 6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>
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<p>7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: 18</p>

<p>8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: 5640 mg/l/48 hr/bluegill/TL₅₀/fresh water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 214%, 5 days 8.4 Food Chain Concentration Potential: None</p>

<p>9. SHIPPING INFORMATION</p> <p>9.1 Grade of Purity: 99.5+ % 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Open (flame arrester) or pressure-vacuum</p>

<p>10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-P-Q-R-S</p>

<p>11. HAZARD CLASSIFICATIONS</p> <p>11.1 Code of Federal Regulations: Flammable liquid 11.2 NFPA Hazard Rating for Bulk Water Transportation:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td>3</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>Vapor Irritant</td> <td>1</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td>1</td> </tr> <tr> <td>Poisons</td> <td>2</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>Human Toxicity</td> <td>2</td> </tr> <tr> <td>Aquatic Toxicity</td> <td>1</td> </tr> <tr> <td>Aesthetic Effect</td> <td>1</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>Other Chemicals</td> <td>2</td> </tr> <tr> <td>Water</td> <td>0</td> </tr> <tr> <td>Self Reaction</td> <td>0</td> </tr> </tbody> </table> <p>11.3 NFPA Hazard Classification:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td>1</td> </tr> <tr> <td>Flammability (Red)</td> <td>3</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>0</td> </tr> </tbody> </table>	Category	Rating	Fire	3	Health		Vapor Irritant	1	Liquid or Solid Irritant	1	Poisons	2	Water Pollution		Human Toxicity	2	Aquatic Toxicity	1	Aesthetic Effect	1	Reactivity		Other Chemicals	2	Water	0	Self Reaction	0	Category	Classification	Health Hazard (Blue)	1	Flammability (Red)	3	Reactivity (Yellow)	0
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<p>12. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>12.1 Physical State at 15°C and 1 atm: Liquid 12.2 Molecular Weight: 72.11 12.3 Boiling Point at 1 atm: 175.3°F = 79.6°C = 352.8°K 12.4 Freezing Point: -123.3°F = -86.3°C = 188.9°K 12.5 Critical Temperature: 504.5°F = 262.5°C = 535.7°K 12.6 Critical Pressure: 603 psia = 41.0 atm = 4.15 MN/m² 12.7 Specific Gravity: 0.806 at 20°C (liquid) 12.8 Liquid Surface Tension: Not pertinent 12.9 Liquid Water Interfacial Tension: Not pertinent 12.10 Vapor (Gas) Specific Gravity: 2.5 12.11 Ratio of Specific Heats of Vapor (Gas): 1.075 12.12 Latent Heat of Vaporization: 191 Btu/lb = 106 cal/g = 4.44 X 10⁴ J/kg 12.13 Heat of Combustion: -13,480 Btu/lb = -7491 cal/g = -313.6 X 10⁴ J/kg 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution (est.): -9 Btu/lb = -5 cal/g = -0.2 X 10⁴ J/kg 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: Data not available 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 3.5 psia</p>
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NOTES

MEK

METHYL ETHYL KETONE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
35	51.460	-35	.501	10	1.073		N O T P E R T I N E N T
40	51.280	-30	.502	15	1.068		
45	51.110	-25	.503	20	1.063		
50	50.940	-20	.504	25	1.058		
55	50.760	-15	.505	30	1.053		
60	50.590	-10	.507	35	1.048		
65	50.420	-5	.508	40	1.043		
70	50.240	0	.509	45	1.038		
75	50.070	5	.510	50	1.033		
80	49.900	10	.511	55	1.028		
85	49.720	15	.512	60	1.023		
90	49.550	20	.513	65	1.018		
95	49.380	25	.514	70	1.013		
100	49.200	30	.516	75	1.008		
105	49.030	35	.517	80	1.003		
110	48.860	40	.518	85	.998		
115	48.680	45	.519	90	.993		
120	48.510	50	.520	95	.988		
		55	.521	100	.983		
		60	.522	105	.978		
		65	.523				
		70	.524				
		75	.526				
		80	.527				
		85	.528				
		90	.529				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68.02	27.000	0	.148	0	.00216	0	.352
		10	.216	10	.00310	25	.368
		20	.310	20	.00435	50	.384
		30	.437	30	.00599	75	.399
		40	.604	40	.00812	100	.414
		50	.823	50	.01085	125	.429
		60	1.104	60	.01427	150	.444
		70	1.461	70	.01853	175	.458
		80	1.909	80	.02376	200	.472
		90	2.465	90	.03012	225	.486
		100	3.147	100	.03778	250	.500
		110	3.977	110	.04690	275	.513
		120	4.977	120	.05768	300	.526
		130	6.171	130	.07030	325	.538
		140	7.586	140	.08498	350	.551
		150	9.250	150	.10190	375	.563
		160	11.190	160	.12130	400	.575
		170	13.450	170	.14350	425	.586
		180	16.050	180	.16850	450	.598
		190	19.030	190	.19670	475	.609
		200	22.420	200	.22830	500	.620
		210	26.270	210	.26350	525	.630
		220	30.610	220	.30250	550	.640
		230	35.480	230	.34560	575	.650
		240	40.930	240	.39290	600	.660

METHYL CHLORIDE

MTC

Common Synonyms Chloromethane Arlic		Gas Colorless Odorless or sweet odor
Floats and boils on water. Flammable, visible vapor cloud is formed.		
Avoid contact with liquid and vapor. Keep people away. Wear goggles and self-contained breathing apparatus. Stop discharge if possible. Shut off ignition sources and call fire department. Stay upwind and use water spray to "knock down" vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.		
Fire	FLAMMABLE. POISONOUS GASES ARE PRODUCED IN FIRE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Wear goggles and self-contained breathing apparatus. Stop discharge if possible. Cool exposed containers and protect men effecting shutoff with water. Let fire burn.	
Exposure	CALL FOR MEDICAL AID. VAPOR Not irritating to eyes, nose or throat. If inhaled, will cause nausea, vomiting, headache, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Will cause frostbite. Flush affected areas with plenty of water. DO NOT RUB AFFECTED AREAS.	
Water Pollution	Not harmful to aquatic life.	
1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Issue warning-high flammability, air contaminant Restrict access Evacuate area		2. LABEL 2.1 Category: Flammable gas 2.2 Class: 2
3. CHEMICAL DESIGNATIONS 3.1 CG Compatibility Class: Halogenated hydrocarbon 3.2 Formula: CH ₂ Cl 3.3 IMO/UN Designation: 2.0/1063 3.4 DOT ID No.: 1063 3.5 CAS Registry No.: 74-87-3		4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquefied gas 4.2 Color: Colorless 4.3 Odor: Faint, sweet, non-irritating; faint ether-like
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Approved canister mask; leather or vinyl gloves; goggles or face shield. 5.2 Symptoms Following Exposure: Inhalation causes nausea, vomiting, weakness, headache, emotional disturbances; high concentrations cause mental confusion, eye disturbances, muscular tremors, cyanosis, convulsions. Contact of liquid with skin may cause frostbite. 5.3 Treatment of Exposure: Remove to fresh air. Call a doctor and have patient hospitalized for observation of slowly developing symptoms. 5.4 Threshold Limit Value: 50 ppm 5.5 Short Term Inhalation Limits: 100 ppm for 5 min. 5.6 Toxicity by Ingestion: Not pertinent 5.7 Late Toxicity: None 5.8 Vapor (Gas) Irritant Characteristics: Vapors are nonirritating to the eyes and throat. 5.9 Liquid or Solid Irritant Characteristics: No appreciable hazard. Practically harmless to the skin because it evaporates quickly. May cause frostbite. 5.10 Odor Threshold: Data not available 5.11 IDLH Value: 10,000 ppm		

6. FIRE HAZARDS 6.1 Flash Point: <32°F C.C. 6.2 Flammable Limits in Air: 8.1%-17.2% 6.3 Fire Extinguishing Agents: Dry chemical or carbon dioxide. Stop flow of gas. 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion Products: Toxic and irritating gases are generated in fires. 6.6 Behavior in Fire: Containers may explode 6.7 Ignition Temperature: 1170°F 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: 2.2 mm/min. 6.10 Adiabatic Flame Temperature: Data not available 6.11 Stoichiometric Air to Fuel Ratio: 4.078 (Est.) 6.12 Flame Temperature: Data not available	10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-B-C-D-E-F-G																																				
7. CHEMICAL REACTIVITY 7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: Reacts with zinc, aluminum, magnesium, and their alloys; reaction is not violent. 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: 36	11. HAZARD CLASSIFICATIONS 11.1 Code of Federal Regulations: Flammable gas 11.2 NAS Hazard Rating for Bulk Water Transportation: <table border="1"> <thead> <tr> <th>Category</th> <th>Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td>4</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>Vapor Irritant</td> <td>0</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td>0</td> </tr> <tr> <td>Poisons</td> <td>2</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>Human Toxicity</td> <td>0</td> </tr> <tr> <td>Aquatic Toxicity</td> <td>1</td> </tr> <tr> <td>Aesthetic Effect</td> <td>0</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>Other Chemicals</td> <td>1</td> </tr> <tr> <td>Water</td> <td>0</td> </tr> <tr> <td>Self Reaction</td> <td>0</td> </tr> </tbody> </table> 11.3 NFPA Hazard Classification: <table border="1"> <thead> <tr> <th>Category</th> <th>Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td>2</td> </tr> <tr> <td>Flammability (Red)</td> <td>4</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>0</td> </tr> </tbody> </table>	Category	Rating	Fire	4	Health		Vapor Irritant	0	Liquid or Solid Irritant	0	Poisons	2	Water Pollution		Human Toxicity	0	Aquatic Toxicity	1	Aesthetic Effect	0	Reactivity		Other Chemicals	1	Water	0	Self Reaction	0	Category	Classification	Health Hazard (Blue)	2	Flammability (Red)	4	Reactivity (Yellow)	0
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8. WATER POLLUTION 8.1 Aquatic Toxicity: None 8.2 Waterfowl Toxicity: None 8.3 Biological Oxygen Demand (BOD): None 8.4 Food Chain Concentration Potential: None	12. PHYSICAL AND CHEMICAL PROPERTIES 12.1 Physical State at 15°C and 1 atm: Gas 12.2 Molecular Weight: 50.49 12.3 Boiling Point at 1 atm: -11.6°F = -24.2°C = 249°K 12.4 Freezing Point: -143.9°F = 97.7°C = 175.5°K 12.5 Critical Temperature: 290.5°F = 143.6°C = 416.8°K 12.6 Critical Pressure: 969 psia = 65.9 atm = 6.68 MN/m ² 12.7 Specific Gravity: 0.997 at -24°C (liquid) 12.8 Liquid Surface Tension: 16.2 dynes/cm = 0.0162 N/m at 20°C 12.9 Liquid Water Interfacial Tension: (est.) 50 dynes/cm = 0.05 N/m at -24°C 12.10 Vapor (Gas) Specific Gravity: 1.7 12.11 Ratio of Specific Heats of Vapor (Gas): 1.259 12.12 Latent Heat of Vaporization: 182.3 Btu/lb = 101.3 cal/g = 4.241 X 10 ⁴ J/kg 12.13 Heat of Combustion: -5290 Btu/lb = -2939 cal/g = -123.1 X 10 ⁴ J/kg 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: Data not available 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 116.7 psia																																				
9. SHIPPING INFORMATION 9.1 Grades of Purity: Technical grade; "Arlic" refrigerant grade 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Safety relief	NOTES																																				

MTC

METHYL CHLORIDE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
-20	62.170	-50	.354		D A T A N O T A V A I L A B L E	-30	.332
-15	61.860	-40	.357			-20	.320
		-30	.359				
		-20	.362				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68.02	.600	-55	4.590	-55	.05335	0	.177
		-50	5.298	-50	.06083	25	.182
		-45	6.095	-45	.06913	50	.187
		-40	6.987	-40	.07831	75	.192
		-35	7.985	-35	.08843	100	.197
		-30	9.096	-30	.09957	125	.202
		-25	10.330	-25	.11180	150	.207
		-20	11.700	-20*	.12520	175	.212
		-15	13.210	-15	.13980	200	.217
		-10	14.880	-10	.15570	225	.221
		-5	16.720	-5	.17300	250	.226
		0	18.730	0	.19170	275	.231
		5	20.940	5	.21200	300	.236
		10	23.350	10	.23390	325	.240
		15	25.980	15	.25740	350	.245
		20	28.840	20	.28280	375	.249
		25	31.950	25	.31000	400	.254
		30	35.320	30	.33920	425	.258
		35	38.960	35	.37040	450	.263
		40	42.890	40	.40380	475	.267
45	47.140	45	.43930	500	.272		
50	51.700	50	.47720	525	.276		
55	56.610	55	.51740	550	.281		
60	61.880	60	.56000	575	.285		
65	67.520	65	.60530	600	.289		

NITRIC ACID

NAC

<p>Common Synonyms</p>	<p>Wettest liquid</p> <p>Colorless to light brown</p> <p>Choking odor</p> <p>Sinks and mixes with water. Harmful vapor is produced.</p>		
<p>AVOID CONTACT WITH LIQUID AND VAPOR Keep people away. Wear chemical protective suit with self-contained breathing apparatus. Stop discharge if possible. Isolate and remove discharged materials. Notify local health and pollution control agencies.</p>			
<p>Fire</p>	<p>Not flammable. May cause fire on contact with combustibles. Flammable gas may be formed on contact with metals. Poisonous gases are produced when heated. Wear chemical protective suit with self-contained breathing apparatus. Cool exposed containers with water.</p>		
<p>Exposure</p>	<p>CALL FOR MEDICAL AID.</p> <p>VAPOR Will burn eyes, nose and throat. If inhaled, will cause difficult breathing or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.</p> <p>LIQUID Will burn skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.</p>		
<p>Water Pollution</p>	<p>HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>		
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Issue warning-corrosive Restrict access Evacuate area Disperse and flush</p>		<p>2. LABEL</p> <p>2.1 Category: Oxidizer; Corrosive 2.2 Class: 5 & 6</p>	
<p>3. CHEMICAL DESIGNATIONS</p> <p>3.1 CG Compatibility Class: Nitric acid 3.2 Formula: HNO₃-H₂O 3.3 IMO/UN Designation: 8.0/2031 3.4 DOT ID No.: 2031 3.5 CAS Registry No.: 7887-37-2</p>		<p>4. OBSERVABLE CHARACTERISTICS</p> <p>4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Acid; sweet to acid</p>	
<p>5. HEALTH HAZARDS</p>			
<p>5.1 Personal Protective Equipment: Air mask; rubber acid suit, hood, boots and gloves; chemical goggles; safety shower and eye bath. 5.2 Symptoms Following Exposure: Vapors irritate eyes and respiratory tract; lung injury may not become apparent for several hours following exposure. Liquid may cause severe burns to eyes and skin. 5.3 Treatment of Exposure: INHALATION: remove to fresh air, administer artificial respiration if required. INGESTION: drink large volumes of water; do NOT induce vomiting. SKIN OR EYES: flush with water for at least 15 min. 5.4 Threshold Limit Values: 2 ppm 5.5 Short Term Inhalation Limit: 14 ppm (4 ppm) PEL 4 ppm 5.6 Toxicity by Ingestion: Grade 3; LD₅₀ = 50 to 500 mg/kg 5.7 Lethal Toxicity: None 5.8 Vapor (Gas) Irritant Characteristics: 58-68%: Vapor is moderately irritating such that personnel will not usually tolerate moderate or high vapor concentrations. 85%: Vapors cause severe irritation of eye and throat and can cause eye and lung injury. They cannot be tolerated even at low concentrations. 5.9 Liquid or Solid Irritant Characteristics: Severe skin irritant. Causes second and third-degree burns on short contact and is very injurious to the eyes. 5.10 Other Thresholds: Data not available 5.11 IDLH Value: 100 ppm</p>			

<p>6. FIRE HAZARDS</p> <p>6.1 Flash Point: Not flammable 6.2 Flammable Limits in Air: Not flammable 6.3 Fire Extinguishing Agents: Use water on adjacent fires. 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion: Products: May give off poisonous oxides of nitrogen and acid fumes when heated in fires. 6.6 Behavior in Fire: Decomposes and gives off poisonous oxides of nitrogen. 6.7 Ignition Temperature: Not flammable 6.8 Elevated Temperature: Not pertinent 6.9 Burning Rate: Not pertinent 6.10 Adiabatic Flame Temperature: Data not available</p> <p style="text-align: right;">(Continued)</p>	<p>10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-P</p>																																				
<p>7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity With Water: May heat up on mixing, but explosion or formation of steam unlikely. 7.2 Reactivity with Common Materials: Very corrosive to wood, paper, cloth and most metals. Toxic red oxides of nitrogen are formed. 7.3 Stability During Transport: When heated may give off toxic red oxides of nitrogen. 7.4 Neutralizing Agents for Acids and Caustics: Flush with water 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Molecular Reactant to Products: Data not available 7.8 Reactivity Group: 3</p>	<p>11. HAZARD CLASSIFICATIONS</p> <p>11.1 Code of Federal Regulations: Oxidizer 11.2 NAB Hazard Rating for Bulk Water Transportation:</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Category</th> <th style="text-align: center;">Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td style="text-align: center;">0</td> </tr> <tr> <td>Health</td> <td style="text-align: center;">0</td> </tr> <tr> <td>Vapor Irritant</td> <td style="text-align: center;">3</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td style="text-align: center;">4</td> </tr> <tr> <td>Poison</td> <td style="text-align: center;">3</td> </tr> <tr> <td>Water Pollution</td> <td style="text-align: center;">3</td> </tr> <tr> <td>Human Toxicity</td> <td style="text-align: center;">3</td> </tr> <tr> <td>Aquatic Toxicity</td> <td style="text-align: center;">3</td> </tr> <tr> <td>Aesthetic Effect</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Reactivity</td> <td style="text-align: center;">0</td> </tr> <tr> <td>Other Chemical</td> <td style="text-align: center;">4</td> </tr> <tr> <td>Water</td> <td style="text-align: center;">0</td> </tr> <tr> <td>Self Reaction</td> <td style="text-align: center;">0</td> </tr> </tbody> </table> <p>11.3 NFPA Hazard Classification:</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Category</th> <th style="text-align: center;">Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td style="text-align: center;">3</td> </tr> <tr> <td>Flammability (Red)</td> <td style="text-align: center;">0</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td style="text-align: center;">0</td> </tr> </tbody> </table>	Category	Rating	Fire	0	Health	0	Vapor Irritant	3	Liquid or Solid Irritant	4	Poison	3	Water Pollution	3	Human Toxicity	3	Aquatic Toxicity	3	Aesthetic Effect	2	Reactivity	0	Other Chemical	4	Water	0	Self Reaction	0	Category	Classification	Health Hazard (Blue)	3	Flammability (Red)	0	Reactivity (Yellow)	0
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Reactivity (Yellow)	0																																				
<p>8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: 72 ppm/96 hr/mosquito fish/TL₅₀/fresh water 330-1000 ppm/48 hr/codfish/LC₅₀/salt water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): None 8.4 Fecal Chain Concentration Potential: None</p>	<p>12. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>12.1 Physical State at 15°C and 1 atm: Liquid 12.2 Molecular Weight: Not pertinent 12.3 Boiling Point at 1 atm: 182.0°F = 88.9°C = 362.1°K 12.4 Freezing Point: -50°F = -45.6°C = 227.8°K 12.5 Critical Temperature: Not pertinent 12.6 Critical Pressure: Not pertinent 12.7 Specific Gravity: 1.48 at 20°C (liquid) 12.8 Liquid Surface Tension: Not pertinent 12.9 Liquid Water Interfacial Tension: Not pertinent 12.10 Vapor (Gas) Specific Gravity: Not pertinent 12.11 Ratio of Specific Heats of Vapor (Gas) (est.): 1.248 12.12 Latent Heat of Vaporization: 214 Btu/lb = 119 cal/g = 4.98 X 10⁵ J/kg 12.13 Heat of Combustion: Not pertinent 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: -205 Btu/lb = -114 cal/g = -4.76 X 10⁵ J/kg 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: Data not available 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 1.9 psia</p>																																				
<p>9. SHIPPING INFORMATION</p> <p>9.1 Grades of Purity: Various grades: 52-68% 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Open or pressure-relief</p>	<p>6. FIRE HAZARDS (Continued)</p> <p>6.11 Spontaneous Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>																																				

NAC	NITRIC ACID
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12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
35	95.139	51	.470		N		N
40	94.830	52	.471		O		O
45	94.520	53	.472		T		T
50	94.209	54	.472				
55	93.910	55	.473		P		P
60	93.599	56	.473		E		E
65	93.290	57	.474		R		R
70	92.990	58	.474		T		T
75	92.679	59	.475		I		I
80	92.370	60	.475		N		N
85	92.070	61	.476		E		E
90	91.759	62	.477		N		N
95	91.450	63	.477		T		T
		64	.478				
		65	.478				
		66	.479				
		67	.479				
		68	.480				
		69	.480				
		70	.481				
		71	.482				
		72	.482				
		73	.483				
		74	.483				
		75	.484				
		76	.484				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	M	80	1.291	80	.01404	0	.206
	I	85	1.489	85	.01605	10	.209
	S	90	1.713	90	.01829	20	.213
	C	95	1.964	95	.02078	30	.216
	I	100	2.246	100	.02355	40	.219
	B	105	2.560	105	.02662	50	.223
	L	110	2.912	110	.03000	60	.226
	E	115	3.303	115	.03374	70	.229
		120	3.737	120	.03784	80	.232
		125	4.218	125	.04235	90	.236
		130	4.750	130	.04728	100	.239
		135	5.336	135	.05267	110	.242
		140	5.981	140	.05855	120	.246
		145	6.690	145	.06494	130	.249
		150	7.467	150	.07189	140	.252
		155	8.317	155	.07943	150	.255
		160	9.246	160	.08758	160	.259
		165	10.260	165	.09640	170	.262
		170	11.360	170	.10590	180	.265
		175	12.560	175	.11610	190	.269
		180	13.860	180	.12720	200	.272
						210	.275
						220	.278
						230	.282
						240	.285
						250	.288

PHENOL

PHN

<p>Common Synonyms Hydroxybenzene Carbolic acid Phenic acid Phenyl hydroxide</p>	<p>Solid crystals, or watery liquid</p> <p>White solid, or light pink liquid</p> <p>Sweet tarry odor</p> <p>May float or sink, and mixes slowly with water.</p>	
<p>AVOID CONTACT WITH LIQUID AND SOLID. Keep people away. Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves). Stop discharge if possible. Call fire department. Evacuate area in case of large discharge. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>		
Fire	<p>Combustible. POISONOUS GASES ARE PRODUCED IN FIRE. Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves). Extinguish with water, carbon dioxide, dry chemical, or foam. Cool exposed containers with water.</p>	
Exposure	<p>CALL FOR MEDICAL AID.</p> <p>LIQUID OR SOLID POISONOUS IF SWALLOWED. Will burn skin and eyes. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.</p>	
Water Pollution	<p>HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>	
1. RESPONSE TO DISCHARGE <i>(See Response Methods Handbook)</i>	2. LABEL	
<p>Issue warning-poison Restrict access Should be removed Chemical and physical treatment</p>	<p>2.1 Category: Poison 2.2 Class: 6</p>	
3. CHEMICAL DESIGNATIONS	4. OBSERVABLE CHARACTERISTICS	
<p>3.1 CG Compatibility Class: Phenol, cresol 3.2 Formula: C₆H₅OH 3.3 IMO/UN Designation: 9.0/1671 3.4 DOT ID No.: 1671 3.5 CAS Registry No.: 108-95-2</p>	<p>4.1 Physical State (as shipped): Solid or molten liquid 4.2 Color: Colorless to light pink 4.3 Odor: Characteristically sweet, sweet, tarry; pungent, distinctive; distinct, aromatic, somewhat sickening sweet and acid</p>	
5. HEALTH HAZARDS		
<p>5.1 Personal Protective Equipment: Fresh-air mask for confined areas; rubber gloves; protective clothing; full face shield. 5.2 Symptoms Following Exposure: Will burn eyes and skin. The analgesic action may cause loss of pain sensation. Readily absorbed through skin, causing increase in heart rate, convulsions, and death. 5.3 Treatment of Exposure: INHALATION: if victim shows any ill effects, move him to fresh air, keep him quiet and warm, and call a doctor immediately; if breathing stops, give artificial respiration. INGESTION: do NOT induce vomiting; give milk, egg whites, or large amounts of water and call doctor immediately; no known antidote; treat the symptoms. EYES: immediately flush with plenty of water for at least 15 min.; continue for another 15 min. if doctor has not taken over. SKIN: immediately remove all clothing while in a shower and wash affected area with abundant flowing water or soap and water for at least 15 min.; clean clothing thoroughly or discard. 5.4 Threshold Limit Value: 5 ppm (includes skin exposure). 5.5 Short Term Inhalation Limits: Data not available 5.6 Toxicity by Ingestion: Grade 2; LD₅₀ = 0.5 to 5 g/kg (rat) 5.7 Late Toxicity: Carcinogenic in laboratory animals 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Fairly severe skin irritant; may cause pain and second-degree burns after a few minutes' contact. 5.10 Odor Threshold: 0.05 ppm 5.11 IDLH Value: 100 ppm</p>		

<p>6. FIRE HAZARDS</p> <p>6.1 Flash Point: 185°F O.C.; 175°F C.C. 6.2 Flammable Limits in Air: 1.7%-8.6% 6.3 Fire Extinguishing Agents: Water fog, foam, carbon dioxide, or dry chemical 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion Products: Toxic and irritating vapors are generated when heated. 6.6 Behavior in Fire: Yields flammable vapors when heated which will form explosive mixtures with air. 6.7 Ignition Temperature: 1319°F 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: 3.5 mm/min. 6.10 Adiabatic Flame Temperature: Data not available</p> <p style="text-align: right;"><i>(Continued)</i></p>	<p>10. HAZARD ASSESSMENT CODE <i>(See Hazard Assessment Handbook)</i> A-P-Q</p> <p>11. HAZARD CLASSIFICATIONS</p> <p>11.1 Code of Federal Regulations: Poison, B</p> <p>11.2 NAS Hazard Rating for Bulk Water Transportation:</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Category</th> <th style="text-align: left;">Rating</th> </tr> </thead> <tbody> <tr> <td>Fire.....</td> <td>1</td> </tr> <tr> <td>Health.....</td> <td></td> </tr> <tr> <td>Vapor Irritant.....</td> <td>2</td> </tr> <tr> <td>Liquid or Solid Irritant.....</td> <td>3</td> </tr> <tr> <td>Poisons.....</td> <td>3</td> </tr> <tr> <td>Water Pollution.....</td> <td></td> </tr> <tr> <td>Human Toxicity.....</td> <td>2</td> </tr> <tr> <td>Aquatic Toxicity.....</td> <td>3</td> </tr> <tr> <td>Aesthetic Effect.....</td> <td>3</td> </tr> <tr> <td>Reactivity.....</td> <td></td> </tr> <tr> <td>Other Chemicals.....</td> <td>2</td> </tr> <tr> <td>Water.....</td> <td>0</td> </tr> <tr> <td>Self Reaction.....</td> <td>0</td> </tr> </tbody> </table> <p>11.3 NFPA Hazard Classification:</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Category</th> <th style="text-align: left;">Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue).....</td> <td>3</td> </tr> <tr> <td>Flammability (Red).....</td> <td>2</td> </tr> <tr> <td>Reactivity (Yellow).....</td> <td>0</td> </tr> </tbody> </table>	Category	Rating	Fire.....	1	Health.....		Vapor Irritant.....	2	Liquid or Solid Irritant.....	3	Poisons.....	3	Water Pollution.....		Human Toxicity.....	2	Aquatic Toxicity.....	3	Aesthetic Effect.....	3	Reactivity.....		Other Chemicals.....	2	Water.....	0	Self Reaction.....	0	Category	Classification	Health Hazard (Blue).....	3	Flammability (Red).....	2	Reactivity (Yellow).....	0
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Reactivity (Yellow).....	0																																				
<p>7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: 21</p>	<p>12. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>12.1 Physical State at 15°C and 1 atm: Solid or liquid 12.2 Molecular Weight: 94.11 12.3 Boiling Point at 1 atm: 359.2°F = 181.8°C = 455.0°K 12.4 Freezing Point: 105.6°F = 40.9°C = 314.1°K 12.5 Critical Temperature: 790.0°F = 421.1°C = 694.3°K 12.6 Critical Pressure: 889 psia = 60.5 atm = 6.13 MN/m² 12.7 Specific Gravity: 1.058 at 41°C (liquid) 12.8 Liquid Surface Tension: 36.5 dynes/cm = 0.0365 N/m at 55°C 12.9 Liquid Water Interfacial Tension: (est.) 20 dynes/cm = 0.02 N/m at 42°C 12.10 Vapor (Gas) Specific Gravity: Not pertinent 12.11 Ratio of Specific Heats of Vapor (Gas): 1.089 12.12 Latent Heat of Vaporization: 130 Btu/lb = 72 cal/g = 3.0 X 10³ J/kg 12.13 Heat of Combustion: -13,400 Btu/lb = -7,445 cal/g = -311.7 X 10³ J/kg 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: Data not available 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 0.3 psia</p>																																				
<p>8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: 11.5-28.5 mg/l/96 hr/bluegill/TL₅₀/fresh water 1.5 ppm/48 hr/rainbow trout/TL₅₀/fresh water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 200%, 5 days 8.4 Food Chain Concentration Potential: None</p>	<p>9. SHIPPING INFORMATION</p> <p>9.1 Grades of Purity: 90-99% (solid), 60-85% (liquid). Technical: 82-92% (contains cresols) 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Pressure-vacuum</p>																																				
6. FIRE HAZARDS (Continued)																																					
<p>6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>																																					

PHN	PHENOL
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12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F (estimate)	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
110	65.870	108	.561	122.02	1.113	110	4.302
115	65.719	109	.561			115	3.929
120	65.559	110	.561			120	3.594
125	65.410	111	.561			125	3.292
130	65.250	112	.561			130	3.021
135	65.099	113	.561			135	2.775
140	64.940	114	.561			140	2.554
145	64.790	115	.561			145	2.353
150	64.629	116	.561			150	2.171
155	64.469	117	.561			155	2.005
160	64.309	118	.561			160	1.855
165	64.160	119	.561			165	1.718
170	64.000	120	.561			170	1.593
175	63.840	121	.561			175	1.479
180	63.670	122	.561				
185	63.510	123	.561				
190	63.350	124	.561				
195	63.190	125	.561				
200	63.020	126	.561				
205	62.860	127	.561				
210	62.690	128	.561				
		129	.561				
		130	.561				
		131	.561				
		132	.561				
		133	.561				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68.02	8.400	70	.012	70	.00019	0	.224
		80	.017	80	.00027	25	.237
		90	.024	90	.00039	50	.250
		100	.034	100	.00054	75	.262
		110	.048	110	.00074	100	.274
		120	.066	120	.00100	125	.286
		130	.091	130	.00135	150	.297
		140	.123	140	.00180	175	.309
		150	.165	150	.00238	200	.319
		160	.220	160	.00311	225	.330
		170	.289	170	.00403	250	.341
		180	.378	180	.00518	275	.351
		190	.490	190	.00661	300	.360
		200	.629	200	.00836	325	.370
		210	.802	210	.01050	350	.379
		220	1.016	220	.01311	375	.388
		230	1.278	230	.01624	400	.397
		240	1.596	240	.02000	425	.405
		250	1.982	250	.02449	450	.414
		260	2.446	260	.02980	475	.422
		270	3.002	270	.03607	500	.429
		280	3.663	280	.04342	525	.436
		290	4.446	290	.05200	550	.444
		300	5.370	300	.06197	575	.450
		310	6.453	310	.07350	600	.457
		320	7.718	320	.08679		

SODIUM

SDU

Common Synonyms	Soft solid under kerosene	Silver to grayish-white	Odorless
	Floats and reacts violently with water. Flammable gas is produced.		
<p>AVOID CONTACT WITH SOLID. Keep people away. Call fire department. Wear goggles, and rubber overclothing (including gloves). Notify local health and pollution control agencies.</p>			
Fire	<p>FLAMMABLE. FIRE MAY START ON CONTACT WITH AIR. Flammable gas formed on contact with water or moisture. Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves). DO NOT USE WATER, CARBON DIOXIDE, OR VAPORIZING LIQUIDS. Extinguish with dry graphite, soda ash, powdered sodium chloride or other approved dry powder.</p>		
Exposure	<p>CALL FOR MEDICAL AID. SOLID Will burn skin and eyes. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water.</p>		
Water Pollution	<p>Dangerous to aquatic life in high concentrations. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>		
1. RESPONSE TO DISCHARGE (See Response Methods Handbook)		2. LABEL	
Issue warning-high flammability Restrict access Evacuate area Chemical and physical treatment		2.1 Category: Flammable solid; dangerous when wet 2.2 Class: 4	
3. CHEMICAL DESIGNATIONS		4. OBSERVABLE CHARACTERISTICS	
3.1 CG Compatibility Class: Not listed 3.2 Formula: Na 3.3 IMO/UN Designation: 4.3/1428 3.4 DOT ID No.: 1428 3.5 CAS Registry No.: 7440-23-5		4.1 Physical State (as shipped): Soft solid or liquid 4.2 Color: Silvery white, changing to gray on exposure to air 4.3 Odor: Odorless	
5. HEALTH HAZARDS			
5.1 Personal Protective Equipment: Maximum protective clothing; goggles and face shield. 5.2 Symptoms Following Exposure: Severe burns caused by burning metal or by caustic soda formed by reaction with moisture on skin. 5.3 Treatment of Exposure: SKIN: brush off any metal, then flood with water for at least 15 min.; treat as heat or caustic burn; call a doctor. 5.4 Threshold Limit Value: Data not available 5.5 Short Term Inhalation Limits: Not pertinent 5.6 Toxicity by Ingestion: Not pertinent 5.7 Late Toxicity: None 5.8 Vapor (Gas) Irritant Characteristics: Non-volatile 5.9 Liquid or Solid Irritant Characteristics: Severe skin irritant. Causes second- and third-degree burns on short contact and is very injurious to the eyes. 5.10 Odor Threshold: Not pertinent 5.11 IDLH Value: Data not available			

<p style="text-align: center;">6. FIRE HAZARDS</p> <p>6.1 Flash Point: Not pertinent 6.2 Flammable Limits in Air: Not pertinent 6.3 Fire Extinguishing Agents: Dry soda ash, graphite, salt, or other approved dry powder such as dry limestone. 6.4 Fire Extinguishing Agents Not to be Used: Water, carbon dioxide or halogenated extinguishing agents. 6.5 Special Hazards of Combustion Products: Fumes of burning Na are highly irritating to skin, eyes, and mucous membranes. 6.6 Behavior in Fire: Not pertinent 6.7 Ignition Temperature: 250°F 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: Not pertinent 6.10 Adiabatic Flame Temperature: Data not available</p> <p style="text-align: right;"><i>(Continued)</i></p> <p style="text-align: center;">7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity With Water: Reacts violently, with formation of flammable hydrogen gas and caustic soda solution. A fire often occurs. 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: After reaction with water, caustic soda formed can be diluted with water and/or neutralized with acetic acid. 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: Data not available</p> <p style="text-align: center;">8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: Not pertinent 8.2 Waterfowl Toxicity: Not pertinent 8.3 Biological Oxygen Demand (BOD): None 8.4 Food Chain Concentration Potential: None</p> <p style="text-align: center;">9. SHIPPING INFORMATION</p> <p>9.1 Grades of Purity: Commercial grade: 99.95% 9.2 Storage Temperature: 230°—250°F (liquid); ambient (solid) 9.3 Inert Atmosphere: Dry nitrogen or argon (for liquid); under kerosene (for solid) 9.4 Venting: Pressure-vacuum</p> <p style="text-align: center;">6. FIRE HAZARDS (Continued)</p> <p>6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>	<p style="text-align: center;">10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) RR-C</p> <p style="text-align: center;">11. HAZARD CLASSIFICATIONS</p> <p>11.1 Code of Federal Regulations: Flammable solid 11.2 MAS Hazard Rating for Bulk Water Transportation: Not listed 11.3 NFPA Hazard Classification:</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Category</th> <th style="text-align: left;">Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue).....</td> <td>3</td> </tr> <tr> <td>Flammability (Red).....</td> <td>1</td> </tr> <tr> <td>Reactivity (Yellow).....</td> <td>2</td> </tr> <tr> <td></td> <td style="text-align: right;">3</td> </tr> </tbody> </table> <p style="text-align: center;">12. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>12.1 Physical State at 15°C and 1 atm: Solid 12.2 Molecular Weight: 22.49 12.3 Boiling Point at 1 atm: 1621°F = 883°C = 1156°K 12.4 Freezing Point: 207.5°F = 97.5°C = 370.7°K 12.5 Critical Temperature: 3632°F = 2000°C = 2273°K 12.6 Critical Pressure: 5040 psia = 343 atm = 34.8 MN/m² 12.7 Specific Gravity: 0.971 at 20°C (solid) 12.8 Liquid Surface Tension: Not pertinent 12.9 Liquid Water Interfacial Tension: Not pertinent 12.10 Vapor (Gas) Specific Gravity: Not pertinent 12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent 12.12 Latent Heat of Vaporization: Not pertinent 12.13 Heat of Combustion: Not pertinent 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: 27.4 cal/g 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: Data not available</p>	Category	Classification	Health Hazard (Blue).....	3	Flammability (Red).....	1	Reactivity (Yellow).....	2		3
Category	Classification										
Health Hazard (Blue).....	3										
Flammability (Red).....	1										
Reactivity (Yellow).....	2										
	3										

SDU

SODIUM

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
	N O T P E R T I N E N T		N O T P E R T I N E N T		N O T P E R T I N E N T		N O T P E R T I N E N T

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	R E A C T S		N O T P E R T I N E N T		N O T P E R T I N E N T		N O T P E R T I N E N T

SODIUM HYDROXIDE

SHD

<p>Common Synonyms</p> <p>Caustic soda Lye</p>		<p>Solid flakes or pellets White</p> <p>Odorless</p> <p>Sinks and mixes with water.</p>		<p>6. FIRE HAZARDS</p> <p>6.1 Flash Point: Not flammable 6.2 Flammable Limits in Air: Not flammable 6.3 Fire Extinguishing Agents: Not pertinent 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion Products: Not pertinent 6.6 Behavior in Fire: Not pertinent 6.7 Ignition Temperature: Not flammable 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: Not flammable 6.10 Autoxidative Flame Temperature: Data not available 6.11 Self-heating Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>		<p>10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook)</p> <p style="text-align: center;">SS</p>	
<p>Avoid contact with solid and dust. Keep people away. Wear rubber overclothing (including gloves). Stop discharge if possible. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>				<p>11. HAZARD CLASSIFICATIONS</p> <p>11.1 Code of Federal Regulations: Corrosive material</p> <p>11.2 NAB Hazard Rating for Bulk Water Transporters: Not listed</p> <p>11.3 NFPA Hazard Classification: Category _____ Classification _____ Health Hazard (Blue) _____ 3 Flammability (Red) _____ 0 Reactivity (Yellow) _____ 1</p>			
<p>Fire</p> <p>Not flammable. May cause fire on contact with combustibles. Flammable gas may be produced on contact with metals. Wear rubber overclothing (including gloves). Stop discharge area with water. Cool exposed containers with water.</p>		<p>7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity With Water: Dissolves with liberation of much heat; may steam and spatter 7.2 Reactivity with Common Materials: When wet, attacks metals such as aluminum, tin, lead, and zinc to produce flammable hydrogen gas. 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Flush with water, treat with dilute acetic acid 7.5 Polymerizations: Not pertinent 7.6 Inhibitor of Polymerizations: Not pertinent 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: Data not available</p>					
<p>Exposure</p> <p>CALL FOR MEDICAL AID</p> <p>DUST Irritating to eyes, nose and throat. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. If IN EYES, hold eyelids open and flush with plenty of water.</p> <p>SOLID Will burn skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. If IN EYES, hold eyelids open and flush with plenty of water. If SWALLOWED and victim is CONSCIOUS, have victim drink water. DO NOT INDUCE VOMITING.</p>		<p>8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: 125 ppm/96 hr/mosquito fish/TL₅₀/fish 180 ppm/24 hr/oysters/lethal/salt water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): None 8.4 Food Chain Concentration Potential: None</p>					
<p>Water Pollution</p> <p>Dangerous to aquatic life in high concentrations. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>		<p>12. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>12.1 Physical State at 15°C and 1 atm: Solid 12.2 Molecular Weight: 40.00 12.3 Boiling Point at 1 atm: Very high 12.4 Freezing Point: 604°F = 318°C = 581°K 12.5 Critical Temperature: Not pertinent 12.6 Critical Pressure: Not pertinent 12.7 Specific Gravity: 2.13 at 20°C (solid) 12.8 Liquid Surface Tension: Not pertinent 12.9 Liquid Water Intercal Tension: Not pertinent 12.10 Vapor (Gas) Specific Gravity: Not pertinent 12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent 12.12 Latent Heat of Vaporization: Not pertinent 12.13 Heat of Combustion: Not pertinent 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: 50.0 cal/g 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: Data not available</p>					
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook)</p> <p>Issue warning-corrosive Restrict access Disperse and flush</p>		<p>2. LABEL</p> <p>2.1 Category: Corrosive 2.2 Class: 8</p>		<p>3. CHEMICAL DESIGNATIONS</p> <p>3.1 CG Compatibility Class: Not listed 3.2 Formula: NaOH 3.3 IMO/UN Designations: 8.0/1823 3.4 DOT ID No.: 1823 3.5 CAS Registry No.: 1310-73-2</p>		<p>4. OBSERVABLE CHARACTERISTICS</p> <p>4.1 Physical State (as shipped): Solid 4.2 Color: White 4.3 Odor: Odorless</p>	
<p>5. HEALTH HAZARDS</p> <p>5.1 Personal Protective Equipment: Chemical safety goggles; face shield; filter or dust-type respirator; rubber boots; rubber gloves. 5.2 Symptoms Following Exposure: Strong corrosive action on contacted tissues. INHALATION: dust may cause damage to upper respiratory tract and lung itself, producing from mild nose irritation to pneumonitis. INGESTION: severe damage to mucous membranes; severe scar formation or perforation may occur. EYE CONTACT: produces severe damage. 5.3 Treatment of Exposure: INHALATION: remove from exposure; support respiratory call physician. INGESTION: give water or milk followed by dilute vinegar or fruit juice; do NOT induce vomiting. SKIN: wash immediately with large quantities of water under emergency safety shower while removing clothing; continue washing until medical help arrives; call physician. EYES: irrigate immediately with copious amounts of water for at least 15 min.; call physician. 5.4 Threshold Limit Value: 2 mg/m³ (PEL) 5.5 Short Term Inhalation Limits: Not pertinent 5.6 Toxicity by Ingestion (10% solution) oral rabbit LD₅₀ = 500 mg/kg 5.7 Lethal Toxicity: None 5.8 Vapor (Gas) Irritant Characteristics: Non-volatile 5.9 Liquid or Solid Irritant Characteristics: Severe skin irritant. Causes second- and third-degree burns on short contact and is very injurious to the eyes. 5.10 Odor Threshold: Not pertinent 5.11 IDLH Value: 200 mg/m³</p>				<p>9. SHIPPING INFORMATION</p> <p>9.1 Grades of Purity: Technical flakes; USP pellets 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Open</p>			
<p>NOTES</p>							

SHD

SODIUM HYDROXIDE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
	N O T P E R T I N E N T		N O T P E R T I N E N T		N O T P E R T I N E N T		N O T P E R T I N E N T

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
34	44.810		N O T P E R T I N E N T		N O T P E R T I N E N T		N O T P E R T I N E N T
36	47.660						
38	50.500						
40	53.350						
42	56.190						
44	59.040						
46	61.880						
48	64.719						
50	67.570						
52	70.410						
54	73.259						
56	76.099						
58	78.950						
60	81.790						
62	84.639						
64	87.480						
66	90.320						
68	93.169						
70	96.009						
72	98.860						
74	101.700						
76	104.500						
78	107.400						
80	110.200						
82	113.099						
84	115.900						

SULFURIC ACID

SFA

Common Synonyms Oil of vitrol Battery acid Fertilizer acid Chamber acid		Oily liquid Colorless Odorless
Sinks and mixes violently with water. Irritating mist is produced.		
AVOID CONTACT WITH LIQUID. Keep people away. Wear goggles, self-contained breathing apparatus, and rubber overclothing. Stop discharge if possible. Isolate and remove discharged material. Notify local health and pollution control agencies.		
Fire	Not flammable. May cause fire on contact with combustibles. Flammable gas may be produced on contact with metals. POISONOUS GAS MAY BE PRODUCED IN FIRE. Wear goggles, self-contained breathing apparatus, and rubber overclothing. DO NOT USE WATER ON ADJACENT FIRES. Extinguish with dry chemical or carbon dioxide.	
Exposure	CALL FOR MEDICAL AID MIST Irritating to eyes, nose and throat. If inhaled, will cause coughing, difficult breathing, or loss of consciousness. Move to fresh air. IF IN EYES: hold eyelids open and flush with plenty of water if breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Will burn skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES: hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS: have victim drink water or milk. DO NOT INDUCE VOMITING.	
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.	
1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Issue warning-corrosive Restrict access Disperse and flush with care		2. LABEL 2.1 Category: Corrosive 2.2 Class: 8
3. CHEMICAL DESIGNATIONS 3.1 CG Compatibility Class: Sulfuric acid 3.2 Formula: H ₂ SO ₄ 3.3 IMO/UN Designation: 8.0/1830 3.4 DOT ID No.: 1830 3.5 CAS Registry No.: 7664-93-9		4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless (pure) to dark brown 4.3 Odor: Odorless unless hot, then choking
5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Safety shower; eyewash fountain; safety goggles; face shield; approved respirator (self-contained or air-line); rubber safety shoes; rubber apron. 5.2 Symptoms Following Exposure: Inhalation of vapor from hot, concentrated acid may injure lungs. Swallowing may cause severe injury or death. Contact with skin or eyes causes severe burns. 5.3 Treatment of Exposure: Call a doctor. INHALATION: observe victim for delayed pulmonary reaction. INGESTION: have victim drink water if possible; do NOT induce vomiting. EYES AND SKIN: wash with large amounts of water for at least 15 min.; do not use oils or ointments in eyes; treat skin burns. 5.4 Threshold Limit Value: 1 mg/m ³ 5.5 Short Term Inhalation Limits: 10 mg/m ³ for 5 min.; 5 mg/m ³ for 10 min.; 2 mg/m ³ for 30 min.; 1 mg/m ³ for 60 min. 5.6 Toxicity by Ingestion: No effects except those secondary to tissue damage. 5.7 Late Toxicity: None 5.8 Vapor (Gas) Irritant Characteristics: Vapors from hot acid (77-98%) cause moderate irritation of eyes and respiratory system. Effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: 77-98% acid causes severe second- and third-degree burns of skin on short contact and is very injurious to the eyes. 5.10 Odor Threshold: Greater than 1 mg/m ³ 5.11 IDLH Value: 80 mg/m ³		

6. FIRE HAZARDS 6.1 Flash Point: Not flammable 6.2 Flammable Limits in Air: Not flammable 6.3 Fire Extinguishing Agents: Not pertinent 6.4 Fire Extinguishing Agents Not to be Used: Water used on adjacent fires should be carefully handled. 6.5 Special Hazards of Combustion Products: Not pertinent 6.6 Behavior in Fire: Not flammable 6.7 Ignition Temperature: Not flammable 6.8 Electrical Hazard: None 6.9 Burning Rate: Not flammable 6.10 Adiabatic Flame Temperature: Data not available 6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available	10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-P-O																																				
7. CHEMICAL REACTIVITY 7.1 Reactivity With Water: Reacts violently with evolution of heat. Spattering occurs when water is added to the compound. 7.2 Reactivity with Common Materials: Extremely hazardous in contact with many materials, particularly metals and combustibles. Dilute acid reacts with most metals, releasing hydrogen which can form explosive mixtures with air in confined spaces. 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Dilute with water, then neutralize with lime, limestone, or soda ash. 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent	11. HAZARD CLASSIFICATIONS 11.1 Code of Federal Regulations: Corrosive material 11.2 MAS Hazard Rating for Bulk Water Transportation: <table border="1"> <thead> <tr> <th>Category</th> <th>Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td>0</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>Vapor Irritant</td> <td>2</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td>4</td> </tr> <tr> <td>Poisons</td> <td>2</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>Human Toxicity</td> <td>2</td> </tr> <tr> <td>Aquatic Toxicity</td> <td>3</td> </tr> <tr> <td>Aesthetic Effect</td> <td>2</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>Other Chemicals</td> <td>4</td> </tr> <tr> <td>Water</td> <td>3</td> </tr> <tr> <td>Self Reaction</td> <td>0</td> </tr> </tbody> </table> 11.3 NFPA Hazard Classification: <table border="1"> <thead> <tr> <th>Category</th> <th>Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td>3</td> </tr> <tr> <td>Flammability (Red)</td> <td>0</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>2</td> </tr> </tbody> </table>	Category	Rating	Fire	0	Health		Vapor Irritant	2	Liquid or Solid Irritant	4	Poisons	2	Water Pollution		Human Toxicity	2	Aquatic Toxicity	3	Aesthetic Effect	2	Reactivity		Other Chemicals	4	Water	3	Self Reaction	0	Category	Classification	Health Hazard (Blue)	3	Flammability (Red)	0	Reactivity (Yellow)	2
Category	Rating																																				
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8. WATER POLLUTION 8.1 Aquatic Toxicity: 24.5 ppm/24 hr/bluegill/lethal/fresh water 42.5 ppm/48 hr/prawn/LC ₅₀ /salt water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): None 8.4 Food Chain Concentration Potential: None	12. PHYSICAL AND CHEMICAL PROPERTIES 12.1 Physical State at 15°C and 1 atm: Liquid 12.2 Molecular Weight: 98.08 12.3 Boiling Point at 1 atm: 644°F = 340°C = 613°K 12.4 Freezing Point: Not pertinent 12.5 Critical Temperature: Not pertinent 12.6 Critical Pressure: Not pertinent 12.7 Specific Gravity: 1.84 at 20°C (liquid) 12.8 Liquid Surface Tension: Not pertinent 12.9 Liquid Water Interfacial Tension: Not pertinent 12.10 Vapor (Gas) Specific Gravity: Not pertinent 12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent 12.12 Latent Heat of Vaporization: Not pertinent 12.13 Heat of Combustion: Not pertinent 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: -418.0 Btu/lb = -232.2 cal/g = -9.715 X 10 ³ J/kg 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: Data not available 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: Low *Physical properties apply to concentrated (98%) acid unless otherwise stated. More dilute acid is more water-like.																																				
9. SHIPPING INFORMATION 9.1 Grades of Purity: CP; USP; Technical, at 33% to 98% (50° Be to 66° Be). 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Open	7. CHEMICAL REACTIVITY (Continued) 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: 2																																				

SFA

SULFURIC ACID

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
35	115.400	35	.330		N O T P E R T I N E N T		N O T P E R T I N E N T
40	115.200	40	.331				
45	115.000	45	.331				
50	114.900	50	.332				
55	114.700	55	.333				
60	114.500	60	.333				
65	114.299	65	.334				
70	114.200	70	.334				
75	114.000	75	.335				
80	113.799	80	.335				
85	113.599	85	.336				
90	113.500	90	.336				
95	113.299	95	.337				
100	113.099	100	.338				
105	112.900	105	.338				
110	112.799	110	.339				
115	112.599	115	.339				
120	112.400	120	.340				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	M I S C I B L E		N O T P E R T I N E N T		N O T P E R T I N E N T		N O T P E R T I N E N T

TTE

TETRACHLOROETHYLENE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
35	103.400	0	.198		N O T P E R T I N E N T	55	.958
40	103.099	10	.200			60	.929
45	102.900	20	.201			65	.900
50	102.599	30	.202			70	.873
55	102.299	40	.203			75	.848
60	102.000	50	.204			80	.823
65	101.700	60	.205			85	.800
70	101.400	70	.206			90	.777
75	101.099	80	.207			95	.756
80	100.799	90	.208			100	.736
85	100.500	100	.210			105	.716
90	100.200	110	.211			110	.698
95	99.910	120	.212			115	.680
100	99.610	130	.213			120	.663
105	99.320	140	.214			125	.647
110	99.020	150	.215			130	.631
115	98.730	160	.216			135	.616
120	98.429	170	.217		140	.601	
125	98.139	180	.218		145	.588	
130	97.839	190	.220		150	.574	
135	97.549	200	.221		155	.561	
140	97.250	210	.222		160	.549	
145	96.959				165	.537	
150	96.669				170	.526	
155	96.370				175	.515	
160	96.080						

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68.02	.016	60	.236	60	.00702	0	.108
		70	.318	70	.00929	25	.110
		80	.425	80	.01216	50	.113
		90	.561	90	.01575	75	.116
		100	.732	100	.02022	100	.118
		110	.948	110	.02571	125	.120
		120	1.217	120	.03242	150	.122
		130	1.548	130	.04055	175	.125
		140	1.953	140	.05032	200	.127
		150	2.446	150	.06199	225	.129
		160	3.042	160	.07583	250	.131
		170	3.756	170	.09215	275	.132
		180	4.607	180	.11130	300	.134
		190	5.616	190	.13360	325	.136
		200	6.805	200	.15940	350	.138
		210	8.199	210	.18910	375	.139
		220	9.824	220	.22330	400	.141
		230	11.710	230	.26230	425	.142
		240	13.890	240	.30660	450	.143
		250	16.390	250	.35680	475	.144
		260	19.260	260	.41330	500	.146
		270	22.520	270	.47680	525	.147
		280	26.230	280	.54790	550	.148
						575	.148
						600	.149

TETRACHLOROETHYLENE

TTE

<p>Common Synonyms</p> <p>Tetracap Perclene Perchloroethylene Perk</p>	<p>Watery liquid Colorless Sweet odor</p> <p>Sinks in water. Irritating vapor is produced.</p>	
<p>Stop discharge if possible. Avoid contact with liquid and vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>		
Fire	<p>Not flammable. Poisonous gases are produced when heated.</p>	
Exposure	<p>CALL FOR MEDICAL AID.</p> <p>VAPOR Irritating to eyes, nose and throat. If inhaled, will cause difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.</p> <p>LIQUID Irritating to skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.</p>	
Water Pollution	<p>Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>	
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Should be removed Chemical and physical treatment</p>		<p>2. LABEL</p> <p>2.1 Category: None 2.2 Class: Not pertinent</p>
<p>3. CHEMICAL DESIGNATIONS</p> <p>3.1 CG Compatibility Class: Not listed 3.2 Formula: C₂Cl₄ 3.3 IMO/UN Designation: 9.0/1897 3.4 DOT ID No.: 1897 3.5 CAS Registry No.: 127-18-4</p>		<p>4. OBSERVABLE CHARACTERISTICS</p> <p>4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Ethereal; like chloroform; mildly sweet</p>
<p style="text-align: center;">5. HEALTH HAZARDS</p> <p>5.1 Personal Protective Equipment: For high vapor concentrations use approved canister or air-supplied mask; chemical goggles or face shield; plastic gloves.</p> <p>5.2 Symptoms Following Exposure: Vapor can affect central nervous system and cause anesthesia. Liquid may irritate skin after prolonged contact. May irritate eyes but causes no injury.</p> <p>5.3 Treatment of Exposure: INHALATION: if illness occurs, remove patient to fresh air, keep him warm and quiet, and get medical attention. INGESTION: induce vomiting only on physician's recommendation. EYES AND SKIN: flush with plenty of water and get medical attention if irritation or injury occurs.</p> <p>5.4 Threshold Limit Value: 50 ppm</p> <p>5.5 Short Term Inhalation Limits: 100 ppm for 60 min.</p> <p>5.6 Toxicity by Ingestion: Grade 2; LD₅₀ = 0.5 to 5 g/kg</p> <p>5.7 Late Toxicity: None</p> <p>5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or throat if present in high concentrations. The effect is temporary.</p> <p>5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.</p> <p>5.10 Odor Threshold: 5 ppm</p> <p>5.11 IDLH Value: 500 ppm</p>		

6. FIRE HAZARDS

6.1 Flash Point: Not flammable
6.2 Flammable Limits in Air: Not flammable
6.3 Fire Extinguishing Agents: Not pertinent
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion: Products: Toxic, irritating gases may be generated in fires.
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: Not flammable
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Not flammable
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity: Data not available
8.2 Waterway Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): None
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Dry cleaning and industrial grades: 95+ %
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE
(See Hazard Assessment Handbook)
A-X

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-A
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire.....	0
Health	
Vapor Irritant.....	1
Liquid or Solid Irritant.....	1
Poisons.....	2
Water Pollution	
Human Toxicity.....	1
Aquatic Toxicity.....	3
Aesthetic Effect.....	2
Reactivity	
Other Chemicals.....	1
Water.....	0
Self Reaction.....	1

11.3 NFPA Hazard Classification: Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 165.83
12.3 Boiling Point at 1 atm: 250°F = 121°C = 394°K
12.4 Freezing Point: -8.3°F = -22.4°C = 250.8°K
12.5 Critical Temperature: 657°F = 347°C = 620°K
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.63 at 20°C (liquid)
12.8 Liquid Surface Tension: 31.3 dynes/cm = 0.0313 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 44.4 dynes/cm = 0.0444 N/m at 25°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.116
12.12 Latent Heat of Vaporization: 90.2 Btu/lb = 50.1 cal/g = 2.10 X 10⁴ J/kg
12.13 Heat of Combustion: Not pertinent
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

NOTES

TOLUENE

TOL

<p>Common Synonyms Toluol Methylbenzene Mesitylbenzol</p>		<p>Heavy liquid Colorless Pleasant odor</p>
<p>Floats on water. Flammable, emitting vapor is produced.</p>		
<p>Stop discharge if possible. Keep people away. Shut off ignition sources and call fire department. Stay upwind and use water spray to "knock down" vapor. Avoid contact with liquid and vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>		
<p>Fire</p>	<p>FLAMMABLE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Wear goggles and self-contained breathing apparatus. Extinguish with dry chemical, foam, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.</p>	
<p>Exposure</p>	<p>CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled, will cause nausea, vomiting, headache, dizziness, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing difficult, give oxygen. LIQUID Irritating to skin and eyes. If inhaled, will cause nausea, vomiting or loss of consciousness. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water or milk. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.</p>	
<p>Water Pollution</p>	<p>Dangerous to aquatic life in high concentrations. Fouling to shoreline. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>	
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Issue warning-high flammability Evacuate area</p>		<p>2. LABEL 2.1 Category: Flammable liquid 2.2 Class: 3</p>
<p>3. CHEMICAL DESIGNATIONS 3.1 CG Compatibility Class: Aromatic hydrocarbon 3.2 Formula: C₇H₈ 3.3 IMO/UN Designation: 3.2/1294 3.4 DOT ID No.: 1294 3.5 CAS Registry No.: 108-88-3</p>		<p>4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Pungent aromatic, benzene-like; distinct, pleasant</p>
<p>5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Air-supplied mask; goggles or face shield; plastic gloves. 5.2 Symptoms Following Exposure: Vapors irritate eyes and upper respiratory tract; causes dizziness, headache, anesthesia, respiratory arrest. Liquid irritates eyes and causes drying of skin. If absorbed, causes coughing, gagging, dizziness, and rapidly developing pulmonary edema. If ingested causes vomiting, gnawing, diarrhea, decreased respiration. 5.3 Treatment of Exposure: 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. 5.4 Threshold Limit Value: 100 ppm 5.5 Short Term Inhalation Limits: 600 ppm for 30 min. 5.6 Toxicity by Ingestion: Grade 2; LD₅₀ = 0.5 to 5 g/kg 5.7 Late Toxicity: Kidney and liver damage may follow ingestion. 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight stinging of the eyes or respiratory system if present in high concentrations. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause stinging and reddening of the skin. 5.10 Odor Threshold: 0.17 ppm 5.11 IDLH Value: 2,000 ppm</p>		

<p>6. FIRE HAZARDS 6.1 Flash Point: 40°F C.C.; 56°F O.C. 6.2 Flammable Limits in Air: 1.27%-7% 6.3 Fire Extinguishing Agents: Carbon dioxide or dry chemicals for small fires, ordinary foam for large fires. 6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective 6.5 Special Hazards of Combustion Products: Not pertinent 6.6 Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back. 6.7 Ignition Temperature: 967°F 6.8 Electrical Hazard: Class I, Group D 6.9 Burning Rate: 5.7 mm/min. 6.10 Adiabatic Flame Temperature: Data not available</p>	<p>10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-T-U</p>																																				
<p>7. CHEMICAL REACTIVITY 7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Moisture (Resistant to Product): Data not available 7.8 Reactivity Group: 2</p>	<p>11. HAZARD CLASSIFICATIONS 11.1 Code of Federal Regulations: Flammable liquid 11.2 MAS Hazard Rating for Bulk Water Transportation</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td>3</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>Vapor Irritant</td> <td>1</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td>1</td> </tr> <tr> <td>Poison</td> <td>2</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>Human Toxicity</td> <td>1</td> </tr> <tr> <td>Aquatic Toxicity</td> <td>3</td> </tr> <tr> <td>Aesthetic Effect</td> <td>2</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>Other Chemicals</td> <td>1</td> </tr> <tr> <td>Water</td> <td>0</td> </tr> <tr> <td>Self Reaction</td> <td>0</td> </tr> </tbody> </table> <p>11.3 NFPA Hazard Classification:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td>2</td> </tr> <tr> <td>Flammability (Red)</td> <td>3</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>0</td> </tr> </tbody> </table>	Category	Rating	Fire	3	Health		Vapor Irritant	1	Liquid or Solid Irritant	1	Poison	2	Water Pollution		Human Toxicity	1	Aquatic Toxicity	3	Aesthetic Effect	2	Reactivity		Other Chemicals	1	Water	0	Self Reaction	0	Category	Classification	Health Hazard (Blue)	2	Flammability (Red)	3	Reactivity (Yellow)	0
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Flammability (Red)	3																																				
Reactivity (Yellow)	0																																				
<p>8. WATER POLLUTION 8.1 Aquatic Toxicity: 1180 mg/l/96 hr/sunfish/TL₀₁/fresh water 8.2 Waterway Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 0%, 5 days; 38% (theor), 8 days 8.4 Feed Chain Concentration Potential: None</p>	<p>12. PHYSICAL AND CHEMICAL PROPERTIES 12.1 Physical State at 15°C and 1 atm: Liquid 12.2 Molecular Weight: 92.14 12.3 Boiling Point at 1 atm: 110.6°C = 231.1°F = 110.6°C = 383.8°K 12.4 Freezing Point: -108°F = -25.0°C = 178.2°K 12.5 Critical Temperature: 605.4°F = 318.6°C = 591.8°K 12.6 Critical Pressure: 596.1 atm = 40.55 atm = 4.106 MN/m² 12.7 Specific Gravity: 0.867 at 20°C (liquid) 12.8 Liquid Surface Tension: 29.0 dynes/cm = 0.0290 N/m at 20°C 12.9 Liquid Water Interfacial Tension: 36.1 dynes/cm = 0.0361 N/m at 25°C 12.10 Vapor (Gas) Specific Gravity: Not pertinent 12.11 Ratio of Specific Heats of Vapor (Gas): 1.089 12.12 Latent Heat of Vaporization: 155 Btu/lb = 86.1 cal/g = 3.61 x 10⁵ J/kg 12.13 Heat of Combustion: -17,430 Btu/lb = -9666 cal/g = -405.5 x 10³ J/kg 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: 17.17 cal/g 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 1.1 atm</p>																																				
<p>9. SHIPPING INFORMATION 9.1 Grades of Purity: Research, reagent, nitrogen-free 99.8 - %, industrial containing 94 - %, with 5% xylene and small amounts of benzene and nonaromatic hydrocarbons; 90/120: less pure than industrial. 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Open (flame arrest) or pressure-vacuum</p>	<p>6. FIRE HAZARDS (Continued) 6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>																																				

TOL	TOLUENE
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12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
-30	57.180	0	.396	0	1.026	0	1.024
-20	56.870	5	.397	10	1.015	5	.978
-10	56.550	10	.399	20	1.005	10	.935
0	56.240	15	.400	30	.994	15	.894
10	55.930	20	.402	40	.983	20	.857
20	55.620	25	.403	50	.972	25	.821
30	55.310	30	.404	60	.962	30	.788
40	54.990	35	.406	70	.951	35	.757
50	54.680	40	.407	80	.940	40	.727
60	54.370	45	.409	90	.929	45	.700
70	54.060	50	.410	100	.919	50	.673
80	53.750	55	.411	110	.908	55	.649
90	53.430	60	.413	120	.897	60	.625
100	53.120	65	.414	130	.886	65	.603
110	52.810	70	.415	140	.876	70	.582
120	52.500	75	.417	150	.865	75	.562
		80	.418	160	.854	80	.544
		85	.420	170	.843	85	.526
		90	.421	180	.833	90	.509
		95	.422	190	.822	95	.493
		100	.424	200	.811	100	.477
		105	.425	210	.800		
		110	.427				
		115	.428				
		120	.429				
		125	.431				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68.02	.050	0	.038	0	.00070	0	.228
		10	.057	10	.00103	25	.241
		20	.084	20	.00150	50	.255
		30	.121	30	.00212	75	.268
		40	.172	40	.00296	100	.281
		50	.241	50	.00405	125	.294
		60	.331	60	.00547	150	.306
		70	.449	70	.00727	175	.319
		80	.600	80	.00954	200	.331
		90	.792	90	.01237	225	.343
		100	1.033	100	.01584	250	.355
		110	1.332	110	.02007	275	.367
		120	1.700	120	.02518	300	.378
		130	2.148	130	.03127	325	.389
		140	2.690	140	.03850	350	.400
		150	3.338	150	.04700	375	.411
		160	4.109	160	.05691	400	.422
		170	5.018	170	.06840	425	.432
		180	6.083	180	.08162	450	.443
		190	7.323	190	.09675	475	.453
		200	8.758	200	.11400	500	.462
		210	10.410	210	.13340	525	.472
						550	.482
						575	.491
						600	.500

TRICHLOROETHANE

TCE

<p>Common Synonyms 1,1,1-Trichloroethane Methychloroform Aerthane Chlorthane</p>	<p>Watery liquid Colorless Sweet odor</p> <p>Sinks in water. Irritating vapor is produced.</p>
<p>Stop discharge if possible. Keep people away. Avoid contact with liquid and vapor. Call fire department, toxicologist and remove discharged material. Notify local health and pollution control agencies.</p>	
<p>Fire</p>	<p>Combustible. POISONOUS GASES ARE PRODUCED IN FIRE. Wear goggles and self-contained breathing apparatus. Extinguish with dry chemical, carbon dioxide, or foam.</p>
<p>Exposure</p>	<p>CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled, will cause dizziness or difficult breathing. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Irritating to skin and eyes. If swallowed, they produce nausea. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting. IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.</p>
<p>Water Pollution</p>	<p>Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Should be removed Chemical and physical treatment</p>	<p>2. LABEL 2.1 Category: None 2.2 Class: Not pertinent</p>
<p>3. CHEMICAL DESIGNATIONS 3.1 CG Compatibility Class: Halogenated hydrocarbon 3.2 Formula: CH₂Cl₃ 3.3 IMO/IUM Designation: Not listed 3.4 DOT ID No.: 2831 3.5 CAS Registry No.: 71-55-6</p>	<p>4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Chloroform-like, sweetish</p>
<p>5. HEALTH HAZARDS</p> <p>5.1 Personal Protective Equipment: Organic vapor-acid gas canister; self-contained breathing apparatus for emergencies; neoprene or polyvinyl-alcohol-type gloves; chemical safety goggles and face shield; neoprene safety shoes or leather safety shoes plus neoprene footwear; neoprene or polyvinyl alcohol suit or apron for splash protection.</p> <p>5.2 Symptoms Following Exposure: 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: irritating action may cause dermatitis.</p> <p>5.3 Treatment of Exposure: Get medical attention for all eye exposures and any other serious over-exposures. Do NOT administer aspirin or aspirin-like, 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.</p> <p>5.4 Threshold Limit Value: 250 ppm 5.5 Short Term Exposure Limit: 1,000 ppm for 80 min. in man 5.6 Toxicity by Ingestion: Grade 1; LD₅₀ = 5 to 15 g/kg (rat, mouse, rabbit, guinea pig) 5.7 Lethal Toxicity: Data not available 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight stinging of the eyes or respiratory system if present in high concentrations. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause stinging and reddening of the skin. 5.10 Odor Threshold: 100 ppm 5.11 IDLH Value: 1,000 ppm</p>	

<p>6. FIRE HAZARDS</p> <p>6.1 Flash Point: Data not available 6.2 Flammable Limits in Air: 7%-18% 6.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion Products: Toxic and irritating gases are generated in fire. 6.6 Behavior in Fire: Not pertinent 6.7 Ignition Temperature: 932°F 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: (est.) 2.9 mm/min. 6.10 Adiabatic Flame Temperature: Data not available 6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>	<p>10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-X-Y</p>
<p>7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity With Water: Reacts slowly, releasing corrosive hydrochloric acid. 7.2 Reactivity With Common Materials: Corrodes aluminum, but reaction is not hazardous. 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: 36</p>	<p>11. HAZARD CLASSIFICATIONS</p> <p>11.1 Code of Federal Regulations: ORM-A 11.2 NAS Hazard Rating for Bulk Water Transportation: Category Rating Fire 1 Health Vapor Irritant 1 Liquid or Solid Irritant 1 Poisons 2 Water Pollution Human Toxicity 1 Aquatic Toxicity 3 Aesthetic Effect 2 Reactivity Other Chemicals 1 Water 0 Self Reaction 0 11.3 NFPA Hazard Classification: Category Classification Health Hazard (Blue) 2 Flammability (Red) 1 Reactivity (Yellow) 0</p>
<p>8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: 75-150 ppm/1 g/liters/LTL₅₀/salt water *Time period not specified. 8.2 Waterflow Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): Data not available 8.4 Food Chain Concentration Potential: None</p>	<p>12. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>12.1 Physical State at 15°C and 1 atm: Liquid 12.2 Molecular Weight: 133.41 12.3 Boiling Point at 1 atm: 185°F = 74°C = 347°K 12.4 Freezing Point: <-38°F = <-38°C = <234°K 12.5 Critical Temperature: Not pertinent 12.6 Critical Pressure: Not pertinent 12.7 Specific Gravity: 1.31 at 20°C (liquid) 12.8 Liquid Surface Tension: 25.4 dynes/cm = 0.0254 N/m at 20°C 12.9 Liquid Water Interfacial Tension: (est.) 45 dynes/cm = 0.045 N/m at 20°C 12.10 Vapor (Gas) Specific Gravity: 4.6 12.11 Ratio of Specific Heats of Vapor (Gas): 1.104 12.12 Latent Heat of Vaporization: 100 Btu/lb = 56 cal/g = 2.4 X 10⁶ J/kg 12.13 Heat of Combustion: (est.) 4700 Btu/lb = 2600 cal/g = 110 X 10⁶ J/kg 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.18 Heat of Fusion: Data not available 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 4.0 psia</p>
<p>9. SHIPPING INFORMATION</p> <p>9.1 Grades of Purity: Uninhibited; inhibited; industrial inhibited; white room; cold clearing 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Pressure-vacuum</p>	<p>NOTES</p>

TCE	TRICHLOROETHANE
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12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
0	85.419	55	.240		N O T P E R T I N E N T	15	1.363
10	84.870	60	.242			20	1.295
20	84.309	65	.244			25	1.231
30	83.759	70	.246			30	1.172
40	83.200	75	.248			35	1.117
50	82.650	80	.250			40	1.065
60	82.089	85	.252			45	1.017
70	81.540	90	.254			50	.972
80	80.981	95	.256			55	.929
90	80.429	100	.258			60	.889
100	79.870	105	.260			65	.852
110	79.320	110	.262			70	.817
120	78.759	115	.264			75	.784
130	78.209	120	.266			80	.753
140	77.650	125	.268			85	.723
150	77.099	130	.270				
160	76.540	135	.272				
		140	.274				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68.02	.070	70	2.099	70	.04925	0	.146
		75	2.364	75	.05495	25	.150
		80	2.657	80	.06119	50	.155
		85	2.980	85	.06799	75	.159
		90	3.335	90	.07540	100	.163
		95	3.725	95	.08346	125	.167
		100	4.152	100	.09220	150	.171
		105	4.619	105	.10170	175	.175
		110	5.130	110	.11190	200	.179
		115	5.686	115	.12300	225	.183
		120	6.292	120	.13490	250	.186
		125	6.950	125	.14770	275	.190
		130	7.663	130	.16150	300	.193
		135	8.437	135	.17630	325	.196
		140	9.273	140	.19220	350	.199
		145	10.180	145	.20920	375	.202
		150	11.150	150	.22730	400	.205
		155	12.200	155	.24670	425	.208
		160	13.330	160	.26730	450	.210
		165	14.540	165	.28930	475	.213
170	15.840	170	.31270	500	.215		
175	17.240	175	.33760	525	.217		
180	18.730	180	.36390	550	.219		
185	20.330	185	.39180	575	.222		
190	22.030	190	.42140	600	.223		

TRICHLOROETHYLENE

TCL

<p>Common Synonyms</p> <p>Trichloroethylene Triclene; Agyten Chlorylene Gemaigene Tethylene Trichloran; Trilene</p>		<p>Watery liquid</p> <p>Sinks in water. Irritating vapor is produced.</p>	<p>Colorless</p>	<p>Sweet odor</p>
<p>Stop discharge if possible. Keep people away. Avoid contact with liquid and vapor. Call fire department. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>				
<p>Fire</p>		<p>Combustible. POISONOUS GASES ARE PRODUCED IN FIRE. Wear goggles and self-contained breathing apparatus. Extinguish with dry chemical, carbon dioxide, or foam.</p>		
<p>Exposure</p>		<p>CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled, will cause nausea, vomiting, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Irritating to skin and eyes. If swallowed, will cause nausea, vomiting, difficult breathing, or loss of consciousness. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting. IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.</p>		
<p>Water Pollution</p>		<p>Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>		
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Should be removed Chemical and physical treatment</p>		<p>2. LABEL 2.1 Category: None 2.2 Class: Not pertinent</p>		
<p>3. CHEMICAL DESIGNATIONS 3.1 CG Compatibility Class: Halogenated hydrocarbon 3.2 Formula: $\text{CHCl}_2 = \text{CCl}_2$ 3.3 IMO/UN Designators: 6.0/1710 3.4 DOT ID No.: 1710 3.5 CAS Registry No.: 79-01-8</p>		<p>4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Chloroform-like; ethereal</p>		
<p>5. HEALTH HAZARDS</p> <p>6.1 Personal Protective Equipment: Organic vapor-acid gas canister; self-contained breathing apparatus for emergencies; neoprene or vinyl gloves; chemical safety goggles; face shield; neoprene safety shoes; neoprene suit or apron for splash protection. 6.2 Symptoms Following Exposure: INHALATION: symptoms range from irritation of the nose and throat to nausea, an attitude of irresponsibility, blurred vision, and finally disturbance of central nervous system resulting in cardiac failure. Chronic exposure may cause organic injury. INGESTION: symptoms similar to inhalation. SKIN: defatting action can cause dermatitis. EYES: slightly irritating sensation and lachrymation. 6.3 Treatment of Exposure: Do NOT administer adrenalin or epinephrine; get medical attention for all cases of overexposure. INHALATION: remove victim to fresh air; if necessary, apply artificial respiration and/or administer oxygen. INGESTION: have victim drink water and induce vomiting; repeat three times; then give 1 tablespoon epsom salts in water. EYES: flush thoroughly with water. SKIN: wash thoroughly with soap and warm water. 6.4 Threshold Limit Value: 50 ppm 6.5 Short Term Inhalation Limit: 200 ppm for 30 min. 6.6 Toxicity by Ingestion: Grade 3; $\text{LD}_{50} = 50$ to 500 mg/kg 6.7 Late Toxicity: Data not available 6.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary. 6.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin. 6.10 Odor Threshold: 50 ppm 6.11 IDLH Value: 1,000 ppm</p>				

<p>6. FIRE HAZARDS</p> <p>6.1 Flash Point: 90°F C.C.; practically nonflammable 6.2 Flammable Limits in Air: 6.0%-10.5% 6.3 Fire Extinguishing Agents: Water fog 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent 6.5 Special Hazards of Combustion Products: Toxic and irritating gases are produced in fire situations. 6.6 Behavior in Fire: Not pertinent 6.7 Ignition Temperature: 770°F 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: Not pertinent 6.10 Adiabatic Flame Temperature: Data not available 6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>		<p>10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-X-Y</p>																																					
<p>7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: 36</p>		<p>11. HAZARD CLASSIFICATIONS</p> <p>11.1 Code of Federal Regulations: ORM-A 11.2 NAB Hazard Rating for Bulk Water Transportation: <table border="1"> <thead> <tr> <th>Category</th> <th>Rating</th> </tr> </thead> <tbody> <tr> <td>Fire.....</td> <td>1</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>Vapor Irritant.....</td> <td>1</td> </tr> <tr> <td>Liquid or Solid Irritant.....</td> <td>1</td> </tr> <tr> <td>Poisons.....</td> <td>2</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>Human Toxicity.....</td> <td>1</td> </tr> <tr> <td>Aquatic Toxicity.....</td> <td>2</td> </tr> <tr> <td>Aesthetic Effect.....</td> <td>2</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>Other Chemicals.....</td> <td>1</td> </tr> <tr> <td>Water.....</td> <td>0</td> </tr> <tr> <td>Self Reaction.....</td> <td>1</td> </tr> </tbody> </table> <p>11.3 NFPA Hazard Classification: <table border="1"> <thead> <tr> <th>Category</th> <th>Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue).....</td> <td>2</td> </tr> <tr> <td>Flammability (Red).....</td> <td>1</td> </tr> <tr> <td>Reactivity (Yellow).....</td> <td>0</td> </tr> </tbody> </table> </p> </p>		Category	Rating	Fire.....	1	Health		Vapor Irritant.....	1	Liquid or Solid Irritant.....	1	Poisons.....	2	Water Pollution		Human Toxicity.....	1	Aquatic Toxicity.....	2	Aesthetic Effect.....	2	Reactivity		Other Chemicals.....	1	Water.....	0	Self Reaction.....	1	Category	Classification	Health Hazard (Blue).....	2	Flammability (Red).....	1	Reactivity (Yellow).....	0
Category	Rating																																						
Fire.....	1																																						
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Health Hazard (Blue).....	2																																						
Flammability (Red).....	1																																						
Reactivity (Yellow).....	0																																						
<p>8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: 660 mg/l/40 hr/daphna/kill/fresh water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): Data not available 8.4 Food Chain Concentration Potential: None</p>		<p>12. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>12.1 Physical State at 15°C and 1 atm: Liquid 12.2 Molecular Weight: 131.39 12.3 Boiling Point at 1 atm: 188°F = 87°C = 360°K 12.4 Freezing Point: -123.5°F = -86.4°C = 186.8°K 12.5 Critical Temperature: Not pertinent 12.6 Critical Pressure: Not pertinent 12.7 Specific Gravity: 1.46 at 20°C (liquid) 12.8 Liquid Surface Tension: 29.3 dynes/cm = 0.0293 N/m at 20°C 12.9 Liquid Water Interfacial Tension: 34.5 dynes/cm = 0.0345 N/m at 24°C 12.10 Vapor (Gas) Specific Gravity: 4.5 12.11 Ratio of Specific Heats of Vapor (Gas): 1.116 12.12 Latent Heat of Vaporization: 103 Btu/lb = 57.2 cal/g = 2.4×10^4 J/kg 12.13 Heat of Combustion: Not pertinent 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: Data not available 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 2.5 psia</p>																																					
<p>9. SHIPPING INFORMATION</p> <p>9.1 Grades of Purity: Technical; dry cleaning; degreasing; extraction 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Pressure-vacuum</p>		<p>NOTES</p>																																					

TCL

TRICHLOROETHYLENE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
0	94.669	0	.220		N	15	.800
5	94.410	10	.221		O	20	.775
10	94.150	20	.223		T	25	.750
15	93.889	30	.225			30	.727
20	93.629	40	.226		P	35	.705
25	93.370	50	.228		E	40	.684
30	93.110	60	.230		R	45	.664
35	92.849	70	.231		T	50	.645
40	92.589	80	.233		I	55	.627
45	92.330	90	.235		N	60	.610
50	92.070	100	.236		E	65	.593
55	91.809	110	.238		N	70	.577
60	91.549	120	.240		T	75	.562
65	91.290	130	.241			80	.548
70	91.030	140	.243			85	.534
75	90.770	150	.245			90	.521
80	90.509	160	.246			95	.508
85	90.250	170	.248			100	.496
90	89.990					105	.485
95	89.730					110	.474
100	89.469					115	.463
105	89.209					120	.453
110	88.950						
115	88.690						
120	88.429						
125	88.169						

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
77.02	.110	40	.508	40	.01245	0	.136
		50	.678	50	.01628	25	.139
		60	.894	60	.02105	50	.143
		70	1.166	70	.02695	75	.146
		80	1.507	80	.03418	100	.149
		90	1.929	90	.04296	125	.152
		100	2.448	100	.05354	150	.155
		110	3.081	110	.06619	175	.157
		120	3.846	120	.08120	200	.160
		130	4.765	130	.09891	225	.162
		140	5.862	140	.11960	250	.165
		150	7.163	150	.14380	275	.167
		160	8.695	160	.17180	300	.169
		170	10.490	170	.20390	325	.172
		180	12.580	180	.24080	350	.174
		190	15.010	190	.28280	375	.176
		200	17.810	200	.33040	400	.177
		210	21.020	210	.38420	425	.179
						450	.181
						475	.182
						500	.184
						525	.185
						550	.186
						575	.187
						600	.188

VCM	VINYL CHLORIDE
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12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
0	61.000	-30	.259		N	-10	.287
5	60.710	-20	.265		O	-5	.281
		-10	.272		T	0	.276
		0	.279		P	5	.271
					E		
					R		
					T		
					I		
					N		
					E		
					N		
					T		

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68.02	.600	-50	3.384	-50	.04810	0	.185
		-40	4.501	-40	.06245	25	.192
		-30	5.908	-30	.08005	50	.198
		-20	7.658	-20	.10140	75	.205
		-10	9.814	-10	.12710	100	.211
		0	12.440	0	.15760	125	.217
		10	15.610	10	.19360	150	.224
		20	19.410	20	.23560	175	.230
		30	23.920	30	.28440	200	.235
		40	29.220	40	.34050	225	.241
		50	35.430	50	.40470	250	.247
		60	42.630	60	.47760	275	.252
		70	50.940	70	.56000	300	.257
		80	60.480	80	.65250	325	.263
		90	71.349	90	.75570	350	.268
		100	83.669	100	.87050	375	.273
		110	97.580	110	.99740	400	.277
		120	113.200	120	1.13700	425	.282
						450	.286
						475	.291
						500	.295
						525	.299
						550	.303
						575	.307
						600	.311

VINYL CHLORIDE

VCM

<p>Common Synonyms Chloroethylene VCL Vinyl C Monomer VCM</p>		<p>Gas</p>	<p>Colorless</p>	<p>Sweet odor</p>
<p>Liquid floats and boils on water. Flammable, irritating visible vapor cloud is produced.</p>				
<p>Stop discharge if possible. Keep people away. Shut off ignition sources and call fire department. Stay upwind and use water spray to "knock down" vapor. Evacuate area in case of large discharge. Avoid contact with liquid and vapor. Notify local health and pollution control agencies.</p>				
<p>Fire</p>	<p>FLAMMABLE. POISONOUS GAS IS PRODUCED IN FIRE. Flashback along vapor trail may occur. May explode if ignited in an enclosed area. Wear self-contained breathing apparatus. Cool exposed containers and protect men effecting shutoff with water. Stop flow of gas if possible. Let fire burn. Extinguish small fires with dry chemical.</p>			
<p>Exposure</p>	<p>CALL FOR MEDICAL AID.</p> <p>VAPOR Irritating to eyes, nose, and throat. If inhaled, will cause dizziness or difficult breathing. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.</p> <p>LIQUID Will cause frostbite. Flush affected area with plenty of water. DO NOT RUB AFFECTED AREAS.</p>			
<p>Water Pollution</p>	<p>Not harmful to aquatic life.</p>			
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Issue warning-high flammability Evacuate area</p>		<p>2. LABEL 2.1 Category: Flammable gas 2.2 Class: 2</p>		
<p>3. CHEMICAL DESIGNATIONS 3.1 CG Compatibility Class: Vinyl halides 3.2 Formula: CH₂=CHCl 3.3 IMO/UN Designation: 2.0/1086 3.4 DOT ID No.: 1086 3.5 CAS Registry No.: 75-01-4</p>		<p>4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquefied compressed gas 4.2 Color: Colorless 4.3 Odor: Pleasant, sweet</p>		
<p>5. HEALTH HAZARDS</p> <p>5.1 Personal Protective Equipment: Rubber gloves and shoes; gas-tight goggles; organic vapor canister or self-contained breathing apparatus.</p> <p>5.2 Symptoms Following Exposure: INHALATION: high concentrations cause dizziness, anesthesia, lung irritation. SKIN: may cause frostbite; phenol inhibitor may be absorbed through skin if large amounts of liquid evaporate.</p> <p>5.3 Treatment of Exposure: INHALATION: remove patient to fresh air and keep him quiet and warm; call a doctor; give artificial respiration if breathing stops. EYES AND SKIN: flush with plenty of water for at least 15 min.; for eyes, get medical attention; remove contaminated clothing.</p> <p>5.4 Threshold Limit Value: 5 ppm</p> <p>5.5 Short Term Inhalation Limits: 500 ppm for 5 min.</p> <p>5.6 Toxicity by Ingestion: Not pertinent</p> <p>5.7 Late Toxicity: Chronic exposure may cause liver damage.</p> <p>5.8 Vapor (Gas) Irritant Characteristics: Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.</p> <p>5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of skin. May cause frostbite.</p> <p>5.10 Odor Threshold: 280 ppm</p> <p>5.11 IDLH Value: Data not available</p>				

6. FIRE HAZARDS

6.1 **Flash Point:** -110°F O.C.

6.2 **Flammable Limits in Air:** 4%-26%

6.3 **Fire Extinguishing Agents:** For small fires use dry chemical or carbon dioxide. For large fires stop flow of gas. Cool exposed containers with water.

6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent

6.5 **Special Hazards of Combustion**
Products: Forms highly toxic combustion products such as hydrogen chloride, phosgenic, and carbon monoxide.

6.6 **Behavior in Fire:** Container may explode in fire. Gas is heavier than air and may travel considerable distance to a source of ignition and flash back.

6.7 **Ignition Temperature:** 882°F

6.8 **Electrical Hazard:** Class I, Group D

6.9 **Burning Rate:** 4.3 mm/min. (Continued)

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction

7.2 **Reactivity with Common Materials:** No reaction

7.3 **Stability During Transport:** Stable

7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent

7.5 **Polymerization:** Polymerizes in presence of air, sunlight, or heat unless stabilized by inhibitors.

7.6 **Inhibitor of Polymerization:** Not normally used except when high temperatures are expected. Then 40-100 ppm of phenol used.

7.7 **Molar Ratio (Reactant to Product):** Data not available

7.8 **Reactivity Group:** 35

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** None

8.2 **Waterfowl Toxicity:** None

8.3 **Biological Oxygen Demand (BOD):** None

8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Commercial or technical 99+%

9.2 **Storage Temperature:** Under pressure; ambient At atm. pressure; low

9.3 **Inert Atmosphere:** No requirement

9.4 **Venting:** Under pressure; safety relief At atm. pressure; pressure-vacuum

6. FIRE HAZARDS (Continued)

6.10 **Adiabatic Flame Temperature:** Data not available

6.11 **Stoichiometric Air to Fuel Ratio:** 5.490 (Est.)

6.12 **Flame Temperature:** Data not available

10. HAZARD ASSESSMENT CODE
(See Hazard Assessment Handbook)
A-B-C-D-E-F-G-Z

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Flammable gas

11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire.....	4
Health.....	
Vapor Irritant.....	2
Liquid or Solid Irritant.....	1
Poisons.....	2
Water Pollution.....	
Human Toxicity.....	0
Aquatic Toxicity.....	0
Aesthetic Effect.....	0
Reactivity.....	
Other Chemicals.....	2
Water.....	0
Self Reaction.....	2

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue).....	2
Flammability (Red).....	4
Reactivity (Yellow).....	1

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Gas

12.2 **Molecular Weight:** 62.50

12.3 **Boiling Point at 1 atm:** 7.2°F = 13.8°C = 259.4°K

12.4 **Freezing Point:** -244.8°F = -153.8°C = -119.4°K

12.5 **Critical Temperature:** 317.1°F = 158.4°C = 431.6°K

12.6 **Critical Pressure:** 775 psia = 52.7 atm = 5.34 MN/m²

12.7 **Specific Gravity:** 0.969 at -13°C (liquid)

12.8 **Liquid Surface Tension:** 16.0 dynes/cm = 0.0160 N/m at 25°C

12.9 **Liquid Water Interfacial Tension: (est.)** 30 dynes/cm = 0.03 N/m at 20°C

12.10 **Vapor (Gas) Specific Gravity:** 2.2

12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.186

12.12 **Latent Heat of Vaporization:** 160 Btu/lb = 88 cal/g = 3.7 X 10⁴ J/kg

12.13 **Heat of Combustion:** -8136 Btu/lb = -4520 cal/g = -189.1 X 10⁴ J/kg

12.14 **Heat of Decomposition:** Not pertinent

12.15 **Heat of Solution:** Not pertinent

12.16 **Heat of Polymerization:** -729 Btu/lb = -405 cal/g = 16.9 X 10⁴ J/kg

12.25 **Heat of Fusion:** 18.14 cal/g

12.26 **Limiting Value:** Data not available

12.27 **Reid Vapor Pressure:** 75 psia

m-XYLENE

XLM

<p>Common Synonyms 1,3-Dimethylbenzene Xylol</p>	<p>Watery liquid Colorless Sweet odor</p> <p>Floats on water. Flammable, irritating vapor is produced.</p>
<p>Slow discharge if possible. Keep people away. Call fire department. Avoid contact with liquid and vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>	
Fire	<p>FLAMMABLE Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Wear self-contained breathing apparatus. Extinguish with foam, dry chemical, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.</p>
Exposure	<p>CALL FOR MEDICAL AID.</p> <p>VAPOR Irritating to eyes, nose, and throat. If inhaled, will cause headache, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.</p> <p>LIQUID Irritating to skin and eyes. If swallowed, will cause nausea, vomiting, or loss of consciousness. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.</p>
Water Pollution	<p>HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. Floating to shorelines. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Issue warning-high flammability Evacuate area Should be removed Chemical and physical treatment</p>	<p>2. LABEL 2.1 Category: Flammable liquid 2.2 Class: 3</p>
<p>3. CHEMICAL DESIGNATIONS 3.1 CO Compatibility Class: Aromatic Hydrocarbon 3.2 Formula: m-C₈H₁₀(CH₃)₂ 3.3 IMO/UN Designator: 3.2/1307 3.4 DOT ID No.: 1307 3.5 CAS Registry No.: 106-38-3</p>	<p>4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Like benzene; characteristic odor</p>
<p style="text-align: center;">5. HEALTH HAZARDS</p> <p>5.1 Personal Protective Equipment: Approved canister or air-supplied mask; goggles or face shield; plastic gloves and boots. 5.2 Symptoms Following Exposure: Vapors cause headache and dizziness. Liquid irritates eyes and skin. If taken into lungs, causes severe coughing, distress, and rapidly developing pulmonary edema. If ingested, causes nausea, vomiting, cramps, headache, and coma; can be fatal. Kidney and liver damage can occur. 5.3 Treatment of Exposure: INHALATION: remove to fresh air; administer artificial respiration and oxygen if required; 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. 5.4 Threshold Limit Value: 100 ppm 5.5 Short Term Inhalation Limit: 300 ppm for 30 min. 5.6 Toxicity by Ingestion: Grade 3; LD₅₀ = 50 to 500 g/kg 5.7 Late Toxicity: Kidney and liver damage. 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight stinging of the eyes or respiratory system if present in high concentrations. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause stinging and reddening of the skin. 5.10 Odor Threshold: 0.05 ppm 5.11 IDLH Value: 10,000 ppm</p>	

6. FIRE HAZARDS

6.1 Flash Point: 64°F C.C.
6.2 Flammable Limits in Air: 1.1%-6.4%
6.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective.
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 986°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 5.8 mm/min.
6.10 Autoxidative Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Oxidizer Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 32

8. WATER POLLUTION

8.1 Aquatic Toxicity: 22 ppm/96 hr/blue/gill/TL₅₀/fresh water
8.2 Waterway Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 0 lb/lb, 5 days; 0% (theor.), 8 days
8.4 Feed Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: Research: 99.99%; Pure: 99.9%; Technical: 99.2%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE
(See Hazard Assessment Handbook)
A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations:
Flammable liquid

11.2 NAS Hazard Rating for Bulk Water Transporters:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Soil Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 106.16
12.3 Boiling Point at 1 atm: 268.4°F = 131.9°C = 405.1°K
12.4 Freezing Point: -54.2°F = -47.9°C = 225.3°K
12.5 Critical Temperature: 650.6°F = 343.8°C = 617.0°K
12.6 Critical Pressure: 513.8 atm = 34.95 psia = 3.540 MN/m²
12.7 Specific Gravity: 0.864 at 20°C (liquid)
12.8 Liquid Surface Tension: 28.6 dynes/cm = 0.0286 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 38.4 dynes/cm = 0.0384 N/m at 30°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.071
12.12 Latent Heat of Vaporization: 147 Btu/lb = 81.9 cal/g = 3.43 x 10⁵ J/kg
12.13 Heat of Combustion: -17,554 Btu/lb = -9752.4 cal/g = -408.31 x 10⁶ J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: 26.01 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 0.34 psia

NOTES

APPENDIX B APPENDIX C APPENDIX D APPENDIX E APPENDIX F

XLM

m-XYLENE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
15	55.400	40	.387	35	.962	15	.938
20	55.260	50	.393	40	.953	20	.898
25	55.130	60	.398	45	.944	25	.862
30	54.990	70	.404	50	.935	30	.827
35	54.850	80	.410	55	.926	35	.794
40	54.710	90	.415	60	.917	40	.764
45	54.570	100	.421	65	.908	45	.735
50	54.430	110	.426	70	.899	50	.708
55	54.290	120	.432	75	.890	55	.682
60	54.160	130	.437	80	.881	60	.658
65	54.020	140	.443	85	.873	65	.635
70	53.880	150	.448	90	.864	70	.613
75	53.740	160	.454	95	.855	75	.592
80	53.600	170	.460	100	.846	80	.572
85	53.460	180	.465			85	.554
90	53.320	190	.471				
95	53.180	200	.476				
100	53.050	210	.482				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	I N S O L U B L E	60	.090	60	.00172	0	.247
		70	.127	70	.00238	25	.260
		80	.177	80	.00324	50	.273
		90	.242	90	.00435	75	.286
		100	.326	100	.00577	100	.299
		110	.434	110	.00754	125	.311
		120	.571	120	.00975	150	.324
		130	.743	130	.01247	175	.336
		140	.956	140	.01577	200	.348
		150	1.219	150	.01977	225	.360
		160	1.538	160	.02455	250	.371
		170	1.924	170	.03023	275	.383
		180	2.388	180	.03691	300	.394
		190	2.939	190	.04473	325	.406
		200	3.590	200	.05382	350	.417
		210	4.355	210	.06431	375	.427
		220	5.247	220	.07635	400	.438
		230	6.282	230	.09009	425	.449
		240	7.476	240	.10570	450	.459
		250	8.846	250	.12330	475	.469
	260	10.410	260	.14310	500	.479	
					525	.489	
					550	.499	
					575	.508	
					600	.517	

o-XYLENE

XLO

<p>Common Synonyms 1, 2-Dimethylbenzene Xylol</p>	<p>Watery liquid</p> <p>Floats on water. Flammable, irritating vapor is produced.</p>	<p>Colorless</p>	<p>Sweet odor</p>																																				
<p>Stop discharge if possible. Keep people away. Call fire department. Avoid contact with liquid and vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>																																							
Fire	<p>FLAMMABLE Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Wear self-contained breathing apparatus. Extinguish with foam, dry chemical, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.</p>																																						
Exposure	<p>CALL FOR MEDICAL AID</p> <p>VAPOR Irritating to eyes, nose and throat. If inhaled, may cause headache, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.</p> <p>LIQUID Irritating to skin and eyes. If swallowed, will cause nausea, vomiting, or loss of consciousness. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES: hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.</p>																																						
Water Pollution	<p>Dangerous to aquatic life in high concentrations. Fouling to shorelines. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>																																						
<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Issue warning-high flammability Evacuate area Should be removed Chemical and physical treatment</p>		<p>2. LABEL 2.1 Category: Flammable liquid 2.2 Class: 3</p>																																					
<p>1. CHEMICAL DESIGNATIONS 3.1 CQ Compatibility Class: Aromatic hydrocarbon 3.2 Formula: <chem>c1ccc(C)c(C)c1</chem> 3.3 IMO/IUN Designation: 3.2/1307 3.4 DOT ID No.: 1307 3.5 CAS Registry No.: 95-47-4</p>		<p>4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Benzene-like; characteristic aromatic</p>																																					
<p style="text-align: center;">5. HEALTH HAZARDS</p> <p>5.1 Personal Protective Equipment: Approved canister or air-supplied mask; goggles or face shield; plastic gloves and boots.</p> <p>5.2 Symptoms Following Exposure: Vapors cause headache and dizziness. Liquid irritates eyes and skin. If taken into lungs, causes severe coughing, distress, and rapidly developing pulmonary edema. If ingested, causes nausea, vomiting, cramps, headache, and coma. Can be fatal. Kidney and liver damage can occur.</p> <p>5.3 Treatment of Exposure: INHALATION: remove to fresh air; administer artificial respiration and oxygen if required; 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.</p> <p>5.4 Threshold Limit Value: 100 ppm</p> <p>5.5 Short Term Inhalation Limit: 300 ppm for 30 min.</p> <p>5.6 Toxicity by Ingestion: Grade 3; LD₅₀ = 50 to 500 mg/kg</p> <p>5.7 Lethal Toxicity: Kidney and liver damage.</p> <p>5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight stinging of the eyes or respiratory system if present in high concentrations. The effect is temporary.</p> <p>5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause stinging and reddening of the skin.</p> <p>5.10 Odor Threshold: 0.05 ppm</p> <p>5.11 IDLH Value: 10,000 ppm</p>																																							
<p style="text-align: center;">6. FIRE HAZARDS</p> <p>6.1 Flash Point: 63°F C.C.; 75°F O.C.</p> <p>6.2 Flammable Limits in Air: 1.1%-7.0%</p> <p>6.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide</p> <p>6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective.</p> <p>6.5 Special Hazards of Combustion Products: Not pertinent</p> <p>6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.</p> <p>6.7 Ignition Temperature: 860°F</p> <p>6.8 Electrical Hazard: Class I, Group D</p> <p>6.9 Burning Rate: 5.8 mm/min.</p> <p>6.10 Auto-oxidation Potential: Data not available</p> <p>6.11 Stoichiometric Air to Fuel Ratio: Data not available</p> <p>6.12 Flame Temperature: Data not available</p>																																							
<p style="text-align: center;">7. CHEMICAL REACTIVITY</p> <p>7.1 Reactivity With Water: No reaction</p> <p>7.2 Reactivity With Common Materials: No reaction</p> <p>7.3 Stability During Transport: Stable</p> <p>7.4 Neutralizing Agents for Acids and Caustics: Not pertinent</p> <p>7.5 Polymerization: Not pertinent</p> <p>7.6 Inhibitor of Polymerization: Not pertinent</p> <p>7.7 Molar Ratio (Reactant to Product): Data not available</p> <p>7.8 Reactivity Group: 32</p>																																							
<p style="text-align: center;">8. WATER POLLUTION</p> <p>8.1 Aquatic Toxicity: > 100 mg/l/96 hr/D. magna/TL₅₀/fresh water</p> <p>8.2 Waterway Toxicity: Data not available</p> <p>8.3 Biological Oxygen Demand (BOD): 0 @/b. 5 days; 2.5% (theor.); 8 days</p> <p>8.4 Food Chain Concentration Potential: Data not available</p>																																							
<p style="text-align: center;">9. SHIPPING INFORMATION</p> <p>9.1 Grades of Purity; Research: 99.99%; Pure: 99.7%; Commercial: 95- %</p> <p>9.2 Storage Temperature: Ambient</p> <p>9.3 Inert Atmosphere: No reaction</p> <p>9.4 Venting: Open (flame arrester or pressure-relief)</p>																																							
<p style="text-align: center;">10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-T-U</p>																																							
<p style="text-align: center;">11. HAZARD CLASSIFICATIONS</p> <p>11.1 Code of Federal Regulations: Flammable liquid</p> <p>11.2 NAB Hazard Rating for Bulk Water Transportation:</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Category</th> <th style="text-align: right;">Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td style="text-align: right;">3</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>Vapor Irritant</td> <td style="text-align: right;">1</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td style="text-align: right;">1</td> </tr> <tr> <td>Poisons</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>Human Toxicity</td> <td style="text-align: right;">1</td> </tr> <tr> <td>Aquatic Toxicity</td> <td style="text-align: right;">3</td> </tr> <tr> <td>Aesthetic Effect</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>Other Chemicals</td> <td style="text-align: right;">1</td> </tr> <tr> <td>Water</td> <td style="text-align: right;">0</td> </tr> <tr> <td>Self Reaction</td> <td style="text-align: right;">0</td> </tr> </tbody> </table> <p>11.3 MFPA Hazard Classification:</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Category</th> <th style="text-align: right;">Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (B&E)</td> <td style="text-align: right;">2</td> </tr> <tr> <td>Flammability (Rea)</td> <td style="text-align: right;">3</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td style="text-align: right;">0</td> </tr> </tbody> </table>				Category	Rating	Fire	3	Health		Vapor Irritant	1	Liquid or Solid Irritant	1	Poisons	2	Water Pollution		Human Toxicity	1	Aquatic Toxicity	3	Aesthetic Effect	2	Reactivity		Other Chemicals	1	Water	0	Self Reaction	0	Category	Classification	Health Hazard (B&E)	2	Flammability (Rea)	3	Reactivity (Yellow)	0
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<p style="text-align: center;">12. PHYSICAL AND CHEMICAL PROPERTIES</p> <p>12.1 Physical State at 15°C and 1 atm: Liquid</p> <p>12.2 Molecular Weight: 106.16</p> <p>12.3 Boiling Point at 1 atm: 291.8°F = 144.4°C = 417.6°K</p> <p>12.4 Freezing Point: -13.3°F = -25.2°C = 248.0°K</p> <p>12.5 Critical Temperature: 674.8°F = 357.1°C = 630.3°K</p> <p>12.6 Critical Pressure: 541.5 atm = 36.84 atm = 3.732 MN/m²</p> <p>12.7 Specific Gravity: 0.880 at 20°C (liquid)</p> <p>12.8 Liquid Surface Tension: 30.53 dynes/cm = 0.00053 N/m at 15.5°C</p> <p>12.9 Liquid Water Interfacial Tension: 36.06 dynes/cm = 0.02806 N/m at 20°C</p> <p>12.10 Vapor (Gas) Specific Gravity: Not pertinent</p> <p>12.11 Ratio of Specific Heats of Vapor (Gas): 1.068</p> <p>12.12 Latent Heat of Vaporization: 148 Btu/lb = 82.9 cal/g = 3.47 X 10⁴ J/kg</p> <p>12.13 Heat of Combustion: -17,558 Btu/lb = -8754.7 cal/g = -408.41 X 10⁴ J/kg</p> <p>12.14 Heat of Decomposition: Not pertinent</p> <p>12.16 Heat of Solution: Not pertinent</p> <p>12.16 Heat of Polymerization: Not pertinent</p> <p>12.26 Heat of Fusion: 30.64 cal/g</p> <p>12.26 Limiting Value: Data not available</p> <p>12.27 Reid Vapor Pressure: 0.28 atm</p>																																							
<p style="text-align: center;">NOTES</p>																																							

XLO

O-XYLENE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
15	56.460	35	.389	35	1.043	15	1.328
20	56.330	40	.391	40	1.035	20	1.263
25	56.190	45	.394	45	1.027	25	1.202
30	56.050	50	.396	50	1.018	30	1.145
35	55.910	55	.398	55	1.010	35	1.092
40	55.770	60	.400	60	1.002	40	1.042
45	55.630	65	.402	65	.993	45	.995
50	55.490	70	.404	70	.985	50	.952
55	55.360	75	.406	75	.977	55	.911
60	55.220	80	.408	80	.969	60	.873
65	55.080	85	.411	85	.960	65	.836
70	54.940	90	.413	90	.952	70	.802
75	54.800	95	.415	95	.944	75	.770
80	54.660	100	.417	100	.935	80	.740
85	54.520					85	.712
90	54.380						
95	54.250						
100	54.110						

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	I N S O L U B L E	60	.071	60	.00135	0	.261
		70	.101	70	.00188	25	.274
		80	.141	80	.00258	50	.287
		90	.194	90	.00349	75	.299
		100	.263	100	.00464	100	.311
		110	.352	110	.00611	125	.323
		120	.465	120	.00794	150	.335
		130	.609	130	.01021	175	.347
		140	.787	140	.01298	200	.358
		150	1.007	150	.01634	225	.370
		160	1.277	160	.02038	250	.381
		170	1.605	170	.02520	275	.392
		180	1.999	180	.03090	300	.403
		190	2.469	190	.03759	325	.414
		200	3.028	200	.04539	350	.424
		210	3.686	210	.05443	375	.435
		220	4.456	220	.06484	400	.445
		230	5.352	230	.07674	425	.455
		240	6.389	240	.09030	450	.465
		250	7.581	250	.10560	475	.475
	260	8.947	260	.12290	500	.485	
					525	.494	
					550	.504	
					575	.513	
					600	.522	

p-XYLENE

XLP

Common Synonyms 1,4-Dimethylbenzene Xylol	Watery liquid	Colorless	Sweet odor
Floats on water. Flammable, irritating vapor is produced. Freezing point is 58°F.			

Stop discharge if possible. Keep people away. Call fire department. Avoid contact with liquid and vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.

Fire	<p>FLAMMABLE Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Wear self-contained breathing apparatus. Extinguish with foam, dry chemical, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.</p>
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Exposure	<p>CALL FOR MEDICAL AID. VAPOR Irritating to eyes, nose and throat. If inhaled, will cause dizziness, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Irritating to skin and eyes. If swallowed, will cause nausea, vomiting, loss of consciousness. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.</p>
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Water Pollution	<p>HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. Fouling to shoreline. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>
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<p>1. RESPONSE TO DISCHARGE (See Response Methods Handbook) Issue warning-high flammability Evacuate area Should be removed Chemical and physical treatment</p>	<p>2. LABEL 2.1 Category: Flammable liquid 2.2 Class: 3</p>
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<p>3. CHEMICAL DESIGNATIONS 3.1 CG Compatibility Class: Aromatic Hydrocarbon 3.2 Formula: $p-C_6H_4(CH_3)_2$ 3.3 IMO/UN Designation: 3.2/1307 3.4 DOT ID No.: 1307 3.5 CAS Registry No.: 106-42-3</p>	<p>4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Like benzene; characteristic aromatic</p>
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<p>5. HEALTH HAZARDS 5.1 Personal Protective Equipment: Approved canister or air-supplied mask; goggles or face shield; plastic gloves and boots. 5.2 Symptoms Following Exposure: Vapors cause headache and dizziness. Liquid irritates eyes and skin. If taken into lungs, causes severe coughing, distress, and rapidly developing pulmonary edema. If ingested, causes nausea, vomiting, cramps, headache, and coma. Can be fatal. Kidney and liver damage can occur. 5.3 Treatment of Exposure: INHALATION: remove to fresh air; administer artificial respiration and oxygen if required; 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. 5.4 Threshold Limit Value: 100 ppm 5.5 Short Term Inhalation Limits: 300 ppm for 30 min. 5.6 Toxicity by Ingestion: Grade 3; LD₅₀ = 50 to 500 mg/kg 5.7 Late Toxicity: Kidney and liver damage. 5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin. 5.10 Odor Threshold: 0.05 ppm 5.11 IDLH Value: 10,000 ppm</p>

<p>6. FIRE HAZARDS 6.1 Flash Point: 81°F C.C. 6.2 Flammable Limits in Air: 1.1%-6.6% 6.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide 6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective. 6.5 Special Hazards of Combustion Products: Not pertinent 6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back. 6.7 Ignition Temperature: 870°F 6.8 Electrical Hazard: Class I, Group D 6.9 Burning Rate: 5.8 mm/min. 6.10 Adiabatic Flame Temperature: Data not available 6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>

<p>7. CHEMICAL REACTIVITY 7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Molar Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: 32</p>
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<p>8. WATER POLLUTION 8.1 Aquatic Toxicity: 22 ppm/96 hr/bluegill/TL₅₀/fresh water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): 0 lb/lb in 5 days 8.4 Food Chain Concentration Potential: Data not available</p>
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<p>9. SHIPPING INFORMATION 9.1 Grades of Purity: Research: 99.99%; Pure: 99.6%; Technical: 99.0% 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Open (flame arrester) or pressure-vacuum</p>

<p>10. HAZARD ASSESSMENT CODE (See Hazard Assessment Handbook) A-T-U</p>

<p>11. HAZARD CLASSIFICATIONS 11.1 Code of Federal Regulations: Flammable liquid 11.2 NAS Hazard Rating for Bulk Water Transportation:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Rating</th> </tr> </thead> <tbody> <tr> <td>Fire.....</td> <td>3</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>Vapor Irritant.....</td> <td>1</td> </tr> <tr> <td>Liquid or Solid Irritant.....</td> <td>1</td> </tr> <tr> <td>Poisons.....</td> <td>2</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>Human Toxicity.....</td> <td>1</td> </tr> <tr> <td>Aquatic Toxicity.....</td> <td>3</td> </tr> <tr> <td>Aesthetic Effect.....</td> <td>2</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>Other Chemicals.....</td> <td>1</td> </tr> <tr> <td>Water.....</td> <td>0</td> </tr> <tr> <td>Self Reaction.....</td> <td>0</td> </tr> </tbody> </table> <p>11.3 NFPA Hazard Classification:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue).....</td> <td>2</td> </tr> <tr> <td>Flammability (Red).....</td> <td>3</td> </tr> <tr> <td>Reactivity (Yellow).....</td> <td>0</td> </tr> </tbody> </table>	Category	Rating	Fire.....	3	Health		Vapor Irritant.....	1	Liquid or Solid Irritant.....	1	Poisons.....	2	Water Pollution		Human Toxicity.....	1	Aquatic Toxicity.....	3	Aesthetic Effect.....	2	Reactivity		Other Chemicals.....	1	Water.....	0	Self Reaction.....	0	Category	Classification	Health Hazard (Blue).....	2	Flammability (Red).....	3	Reactivity (Yellow).....	0
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Vapor Irritant.....	1																																			
Liquid or Solid Irritant.....	1																																			
Poisons.....	2																																			
Water Pollution																																				
Human Toxicity.....	1																																			
Aquatic Toxicity.....	3																																			
Aesthetic Effect.....	2																																			
Reactivity																																				
Other Chemicals.....	1																																			
Water.....	0																																			
Self Reaction.....	0																																			
Category	Classification																																			
Health Hazard (Blue).....	2																																			
Flammability (Red).....	3																																			
Reactivity (Yellow).....	0																																			

<p>12. PHYSICAL AND CHEMICAL PROPERTIES 12.1 Physical State at 16°C and 1 atm: Liquid 12.2 Molecular Weight: 106.16 12.3 Boiling Point at 1 atm: 280.9°F = 138.3°C = 411.5°K 12.4 Freezing Point: 55.9°F = 13.3°C = 286.5°K 12.5 Critical Temperature: 649.4°F = 343.0°C = 616.2°K 12.6 Critical Pressure: 509.4 atm = 34.85 psia = 3.510 MN/m² 12.7 Specific Gravity: 0.861 at 20°C (liquid) 12.8 Liquid Surface Tension: 28.3 dynes/cm = 0.0283 N/m at 20°C 12.9 Liquid Water Interfacial Tension: 37.8 dynes/cm = 0.0378 N/m at 20°C 12.10 Vapor (Gas) Specific Gravity: Not pertinent 12.11 Ratio of Specific Heats of Vapor (Gas): 1.071 12.12 Latent Heat of Vaporization: 150 Btu/lb = 81 cal/g = 3.4 X 10⁴ J/kg 12.13 Heat of Combustion: -17,559 Btu/lb = -9754.7 cal/g = -408.41 X 10³ J/kg 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.25 Heat of Fusion: 37.83 cal/g 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 0.34 psia</p>
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NOTES

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
60	53.970	60	.412	60	.935	60	.678
65	53.830	70	.418	65	.928	65	.654
70	53.690	80	.424	70	.921	70	.631
75	53.550	90	.429	75	.914	75	.610
80	53.410	100	.435	80	.907	80	.590
85	53.270	110	.440	85	.900	85	.571
90	53.140	120	.446	90	.892	90	.552
95	53.000	130	.451	95	.885	95	.535
100	52.860	140	.457	100	.878	100	.519
105	52.720	150	.462			105	.503
110	52.580	160	.468			110	.488
115	52.440	170	.474			115	.474
120	52.300	180	.479			120	.460
		190	.485				
		200	.490				
		210	.496				
		220	.501				
		230	.507				
		240	.512				
		250	.518				
		260	.524				
		270	.529				
		280	.535				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	I	60	.096	60	.00183	0	.246
	N	70	.135	70	.00252	25	.259
	S	80	.187	80	.00343	50	.272
	O	90	.255	90	.00459	75	.285
	L	100	.343	100	.00607	100	.297
	U	110	.456	110	.00792	125	.309
	B	120	.599	120	.01022	150	.321
	L	130	.777	130	.01303	175	.333
	E	140	.998	140	.01646	200	.345
		150	1.270	150	.02059	225	.357
		160	1.600	160	.02553	250	.368
		170	1.998	170	.03138	275	.380
		180	2.475	180	.03826	300	.391
		190	3.041	190	.04629	325	.402
		200	3.710	200	.05561	350	.413
		210	4.493	210	.06636	375	.424
		220	5.407	220	.07867	400	.435
		230	6.465	230	.09270	425	.445
		240	7.683	240	.10860	450	.456
		250	9.080	250	.12650	475	.466
		260	10.670	260	.14670	500	.476
						525	.486
						550	.496
						575	.505
						600	.515

APPENDIX B.2

OSHA POSTER

JOB SAFETY & HEALTH PROTECTION

The Occupational Safety and Health Act of 1970 provides job safety and health protection for workers by promoting safe and healthful working conditions throughout the Nation. Requirements of the Act include the following:

Employers

All employers must furnish to employees employment and a place of employment free from recognized hazards that are causing or are likely to cause death or serious harm or employees. Employers must comply with occupational safety and health standards issued under the Act.

Employees

Employees must comply with all occupational safety and health standards, rules, regulations and orders issued under the Act that apply to their own actions and conduct on the job.

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor has the primary responsibility for administering the Act. OSHA issues occupational safety and health standards, and its Compliance Safety and Health Officers conduct jobsite inspections to help ensure compliance with the Act.

Inspection

The Act requires that a representative of the employer and a representative authorized by the employees be given an opportunity to accompany the OSHA inspector for the purpose of aiding the inspection.

Where there is no authorized employee representative, the OSHA Compliance Officer must consult with a reasonable number of employees concerning safety and health conditions in the workplace.

Complaint

Employees or their representatives have the right to file a complaint with the nearest OSHA office requesting an inspection if they believe unsafe or unhealthful conditions exist in their workplace. OSHA will withhold, on request, names of employees complaining.

The Act provides the employees may not be discharged or discriminated against in any way for filing safety and health complaints or for otherwise exercising their rights under the Act.

Employees who believe they have been discriminated against may file a complaint with their nearest OSHA office within 30 days of the alleged discrimination.

Citation

If upon inspection OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected.

The OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

Proposed Penalty

The Act provides for mandatory penalties against employers of up to \$1,000 for each serious violation and for optional penalties of up to \$1,000 for each nonserious violation. Penalties of up to \$1,000 per day may be proposed for failure to correct violations within the proposed time period. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to \$10,000 for each such violation.

Criminal penalties are also provided for in the Act. Any willful violation resulting in death of an employee, upon conviction, is punishable by a fine of up to \$250,000 (or \$500,000 if the employer is a corporation), or by imprisonment for up to six months, or by both. Conviction of an employer after a first conviction doubles these maximum penalties.

Voluntary Activity

While providing penalties for violations, the Act also encourages efforts by labor and management, before an OSHA inspection, to reduce workplace hazards voluntarily and to develop and improve safety and health programs in all workplaces and industries. OSHA's Voluntary Protection Programs recognize outstanding efforts of this nature.

OSHA has published Safety and Health Program Management Guidelines to assist employers in establishing or perfecting programs to prevent or control employee exposure to workplace hazards. There are many public and private organizations that can provide information and assistance in this effort, if requested. Also, your local OSHA office can provide considerable help and advice on solving safety and health problems or can refer you to other sources for health such as training.

Consultation

Free assistance in identifying and correcting hazards and in improving safety and health management is available to employers, without citation or penalty, through OSHA-supported programs in each State. These programs are usually administered by the State labor or Health department or a State university.

POSTING INSTRUCTIONS

Employees in States operating OSHA approved State Plans should obtain and post the State's equivalent poster.

More Information

Additional information and copies of the Act, specific OSHA safety and health standards, and other applicable regulations may be obtained from your employer or from the nearest OSHA Regional Office in the following locations:

Atlanta, Georgia	(404) 347-3573
Boston, Massachusetts	(617) 565-7164
Chicago, Illinois	(312) 353-2220
Dallas, Texas	(214) 767-4731
Denver, Colorado	(303) 844-3061
Kansas City, Missouri	(816) 426-5861
New York, New York	(212) 337-2325
Philadelphia, Pennsylvania	(215) 596-1201
San Francisco, California	(415) 995-5672
Seattle, Washington	(206) 442-5930

Washington, D.C.
1989 (Revised)
OSHA 2203

Elizabeth Dole, Secretary of Labor
U.S. Department of Labor
Occupational Safety and Health Administration

APPENDIX C
BASELINE RISK ASSESSMENT

IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

After the data have been evaluated (see Subsection 5.4 of the RI/FS Work Plan), the following steps will be used to identify contaminants of potential concern in the quantitative risk assessment.

- Qualitatively evaluate tentatively identified compounds.
- Compare OU-2-related compounds to the USEPA Region III risk-based concentration table to screen out compounds (USEPA, 1991b).
- Consider mobility, persistence, bioaccumulation potential, and potential significant exposure routes of chemicals.
- Possibly use the concentration-toxicity screening method for selecting contaminants to be carried through the risk assessment (chemicals historically associated with OU-2 and in concentrations approaching or exceeding ARARs will not be eliminated).
- Perform the statistical analyses (upper 95 percent confidence limit) deemed appropriate for the evaluation.

Usable data for the quantitative risk assessment will be identified and summarized. The location of apparent "hot spots" or trends in changes of concentrations over time will be noted. A cluster analysis of the chemical data will be conducted to aid in evaluating trends or "hot spots." The upper 95 percent confidence limit will be calculated for appropriate data. Chemicals that will not be carried through to the risk assessment will be identified and justification for their omission will be provided.

EXPOSURE ASSESSMENT

The assumptions used to estimate exposure concentrations are listed below.

- Groundwater:

Following Region IV guidance for evaluation of Class G 1 groundwater (USEPA, 1991b), monitoring well data from the shallow aquifer will be used in the future use scenarios. The values for concentrations will be assumed equal to the values detected at OU-2.

Contaminant concentrations from unfiltered water samples will be used to estimate exposure concentrations.

- Soil/Sediments:

The concentrations detected in soil borings and monitoring well installation borings will be used to calculate exposure concentrations for both current and future land uses.

Surface soil samples (zero to 3 inches) will be considered separately from subsurface samples (zero to 15 feet) for inhalation and ingestion exposures.

During construction at the Wastewater Treatment Plant, deeper soils will be exposed. Concentrations of contaminants in construction zone soils (zero to 15 feet or to the water table) will be analyzed separately to determine potential future exposures to workers.

- Air:

Currently, potential sources of air emissions include volatilization from surface soil and fugitive dust emissions.

If contaminants are present in the surface soil, models may be selected from the National Technical Guidance Series (USEPA, 1989d), the *Superfund Exposure Assessment Manual* (USEPA, 1988c), or current literature to estimate fugitive dust emissions.

Air monitoring data will be used to estimate exposures to volatile emissions if VOCs are found in surface soils.,

- Surface Water:

Surface water exposure concentrations will be estimated using data collected from the Polishing Pond, drainage ditch, and St. Johns River.

The equations used to estimate chemical intake are provided in Table A-1. Tables A-2 through A-6 list the default exposure parameters for each exposure scenario (USEPA, 1991c).

Toxicity Assessment. Toxicity values for the preliminary list of chemicals of potential concern at OU-2 are listed in Tables A-7 through A-10.

Human Health Remediation Goals. Sample calculations for developing remediation goals for carcinogenic and noncarcinogenic contaminants are provided in Table A-11.

TABLE C-1 EQUATIONS USED TO ESTIMATE CHEMICAL INTAKE, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

INGESTION OF SOIL OR SEDIMENT

$$\text{Intake (mg/kg-day)} = \frac{\text{CS} \times \text{IR} \times \text{RAF} \times \text{CF} \times \text{FI} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

- CS = chemical concentration in soil (mg/kg)
- IR = ingestion rate (mg soil/day)
- RAF = relative absorption factor (unitless)¹
- CF = conversion factor (10⁻⁶ kg/mg)
- FI = fraction ingested from site
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- BW = body weight (kg)
- AT = averaging time - period over which exposure is averaged (days)²

DERMAL CONTACT WITH SOIL OR SEDIMENT

$$\text{Absorbed Dose (mg/kg-day)} = \frac{\text{CS} \times \text{AF} \times \text{SA} \times \text{RAF} \times \text{CF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

- CS = chemical concentration in soil (mg/kg)
- AF = soil to skin adherence factor (mg/cm²)
- SA = skin surface area exposed (cm²/event)
- RAF = relative absorption factor (unitless)¹
- CF = conversion factor (10⁻⁶ kg/mg)
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- BW = body weight (kg)
- AT = averaging time - period over which exposure is averaged (days)²

INHALATION OF SUSPENDED PARTICULATES

$$\text{Intake (mg/kg-day)} = \frac{\text{CS} \times \text{IR} \times \text{ET} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

- CS = chemical concentration on suspended particulates (mg/kg)
 - IR = inhalation rate (m³/hour)
 - RAF = relative absorption factor (unitless)¹
 - ET = exposure time (hours/event)
 - EF = exposure frequency (days/year)
 - ED = exposure duration (years)
 - BW = body weight (kg)
 - AT = averaging time - period over which exposure is averaged (days)²
-

TABLE C-1 EQUATIONS USED TO ESTIMATE CHEMICAL INTAKE, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

INGESTION OF SURFACE WATER

$$\text{Intake (mg/kg-day)} = \frac{\text{CW} \times \text{CR} \times \text{ET} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

- CW = chemical concentration in water (mg/L)
- CR = contact rate (L/hour)
- RAF = relative absorption factor (unitless)¹
- ET = exposure time (hours/event)
- EF = exposure frequency (events/year)
- ED = exposure duration (years)
- BW = body weight (kg)
- AT = averaging time - period over which exposure is averaged (days)²

DERMAL CONTACT WITH SURFACE OR GROUND WATER

$$\text{Absorbed Dose (mg/kg-day)} = \frac{\text{CW} \times \text{SA} \times \text{PC} \times \text{ET} \times \text{EF} \times \text{ED} \times \text{CF}}{\text{BW} \times \text{AT}}$$

where:

- CW = chemical concentration in water (mg/L)
- SA = skin surface area (cm²/event)
- PC = chemical specific dermal permeability constant (cm/hr)³
- ET = exposure time (hours/event)
- EF = exposure frequency (events/year)
- ED = exposure duration (years)
- CF = conversion factor (1 liter/1000 cm³)
- BW = body weight (kg)
- AT = averaging time - period over which exposure is averaged (days)²

INGESTION OF GROUNDWATER

$$\text{Intake (mg/kg-day)} = \frac{\text{CW} \times \text{IR} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

- CW = chemical concentration in water (mg/L)
 - IR = ingestion rate (L/day)
 - RAF = relative absorption factor (unitless)¹
 - EF = exposure frequency (days/year)
 - ED = exposure duration (years)
 - BW = body weight (kg)
 - AT = averaging time - period over which exposure is averaged (days)²
-

TABLE C-1 EQUATIONS USED TO ESTIMATE CHEMICAL INTAKE, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

INHALATION OF VOLATILES FROM HOUSEHOLD WATER USE

$$\text{Intake (mg/kg-day)} = \frac{\text{CW} \times \text{K} \times \text{IR} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

- CW = chemical concentration in water (mg/L)
- K = volatilization factor (unitless)
- IR = ingestion rate (L/day)
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- BW = body weight (kg)
- AT = averaging time - period over which exposure is averaged (days)²

Reference: USEPA, 1989b

TABLE C-2 EXPOSURE PARAMETERS, OCCUPATIONAL SOIL CONTACT, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

PARAMETER	WWTP WORKER	CONSTRUCTION WORKER	UNITS	SOURCE
Soil Ingestion Rate	50	480	mg/day	USEPA, 1991c
Soil Adherence Factor	1	1	mg/cm ²	USEPA, 1992d
Surface Area Exposed ¹	2,300	2,300	cm ²	USEPA, 1990c
Fraction Ingested From Site	100%	100%		Assumption
Exposure Frequency ²	250	130	days/year	USEPA, 1991c/ Assumption
Exposure Duration	25	1	years	USEPA, 1991c/ Assumption
Body Weight	70	70	kg	USEPA, 1989b
Averaging Time				
Cancer	70	70	years	USEPA, 1989b
Noncancer	25	1	years	USEPA, 1989b/ Assumption

NOTES:

1. 50th percentile; Hands and forearms
2. Construction Worker - 5 days/week, 26 weeks/year

mg = milligrams

cm² = square centimeters

kg = kilograms

TABLE C-3 DEFAULT EXPOSURE PARAMETERS, OCCUPATIONAL INHALATION EXPOSURE, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

PARAMETER	WWTP WORKER	CONSTRUCTION WORKER	UNITS	SOURCE
Inhalation Rate	20	20	m ³ /workday	USEPA, 1991c
Exposure Frequency	250	30	days/year	USEPA, 1991c/ Assumption
Exposure Duration	25	1	years	USEPA, 1991c/ Assumption
Body Weight	70	70	kg	USEPA, 1989b
Averaging Time				
Cancer	70	70	years	USEPA, 1989b
Noncancer	25	1	years	USEPA, 1989b/ Assumption

m³ = cubic meters
kg = kilograms

TABLE C-4 EXPOSURE PARAMETERS, RESIDENTIAL USE OF POTABLE WATER, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

PARAMETER	CHILD 1 - 6	ADULT 7 - 30	UNITS	SOURCE
Water Ingestion Rate	1	2	liter/day	USEPA, 1986/1991c
Daily Indoor Inhalation Rate	NA	15	m ³ /day	USEPA, 1991c
Surface Area Exposed - Showering ¹	7,195	18,150	cm ²	USEPA, 1990c
Exposure Time - Showering	12 (0.2)	12 (0.2)	min/day (hrs/day)	USEPA, 1989b
Exposure Frequency	350	350	days/year	USEPA, 1991d
Exposure Duration	6	24	years	USEPA, 1991d
Exposure Duration for Inhalation of Vapors	NA	30	years	USEPA, 1991c
Volatilization Factor		0.0005 x 1000 L/m ³	unitless	USEPA, 1991d
Body Weight	15	70	kg	USEPA, 1989b
Averaging Time				
Cancer	70	70	years	USEPA, 1989b
Noncancer	6	24	years	USEPA, 1989b
Inhalation of volatiles	NA	30	years	USEPA, 1991c

NOTES:

1. 50th percentile; Whole body

m³ = cubic meters

cm² = square centimeters

min = minutes

kg = kilograms

TABLE C-5 DEFAULT EXPOSURE PARAMETERS, SWIMMING, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

PARAMETER	CHILD 6 - 16	ADULT 7 - 30	UNITS	SOURCE
Water Ingestion Rate	50	50	ml/hour	USEPA, 1989b
Surface Area Exposed ¹	7,195	18,150	cm ²	USEPA, 1990c
Exposure Time	2.6	2.6	hour/day	USEPA, 1989b
Exposure Frequency	45	45	days/year	USEPA, 1991b
Exposure Duration	6	24	years	USEPA, 1989b
Body Weight	15	70	kg	USEPA, 1989b, 1991c
Averaging Time				
Cancer	70	70	years	USEPA, 1989b
Noncancer	6	24	years	USEPA, 1989b

NOTES:

1. 50th percentile; Whole body
- ml = milliliters
cm² = square centimeters
kg = kilograms

TABLE C-6 DEFAULT EXPOSURE PARAMETERS, WADING, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

PARAMETER	CHILD 6 - 16	UNITS	SOURCE
Water Ingestion Rate	5	ml/hour	Assumption
Surface Area Exposed ¹	6150	cm ²	USEPA, 1990c
Exposure Time	2	hour/day	Assumption
Exposure Frequency	45	days/year	USEPA, 1991b
Exposure Duration	11	years	Assumption
Body Weight	40	kg	USEPA, 1990c
Averaging Time			
Cancer	70	years	USEPA, 1989b
Noncancer	11	years	Assumption

NOTES:

1. 50th percentile; Hands, feet, arms, and legs.
ml = milliliters
cm² = square centimeters
kg = kilograms

TABLE C-7 ORAL DOSE/RESPONSE INFORMATION FOR CARCINOGENIC EFFECTS, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

Compound	Weight of Evidence	Oral Slope Factor		Test Species	Study Type	Tumor Type	Source
		[(mg/kg/day)(-1)]					
1,1,1-Trichloroethane	D						IRIS
1,1-Dichloroethane	C	ND					IRIS
Acetone	D						IRIS
Arsenic	A	1.75E+00 *		Human	DW	Skin tumors	IRIS
Barium	NE						IRIS
Benzene	A	2.90E-02		Human	Occup.	Leukemia	IRIS
Beryllium	B2	4.30E+00		Rat	DW	Total tumors	IRIS
Bis(2-ethylhexyl)phthalate (BEHP)	B2	1.40E-02		Mouse	Oral/Diet	Hepatocellular carcinoma	IRIS
Cadmium	B1	NA					IRIS
Chloroform	B2	6.10E-03		Rat	DW	Kidney tumors	IRIS
Chloromethane	C	1.30E-02		Mouse	Inhalation	Kidney	HEAST
Chromium III	NE						IRIS
Chromium VI	A	NA					IRIS
o-Cresol	C						IRIS
p-Cresol	C	ND					IRIS
Cyanide	D	ND					IRIS
Fluorides (soluble)	NE						IRIS
Lead	B2	ND					IRIS
Manganese	D						IRIS
Mercury	D						IRIS
Methylene Chloride (Dichloromethane)	B2	7.50E-03		Mouse	DW	Hepatocellular cancer	IRIS
Methyl Ethyl Ketone (2-Butanone)	D						IRIS
Nickel	NE						IRIS
Nitrate	P						IRIS
Phenol	D						IRIS
Selenium	D						IRIS
Silver	D						IRIS
Sodium	NE						
Sulfate	NE						
Tetrachloroethene	B2	ND	W				HEAST
Toluene	D						IRIS
trans-1,2-Dichloroethene	NE						IRIS
Trichloroethene	B2	ND	W				HEAST/IRIS

TABLE C-7 ORAL DOSE/RESPONSE INFORMATION FOR CARCINOGENIC EFFECTS, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2 (continued)

Compound	Weight of Evidence	Oral Slope Factor [(mg/kg/day)⁻¹]	Test Species	Study Type	Tumor Type	Source
Vanadium	ND					HEAST/IRIS
Vinyl Chloride	A	1.90E+00 R	Rat	Diet	Lung, liver	HEAST
Xylenes (total)	D					IRIS
Zinc	D					IRIS

Weight of Evidence:

NA – Not Applicable
 ND – Not Determined
 NE – Not Evaluated by EPA
 DW – Drinking water
 * – calculated from unit risk of 5E-5 ug/L

W – Withdrawn from IRIS
 P – IRIS input pending
 R – Under review on IRIS

A – Human carcinogen
 B – Probable human carcinogen (B1 – limited evidence of carcinogenicity in humans; B2 – sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)
 C – Possible human carcinogen
 D – Not classifiable as to human carcinogenicity
 E – Evidence of lack of carcinogenicity to humans

Sources: IRIS, 1992
 HEAST, 1992

TABLE C-8 ORAL DOSE/RESPONSE INFORMATION FOR NONCARCINOGENIC EFFECTS NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

COMPOUND	SUBCHRONIC	CHRONIC ORAL	STUDY TYPE	CONFIDENCE LEVEL	CRITICAL EFFECT	TEST ANIMAL	UNCERTAINTY FACTOR	SOURCE
	ORAL RfD* (mg/kg-day)	RfD (mg/kg-day)						
1,1,1-Trichloroethane	9E-01	9E-02 W	Inhalation		Hepatotoxicity	Guinea Pig	1,000	HEAST
1,1-Dichloroethane	1E+00	1E-01 P	Inhalation		None	Rat	1,000	HEAST
Acetone	1E+00	1E-01	Gavage	Low	Increased liver and kidney weights, nephrotoxicity	Rat	1,000 H,A,S	IRIS
Arsenic	3E-04	3E-04 P	Oral-diet	Medium	Keratosis and hyperpigmentation	Human	3 H	IRIS
Barium	7E-02	7E-02	Oral-DW	Medium	Increased blood pressure	Human	3 H	IRIS
Benzene	ND	P						IRIS
Beryllium	5E-03	5E-03	DW	Low	None observed	Rat	100 H,A	IRIS
Bis(2-ethylhexyl)phthalate (BEHP)	2E-02	2E-02	Oral-diet	Medium	Increased liver weight	Guinea Pig	1,000 H,A,S	IRIS
Cadmium (food)	NA	1E-03	Oral-diet	High	Significant proteinuria	Human	10 H	IRIS
Cadmium (water)	NA	5E-04	Oral-DW	High	Significant proteinuria	Human	10 H	IRIS
Chloroform	1E-02	1E-02	Oral	Medium	Fatty cyst formation in liver	Dog	1,000 H,A,S	IRIS
Chloromethane	Data inadequate for risk assessment							HEAST
Chromium III	1E+00	1E+00	Oral-diet	Low	No effects observed	Rat	100 H,A; MF=10	IRIS
Chromium VI	2E-02	5E-03	Oral-DW	Low	No effects reported	Rat	500 H,A,S	IRIS
2-Methylphenol (o-Cresol)	5E-01	5E-02 W	Oral-diet		Decreased body weights, neurotoxicity	Rat	1,000	HEAST
4-Methylphenol (p-Cresol)	5E-01	5E-02 W	Oral-diet		Decreased body weights, neurotoxicity	Rat	1,000	HEAST
Cyanide	2E-02	2E-02	Oral-diet	Medium	Weight loss, thyroid effects	Rat	100 H,A; MF=5	IRIS
Fluorides	6E-02	6E-02	Epidemiologic	High	Dental fluorosis	Children	1	IRIS
Lead	ND	ND						IRIS/HEAST
Manganese	1E-01	1E-01	Oral-diet	Medium	CNS effects	Human	1	IRIS
Mercury	3E-04	3E-04 P	Parenteral		Kidney effects	Rat	1,000	HEAST
Methyl Ethyl Ketone (2-Butanone)	5E-01	5E-02	Inhalation	Medium	Fetotoxicity	Rat	1,000 H,A,S	IRIS
Methylene Chloride (Dichloromethane)	6E-02	6E-02	DW	Medium	Liver toxicity	Rat	100 H,A	IRIS
Nickel	2E-02	2E-02	Oral-diet	Medium	Decreased body and organ weights	Rat	100 H,A	IRIS
Nitrate	ND	1.6E+00	Epidemiologic	High	Early clinical signs of methemoglobinemia	Human infant	1	IRIS
Phenol	6E-01	6E-01	Oral	Low	Reduced fetal body weight	Rat	100 H,A	IRIS
Selenium	5E-03	5E-03	Epidemiologic	Medium	Clinical selenosis	Human	3 H	IRIS
Silver	5E-03	5E-03	Therapeutic	Medium	Argyria	Human	2 L	IRIS
Sodium		NE						
Sulfate		NE						
Tetrachloroethene	1E-01	1E-02	Gavage	Medium	Hepatotoxicity	Mouse	1,000 H,A,S	IRIS
Toluene	2E+00	2E-01	Gavage	Medium	Weight change in liver and kidneys	Rat	1,000 H,A,S	IRIS

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TABLE C-8 ORAL DOSE/RESPONSE INFORMATION FOR NONCARCINOGENIC EFFECTS NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2 (continued)

COMPOUND	SUBCHRONIC	CHRONIC ORAL	STUDY TYPE	CONFIDENCE LEVEL	CRITICAL EFFECT	TEST ANIMAL	UNCERTAINTY FACTOR	SOURCE
	ORAL RID* (mg/kg-day)	RfD (mg/kg-day)						
trans-1,2-Dichloroethene	2E-01	2E-02	Gavage	Low	Increased serum alkaline phosphatase in males	Mouse	1,000 H,A,S	IRIS
Trichloroethene	ND	P						IRIS
Vanadium	7E-03	7E-03	Oral-DW		None observed	Rat	100	HEAST
Vinyl Chloride	ND	ND						HEAST
Xylenes (total)	4E+00	2E+00	Gavage	Medium	Hyperactivity, decreased body weight	Rat	100 H,A	IRIS
Zinc	2E-01	2E-01	Therapeutic		Anemia	Human	10	HEAST

ND - No data available

W - RfD withdrawn from IRIS

P - RfD pending in IRIS

NE - Not evaluated by IRIS or HEAST

R - Under review by IRIS

NA - Not appropriate

*All subchronic values are from HEAST, 1992

Uncertainty factors: H - variation in human sensitivity

A - animal to human extrapolation

S - extrapolation from subchronic to chronic NOAEL

L - extrapolation from LOAEL to NOAEL

N - NOEL not attained

D - Lack of supporting data

Additional uncertainty factors or modifying factors (MF) of

1 to 10 may be added to account for other uncertainties

such as inadequacies in the database or the severity of the effect.

Sources: IRIS, 1992

HEAST, 1992

TABLE C-9 INHALATION DOSE/RESPONSE INFORMATION FOR CARCINOGENIC EFFECTS, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

Compound	Weight of Evidence	Inhalation Slope Factor* [(mg/kg/day)(-1)]	Unit Risk (ug/m ³)-1	Test Species	Study Type	Tumor Type	Source
1,1,1-Trichloroethane	D						IRIS
1,1-Dichloroethane	C		ND				IRIS
Acetone	D						IRIS
Arsenic	A	5.0E+01	4.3E-03	Human	Inhalation	Respiratory tract	IRIS
Barium	NE						IRIS
Benzene	A	2.9E-02	8.3E-06	Human	Occupational	Leukemia	IRIS
Beryllium	B2	8.4E+00	2.4E-03	Human	Occupational	Lung	IRIS
Bis(2-ethylhexyl)phthalate (BEHP)	B2		ND				IRIS
Cadmium	B1	6.1E+00	1.8E-03	Human	Occupational	Respiratory tract	IRIS
Chloroform	B2	8.1E-02	2.3E-05 +	Mouse	Gavage	Liver	IRIS
Chloromethane	C	6.3E-03	1.8E-06				HEAST
Chromium III	NE						IRIS
Chromium VI	A	4.1E+01	1.2E-02	Human	Occupational	Lung	IRIS
o-Cresol	C		ND				IRIS
p-Cresol	C		ND				IRIS
Cyanide	D						IRIS
Fluorides (soluble)	NE						IRIS
Lead	B2		ND				IRIS
Manganese	D						IRIS
Mercury	D						IRIS
Methylene chloride (Dichloromethane)	B2	1.65E-03 ~	4.7E-07	Mouse	Inhalation	Combined adenomas & carcinomas	IRIS
Methyl ethyl ketone (2-Butanone)	D						IRIS
Nickel	NE						IRIS
Nitrate	P						IRIS
Phenol	D						IRIS
Selenium	D						IRIS
Silver	D						IRIS
Sodium	NE						IRIS
Sulfate	NE						IRIS
Tetrachloroethene	B2		ND	W			IRIS
Toluene	D						IRIS

TABLE C-9 INHALATION DOSE/RESPONSE INFORMATION FOR CARCINOGENIC EFFECTS, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2 (continued)

Compound	Weight of Evidence	Inhalation Slope Factor* [(mg/kg/day)(-1)]	Unit Risk (ug/m ³)-1	Test Species	Study Type	Tumor Type	Source
trans-1,2-Dichloroethene	NE						IRIS
Trichloroethene	B2		ND	W			IRIS
Vanadium	ND						
Vinyl Chloride	A	3.0E-01	8.4E-05	Rat	Inhalation	Liver	HEAST
Xylenes (total)	D						IRIS
Zinc	D						IRIS

NA - Not Applicable

ND - Not Determined

NE - Not Evaluated by EPA

W - Withdrawn from IRIS

P - IRIS input pending

R - Under review on IRIS

* - Source of slope factor is HEAST unless otherwise noted

** - Slope Factor for Benzo(a)Pyrene use for other carcinogenic PAHs

~ - Calculated from unit risk [slope = (unit risk x 70 kg)/20 m³/day x 10⁻³ mg/ug]

+ - Based on route-to-route extrapolation

Sources: IRIS, 1992

HEAST, 1992

Weight of Evidence: A - Human carcinogen

B - Probable human carcinogen (B1 - limited evidence of carcinogenicity in humans;

B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)

C - Possible human carcinogen

D - Not classifiable as to human carcinogenicity

E - Evidence of lack of carcinogenicity to humans

TABLE C-10 INHALATION DOSE/RESPONSE INFORMATION FOR NONCARCINOGENIC EFFECTS, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

COMPOUND	SUBCHRONIC	CHRONIC INH.	STUDY CONFIDENCE			TEST	UNCERTAINTY	SOURCE
	INH. RfD (mg/kg-day)	RfD (mg/kg-day)	TYPE	LEVEL	CRITICAL EFFECT	ANIMAL	FACTOR	
1,1,1-Trichloroethane	1E+01		1E+00	Inhalation	Hepatotoxicity	Guinea Pig	1,000	HEAST
1,1-Dichloroethane	1E+00		1E-01	Inhalation	Kidney damage	Cat	1,000	HEAST
Acetone		ND						HEAST
Arsenic		ND						HEAST
Barium	7E-02		7E-02	Inhalation	Fetotoxicity	Rat	1,000	HEAST
Benzene		ND						HEAST
Beryllium		ND						HEAST
Bis(2-ethylhexyl)phthalate (BEHP)		ND						HEAST
Cadmium (food)		ND						HEAST
Cadmium (water)		ND						HEAST
Chloroform		ND						HEAST
Chloromethane		ND						HEAST
Chromium III		ND						HEAST
Chromium VI		ND						HEAST
2-Methylphenol (o-Cresol)		ND						HEAST
4-Methylphenol (p-Cresol)		ND						HEAST
Cyanide		ND						HEAST
Fluorides		ND						HEAST
Lead		ND						HEAST
Manganese		ND						HEAST
Mercury	3E-04		3E-04	Inhalation	Neurotoxicity	Human	30	HEAST
Methyl Ethyl Ketone (2-Butanone)	3E+00		3E-01	Inhalation	None observed	Rat	1,000	HEAST
Methylene Chloride (Dichloromethane)		ND						HEAST
Nickel		ND						HEAST
Nitrate		ND						HEAST
Phenol		ND						HEAST
Selenium		ND						HEAST
Silver		ND						HEAST
Sodium		ND						HEAST

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TABLE C-10 INHALATION DOSE/RESPONSE INFORMATION FOR NONCARCINOGENIC EFFECTS, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2 (continued)

COMPOUND	SUBCHRONIC	CHRONIC INH.	STUDY CONFIDENCE			TEST	UNCERTAINTY	SOURCE
	INH. RfD (mg/kg-day)	RfD (mg/kg-day)	TYPE	LEVEL	CRITICAL EFFECT	ANIMAL	FACTOR	
Sulfate		ND						HEAST
Tetrachloroethene		ND						HEAST
Toluene	2E+00		4E-01	Inhalation	CNS effects and irritation	Human	300	HEAST
trans-1,2-Dichloroethene		ND						HEAST
Trichloroethene		ND						HEAST
Vanadium		ND						HEAST
Vinyl Chloride		ND						HEAST
Xylenes (total)		ND						HEAST
Zinc		ND						HEAST

ND – No data available

Uncertainty factors: H – variation in human sensitivity
 A – animal to human extrapolation
 S – extrapolation from subchronic to chronic NOAEL
 L – extrapolation from LOAEL to NOAEL
 N – NOEL not attained
 D – Lack of supporting data
 Additional uncertainty factors or modifying factors (MF) of 1 to 10 may be added to account for other uncertainties such as inadequacies in the database or the severity of the effect.

Source: HEAST, 1992

RESIDENTIAL WATER - CARCINOGENIC EFFECTS

$$TR = \frac{SF_o \times C \times IR_w \times EF \times ED}{BW \times AT \times 365days/yr} + \frac{SF_i \times C \times K \times IR_a \times EF \times ED}{BW \times AT \times 365days/yr}$$

$$= \frac{EF \times ED \times C \times [(SF_o \times IR_w) + (SF_i \times K \times IR_a)]}{BW \times AT \times 365days/yr}$$

$$C(mg/L; \text{ risk-based}) = \frac{TR \times BW \times AT \times 365days/yr}{EF \times ED \times [(SF_i \times K \times IR_a) + (SF_o \times IR_w)]}$$

where:

<u>Parameters</u>	<u>Definition (units)</u>	<u>Default Value</u>
C	chemical concentration in water (mg/L)	—
TR	target excess individual lifetime cancer risk (unitless)	10 ⁻⁶
SF _i	inhalation cancer slope factor ((mg/kg-day) ⁻¹)	chemical-specific
SF _o	oral cancer slope factor ((mg/kg-day) ⁻¹)	chemical-specific
BW	adult body weight (kg)	70 kg
AT	averaging time (yr)	70 yr
EF	exposure frequency (days/yr)	350 days/yr
ED	exposure duration (yr)	30 yr
IR _a	daily indoor inhalation rate (m ³ /day)	15 m ³ /day
IR _w	daily water ingestion rate (L/day)	2 L/day
K	volatilization factor (unitless)	0.0005 x 1000 L/m ³ (Anделman 1990)

RESIDENTIAL WATER - NONCARCINOGENIC EFFECTS

$$THI = \frac{C \times IR_w \times EF \times ED}{RfD_o \times BW \times AT \times 365days/yr} + \frac{C \times K \times IR_a \times EF \times ED}{RfD_i \times BW \times AT \times 365days/yr}$$

$$= \frac{EF \times ED \times C \times [(1/RfD_o \times IR_w) + (1/RfD_i \times K \times IR_a)]}{BW \times AT \times 365days/yr}$$

$$C(mg/L; \text{ risk-based}) = \frac{THI \times BW \times AT \times 365days/yr}{EF \times ED \times [(1/RfD_i \times K \times IR_a) + (1/RfD_o \times IR_w)]}$$

where:

<u>Parameters</u>	<u>Definition</u>	<u>Default Value</u>
C	chemical concentration in water (mg/L)	—
THI	target hazard index (unitless)	1
RfD _o	oral chronic reference dose (mg/kg-day)	chemical-specific
RfD _i	inhalation chronic reference dose (mg/kg-day)	chemical-specific
BW	adult body weight (kg)	70 kg
AT	averaging time (yr)	30 yr (for noncarcinogens, equal to ED)
EF	exposure frequency (days/yr)	350 days/yr
ED	exposure duration (yr)	30 yr
IR _a	daily indoor inhalation rate (m ³ /day)	15 m ³ /day
IR _w	daily water ingestion rate (L/day)	2 L/day

ECOLOGICAL FOOD WEB MODEL FOR ESTIMATING EXPOSURE CONCENTRATIONS FOR TERRESTRIAL RECEPTOR SPECIES

A computer food-web model (LOTUS™) will be used to estimate contaminant levels in various prey items consumed by a number of indicator receptor species. Estimated contaminant tissue residues in prey items will be calculated using specific bioaccumulation factors obtained directly or extrapolated from values in the scientific literature. If BAFs are not available in the literature for certain compounds found at the site, BAFs for these compounds will be derived using regression equations (Lyman et al., 1990). BAFs will also be used to model the transfer of surface soil constituents between trophic levels in order to estimate tissue concentrations in secondary prey items such as small mammals and reptiles.

The following equation will be used to estimate contaminant tissue residues in prey items:

$$\text{Prey Tissue Concentration (mg/kg)} = \text{Soil Concentration (mg/kg)} \times \text{Bioconcentration Factor (BCF)}$$

The Potential Dietary Exposure (PDE) level, for each modeled receptor species, will be calculated by multiplying each predicted prey species tissue concentration by the proportion of that prey type in the diet, summing these values, adding soil exposure, and multiplying by the receptor species' Site Foraging Frequency (SFF). Incidental soil ingestion associated with foraging, preening, and cleaning activities, will be conservatively assumed to represent five percent of total dietary intake for all modeled ecological receptors. The PDE will be represented by the following equation:

$$PDE = \sum_{1 \rightarrow n} [P_n \times T_n + \text{soil exposure}] \times SFF$$

where:

PDE	=	Potential Dietary Exposure (mg/kg)
P _n	=	Percent of diet represented by prey item n ingestion
T _n	=	Tissue concentration in prey item n (mg/kg); calculated by multiplying the chemical concentration in soil by a bioaccumulation factor
Soil Exposure	=	(0.05)(Soil concentration in mg/kg)
SFF	=	Site Foraging Frequency; Area of Contaminated Soil (acres)/Home range (acres)

The SFF term for modeled receptor species will not be used when acute exposure concentrations are estimated (i.e., those associated with a single feeding episode) at any of the evaluated site study areas. This will be done because the ecological risk concern for acute exposures is not the probability that an organism will feed at the particular site, but rather what the exposure would be if an organism were to feed in the contaminated area. However, SFF terms for individual prey items consumed by secondary consumers will be used in estimating the individual prey tissue contaminant concentrations.

Finally, the PDE for each receptor species will be multiplied by the receptor-specific ingestion rate and divided by the estimated body weight to calculate a total body dose (TBD):

$$TBD = PDE \times IR \times \frac{I}{BW}$$

where:

TBD =	Total Body Dose (mg/kgBW-day)
PDE =	Potential dietary exposure (mg/kg)
IR =	Ingestion rate (kg/day)
BW =	Body weight (kg)

These TBD estimates will be directly comparable to the available toxicological test data and will be used in conjunction with toxicological data to evaluate ecological risks.

TABLE C-12 ECOLOGICAL INGESTION TOXICITY DOSE/RESPONSE DATA, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2

COMPOUND	ACUTE ORAL RTV (mg/kgBW/day)	CHRONIC ORAL RTV (mg/kgBW/day)	STUDY TYPE	CRITICAL EFFECT	TEST ANIMAL	SOURCE
1,1,1 - Trichloroethane	2060 [a]		Single oral dose	Mortality	Rat	NIOSH, 1985
		90	Oral (subchronic)	Liver toxicity	Guinea pig	IRIS, 1991
1,1-Dichloroethane	150 [a]	15 [b]	Single oral dose	Mortality	Rat	NIOSH, 1985
Acetone	1950 [a]		Single oral dose	Mortality	Rat	Sax, 1984
		500 [d]	Oral (subchronic)	Increased liver/kidney weight; nephrotoxicity	Rat	IRIS, 1991
Arsenic	75 [b]	7.5	Oral (chronic)	Weight loss	Rat	USEPA, 1984
	9.5 [a]	1.0 [b]	Single oral dose	Mortality	California quail	Eisler, 1988
	2500 [b]	250 [d]	Oral (chronic)	Mortality	Dog	USEPA, 1984
Barium	10 [b]	1 [d]	Oral (chronic)	NOEL	Rat	IRIS, 1990
Benzene	100 [b]	10	Oral (chronic)	Hematopoietic effects	Rat	USEPA, 1984
Beryllium	2.0 [a]		Single oral dose	Mortality	Rat	USEPA, 1985
		0.22	Oral (chronic)	Increase in lung sarcomas	Rat	USEPA, 1985
BEHP (also surrogate for dioctylphthalate)	1720 [a]		Single oral dose	Mortality	Rat	NIOSH, 1985
		19	Oral (chronic)	Increased liver weight	Guinea pig	IRIS, 1992
Cadmium		0.32	Oral (subchronic)	Alteration in blood chemistry	Mouse	Eisler, 1985
	30 [a]		Single oral dose	Mortality	Guinea pig	Eisler, 1985
	76 [b]	7.6	Oral (subchronic)	Bone marrow hypoplasia	Japanese quail	Eisler, 1985
Chloromethane	Typically exists in a gaseous state; no oral RTV available					
Chloroform	129 [b]	12.9	Oral (chronic)	Liver cyst formation	Dog (beagle)	IRIS, 1991
Chromium (Cr+6)	57 [b]	5.7	Oral (chronic)	Testicular degeneration	Mouse	ATSDR, 1991
		3.5	Oral (chronic)	Growth patterns altered	Black duck	Eisler, 1986
(Potassium dichromate)	25 [a]		Oral (acute)	Mortality	Japanese quail	Hill and Camardese, 1986
2-Methylphenol (o-Cresol)	24 [a]	2.4 [b]	Oral (acute)	Mortality	Rat	Sax, 1984
4-Methylphenol (p-cresol)	41 [a]	4.1 [b]	Oral (acute)	Mortality	Rat	Sax, 1984
Cyanide	1.7 [a]	0.17 [b]	Single oral dose	Mortality	Mouse	Arthur D. Little, Inc., 1987
Fluorides (sodium fluoride)	36 [a]	3.6 [b]	Oral (acute)	Mortality	Rat	Sax, 1984
	15 [a]	1.5 [b]	Oral (acute)	Mortality	Dog	Sax, 1984
Lead	2 [a]		Single oral dose	Mortality	Rat	Eisler, 1988
		0.0 [b]	Oral (acute)	Increased resorptions/dam	Rat	Kennedy et al., 1975
		1.75 [c]	Oral (chronic)	Decrease in ALAD activity	Mallard	Eisler, 1988
	4.9 [a]		Single oral dose	Mortality	Japanese quail	Eisler, 1988
	25	2.5 [b]	Oral (acute)	ALAD depression	Kestrel (nestlings)	Eisler, 1988

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TABLE C-12 ECOLOGICAL INGESTION TOXICITY DOSE/RESPONSE DATA, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2 (continued)

COMPOUND	ACUTE ORAL RTV (mg/kgBW/day)	CHRONIC ORAL RTV (mg/kgBW/day)	STUDY TYPE	CRITICAL EFFECT	TEST ANIMAL	SOURCE
	30 [b]	3	Oral (subchronic)	Anorexia and convulsions	Dog	Eisler, 1988
Manganese	45 [a]	4.5 [b]	Oral (acute)	Mortality	Rat	ATSDR, 1990
Mercury		0.12 [c]	Oral (subchronic)	Behavioral changes in offspring	Rat	Suzuki, 1979
	3.6 [a]		Single oral dose	Mortality	Rat	NIOSH, 1985
	0.4 [a]		Single oral dose	Mortality	Mallard	Eisler, 1987
		0.007 [c]	Oral (chronic)	Behavioral and reproductive deficiencies	Mallard	Eisler, 1987
	0.2 [a]		Single oral dose	Mortality	Mink	Eisler, 1987
		0.029 [c]	Oral (subchronic)	Mortality	Mink	Eisler, 1987
	1 [b]	0.1	Oral (chronic)	High incidence of stillbirths	Dog	Eisler, 1987
Methyl ethyl ketone (2-Butanone)	1305 [b]	131 [b]	Inhalation	Fetotoxicity	Rat	IRIS, 1991
Methylene chloride	526 [b]	52.6	Oral (chronic)	Liver toxicity	Rat	IRIS, 1991
Nickel	13.4 [a]	1.3 [b]	Single oral dose	Mortality	Rat	ATSDR, 1987
	100.7 [a]	10.1 [b]	Oral (acute)	NOEL	Japanese quail	Hill and Camardese, 1986
	625 [b]	62.5	Oral (chronic)	Histologic lesions in bone marrow	Dog	ATSDR, 1987
Nitrate	1330 [b]	133	Oral (subchronic)	Elevated methemoglobin levels	Mouse	USEPA, 1985
Phenol	70 [a]	7 [b]	Single oral dose	Mortality	Rat	USEPA, 1980
	20 [a]	2 [b]	Single oral dose	Mortality	Cat	USEPA, 1980
Selenium	0.04 [c]	0.004 [b]	Oral (chronic)	Selenosis	Rat	Eisler, 1985
	0.6 [c]	0.06 [b]	Oral (chronic)	Reduced egg hatching	Japanese quail	Eisler, 1985
Silver	181 [b]	18.1	Oral (chronic)	Increased hyperactivity	Mouse	ATSDR, 1990
Sulfate (sodium)	1198	120 [b]	Single oral dose	Mortality	Rabbit	NIOSH, 1985
Tetrachloroethene	1620 [a]		Single oral dose	Mortality	Mouse	TDB, 1984
		71	Oral (subchronic)	Hepatotoxicity	Mouse	IRIS, 1991
Toluene	1000 [a]		Single oral dose	Mortality	Rat	NIOSH, 1985
		446	Oral (chronic)	Liver and kidney weight changes	Rat	IRIS, 1991
t-1,2-Dichloroethene	154 [a]	15 [b]	Single oral dose	Mortality	Rat	NIOSH, 1985
Trichloroethene	480 [a]	48 [b]	Single oral dose	Mortality	Mouse	NIOSH, 1985
Vanadium	25 [b]	2.5	Oral (chronic)	Decreased hair cystine, hemoglobin	Rat	IRIS, 1989
	20 [a]	2 [b]	Oral (acute)	Mortality	Japanese quail	Hill and Camardese, 1986

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TABLE C-12 ECOLOGICAL INGESTION TOXICITY DOSE/RESPONSE DATA, NAS, JACKSONVILLE, FLORIDA, OPERABLE UNIT 2 (continued)

COMPOUND	ACUTE ORAL RTV (mg/kgBW/day)	CHRONIC ORAL RTV (mg/kgBW/day)	STUDY TYPE	CRITICAL EFFECT	TEST ANIMAL	SOURCE
Vinyl chloride	100 [a]	10 [b]	Single oral dose	Mortality	Rat	NIOSH, 1985
Xylenes	860 [a]		Single oral dose	Mortality	Rat	NIOSH, 1985
		> 500	Oral (chronic)	Hyperactivity, decreased BW, mortality	Rat	IRIS, 1991
Zinc	2014 [c]	201 [b]	Oral (acute)	Mortality	Japanese quail	Hill and Camardese, 1986
	500 [a]		Single oral dose	Mortality	Rat	Sax, 1984
		160	Oral (subchronic)	Kidney toxicity	Rat	Llobet, et al., 1988

NOTES:

[a] For chemicals lacking LOAEL or NOAEL data, an Acute Oral Criterion (AOC) is calculated by applying a factor of 0.2 to the acute LD50; this value is expected to protect 99.9% of the exposed population from acute effects (USEPA, 1986).

[b] Estimated by applying an acute-chronic ratio of 10.

[c] Converted to dose per kilogram body weight by multiplying by ingestion rate and dividing by body weight.

[d] Estimated by applying a LOAEL-NOAEL ratio of 5 (Newell, et al., 1987).

[e] Ingestion rate estimated from body weight using allometric equation for chickens in USEPA, 1988.

BW = Body Weight

LOAEL = Lowest Observed Adverse Effect Level

NOAEL = No Observed Adverse Effect Level

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APPENDIX D

SUMMARY OF DATA FROM PREVIOUS INVESTIGATIONS

APPENDIX D
GROSS INDICATORS - OU-2
DOMESTIC AND INDUSTRIAL SLUDGE DRYING BEDS

DATE	COMPOUND	WELL DESIGNATION								
		NAS4-4	NAS4-5	NAS4-9	NAS4-10	NAS4-11	JAX-4-12D	JAX-4-13	JAX-4-13D	JAX-4-14
3/84	pH	4.9	5.2	5.7	ND	NI	NI	NI	NI	NI
	Cond	67	400	36.7	ND	NI	NI	NI	NI	NI
	TOC	3.8	4.0	23.4	ND	NI	NI	NI	NI	NI
	TOH	ND	ND	ND	ND	NI	NI	NI	NI	NI
8/84	pH	6.4	6.9	7.0	ND	NI	NI	NI	NI	NI
	Cond	56	480	336	ND	NI	NI	NI	NI	NI
	TOC	9.5	29.0	32.1	ND	NI	NI	NI	NI	NI
	TOH	<50	80	65	ND	NI	NI	NI	NI	NI
10/84	pH	5.5	6.1	6.5	ND	NI	NI	NI	NI	NI
	Cond	70	320	314	ND	NI	NI	NI	NI	NI
	TOC	3.5	7.3	24.8	ND	NI	NI	NI	NI	NI
	TOH	62	75	9.5	ND	NI	NI	NI	NI	NI
2/85	pH	5.2	6.2	5.8	6.2	NI	NI	NI	NI	NI
	Cond	59	251	216	140	NI	NI	NI	NI	NI
	TOC	59.2	21.4	18.1	115	NI	NI	NI	NI	NI
	TOH	23	33	14	0.11	NI	NI	NI	NI	NI
6/85	pH	5.5	6.7	6.1	6.5	NI	NI	NI	NI	NI
	Cond	106	1060	294	165	NI	NI	NI	NI	NI
	TOC	8.9	30.6	18.3	9.6	NI	NI	NI	NI	NI
	TOH	<50	165	82.5	<50	NI	NI	NI	NI	NI
4/86	pH	5.3	6.2	6.2	6.2	NI	NI	NI	NI	NI
	Cond	53	267	277	80	NI	NI	NI	NI	NI
	TOC	5.3	12.9	28.6	4.2	NI	NI	NI	NI	NI
	TOH	<50	<50	92.5	<50	NI	NI	NI	NI	NI
1/88	pH	5.4	7.0	6.2	5.6	4/47	NI	NI	NI	NI
	Cond	108	3102	220	66	124	NI	NI	NI	NI
	TOC	36.5	353	60.5	23.0	39.7	NI	NI	NI	NI
	TOH	25	825	23.3	27.5	50	NI	NI	NI	NI
2/88	pH	5.2	6.6	6.4	5.9	ND	NI	NI	NI	NI
	Cond	75	2510	290	62	ND	NI	NI	NI	NI
	TOC	5.3	74.0	22.2	2.10	ND	NI	NI	NI	NI
	TOH	24.7	162	83.7	10.2	ND	NI	NI	NI	NI
8/88	pH	5.7	6.3	6.1	5.8	4.6	6.4	5.7	8.6	6.8
	Cond	574	3229	315	85	248	234	215	356	509
	TOC	68.7	31.2	34.2	13.2	18.2	8	17	8	27
	TOH	85	1792	68.7	NA	205	NA	30	46	22
9/88	pH	5.6	6/5	6.6	5.4	6.5	ND	ND	ND	NI
	Cond	440	2948	345	120	408	ND	ND	ND	NI
	TOC	21	61	27	14	38	ND	ND	ND	NI
	TOH	92	392	345	50	80	ND	ND	ND	NI
2/89	pH	5.4	6.3	6.4	5.2	4.4	6.5	6.0	6.1	7.0
	Cond	752	1364	333	232	903	230	188	214	457
	TOC	19	38	31	6	28	3	14	3	8
	TOH	120	200	60	BDL	70	BDL	BDL	BDL	BDL
8/91	pH	4.6	6.4	6.0	5.2	4.9	5.6	6.4	5.7	6.8
	Cond	386	372	294	419	383	219	167	167	465
	TOC	4.7	11	21	11	24	12	4.9	11	8.4
	TOH	110	110	75	45	63	29	43	37	15
8/91	pH	ND	ND	ND	ND	5.0	5.7	5.8	ND	8.3
	Cond	ND	ND	ND	ND	623	157	1160	ND	2590
	TOC	ND	ND	ND	ND	15	2	31	ND	500
	TOH	ND	ND	ND	ND	<50	<50	<50	ND	<50
3/92	pH	ND	6.2	5.4	ND	ND	ND	9.0	ND	9.6
	Cond	ND	365	266	ND	ND	ND	929	ND	2750
	TOC	ND			ND	ND	ND		ND	
	TOH	ND			ND	ND	ND		ND	

APPENDIX D
GROSS INDICATORS - OU-2
DOMESTIC AND INDUSTRIAL SLUDGE DRYING BEDS

DATE	COMPOUND	WELL DESIGNATION									
		JAX-4-15	JAX-4-16	JAX-4-17A	JAX-4-18B	JAX-4-19C	JAX-4-20D	JAX-4-21E	JAX-4-22F	JAX-4-23	
3/84	pH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	Cond	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOC	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
8/84	pH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	Cond	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOC	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
10/84	pH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	Cond	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOC	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
2/85	pH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	Cond	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOC	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
6/85	pH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	Cond	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOC	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
4/86	pH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	Cond	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOC	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
1/88	pH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	Cond	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOC	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
2/88	pH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	Cond	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOC	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
8/88	pH	6.4	5.9	NI	NI	NI	NI	NI	NI	NI	NI
	Cond	778	365	NI	NI	NI	NI	NI	NI	NI	NI
	TOC	65	16	NI	NI	NI	NI	NI	NI	NI	NI
	TOH	113	51	NI	NI	NI	NI	NI	NI	NI	NI
9/88	pH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	Cond	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOC	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	TOH	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
2/89	pH	6.1	7.1	6.5	6.9	4.9	4.9	7.2	6.9	4.5	
	Cond	754	1562	92	175	300	300	150	250	145	
	TOC	24	53	14	40	39	39	<10	<10	33	
	TOH	40	70	7	23	10	10	8	16	3	
8/91	pH	6.0	9.3	6.1	6.7	6.0	4.93	5.0	5.6	4.6	
	Cond	163	1966	111	98	70	124	70	140	11	
	TOC	11	26	12	11	4.1	6.9	7.1	13	5.7	
	TOH	36	71	35	35	<10	20	<10	57	12	
8/91	pH	5.8	7.0	ND	ND	ND	ND	ND	ND	ND	
	Cond	800	403	ND	ND	ND	ND	ND	ND	ND	
	TOC	110	53	ND	ND	ND	ND	ND	ND	ND	
	TOH	<50	<50	ND	ND	ND	ND	ND	ND	ND	
3/92	pH	ND	7.5	ND	ND	ND	5.3	5.9	ND	ND	
	Cond	ND	937	ND	ND	ND	132	84	ND	ND	
	TOC	ND		ND	ND	ND			ND	ND	
	TOH	ND		ND	ND	ND			ND	ND	

APPENDIX D
GROSS INDICATORS - OU-2
DOMESTIC AND INDUSTRIAL SLUDGE DRYING BEDS

DATE	COMPOUND	WELL DESIGNATION							
		JAX-4-17D	JAX-4-18D	JAX-4-19D	JAX-4-20D	JAX-4-21D	JAX-4-22D	JAX-4-23D	
3/84	pH	NI	NI	NI	NI	NI	NI	NI	
	Cond	NI	NI	NI	NI	NI	NI	NI	
	TOC	NI	NI	NI	NI	NI	NI	NI	
	TOH	NI	NI	NI	NI	NI	NI	NI	
8/84	pH	NI	NI	NI	NI	NI	NI	NI	
	Cond	NI	NI	NI	NI	NI	NI	NI	
	TOC	NI	NI	NI	NI	NI	NI	NI	
	TOH	NI	NI	NI	NI	NI	NI	NI	
10/84	pH	NI	NI	NI	NI	NI	NI	NI	
	Cond	NI	NI	NI	NI	NI	NI	NI	
	TOC	NI	NI	NI	NI	NI	NI	NI	
	TOH	NI	NI	NI	NI	NI	NI	NI	
2/85	pH	NI	NI	NI	NI	NI	NI	NI	
	Cond	NI	NI	NI	NI	NI	NI	NI	
	TOC	NI	NI	NI	NI	NI	NI	NI	
	TOH	NI	NI	NI	NI	NI	NI	NI	
8/85	pH	NI	NI	NI	NI	NI	NI	NI	
	Cond	NI	NI	NI	NI	NI	NI	NI	
	TOC	NI	NI	NI	NI	NI	NI	NI	
	TOH	NI	NI	NI	NI	NI	NI	NI	
4/86	pH	NI	NI	NI	NI	NI	NI	NI	
	Cond	NI	NI	NI	NI	NI	NI	NI	
	TOC	NI	NI	NI	NI	NI	NI	NI	
	TOH	NI	NI	NI	NI	NI	NI	NI	
1/88	pH	NI	NI	NI	NI	NI	NI	NI	
	Cond	NI	NI	NI	NI	NI	NI	NI	
	TOC	NI	NI	NI	NI	NI	NI	NI	
	TOH	NI	NI	NI	NI	NI	NI	NI	
2/88	pH	NI	NI	NI	NI	NI	NI	NI	
	Cond	NI	NI	NI	NI	NI	NI	NI	
	TOC	NI	NI	NI	NI	NI	NI	NI	
	TOH	NI	NI	NI	NI	NI	NI	NI	
8/88	pH	NI	NI	NI	NI	NI	NI	NI	
	Cond	NI	NI	NI	NI	NI	NI	NI	
	TOC	NI	NI	NI	NI	NI	NI	NI	
	TOH	NI	NI	NI	NI	NI	NI	NI	
9/88	pH	NI	NI	NI	NI	NI	NI	NI	
	Cond	NI	NI	NI	NI	NI	NI	NI	
	TOC	NI	NI	NI	NI	NI	NI	NI	
	TOH	NI	NI	NI	NI	NI	NI	NI	
2/89	pH	9.5	11.1	6.9	6.6	13.2	11.1	10.0	
	Cond	690	1230	410	280	2350	1000	278	
	TOC	<10	80	37	10	11	40	10	
	TOH	3	10	16	12	4	4	4	
8/91	pH	6.3	6.8	6.0	5.8	6.8	5.8	4.6	
	Cond	113	163	70	130	174	204	11	
	TOC	6.2	3.6	4.7	4.1	3.6	4.3	5.7	
	TOH	<10	<10	<10	<10	<10	18	12	
8/91	pH	ND	ND	ND	ND	ND	ND	ND	
	Cond	ND	ND	ND	ND	ND	ND	ND	
	TOC	ND	ND	ND	ND	ND	ND	ND	
	TOH	ND	ND	ND	ND	ND	ND	ND	
3/92	pH	ND	ND	ND	5.2	6.0	ND	ND	
	Cond	ND	ND	ND	123	182	ND	ND	
	TOC	ND	ND	ND	ND	ND	ND	ND	
	TOH	ND	ND	ND	ND	ND	ND	ND	

NOTES:

1. TOC = Total Organic Carbon (mg/L)
2. TOH = Total Organic Halogen (µg/L)
3. Cond = Specific Conductivity (µmhas/cm)
4. BDL = Below Detection Limits
5. NI = Not Installed
6. ND = No Data
7. Well locations are found in Figure 3-11

APPENDIX D
GROUNDWATER DATA - OU-2
DOMESTIC AND INDUSTRIAL SLUDGE DRYING BEDS
ALL DATA µg/L

DATE	WELL DESIGNATION											
	NAS4-4	NAS4-5	NAS4-9	NAS4-10	NAS4-11	JAX-4-12D	JAX-4-13	JAX-4-13D	JAX-4-14	JAX-4-15	JAX-4-16	JAX-4-17
Sept. 1987	ND	40-Cd 4900-Ni 180-V 1250-MeC	ND	ND	ND	NI	NI	NI	NI	NI	NI	NI
Jan. 1988	ND	230 Cr	ND	ND	ND	NI	NI	NI	NI	NI	NI	NI
Aug. 1988	12 TCE 72 1,1-DCA 0.2 Cd 160 Ni	20 Cd 5400 Ni 52 1,1-DCA	ND	220 Ni 12 1,1-DCA	50 Ni 15 TCE 69 1,1-DCA	ND	10 Zn	ND	30 Zn 0.3 Cd	2 Cd 1600 Ni	50 Zn	NI
Feb. 1989	97 1,1-DCA 80 V 4 Cd	116 1,1-DCA 2 VC 60 V 16 0-Cresol 2000 Phenol 3 Cd	40 V	74 1,1-DCA 10 1,1,1-TCA 30 V 32 MeC 10 0-Cresol 940 Phenol	170 1,1-DCA 13 1,1,1-TCA 2 TCE 260 V 123 MeC 63 0-Cresol 1482 Phenol	ND	30 Zn	ND	6 1,1-DCA 10 1,1,1-TCA 10 Zn 1.1 Cd	50 V 126 Phenol 4.8 Cd	30 Zn 30 V 0.8 Cd	ND
May 1989	120 V 50 1,1-DCA 6 MeC 11 Toluene 28 0-Cresol 64 P-Cresol 933 Phenol 3 Cd 160 Ni	76 1,1-DCA 5 VC 60 V 18 0-Cresol 427 P-Cresol 728 Phenol 54 Toluene 143 Cd 410 Ni	50 V	120 V 121 1,1-DCA 14 1,1,1-TCA 102 MeC 17 0-Cresol 10 P-Cresol 1270 Phenol 7 Toluene 16 V	170 Ni 187 1,1-DCA 11 1,1,1-TCA 2 TCE 440 V 72 MeC 20 0-Cresol 15 P-Cresol 936 Phenol 12 Tol	ND	10 Zn 0.2 Cd 5 1,1-DCA 2 1,1,1-TCA	6 1,1-DCA	0.2 Cd 10 Zn 8 1,1-DCA 15 1,1,1-TCA	0.4 Cd 1100 Ni 70 V 58 Phenol	0.2 Cd 60 Zn 60 V	11 Cd 60 V 9 Zn
Aug. 1991	ND	ND	ND	ND	30 CN 32,600 Fe 200 Mn 5 1,1-DCA	20 CN 2500 Fe 59 Mn	40 CN 7700 Fe 830 Mn 590,000 SO 21 Phenols 24 1,1-DCA 40 V	ND	100 CN 60 Ni 2 CS 2 Toluene 2 MeC 740,000 Na 1800 Fe 2 1,1-DCA 180 V	60 CN 184,000 Na 20,200 Fe 69 Mn 5 1,1-DCA 30 V	40 Ni 2 CS 75 Pb 10,800 Fe 88 Mn	ND
Jan. 1992	ND	516 Cd 56 Cr 312 Ni	ND	ND	ND	ND	9 Pb 158 Cr 80 Ni 1.5 MeCl2 16 CN	ND	960 Phenols 153 Cr 19 CN 207 Ni 20 MeCl2 2.8 Tol 16 MEK	ND	8 Phenols 97 Cr 24 Ni	ND

D-4

APPENDIX D
GROUNDWATER DATA – OU-2
DOMESTIC AND INDUSTRIAL SLUDGE DRYING BEDS
ALL DATA µg/L

DATE	WELL DESIGNATION												
	JAX-4-18	JAX-4-19	JAX-4-20	JAX-4-21	JAX-4-22	JAX-4-23	JAX-4-17D	JAX-4-18D	JAX-4-19D	JAX-4-20D	JAX-4-21D	JAX-4-22D	JAX-4-23D
Sept. 1987	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
Jan. 1988	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
Aug. 1988	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
Feb. 1989	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
May 1989	8 Cd 70 Zn	20 V 71 Zn	9 Cd 6 Cr 53 Pb 10 MeC 19 0-Cresol 90 V 110 Zn 250 Phenol 47 1,1-DCA	6 Cd 70 Cr 80 V 110 Zn	ND	15 Cd 160 Zn	8 Cd	7 Cd	57 Pb	10 Cd 58 Pb	7 Cd	ND	5 Cd
Aug. 1991	ND	ND	ND	70 V	34 V	ND	ND	ND	ND	ND	ND	2.3 VC	ND
Jan. 1992	ND	ND	53 Cr	15 Phenols	ND	ND	ND	ND	ND	12 Cd	17 Cd 18 Ni	ND	ND

NOTES:
 NI = Not Installed
 ND = No Data

D-5

APPENDIX D
GROSS INDICATORS - OU-2
DOMESTIC SLUDGE DRYING BEDS

DATE	COMPOUND	WELL DESIGNATION					
		41-1	41-2	41-3	41-4	41-5	41-6
11/90	pH	4.6	5.6	5.8	9.6	5.8	6.7
	Cond	1200	162	900	3690	900	500
	TOC	19	4	56	537	130	56
	TOH	62	19	183	3120	306	282
5/91	pH	5.5	5.8	5.9	9.3	5.9	7.3
	Cond	610	160	1280	2700	980	575
	TOC	13	2	28	400	120	100
	TOH	32	31	104	402	364	179

NOTES:

TOC = Total Organic Carbon (mg/L)
 TOH = Total Organic Halogens (µg/L)
 Cond = Specific Conductivity (µmhos/cm)

APPENDIX D
GROUNDWATER DATA - OU-2
DOMESTIC SLUDGE DRYING BEDS
ALL DATA µg/L

DATE	WELL DESIGNATION					
	41-1	41-2	41-3	41-4	41-5	41-6
Nov. 1990	30 Ni 5 As 120 Ba 10 Cr 47 Zn 51,000 Fe 520 Mn 470,000 SO	4 As 52 Ba 20 Cr 5 Pb 54 Zn 6800 Fe 75 Mn	50 Ni 6 As 330 Ba 50 Cr 22 Pb 75 Zn 13000 Fe 540 Mn 60 V	200 Ni 19 MeCl2 34 As 200 Ba 110 Cr 17 Pb 30 Zn 985,000 Na 4200 Fe 50 V	30 Ni 4 As 110 Ba 20 Cr 16 Zn 193,000 Na 21,200 Fe 64 Mn	50 Ni 6 As 350 Ba 270 Cr 103 Pb 72 Ag 230 Zn 28,600 Fe 110 Mn 130 V
May 1991	30 Ni 6 As 47 Ba 2 Pb 37,200 Fe 24 Mn 290 SO 5 1,1-DCA	16 CS 2000 Fe 54 Mn	30 CN 30 Ni 670 Fe 880 Mn 530,000 SO 17 1,1,-DCA	80 Ni 1 CS 2 Tol 717,000 Na 3100 Fe 4100 F 15 Phenols 2 1,1-DCA 210 V	20 Ni 205,000 Na 24,300 Fe 71 Mn 4 1,1-DCA 40 V	30 Ni 2 CS 130 Cr 4200 Fe 80 Mn 30 V

APPENDIX D
GROSS INDICATORS - OU - 2
POLISHING PONDS

DATE	COMPOUND	WELL DESIGNATION				
		42-5	42-6	42-7	42-8	42-9
3/84	pH	ND	5.5	6.6	6.0	ND
	Cond	ND	NA	NA	NA	ND
	TOC	ND	NA	NA	NA	ND
	TOH	ND	NA	NA	NA	ND
8/84	pH	ND	NA	NA	NA	ND
	Cond	ND	90	500	100	ND
	TOC	ND	NA	NA	NA	ND
	TOH	ND	NA	NA	NA	ND
10/84	pH	ND	5.4	6.1	5.6	ND
	Cond	ND	68	440	85	ND
	TOC	ND	NA	NA	NA	ND
	TOH	ND	NA	NA	NA	ND
2/85	pH	ND	7.5	6.0	5.4	ND
	Cond	ND	70	440	75	ND
	TOC	ND	NA	NA	NA	ND
	TOH	ND	NA	NA	NA	ND
11/90	pH	6.3	4.8	4.5	5.0	6.3
	Cond	1800	100	2200	1590	72
	TOC	37	6	25	89	5
	TOH	154	200	13	145	<10
5/91	pH	5.0	5.3	5.0	5.6	5.4
	Cond	-	95	1820	1590	78
	TOC	14	4	29	20	3
	TOH	62	15	95	56	<10
8/91	pH	5.3	5.1	5.0	5.8	6.2
	Cond	515	96	2390	1100	87
	TOC	26	4	31	33	3
	TOH	71	<50	<50	<50	<50
3/92	pH	5.5	4.7	6.4	ND	ND
	Cond	582	107	1530	ND	ND
	TOC				ND	ND
	TOH				ND	ND

NOTES:

TOC = Total Organic Carbon (mg/L)
 TOH = Total Organic Halogens (µg/L)
 Cond = Specific Conductivity (µmhos/cm)
 ND = No Data

APPENDIX D
GROUNDWATER DATA – OU-2
POLISHING PONDS
ALL DATA µg/L

DATE	WELL DESIGNATION							
	42-5	42-6	42-7	42-8	42-9	NAS 4-6	NAS 4-7	NAS 4-8
April 1984	ND	ND	ND	ND	ND	45 Ba 514 Fe 44 NO3 4 Phenols	99 Ba 39,110 Fe 7 Phenols 3 As 90 Mn 58 Zn 2290 NO3	14 Ba 723 Fe 2 Phenols 15 Mn
July 1984	ND	ND	ND	ND	ND	63 Ba 52 Pb 59 CN 34 Phenols 5 NO3	23 Phenols 82 Ba 15 CN 94 NO3 44,370 Fe	28 NO3 13 Phenols 14 Ba 42 CN
Nov. 1984	ND	ND	ND	ND	ND	48 Ba 8 Phenols	7 As 69 Ba 5 Phenols 43,000 Fe	14 Ba 3 Phenols
Feb. 1985	ND	ND	ND	ND	ND	13 Phenols 43 Ba	63,900 Fe 4 Phenols 819 Ba	11 Phenols 15 Ba
Nov. 1990	3.8 Benzene 51 As 300 Ba 300 Cr 6 Pb 10 Ag 27 Zn 410 Mn 49,600 Fe 20 V 1.4 Total Xyl	9 As 56 Ba 3 Cr 12 Pb 34 Zn 22 Mn 25,500 Fe 30 V	280 Cn 20 Ni 3 As 110 Ba 40 Cr 9 Pb 11 NO3 77 Zn 33,700 Fe 440 Mn 40 V 400 SO4	8 Ac 290 Ba 30 Cr 6 Pb 2 Se 8 Ag 20 V 620 SO4 3.8 NO3 27 Zn 11,700 Fe 210 Mn	12 As 80 Ba 80 Cr 23 Pb 65,200 Fe 35 Mn 80 V	ND	ND	ND
May 1991	4600 Fe 150 Mn 580,000 SO4 20 V	1 CS2 12,400 Fe	50,000 NO3 6200 Fe 750,000 SO4 30 V	12,600 Fe 360 Mn 980,000 SO4	5 CS2 13,100 Fe	ND	ND	ND
Aug. 1991	30 CN 8200 Fe 60 Mn	20 CN 4 CS2 12,900 Fe	30 CN 1 CS2 73,000 NO3 680 Fe 260 Mn 1,900,000 SO4 20 V	8100 Fe 400 Mn 980,000 SO4	2 Toluene 10,400 Fe	ND	ND	ND
Jan. 1992	10 Phenols 7 CN 169 As 96 Cr 26 Ni	3 CN	9 Phenols 4 CN 106 Cr 26 Ni	ND	ND	ND	ND	ND