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Work Plan
for a Partitioning Interwell Tracer Test

Site 88
Marine Corps Base Camp Lejeune

Prepared for:

Navy Facilities Engineering Service Center
560 Center Drive
Port Hueneme, CA 93043-4328

Prepared by:

DE&S
Duke Engineering & Services

Duke Engineering and Services, Inc.
9111 Research Blvd.
Austin, Texas 78758

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October 31, 1997

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ACRONYMS AND ABBREVIATIONS

This list is supplied as an reference guide to the acronyms and abbreviations used throughout this Work Plan.

AATDF	Advanced Applied Technology Demonstration Facility
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
ASTM	American Society for Testing and Materials
bgs	Below ground surface
COC	Chain of Custody
CPT	Cone Penetrometer Test
DAS	Data Acquisition System
DE&S	Duke Engineering and Services
DCE	Dichloroethane
DNAPL	Dense Non-Aqueous-Phase Liquid
DQO	Data Quality Objective
EPA	U.S. Environmental Protection Agency
GC	Gas Chromatograph
HP	Hadnot Point
HSP	Health and Safety Plan
HSPA	Health and Safety Plan Addendum
IPA	Isopropyl alcohol
IWTP	Industrial Wastewater Treatment Plant
NAPL	Non-Aqueous Phase Liquid
MCB	Marine Corps Base
ND	Not Detected
PCE	Perchloroethylene or Tetrachloroethene
PID	Photo-Ionization Detector
PITT	Partitioning Interwell Tracer Test
ppm	Parts per million
ppb	Parts per billion
PQL	Practical Quantification Limit
QA	Quality Assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QAPPA	Quality Assurance Project Plan Addendum
QC	Quality Control
REV	Representative Elemental Volume
SAP	Sampling and Analysis Plan
SAPA	Sampling and Analysis Plan Addendum

Acronyms and Abbreviations, continued

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SEAR	Surfactant-Enhanced Aquifer Remediation
SOP	Standard Operating Procedure
SSO	Site Safety Officer
TCA	1,1,1-Trichloroethane
TCE	Trichloroethene
UT	University of Texas at Austin
VC	Vinyl Chloride
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

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Site 88 (Building HP25) is the location of the base central dry cleaning operation. Dry cleaning operations have been conducted there since 1940's using first Varsol and then tetrachloroethene (PCE) as dry cleaning fluids. Environmental investigations have detected the presence of both compounds in the subsurface. In particular, free-phase PCE, a dense nonaqueous phase liquid (DNAPL), has accumulated in two shallow wells installed adjacent to the facility during August of 1997.

The Naval Facilities Engineering Service Center (NFESC), in collaboration with the U.S. Environmental Protection Agency (EPA) National Risk Management Research Laboratory (NRMRL), is investigating the surfactant-enhanced aquifer remediation (SEAR) technology for the remediation of sites contaminated with DNAPL. This work is being conducted under the DOD's Environmental Security Technology Certification Program (ESTCP). The purpose is to perform additional validation of SEAR in order to promote its commercialization for the rapid cleanup of DNAPL sites owned by the government and industry. Based on the results of recently completed DNAPL investigations, Site 88 has been identified as a suitable site to conduct a demonstration of SEAR technology. In addition to subsurface treatment by surfactants, this demonstration will include procedures to recover surfactant from the effluent stream for reuse.

To investigate the ability of SEAR technology to remediate the site, the quantity of contamination present both before and after the surfactant flood must be measured. Because soil cores cannot be relied upon to provide reliable DNAPL saturations over large zones, the volume and extent of the DNAPL contamination at the demonstration area will be determined by conducting partitioning interwell tracer tests (PITTs). The SEAR demonstration will involve a pre-surfactant flood PITT, a surfactant flood, and a post-surfactant flood PITT.

The PITT was developed by Dr. Gary A. Pope of the University of Texas Department of Petroleum and Geosystems Engineering. Application of PITT technology to the environmental field was developed in conjunction with Dr. Richard Jackson of Duke Engineering and Services (DE&S). PITTs involve the injection of a suite of tracers in one or more wells and the subsequent extraction from one or more other wells in a well field. Analysis of the test results allow the detection and estimation of the volume of DNAPL present in the aquifer between the injection and extraction wells.

Duke Engineering and Services (DE&S), has been retained by the Navy to:

- conduct preliminary field work in support of a PITT;
- select the tracers to be used in the PITT;
- design the PITT; and
- conduct the pre and post-surfactant flood PITTs in the ESTCP demonstration area.

The results of the pre-surfactant flood PITT will be used in the design of a surfactant flood to be conducted during the summer of 1998. This work plan details the activities to be undertaken to perform the pre-surfactant flood PITT. The PITT is scheduled for the months of January and February, 1998.

1.0 INTRODUCTION

1.1 The Migration, Dissolution and Fate of DNAPL in Alluvium

During 1992, the United States Environmental Protection Agency (EPA) published a document defining DNAPL-related terms that are used in this work plan. Moreover, this document also presents the conceptual model for DNAPLs in the subsurface in which ground-water flow through a DNAPL zone generates a dissolved-phase plume (EPA, 1992). This model is now well established, largely due to the work of J.A. Cherry and colleagues (Mackay and Cherry, 1989; Pankow and Cherry, 1996).

The EPA (1992) defines a DNAPL site as "*a site where DNAPL has been released and is now present in the subsurface as an immiscible phase*", i.e., either free-phase and residual DNAPL or simply residual DNAPL alone. Residual DNAPL is that immiscible liquid trapped by capillary forces within the sand and silt fraction that comprises the aquifer system. In the saturated zone it consists of discrete drops or ganglia and is immobile. In contrast, free-phase DNAPL is present along continuous pathways through the aquifer and is mobile. Free-phase DNAPL can be expected to be present when the volume of DNAPL released to the subsurface is large compared to the available pore space within which it might become trapped by capillary forces.

The aqueous solubility of many DNAPLs, including the PCE found at this site, is relatively low. As such, mass transfer to the aqueous phase is limited. Conventional pump and treat operations rely on the mass transfer of the contaminant to the aqueous phase and as such are ineffective for the remediation of most DNAPL contaminated sites. This failure of ground-water extraction to remove significant amounts of DNAPL trapped in very permeable alluvium is quite typical (Mackay and Cherry, 1989). Consequently, in the late 1980s, those interested in aquifer-restoration research and development began to consider technologies developed for enhanced oil recovery (EOR) by the petroleum industry. Of these EOR technologies, surfactant enhanced oil recovery was particularly advanced and promised significant benefits once adapted for implementation in shallow unconfined aquifers contaminated with chlorinated-solvent DNAPLs (Pope and Wade, 1995). This new technology has become known as surfactant-enhanced aquifer remediation or SEAR.

1.2 Project Overview

The quantity of DNAPL that has entered the shallow aquifer at Site 88 is not known although preliminary investigation indicates it may be confined to a relatively limited area on the north side of Building HP25, the main dry cleaning facility for the base. DNAPLs have densities greater than that of water, low viscosities, and low solubilities in water, which allows them to quickly penetrate the unsaturated sediments, sink through the water table, and migrate as a separate liquid phase to accumulate or "pool" in the topographic lows in the surface of the underlying aquitard. As the DNAPL migrated through the sediments, a portion of the contaminant mass was trapped by capillary forces behind the advancing front as immiscible blobs or ganglia in the pore spaces.

Consequently, DNAPL is found as both free-phase (mobile) and residual (trapped) DNAPL in the subsurface at Site 88.

Free-phase DNAPL can be pumped out of the aquifer but a significant fraction remains as residual contamination. The residual contamination remains as a long term source due to low aqueous solubilities and limited biodegradation. Although conventional ground water pump and treat operations have been shown to be largely ineffectual, SEAR technology has shown great promise for the rapid and cost effective remediation of the DNAPL source area. The purpose of this demonstration is to perform additional validation of SEAR in order to promote its commercialization for the rapid cleanup of DNAPL sites owned by the government and industry. The implementation of DNAPL remediation technologies such as SEAR will not only reduce the long term health and environmental risk of these sites but will also allow remediation to be achieved cost effectively. Based on the results of recently completed DNAPL investigations, Site 88 has been identified as a suitable site to conduct a demonstration of SEAR technology. In addition to investigating subsurface treatment by surfactants for DNAPL removal, an additional facet of this demonstration is to evaluate the feasibility of surfactant recovery processes to recycle and reuse surfactants.

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To investigate the effectiveness of SEAR technology in accomplishing DNAPL removal, it is necessary to measure the quantity of contamination present both before and after the surfactant flood. Because samples collected from point locations, such as those provided by soil cores, cannot be relied upon to provide reliable data over large zones, the volume and extent of residual DNAPL contamination of the shallow aquifer at the ESTCP demonstration area will be determined by the injection and subsequent extraction of partitioning and non-partitioning tracers. The overall demonstration will consist of a pre-surfactant flood partitioning interwell tracer test (PITT), a surfactant flood, and a post-surfactant flood PITT. This work plan details the activities to be undertaken to perform the pre-surfactant flood PITT. This PITT is currently scheduled for the months of January and February, 1998.

1.3 The Partitioning Interwell Tracer Test (PITT)

Studies of residual DNAPL distribution in heterogeneous, sandy aquifer materials indicate that cores are unlikely to either locate or provide reliable estimates of the volume of DNAPL at the field scale. This is true because the representative elementary volume of residual DNAPL appears to be very much larger than that provided by cores (see Mayer and Miller, 1992). Earlier this century, hydrogeologists recognized the inadequacy of using permeameters to measure field-scale hydraulic conductivities and turned to the development of interwell hydraulic interference (pumping) tests. Similarly, it has now become desirable to move away from a reliance on cores alone to locate and estimate DNAPL volumes in the subsurface and to use interwell tests to estimate the residual or pooled DNAPL volumes over meaningful distances at the field scale.

The PITT was developed at the University of Texas by Dr. Gary A. Pope of the Department of Petroleum and Geosystems Engineering during the early 1990s. Application of PITT technology to the environmental field was developed in conjunction with Dr. Richard Jackson of Duke

Engineering and Services (DE&S). Duke Engineering and Services and the University of Texas currently have three patents pending on this process.

The PITT was developed from a predecessor that had been first used by the oil industry to measure the residual oil saturation that is homogeneously distributed in water flooded well fields. Pope and colleagues modified the method so that not only the residual oil saturation but also the swept pore volume and therefore the total volume of heterogeneously-distributed DNAPL could be determined. Therefore, the PITT allows the detection and volume estimation of DNAPL. A particularly important application of the test is remediation performance assessment, i.e., the testing of the volume of DNAPL before and after a remediation effort.

The PITT involves the injection of a suite of tracers in one or more wells and subsequent extraction from other wells in a well field. Conservative (i.e., non-partitioning) tracers pass unretarded through the DNAPL zone, whereas the partitioning tracers are retarded due to their partitioning into and out of the DNAPL. In the unsaturated zone of an aquifer, the tracers employed are gases, whereas liquid tracers (e.g., alcohols) are used in the saturated zone. The arrival times and concentrations of the tracers at the extraction wells are used to measure the volume of DNAPL in the interwell zone. This demonstration will use liquid tracers to characterized the DNAPL contaminant distribution in the shallow aquifer at Site 88. The tracer selection process and description of those to be used in this demonstration are discussed in Section 3.2.

1.4 Project Outline

This project will be a further validation of SEAR technology for the in-situ remediation of aquifers contaminated with organics present as DNAPL. In addition, the demonstration will include procedures to recover surfactant from the demonstration effluent for reuse. PITTs will be conducted to determine the DNAPL saturations before and after the surfactant flood to evaluate the performance of the technology.

The steps involved in conducting a PITT are:

site characterization;

tracer selection;

numerical design;

and conduct of the PITT.

Each of these steps will be discussed in greater detail in the following sections.

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1.5 Project Time Line

A timeline showing the major tasks planned for the project is presented as Figure 1.

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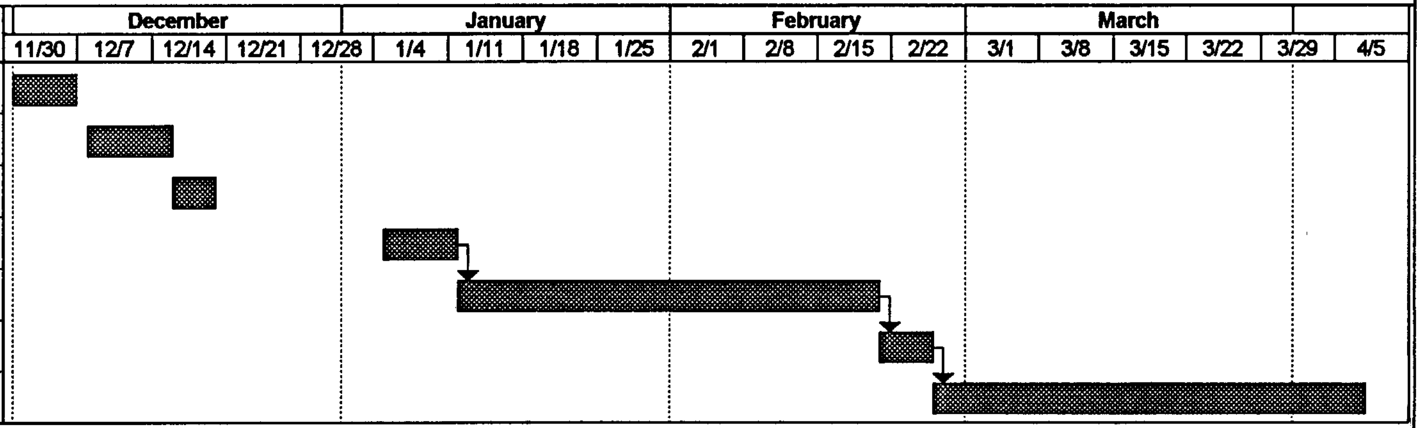
Project Timeline for the Pre-Surfactant Flood Partitioning Interwell Tracer Test at Building HP25, Site 88 - MCB Camp Lejeune, North Carolina

ID	Task Name	Duration
1	Well Array Installation	6d
2	Equipment Set-up	8d
3	Conservative Tracer Test	4d
4	Water Flood	7d
5	Tracer Test	40d
6	Breakdown	5d
7	Report Preparation	30d



Project:
Date: 10/29/97

Task	▨	Summary	▬	Rolled Up Progress	▬
Progress	▬	Rolled Up Task	▨		
Milestone	◆	Rolled Up Milestone	◇		

Project Timeline

Figure 1

2.0 BACKGROUND AND SUMMARY OF EXISTING INFORMATION

2.1 Site Location and Setting

Site 88 is located near Post Lane and Virginia Dare Drive in the "Hadnot Point Industrial Area" on Marine Corps Base Camp Lejeune, North Carolina. The site terrain is relatively flat with an elevation of approximately 25 feet above mean sea level. The site is surrounded by barracks, office buildings, and other occupied structures. The nearest surface water body is the New River which is located approximately 3,000 feet west of Building 25. There are no active water supply wells located within a one mile radius of the site. The nearest active water supply well is HP-642 which is located approximately 1.5 miles east of the site.

2.2 History of Operations

2.2.1 Sources of Contamination

Building 25 has been operating as a dry cleaning facility since the 1940s. Varsol was in use as the dry cleaning fluid from the 1940s through the 1970s. During the 1970s, due to the high flammability of Varsol, the facility began to use tetrachloroethene (PCE) as the dry cleaning fluid. The Varsol was stored in underground storage tanks located on the northern side of the building. These tanks, most probably installed in the 1940s, were removed in November of 1995. The PCE was stored in the same vicinity as the Varsol but in 150 gallon above ground storage tanks. Currently the dry cleaning machines are equipped with self containment units, eliminating the need for separate storage tanks. The first such unit was brought on-line in December 1986, and the second in March 1995.

At the time the underground storage tanks were removed in 1995, contamination of the soil and ground water was suspected. The tanks, floor drains, and associated underground pipes may have provided conduits for contamination to reach the subsurface.

2.2.2 Previous Site Characterization Activities

Beginning in November 1995 a series of investigations have identified the extent of dissolved phase contamination at Site 88. During the course of this work, a total of 41 temporary piezometers and 21 permanent observation wells have been installed. These wells have been installed to monitor both the shallow aquifer, in which the PITT will be conducted, and the underlying aquifer. Figures 2 and 3 show the locations of these wells. Figures 4 and 5 show the extent of the dissolved phase plumes.

Because these early site characterization studies focused on defining the extent of the dissolved organic solvent plume, little was actually learned about the DNAPL contamination at Building 25.

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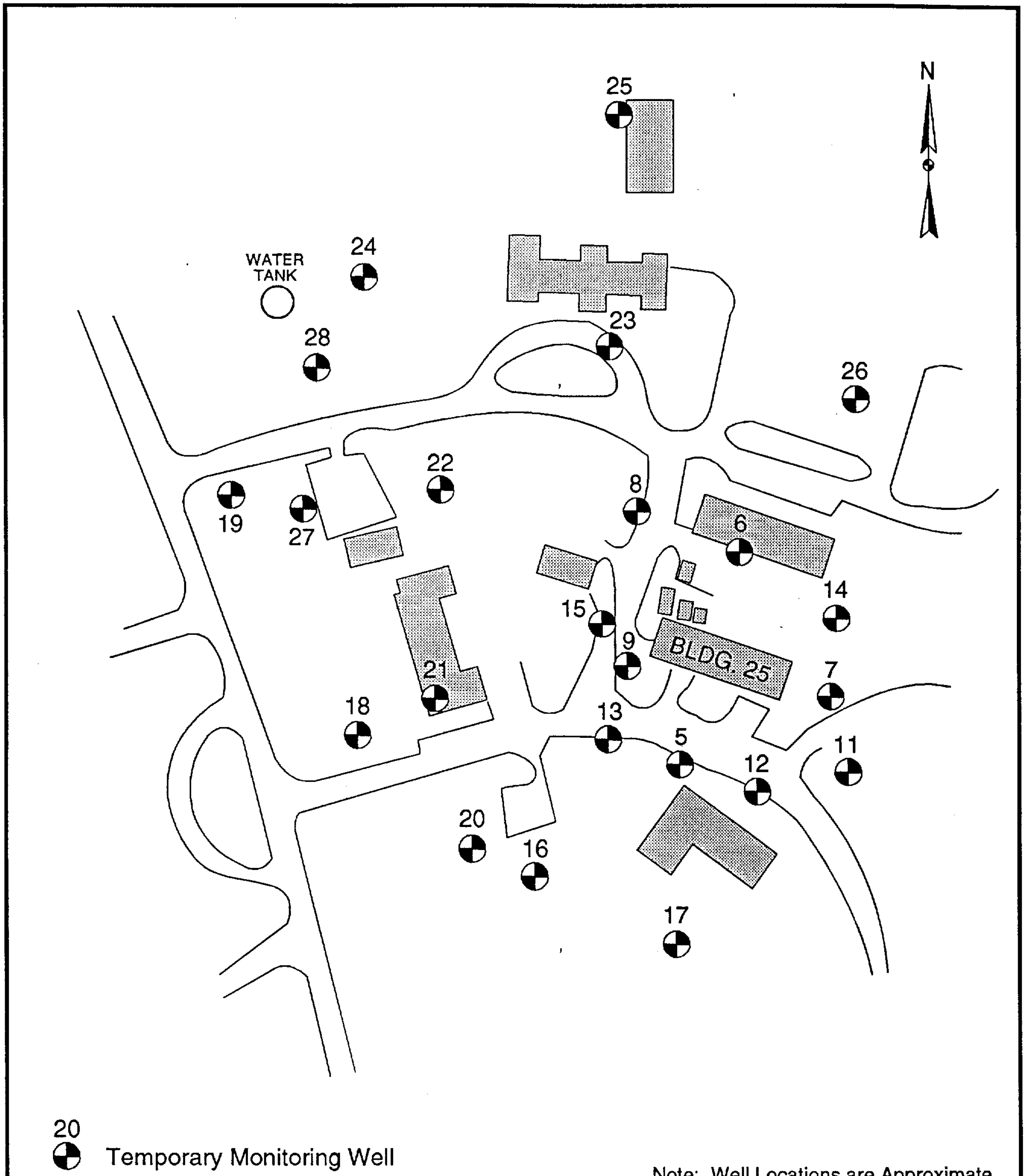

Note: Well Locations are Approximate

DATE: 10/15/97
REF: TDN 30199999
FILE: WELLS.XAR

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Temporary Well Locations

(Modified from Baker Environmental, Inc.)

Figure 2

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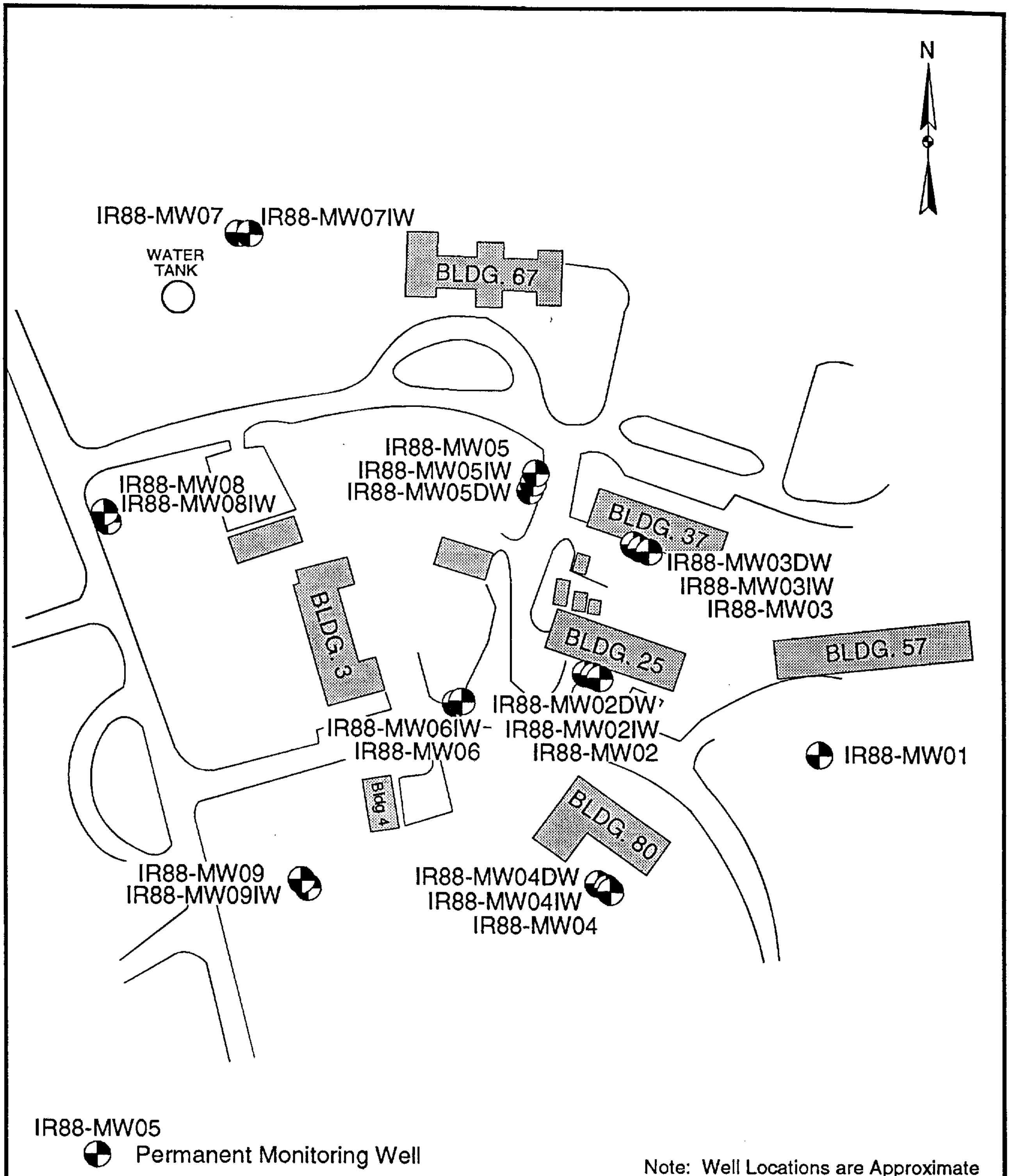

Note: Well Locations are Approximate

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Permanent Monitoring Well Locations

(Modified from Baker Environmental, Inc.) Figure 3

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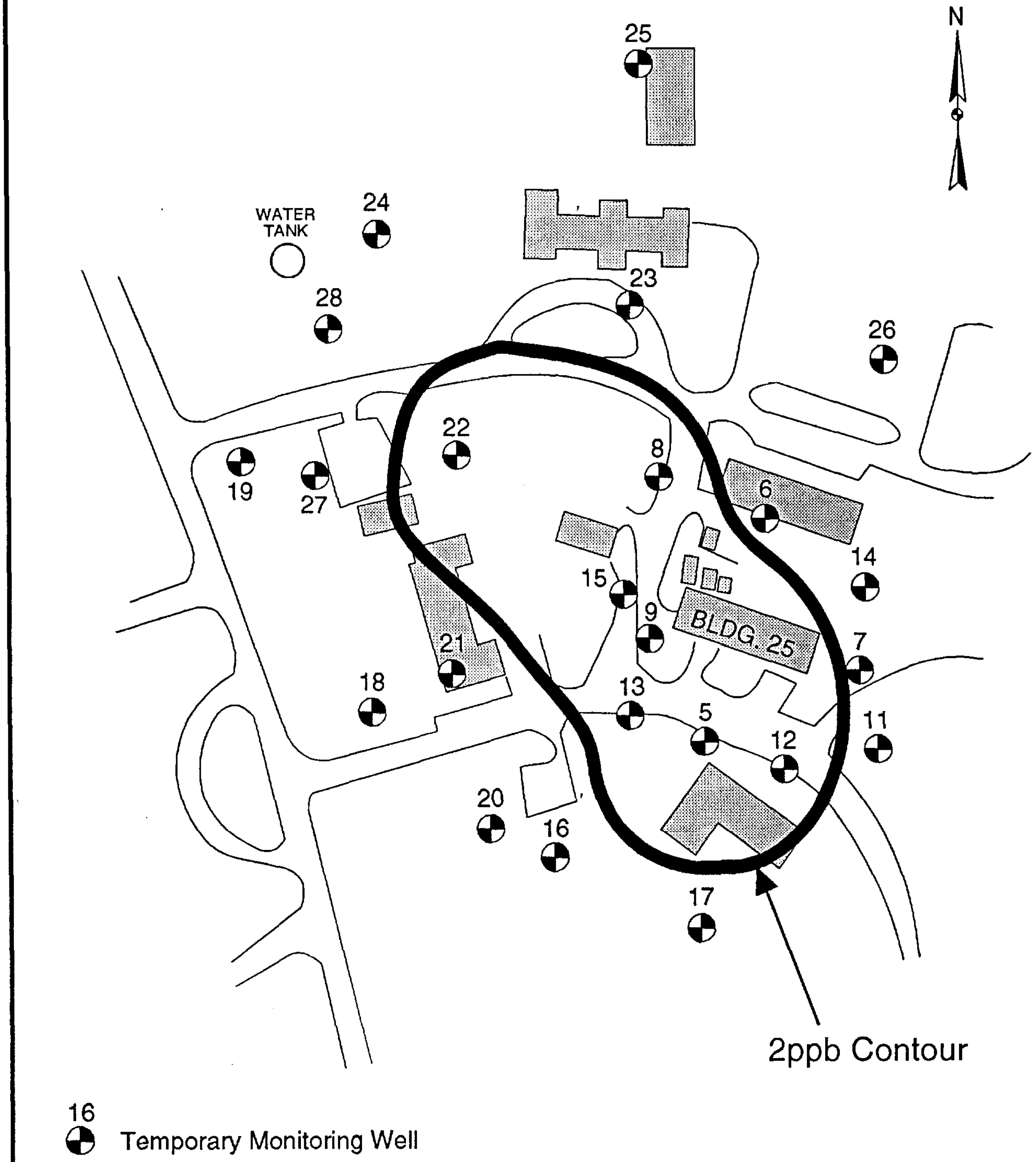

Note: Well Locations are Approximate

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REF: TDN 30199999
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Dissolved PCE Plume in the Shallow Aquifer
August 1996

(Modified from Baker Environmental, Inc.)

Figure 4

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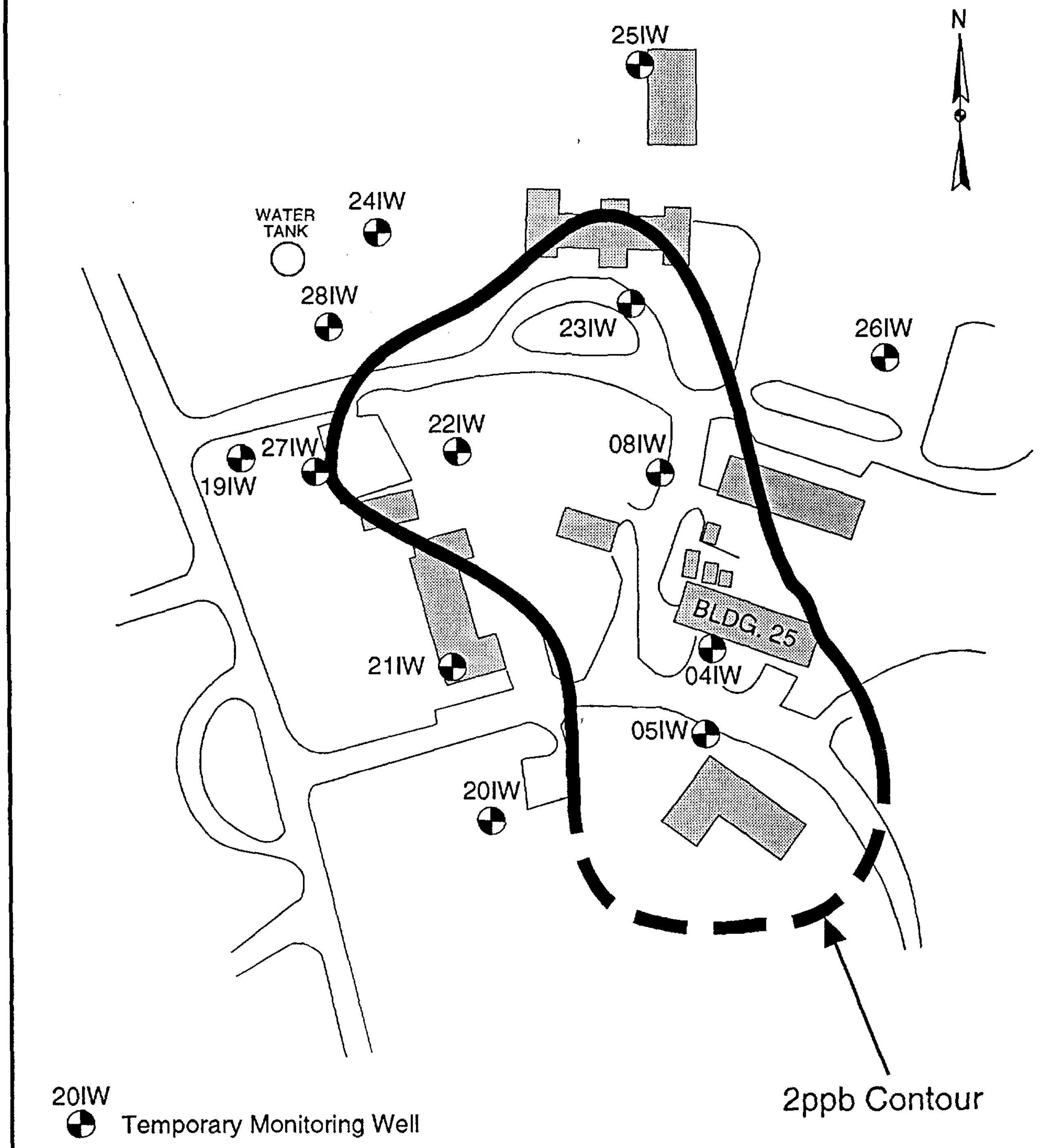

Note: Well Locations are Approximate

DATE:	10/15/97
REF:	TDN 30199999
FILE:	UPPCE.XAR

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Dissolved PCE Plume in the Upper Portion of the Castle Hayne Aquifer - August 1996

(Modified from Baker Environmental, Inc.)

Figure 5

During July and August 1997, personnel from DE&S and Baker Environmental commenced characterization activities in support of a SEAR demonstration for the DOD's Environmental Security Technology Certification Program (ESTCP). This field work included soil coring, soil sampling, and hydraulic testing a section of the shallow contaminated aquifer. A total of 13 soil cores were completed in the shallow aquifer as well as three wells. The approximate locations of the soil cores (IS-1 through IS-13) and wells (RW-01, RW-02, and IW-01) are shown on Figure 6. The result of this effort has been to identify an area on the north side of Building 25 with an accumulation of free-phase and residual PCE contamination. Free-phase PCE accumulated in both wells RW-01 and RW-02. Approximately 1.5 liters of free-phase PCE were pumped from RW-02 and sent to the DE&S Austin, Texas office for use in the selection of tracers and to the University of Texas at Austin for use in the selection of surfactants. Soil cores were sent to the DE&S Austin office to be used in tracer selection as well as to the University of Oklahoma for surfactant column studies. The density and viscosity of the DNAPL collected at the site were subsequently determined to be 1.58 gm/cc and between 0.8 and 1.1 centipoise respectively.

Subsamples were taken of the soil cores and preserved in the field with methanol. Methanol preservation was used to reduce the partial pressure of the volatile organics and thereby minimize their loss from the samples prior to analysis. Analysis of the methanol-preserved samples for volatile organics by SW846 8260A reveals concentrations of PCE from non detect (ND) up to 26,000 ppm. Other chlorinated volatile organics, such as TCE, DCE, and VC, were also detected but at lower concentrations. Analysis of the results using the code NAPLANAL (Mariner et al, 1997), developed by DE&S, shows residual NAPL saturations between zero and over 11 per cent. Table 1 shows the sample locations, sample depths, contaminant concentrations, and estimated NAPL residual saturations. The estimates are based on an average porosity of 30 per cent and a fixed organic carbon content of 0.58 per cent.

Grain size analyses of soil samples taken near the bottom of the shallow aquifer at soil cores IS-08 and IS-10 show the sediments to range from very fine sand to silt and clay. A copy of the grain size curves is included at Appendix A. Additional soil samples were collected for analysis of the fixed organic carbon content by ASTM D2974-87. The results are shown with the volatile organics concentrations and estimated residual NAPL saturations on Table 1.

Ground water samples were collected at wells RW-01 and RW-02 in August, 1997. The concentrations of dissolved PCE, TCE, DCE, and VC detected in the samples are shown in Table 2. Reference to the table shows that 170 and 150 ppm dissolved PCE respectively were detected in the samples from the two wells. Given that the aqueous solubility of PCE at 23 degrees Celsius is approximately 240 ppm, (Broholm, K. et al., 1992 and West, C., 1992) the results further demonstrate the degree of contamination found in this area.

A short duration, 7.0 hour constant rate pumping test was conducted. Water was extracted from well RW-02 at 0.5 gallons per minute. Water level drawdown was recorded at the pumped well and surrounding observation wells. Analysis of the results using the Neumann method yields an average hydraulic conductivity of 5×10^{-4} cm/sec and a specific yield of 0.011.

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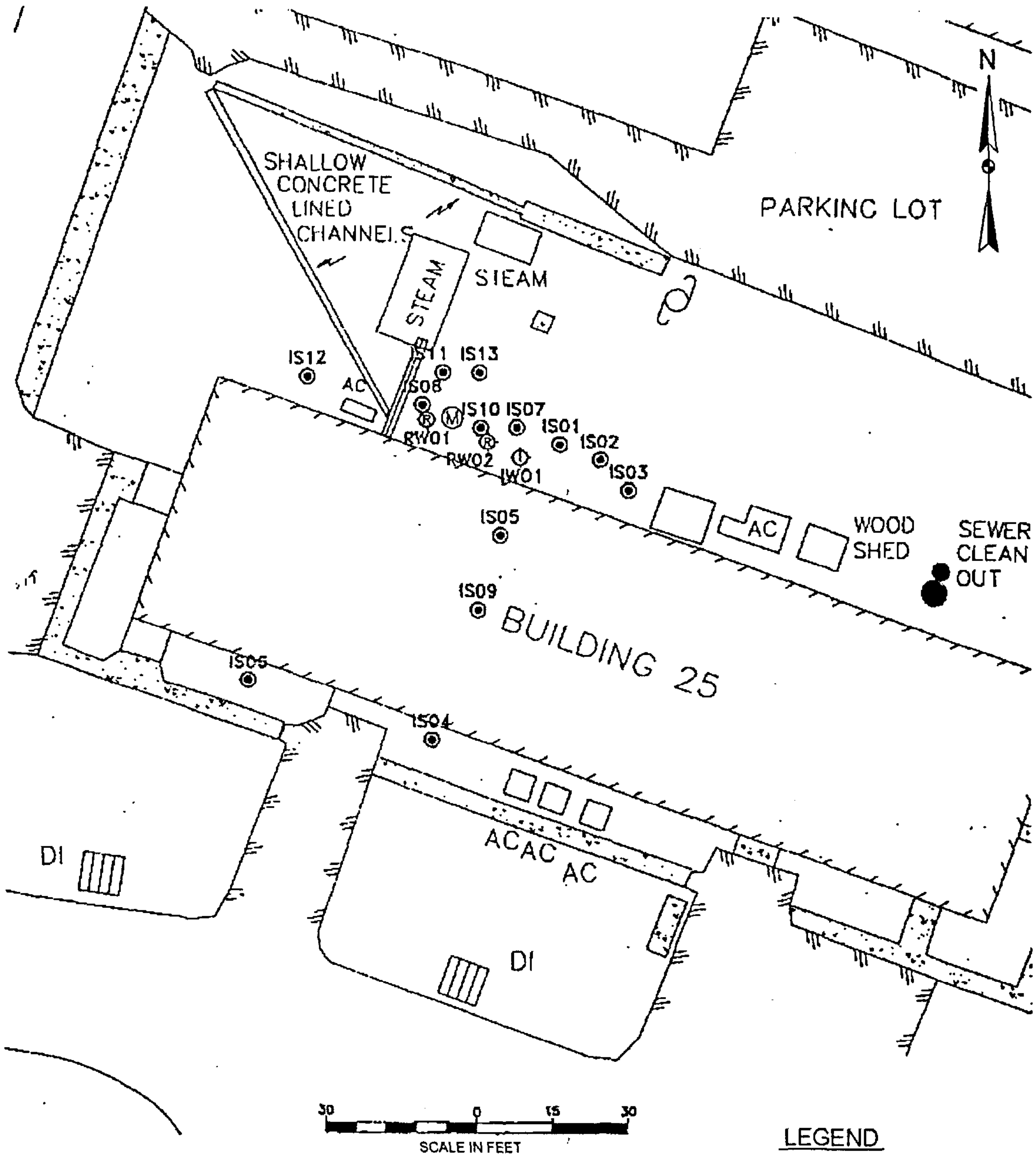

LEGEND

IS12 ◉	SOIL BORING
RW01 Ⓡ	RECOVERY WELL
IW01 Ⓘ	INJECTION WELL
Ⓜ	MANHOLE

NOTE: THE LOCATIONS OF THE MANHOLE, SOIL BORINGS, AND WELLS ARE APPROXIMATE.

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Soil Boring and Well Location Map for the DNAPL Investigation at Site 88

(Modified from Baker Environmental, Inc.)

Figure 6

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Table 1.
Concentration of Select Volatile Organic Compounds in Subsurface Soils, Site 88
MCB, Camp Lejeune, North Carolina

Sample ID	Depth (ft bgs)	Concentration (mg/kg)				FOC %	NAPL Saturation %
		PCE	TCE	DCE	VC		
IR88-IS01-1	5.2-5.5	ND	ND	12	1.8	–	0
IR88-IS01-2	8.0-8.25	37	3.5	22	ND	–	0
IR88-IS01-3	8.5-8.75	63	24	31	ND	–	0
IR88-IS01-4	10.0-10.25	65	4.8	20	ND	–	0
IR88-IS02-1	8.0-8.25	7	1.1	8.1	0.33	–	0
IR88-IS02-2	8.5-8.75	8.9	1.6	17	ND	–	0
IR88-IS02-3	8.8-9.1	7.8	ND	32	0.98	–	0
IR88-IS02-4	16.3-16.4	0.067	ND	ND	ND	–	0
IR88-IS03-1	2.5-2.75	10	ND	ND	ND	–	0
IR88-IS03-2	5.8-6.0	0.78	0.02	0.029	ND	–	0
IR88-IS03-3	7.5-7.75	4	ND	0.1	ND	–	0
IR88-IS04-1	12.0-12.2	4.2	ND	ND	ND	–	0
IR88-IS005-1	2.5-2.7	130	ND	ND	ND	–	0
IR88-IS05-2	5.6-5.8	390	ND	ND	ND	–	0
IR88-IS05-3	8.1-8.3	2,100	ND	ND	ND	–	0.75
IR88-IS05-4	10.2-10.4	220	15	ND	ND	–	0
IR88-IS06-1	9.1-9.3	1.8	ND	ND	ND	–	0
IR88-IS07-1	5.0-5.2	0.074	ND	2.1	3.5	–	0
IR88-IS07-2	8.5-8.7	110	3.9	46	4.8	–	0
IR88-IS07-3	10.9-11.1	32	2.2	18	ND	–	0
IR88-IS07-4	18.3-18.5	1,200	ND	ND	ND	–	0.36
IR88-IS08-1	17.5-17.75	9,500	ND	ND	ND	–	4.03
IR88-IS08-2	18.6-18.8	4,100	27	ND	ND	–	1.65
IR88-IS08-3	19.3-19.5	1,800	ND	ND	ND	–	0.62
IR88-IS08-4	4.6-4.8	800	84	ND	ND	–	0.20
IR88-IS08-5	7.2-7.4	1,100	180	ND	ND	–	0.37
IR88-IS09-1	10.5-10.7	110	ND	ND	ND	–	0
IR88-IS09-2	14.6-14.8	15	ND	ND	ND	–	0
IR88-IS10-1	15.3-15.5	48	2.2	2.2	ND	–	0
IR88-IS10-2	16.1-16.4	16	0.5	0.6	ND	–	0
IR88-IS10-3	17.1-17.3	19,000	ND	ND	ND	–	8.26
IR88-IS010-4	17.7-17.8	2,900	ND	ND	ND	–	1.11
IR88-IS11-1	16.3-16.5	9,500	ND	ND	ND	–	4.03
IR88-IS12-01	15.5-15.7	37	ND	ND	ND	–	0
IR88-IS12-02	16.0-16.2	20	0.16	ND	ND	–	0
IR88-IS12-03	17.0-17.2	25	ND	ND	ND	–	0
IR88-IS12-08	16.2-16.5	–	–	–	–	0.36	

Table 1, continued

Sample ID	Depth (ft bgs)	Concentration (mg/kg)				FOC %	NAPL Saturation %
		PCE	TCE	DCE	VC		
IR88-IS13-01	17.0-17.2	5,500	ND	ND	ND	–	2.25
IR88-IS13-02	17.5-17.7	18,000	ND	ND	ND	–	7.81
IR88-IS13-03	18.0-18.2	4,800	ND	ND	ND	–	1.94
IR88-IS13-08	8.5-9.0	–	–	–	–	–	
IR88-IS13-09	17.5-17.7	–	–	–	–	0.76	
IR88-RW01-01	17.0-17.2	22	ND	ND	ND	–	0
IR88-RW01-02	18.0-18.2	7,900	ND	ND	ND	–	3.32
IR88-RW01-03	20.0-20.2	1,300	ND	ND	ND	–	0.40
IR88-RW-01-05	9.5-10.0	–	–	–	–	–	
IR88-RW02-01	17.0-17.2	12	ND	ND	ND	–	0
IR88-RW02-02	18.0-18.2	730	ND	ND	ND	–	0.15
IR88-RW02-03	18.5-18.7	3,600	ND	ND	ND	–	1.42
IR88-RW02-04	9.0-9.5	–	–	–	–	–	
IR88-RW02-09	18.0-18.5	–	–	–	–	0.87	
IR88-IW01-01	17.5-17.7	100	ND	ND	ND	–	0
IR88-IW01-02	18.0-18.2	26,000	ND	ND	ND	–	11.39
IR88-IW01-03	18.5-18.7	4,200	ND	ND	ND	–	1.68
IR88-IW01-04	9.0-9.5	–	–	–	–	–	
IR88-IW01-06	4.0-4.5	1.4	ND	27	ND	–	0
IR88-IW01-09	18.0-18.5	–	–	–	–	0.29	

Notes: Samples collected during July and August, 1997

PCE = tetrachloroethene
TCE = trichloroethene
DCE = *cis*-1,2-dichloroethene
VC = vinyl chloride
ND = compound not detected
"–" = compound not analyzed

FOC = fixed organic carbon

NAPL = non-aqueous phase liquid

Table 2.
Concentration of Select Volatile Organic Compounds in Groundwater (Site 88) Camp Lejeune, North Carolina

Sample ID	Well Depth (ft. bgs)	Concentration (µg/L)			
		PCE	TCE	DCE	VC
Phase I DNAPL Investigation					
IR88-IS05-97C	14	37,000	1,400	1,500	ND
Phase II DNAPL Investigation					
IR88-RW01-97C	19.5	170,000	3,200	11,000	ND
IR88-RW02-97C	19.5	150,000	3,500	10,000	ND

Notes: PCE = tetrachloroethene
TCE = trichloroethene
DCE = *cis*-1,2-dichloroethene
VC = vinyl chloride
"ND" = compound not detected

Phase I sample collected July 26, 1997
Phase II samples collected August 22, 1997.

2.2.3 Remedial Activities at Site 88

At present, there are no remedial activities being undertaken at the site.

2.3 Site Characteristics

2.3.1 Site Stratigraphy

A fairly consistent depositional sequence was observed in borings across the site. Very fine sands and silt were encountered from the surface to a depth of approximately 18 feet below ground surface (bgs). Below this, a silty clay was encountered to 21 feet, the maximum depth of sampling conducted during the soil coring and well installation activities in July and August, 1997. Previous investigations have reported that the clay layer is laterally discontinuous.

Boring logs for monitor wells completed in the area show the clay layer to be underlain by fine to medium sand with some silt to a depth of over 100 feet bgs. This unit is identified in the Baker Phase I investigation report as the upper portion of the Castle Hayne aquifer. In areas were the clay layer reported above is not present, the shallow aquifer and Castle Hayne aquifers are in direct hydraulic communication.

2.3.2 Hydrogeologic Setting

In the demonstration area, the shallow aquifer is separated from the upper portion of the Castle Hayne aquifer by a clay aquitard. Those cores completed into the clay layer show it to be at least three feet thick. Water levels in the Castle Hayne aquifer are approximately 7 feet lower than those in the shallow aquifer. The difference in water levels between the shallow aquifer and the upper portion of the Castle Hayne aquifer as well as the fact that DNAPL has pooled on the clay layer in the demonstration area attest to its competency as an aquitard. The direction of ground water flow in the shallow aquifer is generally to the southwest.

2.3.3 DNAPL Distribution

While soil cores and wells cannot provide reliable DNAPL saturations over large zones of the subsurface, they can provide information on the approximate location of DNAPL present in the subsurface. The analysis of soil samples can provides an approximate value of residual saturation which can be used for designing PITTs and surfactant floods using a multiphase simulator such as UTCHEM. The NAPLANAL program was used to calculate the partitioning of chlorinated hydrocarbons in soil and ground water from soil sample analyses to determine the residual DNAPL saturations reported in Table 1.

Investigative activities conducted at the site in July and August, 1997 show that free-phase DNAPL is present in the subsurface at wells RW-01 and RW-02. This free-phase DNAPL is perched upon the clay aquitard defining the base of the shallow aquifer in the demonstration area. Residual DNAPL saturations of 0.4 to 11.4 per cent were found at the base of the shallow aquifer at soil borings IS-01, IS-08, IS-10, IS-11, IS-13, and wells RW-01, RW-02, and IW-02. Free-phase DNAPL collected in the sumps of well RW-01 and RW-02. At present, the aerial extent of residual and free-phase DNAPL contamination of the shallow aquifer appears to be confined to a relatively limited area on the north side of Building HP25.

2.3.4 Surface Water

There are no surface water bodies in the immediate vicinity of the site. The New River, located approximately 3,000 feet west of the site, is the nearest surface water.

2.3.5 Water Supply Wells

There are no active water supply wells located within a one mile radius of the site. The nearest active water supply well is HP-642 which is located approximately 1.5 miles east of the site.

3.0 PITT DESIGN AND MODELING

3.1 PITT Design Simulations

The successful implementation of field-scale PITTs requires the development of an engineering design strategy using careful and systematic modeling. Simulation modeling prior to the realization of the field test is used to obtain optimum design parameters such as injection and extraction rates, amount of tracers needed, sampling rates, and sampling times. UTCHEM, a multi-dimensional, multi-phase chemical compositional simulator developed at the University of Texas (Delshad, et al. 1996), was used to design the PITT scheduled for Site 88. UTCHEM has been used for simulating and designing several PITTs performed by INTERA and The University of Texas and is recognized by the EPA as an approved numerical simulator to model DNAPL problems. PITTs performed at Hill OU1, Hill OU2, DOE Portsmouth, Air Force Plant 4 and the PPG facility at Lake Charles, LA were designed using UTCHEM.

To provide an example of the applicability and utility of the UTCHEM simulator for designing PITTs, Figure 7 compares a prediction made by UTCHEM prior to the SEAR demonstration with the actual results of the initial PITT. Note the very close match between the measured tracer concentrations and the concentrations predicted by UTCHEM. This close match is attributable to accurate site characterization in terms of local hydrogeology and the subsequent development of an accurate aquifer model. Moreover, it can be concluded that the UTCHEM simulations can accurately address issues critical to designing field demonstrations provided an accurate geosystem model is developed.

The information obtained from the characterization activities described in Section 2.0 were incorporated into a preliminary geosystem model. This geosystem model contains the best estimate of:

- The geometry and structure of the aquitard
- The nature, extent and hydraulic properties of the shallow aquifer
- The fixed organic carbon content of the shallow aquifer
- An estimate of the spatial distribution of the DNAPL in the source zone of interest, and
- The functional relationships controlling multiphase flow in the geosystem, such as capillary pressure and relative permeability functions for the alluvium and aquiclude with respect to the DNAPL.

A number of sensitivity simulations were run to study the behavior of different partitioning tracers and to formulate an optimum design strategy for the PITT. These sensitivity studies include

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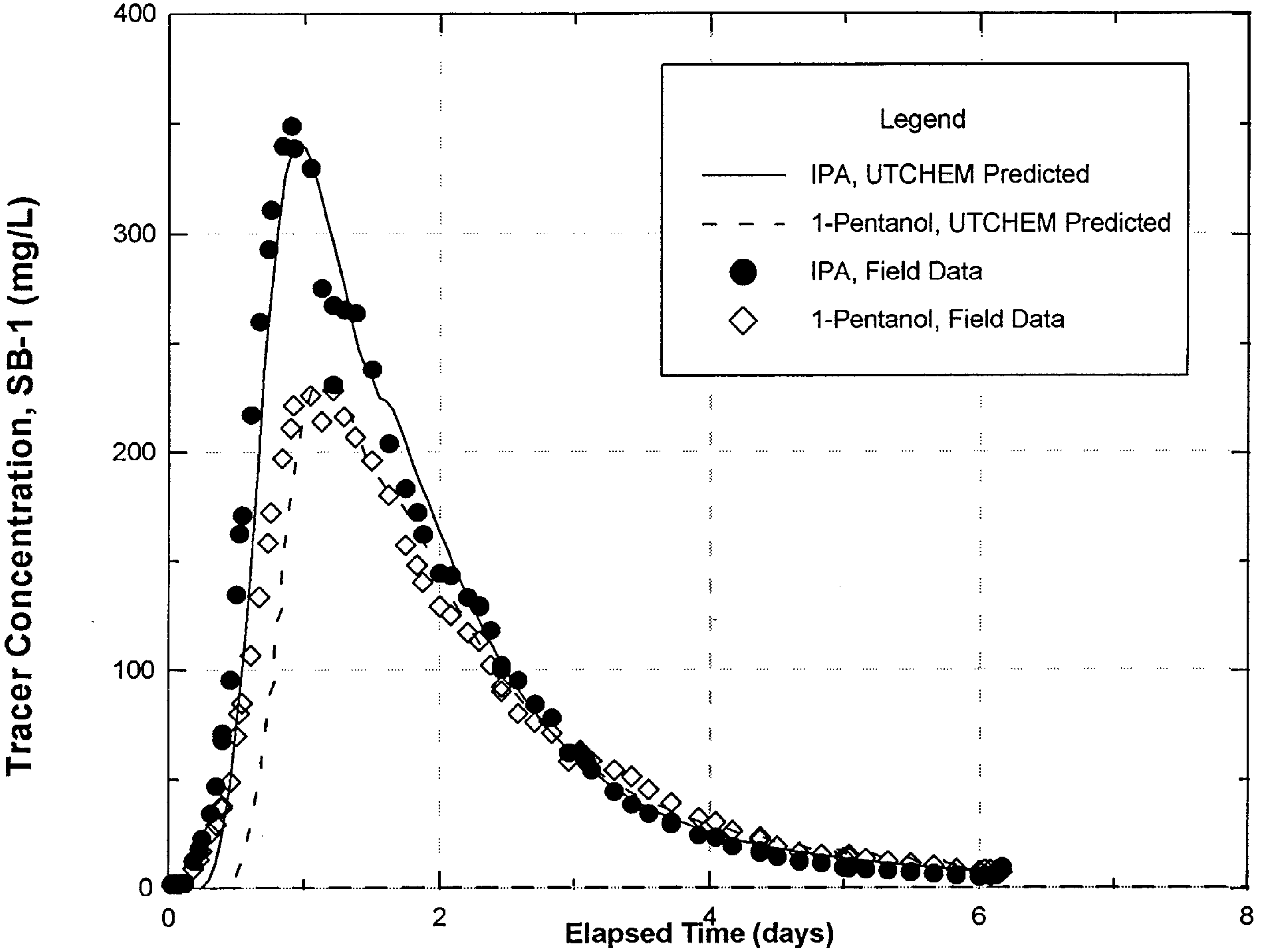

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Comparison of Measured Tracer Concentrations to UTCHEM Predictions

Figure 7

varying the injection and extraction rates and the amount and distribution of DNAPL. The results of these sensitivity studies were then used to:

- Aid the selection of the partitioning tracers
- Determine the duration of the tracer test
- Determine the mass of each tracer needed
- Determine the injection and extraction rate,
- Predict the swept volume
- Predict the extraction well effluent tracer concentrations, and
- Predict the amount of tracer recovered at the end of tracer test.

An optimum operation design was chosen based upon the results of these sensitivity studies. The actual results may vary somewhat for a variety of reasons, including the uncertainties in the aquifer structure, soil heterogeneity, and distribution of DNAPL in the swept pore volume. However, the test can be successful over a very wide range of uncertainty due to the robustness of the PITT tracer design, and the sensitivity of the test to DNAPL mass in the swept test volume. The information gained from the first PITT tracer test will be of great value in making final design decisions for the following surfactant flood and final PITT.

Figure 8 shows the well array and the simulated flow patterns during the injection/extraction operations. These flowlines are generated by a well array which consists of 2 rows of 3 extraction wells placed on either side of a center row of 3 injection wells, and 2 hydraulic control (potable water injection) wells to block movement of the injectate beyond the demonstration area. Simulations based on this well placement indicate a 93% capture efficiency for the injected tracers leaving average tracer concentrations in the shallow aquifer in the 1-5 ppm range. Tracers remaining in the subsurface, principally alcohols, are expected to biodegrade. Further discussion of the well layout, flow rates, hydraulic containment, and well construction is provided in Section 4.0.

3.2 Tracer Selection

When selecting partitioning tracers for use in the PITTs, there are a number of tracer performance criteria that must be met. These include:

- Environmental acceptability
- Chemical and biological stability
- Insensitivity to the precise composition of all pertinent subsurface contaminants

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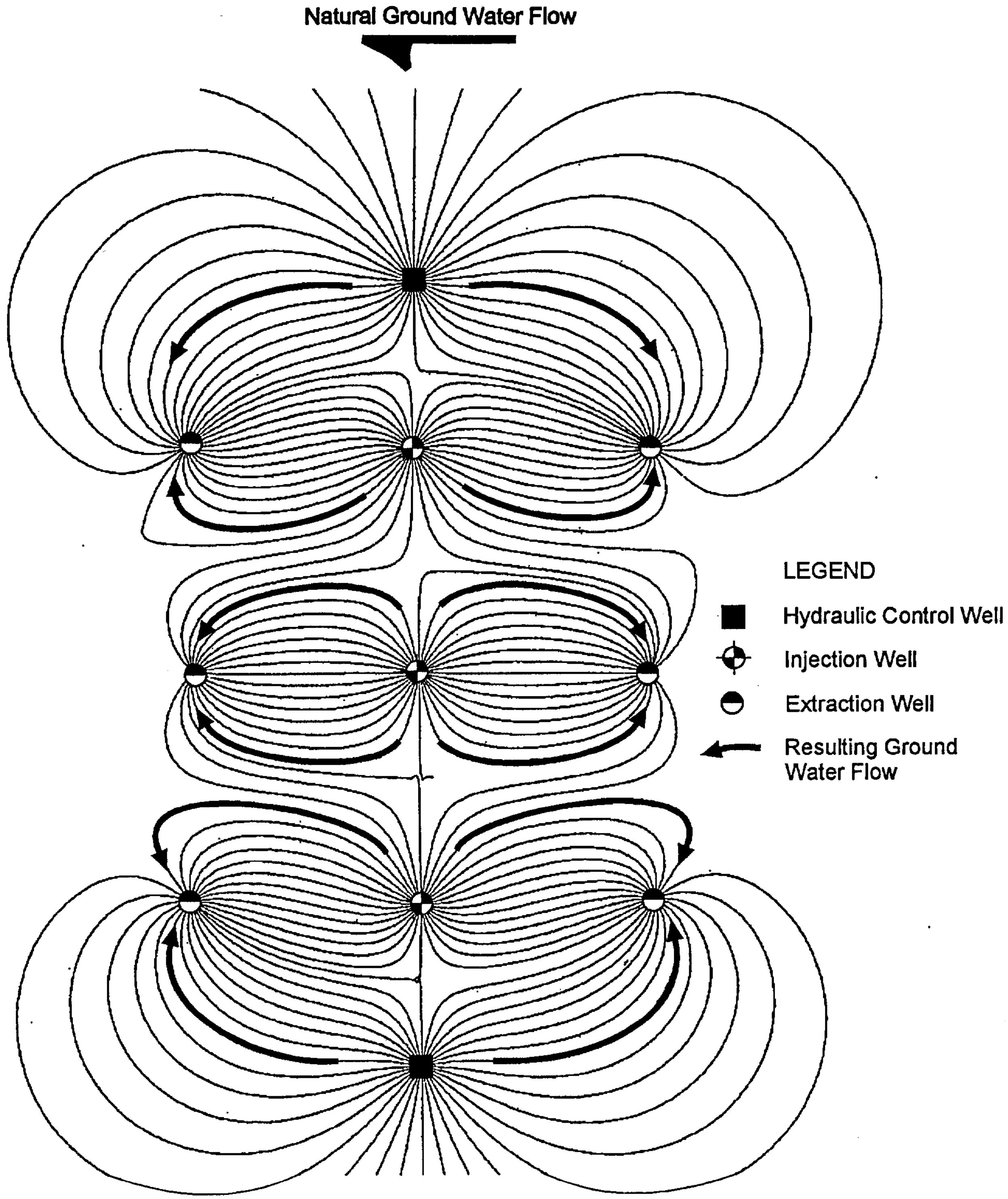

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Figure 8. Simulated Demonstration Flow Field

- Low detection limits
- Cost effectiveness, and
- Reasonable market availability.

A number of aliphatic alcohol tracers such as isopropanol, 1-Propanol, 1-Pentanol, 2-Ethyl-1-butanol, 1-Hexanol, 2,2-Dimethyl-3-pentanol, 1-Heptanol and 1-Octanol have been identified, extensively tested in the laboratory, and successfully used in PITTs at other locations. Soil and DNAPL from Site 88 were used in the laboratory testing for the selection of the tracers to be used for this demonstration.

When both partitioning and non-partitioning tracers are injected into the subsurface, the non-partitioning tracers move with the velocity of the carrier phase (usually water). The partitioning tracer molecules partition between the aqueous and nonaqueous phases and are retarded. This retardation depends on the partition coefficient and the volume of DNAPL in the soil. Since alcohols with known partition coefficients are used, an estimate of the residual DNAPL saturation can be obtained from the retardation of the partitioning tracers.

The first step in the tracer suite selection process for a particular PITT is to determine the number of tracers to be used. Theoretically, only two tracers, one non-partitioning and one partitioning, are required for an interwell test. In practice, however, a suite of tracers with different partitioning coefficients are used to improve the accuracy of the tracer test results. This is especially true when there is a large range of uncertainty in the quantity and distribution of the DNAPL in the zone to be swept by the test.

The partition coefficients of the tracers should result in a retardation factor in the range of 1.2 to 4 to obtain good separation of the non-partitioning and partitioning tracers for a reasonable test duration and provide accurate estimates of residual DNAPL saturation. Since the retardation of the partitioning tracers is proportional to the volume of DNAPL present and the partition coefficient, a small DNAPL saturation and a small partition coefficient will translate into a small retardation of partitioning tracers. Hence tracers with a wide range of partition coefficients are required for characterizing the DNAPL saturation of a DNAPL contaminated area.

If the residual saturation is known to be relatively high, tracers with smaller partition coefficients are sufficient, and it is not mandatory to continue the test to obtain the response curves for the tracers with larger partitioning coefficients. If the residual saturation is lower than expected, the tracers with larger partition coefficients can ensure good separation of the tracer response curves, thereby giving a better estimate of DNAPL saturation.

Site investigations in the source area indicate that DNAPL saturation generally increases with depth. Tracers with larger partition coefficients, such as 1-Heptanol ($K_d = 35.0$ with PCE), are needed to quantify DNAPL saturations for well pairs were low saturations are anticipated, while tracers with smaller partition coefficients, such as 1-Hexanol ($K_d = 8.1$ with PCE), will be needed for well pairs completed in the zones with the highest residual saturations. Tracers with middle range partition coefficients such as 2,4-Dimethyl-3-pentanol ($K_d = 15.0$ with PCE), are needed for well pairs with in-between DNAPL saturations. Finally, it is anticipated that bromide, a conservative ion tracer, will be added to each tracer suite as a back-up for the non-partitioning alcohol. Propyl alcohol (1-Propanol) is usually used as the conservative alcohol tracer.

Several laboratory experiments are required to identify partitioning tracers for use in field PITTs. These experiments consist of:

- static partition coefficient experiments
- column experiments.

As the name suggests, static experiments are batch experiments and are used to measure the partition coefficients of the alcohol tracers with the DNAPL from the site. Column experiments are fluid flow experiments in which alluvium from the target PITT area is used. Column experiments are used to determine the retention/retardation of the partitioning tracers by the uncontaminated alluvium. In addition, partitioning tracer column experiments in soils with a known volume of DNAPL can be used to determine the ability of partitioning tracers to accurately estimate the residual DNAPL saturation.

Based on an extensive program of laboratory experimentation using soil and DNAPL from the site, the following tracers are recommended as candidate tracers for the proposed PITT at Camp Lejeune. The partition coefficients at this time are preliminary and the final partition coefficients will be confirmed at the end of the laboratory study.

Table 3. List of Candidate Tracers to be Used at Camp Lejeune

Tracer	Partition Coefficient	Injected Concentrations mg/L
Bromide	0.0	1,000
1-Propanol	0.1	1,000
1-Hexanol	8.1	800
2,4-Dimethyl-3-pentanol	≈ 15	800
1-Heptanol	35.0	800
2-Ethyl-1-hexanol	≈ 70	500

Bromide and 1-Propanol will be used as the conservative tracers. The bromide will mainly be used as a backup conservative tracer in the event of obtaining poor results from 1-Propanol. Some of the details pertaining to the partitioning tracers are presented in the following sections.

In addition to the chemicals listed above, all the water injected into the wellfield will have 1,000 mg/L of calcium chloride. In studies at the DE&S laboratories, mobilization of fines from columns packed with Camp Lejeune alluvium was observed during freshwater injection. This is due to the stripping of calcium ions from the clays in the subsurface. Mobilization of fines can cause plugging in the subsurface and compound existing fluid flow problems. The addition of 1,000 mg/L calcium chloride will prevent the stripping of calcium ions from the clays and thus prevent mobilization of the fines.

A solution of the above tracers will be injected into the subsurface. The concentration of these chemicals will be measured in the effluent. The well field will also have hydraulic control wells to minimize movement of the injected chemicals outside the target test area.

Product Manufacturer, Name, Address and Phone Number

The alcohol tracers will be purchased from Sigma Aldrich Industries. The address of the manufacturer is:

Sigma-Aldrich Fine Chemicals,
3050 Spruce Street, St. Louis, MO 63103 USA

Phone Number 1-800-325-3010

Contact Person: Tracy Langenberg
Contact Phone Number 1-800-325-3010-ext. 2385

Specific Ingredients in Product

The list of the active ingredients in all the tracers is given in Table 4.

Table 4. Active Ingredients in Alcohols

Tracer	Active Ingredients
Bromide	Sodium Bromide
1-Propanol	Propyl alcohol or 1-Propanol
1-Hexanol	Hexyl alcohol, n-Hexanol or 1-Hexanol
2,4-Dimethyl-3-pentanol	Diisopropylcarbinol or 2,4-Dimethyl-3-pentanol
1-Heptanol	Heptyl alcohol, n-Heptanol or 1-Heptanol
2-Ethyl-1-hexanol	2-Ethyl-1-hexanol

Toxicity Data

Since one of the important prerequisites for the partitioning tracers is that they be environmentally acceptable, results from some studies are summarized in Table 5. These results are from Verschueren (1983). Copies of some pages from this reference and material safety data sheets of all the chemicals that will be injected into the subsurface are provided in Appendix B.

Table 5. Biological Effects of Some Partitioning Tracers

Toxicity Threshold (cell multiplication inhibition test)	1-Hexanol mg/L	1-Heptanol mg/L
bacteria (Pseudomonas putida)	62	67
algae (Micrcystis aeruginosa)	12	3.5
green algae (Scenedesmus quadricauda)	30	17
protozoa (Uronema parduczi Chatton-L woff)	75	31
	93	17

In addition to the above information the following information describes the toxicity of the tracers.

<u>1-Propanol</u>
Inhalation, mouse: LC_{50} = 48 gm/m3; Oral, mouse: LD_{50} = 6800 mg/kg;
Oral, rabbit: LD_{50} = 2825 mg/kg; Oral, rat: LD_{50} = 1870 mg/kg
Skin, rabbit: LD_{50} = 4060 mg/kg.

<u>1-Hexanol</u>
Oral, mouse: LD_{50} = 1950 mg/kg; Oral, rat: LD_{50} = 720 mg/kg;
Skin, rabbit: LD_{50} = 3100 mg/kg

<u>1-Heptanol</u>
Inhalation, mouse: LC_{50} =6600 mg/m3/2H; Oral, mouse: LD_{50} = 1500 mg/kg;
Oral, rabbit: LD_{50} = 750 mg/kg; Oral, rat: LD_{50} = 500 mg/kg;
Skin, rabbit: LD_{50} = 2 gm/kg.

<u>2-Ethyl-1-hexanol</u>
Oral, mouse: LD_{50} = 2500 mg/kg; Oral, rabbit: LD_{50} = 1180 mg/kg;
Oral, rat: LD_{50} = 2049 mg/kg; Skin, rabbit: LD_{50} = 1970 mg/kg.

<u>Sodium Bromide</u>

Human, estimated oral, LD_{50}: 0.5 to 5 g/kg

Oral, rat: LD_{50} = 3,500 mg/kg; toxic effects not yet reviewed

Oral, rabbit: LD_{50} = 580 mg/kg; toxic effects not yet reviewed

4.0 PITT IMPLEMENTATION

The volume and extent of DNAPL contamination at the ESTCP demonstration area will be determined by conducting a PITT. The PITT will be conducted in a well field constructed during the course of this project. Under the current conceptualization, the well field will consist of three injection wells and six extraction wells arranged in a pattern known as a line-drive geometry. That is, the injection wells and extraction wells will be aligned on the order of 15 feet apart, with each injection and each extraction well approximately 10 apart from the neighboring well of like purpose. A hydraulic control well will be installed at each end of the line of three injection wells to help contain the injected fluids and maximize injectate recovery. Figure 9 is a schematic of the site showing the well pattern with tankage.

4.1 Well Construction

The PITT injection and extraction wells will be 4 inches in diameter and constructed using a Schedule 40 PVC riser connected to 5 foot lengths of stainless steel wire wrapped screen at depth. The depth to the aquitard in the demonstration area is approximately 18 feet. The wells will be installed approximately 1 foot into the clay layer to ensure that the shallow aquifer/aquitard contact is spanned by the screened zone of each well. The well risers will be covered with flush mount bolt-down steel manholes. A silica sand will be placed around the well screens to act as a filter pack. The sand will be brought a minimum of 2 feet above the well screens, with the depth to the top of the filter packs being determined by measurement with a weighted calibrated tape. Approximately 2 feet of ¼" bentonite pellets will be placed on top of each filter pack and hydrated with potable water. The bentonite seal will be allowed to hydrate for a minimum of four hours before the well construction is continued. The annulus between the borehole and well will then be grouted to land surface. A careful inventory of each material will be kept during placement into the annulus to ensure that the well is properly installed.

4.2 Hydraulic Control

To provide positive hydraulic control during the water flood and tracer test, potable water mixed with calcium chloride will also be injected into the hydraulic control wells installed at the ends of the row of three injection wells. The injection and extraction rates, will be held constant throughout the demonstration. The injection rate at each of the three injection wells and the two hydraulic control wells will be 0.36 gpm. The extraction rate at each of the six extraction wells will be 0.30 gpm.

Water levels will be monitored in selected demonstration wells and observation wells by means of electronic pressure transducers connected to a data acquisition system (DAS). The DAS will be set to collect water level measurements. The water levels collected in this manner will be augmented and verified by manual readings. Both an interface probe capable of detecting non-

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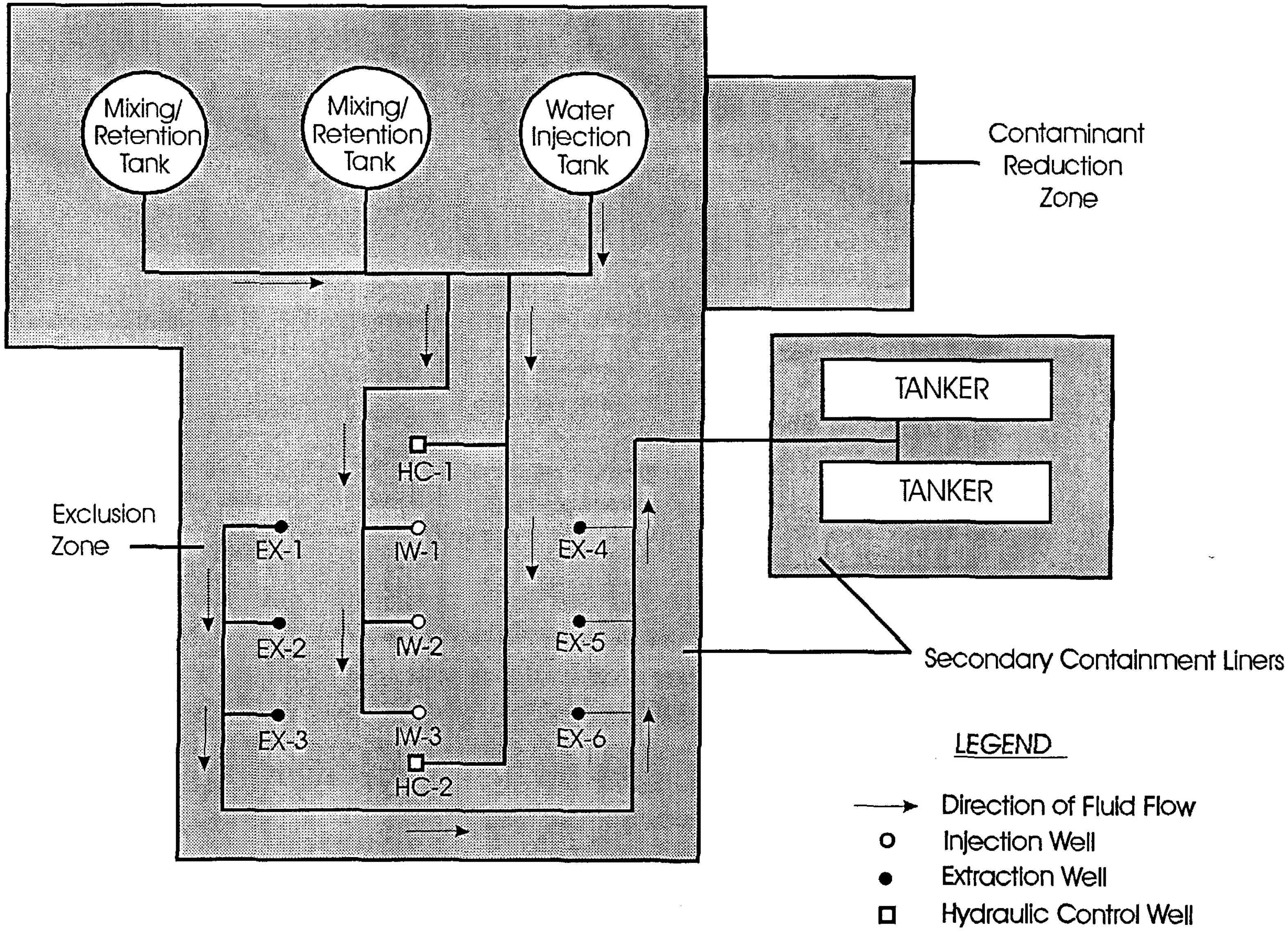

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Schematic of General Test Configuration

Figure 9

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aqueous phase liquid (NAPL) and a standard electric water-level meter will be used during testing. The manual measurements will be recorded to one-hundredth of a foot.

4.3 Sample Collection, Documentation and Transport

Samples of the effluent from each extraction well will be collected at differing rates throughout the duration of the demonstration. In addition, monitor wells MW02 and MW02I, located approximately 70 feet distant and generally downgradient of the demonstration area, will be periodically monitored for tracer and contaminant concentrations throughout the demonstration. Monitoring well MW02 is installed in the shallow aquifer. Monitor well MW02I is installed in the upper portion of the Castle Hayne aquifer. Table 7 shows the planned sampling schedule.

Table 6. PITT Sampling Schedule

Wells	Day	Sampling Frequency Days	Total Number of Samples
Extraction Wells EX-1 through EX-6	1-6 7-12 13-40	0.25 0.5 1.0	144 72 168
Influent	0-2.5	0.25	10
Monitoring Wells MW-02 and MW-02I	1-40	3	28
SUBTOTAL			422
Quality Assurance Replicate Samples at five per cent			22
PRE-PITT Water Flood			36
TOTAL			480

The samples will be collected in 40 ml VOA vials. The samples will be preserved on ice or kept in a refrigerator set to maintain the temperature at 4 degrees Celsius. The holding time for analysis will be 7 days. Each sample container will be properly labeled with the sample number, the project, the date and time, the well, the preservative, and the sampler's initials.. The label will be covered with transparent tape. As a precaution, the sample number will also be marked on the cap of each vial. Field samples will be catalogued using a sample control log that will identify each sample collected, along with the date and time of collection, name of the sampler, and the sample name. An example of the sample control log form can be found in Appendix C.

Samples to be shipped off site will be packaged securely in coolers with ice and sent with a chain of custody form (COC) in the shipping container. An example of a COC form can be found in Appendix C. Field preserved soil samples will be carefully packed and shipped to INTERA via ground freight using Department of Transportation approved packing materials and following the necessary transport requirements.

4.4 Decontaminating Sampling Equipment

The possibility of cross contamination during sampling activities will be minimized by using a combination of newly purchased and unused equipment and sampling materials; the use of washable materials such as viton gloves for materials handling during the preparation and handling of samples, and the implementation of systematic cleaning procedures to clean contaminated equipment.

Any sampling equipment and testing equipment requiring decontamination will be cleaned using the same step-by-step wash procedure used to decontaminate equipment after the test has been conducted. These steps will include:

- Rinse equipment using tap water. A rinse with isopropanol may be used if necessary to remove DNAPL or oil and grease contamination.
- Wash equipment with a detergent solution, followed with a tap-water rinse.
- Rinse equipment with deionized water and air dry, or dry with clean disposable toweling such as Kim-wipes™.

All soil and fluids resulting from this decontamination procedure will be placed in 55-gallon drums. The drums containing fluids will be allowed to stand to allow sediments to settle and the fluid transferred to the tankers holding the demonstration effluent.

4.5 Waste Handling

All effluent and decontamination fluid developed during the PITT will be pumped into tanker trucks provided by the facility. The activity will be responsible for transporting the demonstration effluent to an air stripper for treatment before discharge.

4.6 Field Demonstration

The field work required to conduct the PITT is comprised of the following five tasks:

- Task 1: Coordination and Planning
- Task 2: Equipment Setup and Preparation
- Task 3: Pre-PITT Water Flood

- Task 4: PITT
- Task 5: Demobilization

The following paragraphs provide a brief overview of each of these tasks. This discussion is followed by the methodology and procedures used to analyze a PITT.

4.6.1 Task 1: Coordination and Planning

The planning and coordination phase of a project of this type is crucial to ensuring a technologically successful outcome that meets project objectives without exceeding the resources allocated to its completion. Careful logistical planning is required to avoid costly delays and minimize the number of unforeseen circumstances in the field.

Task 1 is comprised of the following:

- Obtaining necessary work plan review from the EPA and the regulators in North Carolina. Their concurrence is required to assure that regulatory issues have been addressed.
- Ensuring that the appropriate injection permits have been secured.
- Coordinating with Camp Lejeune.
- Coordinating with Baker Environmental.
- Identifying and allocating labor resources for the duration of the field work.
- Identifying and procuring equipment needed for the field demonstration.
- Scheduling and coordinating housing, travel, and other personnel issues.
- Allocating and scheduling analytical laboratory resources.
- Mobilization of people and equipment.

The equipment setup and conservative tracer test are to be conducted in December 1997. The water flood and ensuing PITT will begin in January and last through the end of February, 1998. A project schedule outlining the start date and duration of each phase can be found in Section 1.

4.6.2 Task 2: Equipment Setup and Preparation

Task 2 activities will commence with the installation of the well array as described in Section 4.1. Well installation will be followed equipment assembly for the PITT. Field personnel will set-up the equipment required for the flood, including all plumbing, tanks, pumps, sampling devices, and instrumentation. Figure 9 is a schematic showing the major system components required for a

PITT. High-density polyethylene liners will be installed around mixing/retention tanks to provide secondary containment for any potential incidental spillage or leaks from the plumbing or the mixing and storage tanks. The area covered by secondary containment will also serve as the Exclusion Zone, should air monitoring results dictate. A tent will be erected over the demonstration area to protect the instruments from inclement weather. A general outline of the work to be accomplished during the PITT setup includes:

- Installing the secondary containment liners, and erecting the tent
- Installing and plumbing the injection system, including tanks, pumps, air delivery system, and injection well-head manifolds
- Setting up the automatic sample collection system; and
- Installing the water-level monitoring system.

Once the equipment is in place, a conservative tracer test will be performed to verify equipment operation and provide preliminary operational results under actual demonstration flow rates prior to the PITT. Based on these results, the design injection and extraction flow rates will be adjusted as needed to optimize the hydraulic integrity of the demonstration. For the test, a solution of 1,000 ppm calcium chloride will be injected into the shallow aquifer at the three injection wells and two hydraulic control wells. The injection rate will be 0.36 gpm at each well. Simultaneously, ground water will be extracted at the six extraction wells at a rate of 0.30 gpm per well. Effluent samples will be collected at each extraction well every 4 hours and the specific conductivity measured to determine the time required for breakthrough of the injectate at the extraction wells. Injection/extraction operations will continue for a period of three days or until breakthrough is noted at each of the extraction wells, whichever is shorter.

4.6.3 Task 3: Pre-PITT Water Flood

The purpose of performing a water flood prior to the PITT is to establish a forced-gradient flow field in the test zone and to remove as much free-phase DNAPL as possible via the extraction wells. Therefore, the DNAPL remaining in the shallow aquifer will be predominantly residual DNAPL. The water flood injection/extraction operations are scheduled to begin January 5, 1998. Potable (source) water mixed with 1000 ppm calcium chloride will be injected. The water flood is anticipated to last 12 days.

Mixing calcium chloride with all solutions injected during the demonstration is necessary to prevent the mobilization of fines in the shallow aquifer. During soil column testing, it was discovered that if potable water were to be injected without the salt described above, fines in the sediment will be mobilized leading to a plugging of the effective pore space in the aquifer and the consequential reduction in hydraulic conductivity.

4.6.4 Task 4: PITT

After the water flood has been completed and a steady-state flow field has been established, a PITT using non-partitioning (i.e., conservative) and partitioning tracers dissolved in source water will be conducted. The production of the tracers at the extraction wells will yield the tracer response or breakthrough curves which will be analyzed by DE&S to determine the spatial distribution and total volume of DNAPL in the demonstration area. Prior to the conduct of the surfactant flood, this information will be incorporated into a revised geosystem model of the DNAPL zone in the aquifer which defines the hydrogeological properties and DNAPL distribution in the subsurface. The tracers and salts to be injected are listed in Table 6. The quantities listed for calcium chloride reflect the total amounts required for the entire demonstration and not just the period of tracer injection. It is anticipated that 93 per cent of the tracers will be recovered during the demonstration. This will represent an average remaining tracer concentration in the shallow aquifer of between 1 and 5 ppm. Approximately 7 per cent of the tracers, primarily alcohols, will remain in the aquifer and biodegrade.

A tracer batch solution of 6,600 gallons will be mixed containing the tracers listed in Table 6 as well as the calcium chloride. The tracer solution will be injected at wells IW-1, IW-2, and IW-3 (Figure 9). At the test design injection rate of 1.8 gpm, it will require 2.5 days to complete the injection of the tracer solution. Once the tracer injection is complete, injection will continue using potable water mixed with 1000 ppm of calcium chloride until the demonstration is finished. The period of water flooding, equal to 5 pore volumes, following the injection of tracers will transport the tracers through the demonstration area for capture at the extraction wells. A period of forty days is anticipated from the initiation of tracer injection to the end of the demonstration.

During the demonstration, injection and extraction pressures, rates, and volumes will be monitored to ensure that these parameters are maintained according to the test design. Fluid levels will be monitored electronically and manually to verify that hydraulic control over the test zone is maintained. Tracer concentrations will be monitored by periodically sampling the effluent of each extraction well, ground-water monitor wells, and the injectate. Contaminant concentrations will be monitored by periodically sampling the effluent streams from the extraction wells and the ground water monitor wells.

4.6.5 Task 5: Demobilization

A demobilization and equipment maintenance period will follow the completion of the PITT. This time will be used to disassemble and store the demonstration equipment. The demobilization time will also be used to conduct maintenance on the PITT equipment, and to make minor modifications if necessary.

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Table 7. Injectate Quantities

Tracer/Salt	Quantity (lbs) (to be injected)
4- Methyl-2-pentanol	44
1-Hexanol	44
1-Heptanol	44
1-Propanol	55
2,4-Dimethyl-3-pentanol	44
2-Ethyl-1-hexanol	28
Sodium bromide	66
Calcium chloride*	1,120

* Quantity listed reflects the total amount required for the entire demonstration and not just the period of tracer injection.

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5.0 LABORATORY OPERATIONS

The ground-water samples will be shipped to an analytical laboratory where they will be analyzed for concentrations of PCE, TCE, DCE, VC, and the tracers used. The analytical method for detection of the contaminants listed and alcohol tracers will be SW846 8260. Bromide concentrations will be detected with an ion specific probe. In addition, the conductivity of select samples will be determined.

6.0 QUALITY ASSURANCE OBJECTIVES

The ESTCP demonstration is being conducted as a field demonstration of a developing technology. As such, many of the requirements of this project are considered as belonging to Use Category III, according to EPA QA/R-5 (July 1993). Category III studies involve projects which test research hypotheses and/or develop methods that are used to evaluate processes to provide data for decision making regarding future actions. In projects involving field work of this nature, it is anticipated that unexpected conditions will be encountered which will require the work plan to be altered. Thus, this plan must be flexible enough to allow rapid alteration to meet the required data objectives during the injection/extraction operations of the test.

Sampling, analytical procedures, and laboratory methods will follow the methods presented in SW-846 where applicable. The overall quality assurance objective for the pre-surfactant flood PITT described in this work plan is to implement sampling, sample handling, and analytical procedures that will provide data that can be used to determine the quantity of residual DNAPL present in the demonstration area and provide additional data to support the surfactant flood design.

DRAFT

7.0 PITT DATA ANALYSIS

The PITT data will be analyzed using the method of first temporal moment analysis. The theoretical foundation for the method of first temporal moment analysis of PITTs can be found in Jin et al. (1995) and Jin (1995). This method can be used to estimate the tracer swept volume (the volume of the aquifer through which the tracer solution has flowed), the average NAPL saturation in the tracer swept volume, and the total NAPL volume.

The first step in the PITT data analysis process is a QA/QC evaluation of the data. To ensure the quality of the data used for NAPL volume estimation, tracer data that does not meet QA/QC criteria are eliminated from the data base.

The second step is to evaluate the available field data and select a pair of non-partitioning and partitioning tracers to use for NAPL volume and saturation estimation. Theoretically, each pair of non-partitioning and partitioning tracers data can give an independent estimate of NAPL volume and saturation. Practically, however, the retardation factor should be greater than 1.2 in order to increase the estimation accuracy (Jin, 1995).

The third step is to fit the tracer response data with smooth curves and estimate the NAPL volume and saturation as a function of tracer test duration. The estimated NAPL volume and saturation should approach a plateau as the tracer test approaches completion. Otherwise, the tracer data will need to be extrapolated using the exponential decline function described in Section 7.6.1 to increase the estimation accuracy.

If the pumping rates in some of the extraction wells are not very stable during a PITT, a separate program is used to convert the tracer response data which are recorded as a function of time into a function of total volume of water. The program first reads in the actual cumulative volume of fluid injected/produced for each well as a function of time based on the information obtained from the injection extraction logs, even if the tracer concentration and the flow rate data were not recorded at the same time. These data are used as a lookup table. When the time for which tracer concentration is measured is read in as the input, the program interprets the corresponding volumes of water injected/produced from the lookup table.

8.0 REPORTING AND DELIVERABLES

At the conclusion of the field effort, DE&S will reduce, process, and analyze the data that is collected. Upon completion of the data analysis, a technical report will be prepared documenting the findings of the work. It will present the data in an easy to understand format, provide a discussion of the meaning of the data, and summarized the conclusions developed.

9.0 REFERENCES

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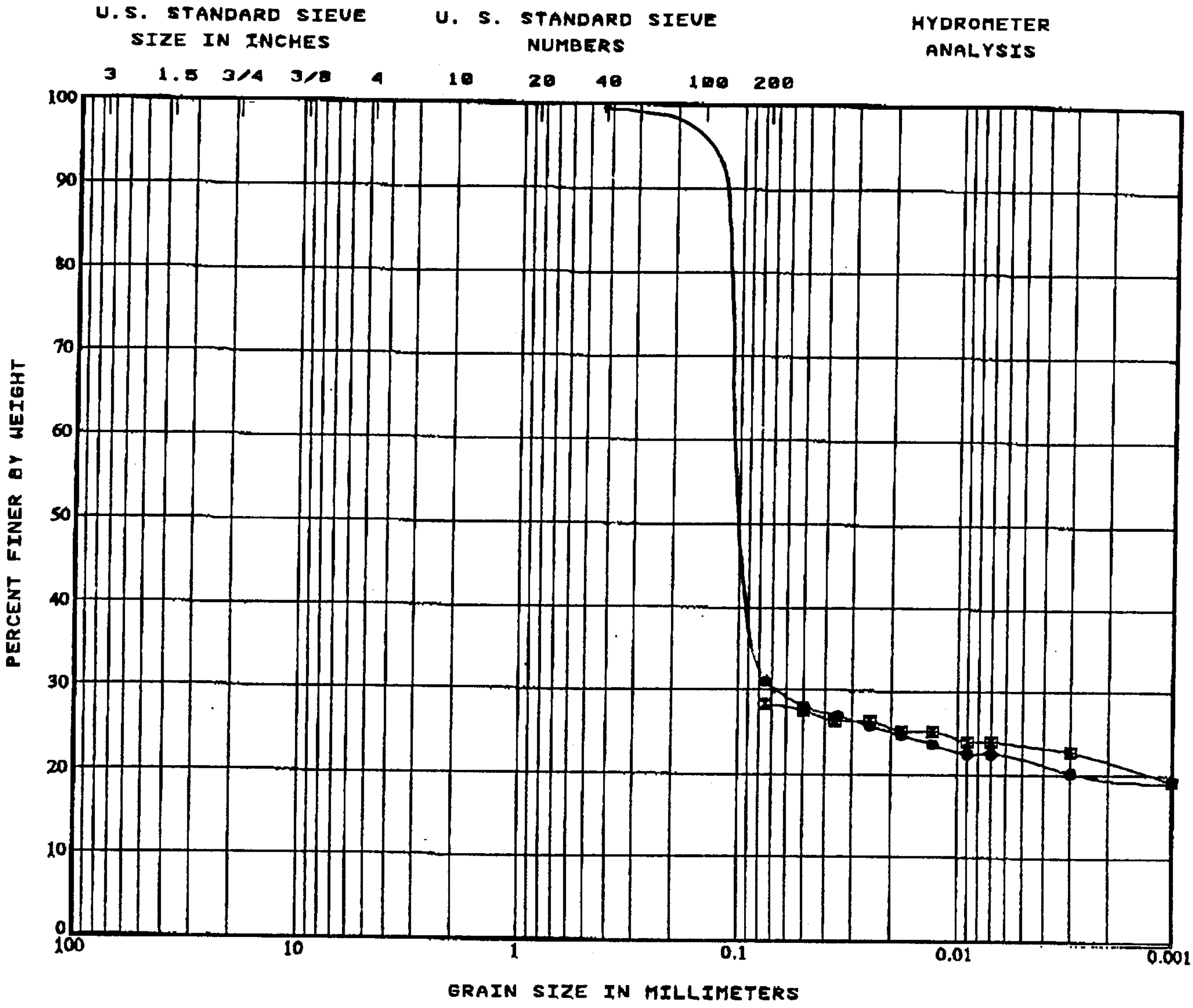
Appendix A

Grain Size Analyses



GRAVEL		SAND			SILT or CLAY
coarse	fine	coarse	medium	fine	

SYMBOL	BORING	DEPTH, FT.	CLASSIFICATION
●	IS-08	18.1	
☒	IS-10	17.5	

Total Sample: 40-45g
70% finer than 200: ~30g
~99% " " 40 sieve

GRAIN SIZE CURVES

Intera

Appendix B

Tracer Data

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 743
Sodium Bromide

Issued: 7/91

Section 1. Material Identification

34

Sodium Bromide (NaBr) Description: Occurs naturally in some salt deposits. Prepared commercially by reacting iron with bromine and water, dissolving the resulting ferrosoferric bromide in water, adding sodium carbonate, and filtering and evaporating that solution. Also by adding excess bromine to a sodium hydroxide solution, then evaporating it to dryness and treating it with carbon to reduce the resulting bromate to bromide. Used in photography and preparing bromides, and medicinally as an oral sedative, diuretic, and antiepileptic.

Other Designations: CAS No. 7647-15-6; bromide salt of sodium; Sedoneural;® trisodium tribromide.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: Sodium bromide is moderately toxic by inhalation and ingestion. Its major influence is on the central nervous system (CNS).

R	1
I	-
S	1
K	0

Genium
0
2 0
-

HMIS
H 2
F 0
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Sodium bromide, ca 100%

1990 OSHA PEL	1990-91 ACGIH TLV	1990 NIOSH REL	1985-86 Toxicity Data*
None established	None established	None established	Human, estimated oral, LD_{50}: 0.5 to 5 g/kg Rat, oral, LD_{50}: 3500 mg/kg; toxic effects not yet reviewed Rabbit, oral, LD_{Lo}: 580 mg/kg; toxic effects not yet reviewed Rat, oral, TD_{Lo}: 338 mg/kg administered for 90 days to pregnant female prior to mating produced maternal effects (ovaries and fallopian tubes)

* See NIOSH, *RTECS* (VZ3150000), for additional reproductive and toxicity data.

Section 3. Physical Data

Boiling Point: 2534 °F (1390 °C)
Melting Point: 1377 °F (747 °C)
Index of Refraction: 1.6412
pH: 6.5 to 8.0 (aqueous solution)
Molecular Weight: 102.9
Density/Specific Gravity: 3.203 at 77 °F (25 °C)
Water Solubility: Soluble; 1.16 kg/l water at 122 °F (50 °C), 1.21 kg/l water at 212 °F (100 °C)

Appearance and Odor: White or colorless crystals, granules or powder with a bitter, saline taste. Sodium bromide is hygroscopic (absorbs moisture from air, becoming hard).

Section 4. Fire and Explosion Data

Flash Point: None reported	**Autoignition Temperature:** None reported	**LEL:** None reported	**UEL:** None reported

Extinguishing Media: Sodium bromide is nonflammable. Use extinguishing media suitable for surrounding materials. Use dry chemical, water spray, or regular foam.

Unusual Fire or Explosion Hazards: Sodium bromide may emit toxic bromide and sodium oxide fumes when involved in a fire; use caution. Avoid inhaling fire-produced vapors.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Sodium bromide is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Keep in a dry area since it is hygroscopic, absorbing moisture of any origin.

Chemical Incompatibilities: Acids, alkaloidal and heavy metal salts (lead, silver, manganese, antimony, mercury, etc.), bromine trifluoride, and strong oxidizers (which liberate bromine).

Conditions to Avoid: Avoid contact with moisture, acids, alkaloidal and heavy metal salts and strong oxidizers.

Hazardous Products of Decomposition: Thermal oxidative decomposition of sodium bromide can produce toxic fumes of bromide (Br^-) and sodium oxide (Na_2O).

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC , NTP, and OSHA do not list sodium bromide as a carcinogen.

Summary of Risks: Sodium bromide is moderately toxic by inhalation and ingestion. As of this update, neither OSHA nor ACGIH has set any limits on occupational exposure. All currently available data is on toxicity by ingestion. Acute toxicity is rare since large amounts are needed to produce toxicity and these are usually purged immediately, preventing absorption. Readily absorbed through the lower part of the small intestine, small amounts of bromide salts build up in the body. Maximum accumulation takes about three months. The main effects of systemic poisoning are central nervous system (CNS) disturbances and development of skin rashes.

Medical Conditions Aggravated by Long-Term Exposure: Alcoholism, dehydration, severe depression, preexisting neurological or psychological disorders.

Target Organs: Skin and CNS.

Primary Entry Routes: Ingestion, possibly inhalation.

Acute Effects: When large amounts of sodium bromide are ingested, acute toxicity may occur. Symptoms include listlessness, dizziness, unsteady gait, impaired reflex movements, and profound stupor or coma.

Chronic Effects: Incoordination and psychiatric disturbances such as depression and psychosis.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Treatment includes hydration, mild diuresis, and possible hemodialysis. Consider ammonium chloride (10 to 15 g *qd*) in divided doses with diuretic.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel. Isolate area and deny entry. Always stay upwind of spills. Cleanup personnel should protect against dust inhalation and skin contact. Avoid generating dusty conditions. Carefully scoop spilled dry material into appropriate containers for later disposal. For liquid spills, absorb with an inert material and place in appropriate containers for disposal. For large spills, dike far ahead of liquid to contain. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lense use in industry is controversial, establish your own policy.

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.(103)

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in a cool, *dry*, well-ventilated area away from acids, alkaloidal and heavy metal salts, and strong oxidizers. *Do not* allow contact with *any* moisture.

Other Precautions: Consider preplacement medical exams for exposed workers that emphasize central nervous system function.

Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 73, 101, 103, 124, 126, 127, 132, 136, 159

repared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

**** MATERIAL SAFETY DATA SHEET **** **** MATERIAL SAFETY DATA SHEET ****

1-Propanol, p.a.
01356

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: 1-Propanol, p.a.

Propyl alcohol
Company Identification: Acros Organics N.V.
Janssen Pharmaceuticalaan 3a
2440 Geel, Belgium
For information in North America, call: 800-ACROS-01
For information in Europe, call: 0032(0) 14575211
For emergencies in the US, call CHEMTREC: 800-424-9300
For emergencies outside the US, call: 0032(0) 14575299

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
71-23-8	n-Propyl alcohol		200-746-9

Hazard Symbols: F

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Appearance: Clear colourless liquid. Flash Point: 15°C.
Warning! Causes respiratory tract irritation. May cause skin irritation. Causes eye irritation. May cause digestive tract irritation. Flammable liquid. May be harmful if swallowed. May cause central nervous system depression. May be absorbed through the skin. May cause liver and kidney damage.
Target Organs: Kidneys, central nervous system, liver.

Potential Health Effects

Eye:

Causes eye irritation. May result in corneal injury. May cause conjunctivitis.

Skin:

May cause mild skin irritation. May be absorbed through the skin. Propanol is not appreciably irritating to the skin of rabbits even after prolonged contact, but it can be absorbed in significant amounts if confined to the skin. May produce dry, cracking skin.

Ingestion:

May cause gastrointestinal irritation with nausea, vomiting and diarrhea. May cause liver and kidney damage. May cause central nervous system depression, characterized by excitement, followed by headache, dizziness, drowsiness, and nausea. Advanced stages may cause collapse, unconsciousness, coma and possible death due to respiratory failure. May be harmful if swallowed.

Inhalation:

Inhalation of high concentrations may cause central nervous system effects characterized by headache, dizziness, unconsciousness and coma. Causes respiratory tract irritation. May cause narcotic effects. Aspiration may cause respiratory swelling and pneumonitis. Inhalation may produce dizziness, incoordination, headache, confusion, stupor, coma.

Chronic:

Chronic inhalation and ingestion may cause effects similar to those of acute inhalation and ingestion.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:

Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid.

Skin:

Get medical aid. Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes.

Ingestion:

Do NOT induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Possible aspiration hazard. Get medical aid.

Inhalation:

Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.

Notes to Physician:

Treat symptomatically.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:

Containers can build up pressure if exposed to heat and/or fire. As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Vapors can travel to a source of ignition and flash back. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Flammable Liquid. Can release vapors that form explosive mixtures at temperatures above the flashpoint.

Extinguishing Media:

Use water spray to cool fire-exposed containers. Water may be ineffective. Use dry chemical, carbon dioxide, or alcohol-resistant foam.

Autoignition Temperature: 405°C (761.00°F)
Flash Point: 15°C (59.00°F)
NFPA Rating: health-1; flammability-3; reactivity-0
Explosion Limits, Lower: 2.1%
Upper: 13.5%

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:

Absorb spill with inert material, (e.g., dry sand or earth), then place into a chemical waste container. Remove all sources of ignition. Provide ventilation.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:

Wash thoroughly after handling. Use only in a well ventilated area. Ground and bond containers when transferring material. Avoid contact with eyes, skin, and clothing. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, sparks or open flames. Keep container tightly closed. Avoid ingestion and inhalation.

Storage:

Keep away from heat, sparks, and flame. Keep away from sources of ignition. Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:

Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
n-Propyl alcohol	200 ppm ; 492 mg/m3; 250 ppm STEL; 614 mg/m3 STEL	200 ppm TWA; 500 mg/m3 TWA; 250 ppm STEL; 625 mg/m3 STEL	200 ppm TWA; 500 mg/m3 TWA

OSHA Vacated PELs:

n-Propyl alcohol:

200 ppm TWA; 500 mg/m3 TWA; 250 ppm STEL; 625 mg/m3 STEL

Personal Protective Equipment

Eyes:

Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133.

Skin:

Wear appropriate protective gloves to prevent skin exposure.

Clothing:

Wear appropriate protective clothing to prevent skin exposure.

Respirators:

Follow the OSHA respirator regulations found in 29CFR 1910.134. Always use a NIOSH-approved respirator when necessary.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State: Liquid
Appearance: Clear colourless liquid
Odor: Alcohol-like odor.
pH: Not available.
Vapor Pressure: 14.9 mm Hg @20C
Vapor Density: 2.07 (air=1)
Evaporation Rate: Not available.
Viscosity: 2.2 mPas 20°C
Boiling Point: 97°C @ 760.00mm Hg
Freezing/Melting Point: -127°C
Decomposition Temperature: Not available.
Solubility: soluble in water
Specific Gravity/Density: .8040g/cm3
Molecular Formula: C_3H_8O
Molecular Weight: 60.10

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:

Stable under normal temperatures and pressures.

Conditions to Avoid:

Incompatible materials, ignition sources.

Incompatibilities with Other Materials:

Acid chlorides - acid anhydrides - oxidizing agents - alcoholates - potassium-tert-butoxide - alkali metals - alkaline earth metals - acids - bases - halogens - aluminum - some forms of plastic, rubber and coatings, aluminum, aluminum isopropoxide + crotonaldehyde, 2-butanone, hydrogen peroxide, and oxidants.

Hazardous Decomposition Products:

Carbon monoxide, carbon dioxide.

Hazardous Polymerization: Will not occur.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:

CAS# 71-23-8: UH8225000

LD50/LC50:

CAS# 71-23-8: Inhalation, mouse: LC50 =48 gm/m3; Oral, mouse: LD50 = 6800 mg/kg; Oral, rabbit: LD50 = 2825 mg/kg; Oral, rat: LD50 = 1870 mg/kg; Skin, rabbit: LD50 = 4060 mg/kg.

Carcinogenicity:

n-Propyl alcohol -

Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.

Epidemiology:

No data available.

Teratogenicity:
No data available.
Reproductive Effects:
No data available.
Neurotoxicity:
No data available.
Mutagenicity:
No data available.
Other Studies:
No data available.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:
Water Danger/Protection: WGK 1
(fathead minnows): 4.63g/l/96H.
mg/l.
minnow: 5000 mg/l/48H; LC50 paddy fish: 5900 mg/l/48H (Sloof, W. et al Aquat. Toxicol. 1983, 4, 113-128).
Daphnia pulex, Daphnia cucullata, Daphnia magna: 3025-7080 mg/l/48H (Canton, J.H. et al Hydrobiologia 1978, 59(2), 135-140).
Photobacterium phosphoreum: 9308 ppm/30min Microtox test (Kaiser, K.L.E. et al Water Pollut. Res.J.Can. 1991, 26(3), 361-431).
Environmental Fate:
Nitrification inhibition: 50% inhibition of NH3 oxidation-pure culture Nitrosomonas europaea at 20 mg/l (Hooper, A. et al J.Bacteriol. 1973, 115, 480).
(2.4g O2/g of 1-propanol) (IPCS Environmental Health Criteria 102 1-propanol 1990, WHO, Geneva); Activated sludge with compound as sole carbon source COD 98.8%, 71 mg COD g dry/inoculum/H (Pitter, P. Water Res. 1976, 10, 231-235); Degradation by activated sludge 13.9% of ThOD after 6 H,26.8% of ThOD after 12 H and 36.9% of ThOD after 24H (Gerhold, R.M. et al J.-Water Pollut. Control Fed., 1966,38(4),562)
Physical/Chemical:
Not available.
Other:
Not available.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants: Not listed.
RCRA D-Series Chronic Toxicity Reference Levels: Not listed.
RCRA F-Series: Not listed.
RCRA P-Series: Not listed.
RCRA U-Series: Not listed.
Not listed as a material banned from land disposal according to RCRA.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT
Shipping Name: N-PROPANOL
Hazard Class: 3
UN Number: UN1274

Packing Group: II
IMO
Shipping Name: NORMAL-PROPANOL
Hazard Class: 3.2
UN Number: 1274
Packing Group: II
IATA
Shipping Name: N-PROPANOL
Hazard Class: 3
UN Number: 1274
Packing Group: II
RID/ADR
Shipping Name: N-PROPANOL
Dangerous Goods Code: 3(3B)
UN Number: 1274
Canadian TDG
No information available.

**** SECTION 15 - REGULATORY INFORMATION ****

FEDERAL
TSCA
CAS# 71-23-8 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
SARA
Section 302 (RQ)
None of the chemicals in this material have an RQ.
Section 302 (TPQ)
None of the chemicals in this product have a TPQ.
SARA Codes
CAS # 71-23-8: acute, flammable.
Section 313
No chemicals are reportable under Section 313.
Clean Air Act:
This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.
OSHA:
None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

n-Propyl alcohol can be found on the following state right to know lists: California, New Jersey, Florida, Pennsylvania, Minnesota, Massachusetts.

California No Significant Risk Level:
None of the chemicals in this product are listed.

INTERNATIONAL

European Labeling in Accordance with EC Directives

Hazard Symbols: F
Risk Phrases:
Safety Phrases:
S 16 Keep away from sources of ignition - No smoking.
S 7 Keep container tightly closed.

Canada

CAS# 71-23-8 is listed on Canada's DSL/NDSL List.
CAS# 71-23-8 is listed on Canada's Ingredient Disclosure List.

Exposure Limits:

CAS# 71-23-8:. OEL-AUSTRALIA:TWA 200 ppm (500 mg/m3);STEL 250 ppm;Skin. OEL-BELGIUM:TWA 200 ppm (492 mg/m3);STEL 250 ppm;Skin. OEL-CZECHOSLOVAKIA:TWA 500 mg/m3;STEL 1000 mg/m3. OEL-DENMARK:TWA 200 ppm (500 mg/m3);Skin. OEL-FINLAND:TWA 200 ppm (500 mg/m3);STEL 250 ppm;Skin. OEL-FRANCE:TWA 200 ppm (500 mg/m3). OEL-HUNGARY:TWA 100 mg/m3;STEL 200 mg/m3. OEL-POLAND:TWA 200 mg/m3. OEL-RUSSIA:STEL 10 mg/m3
150 ppm (350 mg/m3);STEL 250 ppm (all isomers). OEL-SWITZERLAND:TWA 200 ppm (500 mg/m3);Skin JAN9. OEL-TURKEY:TWA 200 ppm (500 mg/m3). OEL-UNITED KINGDOM:TWA 200 ppm (500 mg/m3);STEL 250 ppm;Skin. OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA check ACGIH TLV. OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGI TLV

**** SECTION 16 - ADDITIONAL INFORMATION ****

Additional Information:
No additional information available.

MSDS Creation Date: 2/28/1996 Revision #0 Date: Original.

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

**** MATERIAL SAFETY DATA SHEET **** **** MATERIAL SAFETY DATA SHEET ****

Hexyl alcohol, 98%
96607

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: Hexyl alcohol, 98%

Synonyms:
1-Hexanol
Company Identification: Acros Organics N.V.
Janssen Pharmaceuticalaan 3a
2440 Geel, Belgium
For information in North America, call: 800-ACROS-01
For information in Europe, call: 0032(0) 14575211
For emergencies in the US, call CHEMTREC: 800-424-9300
For emergencies outside the US, call: 0032(0) 14575299

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
111-27-3	Hexyl alcohol, 98%		203-852-3

Hazard Symbols: XN

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Appearance: clear colourless liquid.

Target Organs: None.

Potential Health Effects
The toxicological properties of this material have not been investigated. Use appropriate procedures to prevent opportunities for direct contact with the skin or eyes and to prevent inhalation.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:
Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid immediately.

Skin:
Get medical aid. Flush skin with plenty of soap and water for at

least 15 minutes while removing contaminated clothing and shoes. Remove contaminated clothing and shoes.

Ingestion:

If victim is conscious and alert, give 2-4 cupfuls of milk or water. Get medical aid immediately. DO NOT induce vomiting. Allow the victim to rinse his mouth and then to drink 2-4 cupfuls of water, and seek medical advice.

Inhalation:

Get medical aid immediately. Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.

Notes to Physician:

Treat symptomatically.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:

As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Flammable Liquid.

Extinguishing Media:

In case of fire, use water, dry chemical, chemical foam, or alcohol-resistant foam. Use agent most appropriate to extinguish fire.

Autoignition Temperature: 292°C (557.60°F)
Flash Point: 60°C (140.00°F)
NFPA Rating: health-1; flammability-2; reactivity-0
Explosion Limits, Lower: 1.20 vol %
Upper: 7.70 vol %

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:

Absorb spill with inert material, (e.g., dry sand or earth), then place into a chemical waste container. Clean up spills immediately, observing precautions in the Protective Equipment section.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:

Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, sparks or open flames. Avoid contact with heat, sparks and flame.

Storage:

Keep away from heat, sparks, and flame.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:

Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits. Use process enclosure, local exhaust ventilation, or other engineering controls to control airborne levels.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Hexyl alcohol, 98%	none listed	none listed	none listed

OSHA Vacated PELs:
Hexyl alcohol, 98%:
No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes:
Wear chemical goggles. Wear safety glasses and chemical goggles if splashing is possible.

Skin:
Wear appropriate protective gloves and clothing to prevent skin exposure. Wear appropriate protective gloves to prevent skin exposure.

Clothing:
Wear appropriate protective clothing to minimize contact with skin.

Respirators:
A respiratory protection program that meets OSHA's 29 CFR ¦1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrant a respirator's use. Wear a NIOSH/MSHA-approved (or equivalent) full-facepiece airline respirator in the positive pressure mode with emergency escape provisions.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State: Not available.
Appearance: Not available.
Odor: None reported.
pH: Not available.
Vapor Pressure: 1.3 mbar @ 20 C
Vapor Density: Not available.
Evaporation Rate: Not available.
Viscosity: 5.3 mPas 20°C
Boiling Point: 156.4°C @ 760.00mm Hg
Freezing/Melting Point: -52.0°C
Decomposition Temperature: Not available.
Solubility: 5.8 g/l (20 c)
Specific Gravity/Density: .8140g/cm3
Molecular Formula: $C_6H_{14}O$
Molecular Weight: 102.18

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability.
Stable under normal temperatures and pressures.
Conditions to Avoid:
Incompatible materials, strong oxidants.
Incompatibilities with Other Materials:
Strong oxidizing agents - strong acids.
Hazardous Decomposition Products:
Carbon monoxide, irritating and toxic fumes and gases, carbon dioxide.
Hazardous Polymerization: Has not been reported.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 111-27-3: MQ4025000
LD50/LC50:
CAS# 111-27-3: Oral, mouse: LD50 = 1950 mg/kg; Oral, rat: LD50 = 720 mg/kg; Skin, rabbit: LD50 = 3100 mg/kg.
Carcinogenicity:
Hexyl alcohol, 98% -
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:
Not available.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants: Not listed.
RCRA D-Series Chronic Toxicity Reference Levels: Not listed.
RCRA F-Series: Not listed.
RCRA P-Series: Not listed.
RCRA U-Series: Not listed.
Not listed as a material banned from land disposal according to RCRA.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT
Shipping Name: HEXANOLS
Hazard Class: 3
UN Number: UN2282
Packing Group: III
IMO
Shipping Name: HEXANOLS
Hazard Class: 3.3
UN Number: 2282
Packing Group: III
IATA
Shipping Name: HEXANOLS
Hazard Class: 3
UN Number: 2282

Packing Group: III
RID/ADR
Shipping Name: HEXANOLS
Dangerous Goods Code: 3(31C)
UN Number: 2282
Canadian TDG
Shipping Name: HEXANOLS
Hazard Class: 3
UN Number: UN2282
Other Information: FLASHPOINT 60 C

**** SECTION 15 - REGULATORY INFORMATION ****

FEDERAL
TSCA
CAS# 111-27-3 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
SARA
Section 302 (RQ)
None of the chemicals in this material have an RQ.
Section 302 (TPQ)
None of the chemicals in this product have a TPQ.
SARA Codes
CAS # 111-27-3: acute, flammable.
Section 313
No chemicals are reportable under Section 313.
Clean Air Act:
This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.
OSHA:
None of the chemicals in this product are considered highly hazardous by OSHA.
STATE
Hexyl alcohol, 98% can be found on the following state right to know lists: New Jersey, Pennsylvania.
California No Significant Risk Level:
None of the chemicals in this product are listed.
INTERNATIONAL
European Labeling in Accordance with EC Directives

Hazard Symbols: XN
Risk Phrases:
Safety Phrases:
S 24/25 Avoid contact with skin and eyes.

Canada

CAS# 111-27-3 is listed on Canada's DSL/NDSL List.
CAS# 111-27-3 is listed on Canada's Ingredient Disclosure List.

Exposure Limits:

**** SECTION 16 - ADDITIONAL INFORMATION ****

Additional Information:
No additional information available.
MSDS Creation Date: 2/01/1996 Revision #0 Date: Original.

**** MATERIAL SAFETY DATA SHEET **** **** MATERIAL SAFETY DATA SHEET ****

2,4-Dimethyl-3-pentanol, tech., 94%
32180

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: 2,4-Dimethyl-3-pentanol, tech., 94%

Diisopropylcarbinol
Company Identification: Acros Organics N.V.
Janssen Pharmaceuticalaan 3a
2440 Geel, Belgium
For information in North America, call: 800-ACROS-01
For information in Europe, call: 0032(0) 14575211
For emergencies in the US, call CHEMTREC: 800-424-9300
For emergencies outside the US, call: 0032(0) 14575299

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
600-36-2	2,4-Dimethyl-3-pentanol, 99+%	99+	209-993-7

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Appearance: clear colourless liquid.

Target Organs: None.

Potential Health Effects

The toxicological properties of this material have not been investigated. Use appropriate procedures to prevent opportunities for direct contact with the skin or eyes and to prevent inhalation.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:

Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid immediately.

Skin:

Get medical aid. Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Remove contaminated clothing and shoes.

Ingestion:

If victim is conscious and alert, give 2-4 cupfuls of milk or water. Get medical aid immediately. DO NOT induce vomiting. Allow the victim to rinse his mouth and then to drink 2-4 cupfuls of water, and seek medical advice.

Inhalation:

Get medical aid immediately. Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.

Notes to Physician:

Treat symptomatically.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:

As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Flammable Liquid.

Extinguishing Media:

In case of fire, use water, dry chemical, chemical foam, or alcohol-resistant foam. Use agent most appropriate to extinguish fire.

Autoignition Temperature: 398°C (748.40°F)

Flash Point: 35°C (95.00°F)

NFPA Rating: health-0; flammability-2; reactivity-0

Explosion Limits, Lower: Not available.

Upper: Not available.

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:

Absorb spill with inert material, (e.g., dry sand or earth), then place into a chemical waste container. Clean up spills immediately, observing precautions in the Protective Equipment section.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:

Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, sparks or open flames. Avoid contact with heat, sparks and flame.

Storage:

Keep away from heat, sparks, and flame. Flammables-area.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:

Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits. Use process enclosure, local exhaust ventilation, or other engineering controls to control airborne levels.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
2,4-Dimethyl-3-pentanol, 99+%	none listed	none listed	none listed

OSHA Vacated PELs:
2,4-Dimethyl-3-pentanol, 99+%:
No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes:
Wear chemical goggles. Wear safety glasses and chemical goggles if splashing is possible.

Skin:
Wear appropriate protective gloves and clothing to prevent skin exposure. Wear appropriate protective gloves to prevent skin exposure.

Clothing:
Wear appropriate protective clothing to minimize contact with skin.

Respirators:
A respiratory protection program that meets OSHA's 29 CFR ¦1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrant a respirator's use. Wear a NIOSH/MSHA-approved (or equivalent) full-facepiece airline respirator in the positive pressure mode with emergency escape provisions.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State: Not available.
Appearance: Not available.
Odor: None reported.
pH: Not available.
Vapor Pressure: Not available.
Vapor Density: Not available.
Evaporation Rate: Not available.
Viscosity: Not available.
Boiling Point: 139 - 140°C @ 760.00mm Hg
Freezing/Melting Point: -70°C
Decomposition Temperature: Not available.
Solubility: soluble in ethanol and ethyl ether
Specific Gravity/Density: .8290g/cm3
Molecular Formula: C7H16O
Molecular Weight: 116.20

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:
Stable under normal temperatures and pressures.
Conditions to Avoid:
Incompatible materials, strong oxidants.
Incompatibilities with Other Materials:
Strong acids - strong oxidizing agents - acid chlorides - strong reducing agents - acid anhydr. - phosphorus halides.
Hazardous Decomposition Products:
Irritating and toxic fumes and gases.
Hazardous Polymerization: Has not been reported.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 600-36-2 unlisted.
LD50/LC50:
Not available.
Carcinogenicity:
2,4-Dimethyl-3-pentanol, 99+% -
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:
Not available.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants: Not listed.
RCRA D-Series Chronic Toxicity Reference Levels: Not listed.
RCRA F-Series: Not listed.
RCRA P-Series: Not listed.
RCRA U-Series: Not listed.
Not listed as a material banned from land disposal according to RCRA.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT
Shipping Name: ALCOHOLS, N.O.S.
Hazard Class: 3
UN Number: UN1987
Packing Group: II
IMO
Shipping Name: ALCOHOLS, N.O.S.
Hazard Class: 3.3
UN Number: 1987
Packing Group: III
IATA
Shipping Name: ALCOHOLS, N.O.S.*
Hazard Class: 3
UN Number: 1987
Packing Group: III
RID/ADR

Shipping Name: ALCOHOLS, FLAMMABLE, N.O.S.
Dangerous Goods Code: 3(31C)
UN Number: 1987
Canadian TDG
No information available.

**** SECTION 15 - REGULATORY INFORMATION ****

FEDERAL

TSCA

CAS# 600-36-2 is listed on the TSCA inventory.

Health & Safety Reporting List

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

Chemical Test Rules

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

Section 12b

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

TSCA Significant New Use Rule

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

SARA

Section 302 (RQ)

None of the chemicals in this material have an RQ.

Section 302 (TPQ)

None of the chemicals in this product have a TPQ.

Section 313

No chemicals are reportable under Section 313.

Clean Air Act:

This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

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

STATE

Not present on state lists from CA, PA, MN, MA, FL, or NJ.
California No Significant Risk Level:
None of the chemicals in this product are listed.

INTERNATIONAL

European Labeling in Accordance with EC Directives

Hazard Symbols: Not available.
Risk Phrases:
Safety Phrases:
S 16 Keep away from sources of ignition - No smoking.

Canada

CAS# 600-36-2 is listed on Canada's DSL/NDSL List.
CAS# 600-36-2 is not listed on Canada's Ingredient Disclosure List.

Exposure Limits:

**** SECTION 16 - ADDITIONAL INFORMATION ****

Additional Information:
No additional information available.
MSDS Creation Date: 3/01/1994 Revision #1 Date: 3/04/1996

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

**** MATERIAL SAFETY DATA SHEET **** **** MATERIAL SAFETY DATA SHEET ****

1-Heptanol, 98%
36897

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: 1-Heptanol, 98%

Heptyl alcohol
Company Identification: Acros Organics N.V.
Janssen Pharmaceuticalaan 3a
2440 Geel, Belgium
For information in North America, call: 800-ACROS-01
For information in Europe, call: 0032(0) 14575211
For emergencies in the US, call CHEMTREC: 800-424-9300
For emergencies outside the US, call: 0032(0) 14575299

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
111-70-6	1-HEPTANOL		203-897-9

Hazard Symbols: XN

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Not available.
Appearance: Not available. Flash Point: 73°C.
Not available.
Target Organs: None known.

Potential Health Effects

Eye:
Causes eye irritation. Causes redness and pain.

Skin:
Harmful if absorbed through the skin.

Ingestion:
Harmful if swallowed. May cause headache.

Inhalation:
May cause respiratory tract irritation. May cause drowsiness, unconsciousness, and central nervous system depression.

Chronic:
Not available.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:

Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid.

Skin:

Get medical aid. Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes.

Ingestion:

Do NOT induce vomiting. Get medical aid. Wash mouth out with water.

Inhalation:

Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.

Notes to Physician:

Treat symptomatically and supportively.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:

As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Will burn if involved in a fire. Combustible Liquid.

Extinguishing Media:

Do not use water directly on fire. Use water spray to cool fire-exposed containers. Use foam, dry chemical, or carbon dioxide.

Autoignition Temperature: 350°C (662.00°F)
Flash Point: 73°C (163.40°F)
NFPA Rating: Not published.
Explosion Limits, Lower: Not available.
Upper: Not available.

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:

Absorb spill with inert material, (e.g., dry sand or earth), then place into a chemical waste container.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:

Avoid breathing dust, vapor, mist, or gas. Avoid contact with skin and eyes.

Storage:

Keep away from sources of ignition. Store in a cool, dry place. Store in a tightly closed container.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:

Use adequate ventilation to keep airborne concentrations low.

Exposure Limits

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+---------------+---------------+---------------+---------------+
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Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
1-HEPTANOL	none listed	none listed	none listed

OSHA Vacated PELs:
1-HEPTANOL:
No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes:
Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133.

Skin:
Wear appropriate protective gloves to prevent skin exposure.

Clothing:
Wear appropriate protective clothing to prevent skin exposure.

Respirators:
Follow the OSHA respirator regulations found in 29CFR 1910.134. Always use a NIOSH-approved respirator when necessary.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State:	Liquid
Appearance:	Not available.
Odor:	Slight pleasant
pH:	Not available.
Vapor Pressure:	0.5 mbar @ 20°C
Vapor Density:	Not available.
Evaporation Rate:	Not available.
Viscosity:	Not available.
Boiling Point:	176°C @ 760.00mm Hg
Freezing/Melting Point:	-35°C
Decomposition Temperature:	Not available.
Solubility:	soluble in ethanol, ether and usual orga
Specific Gravity/Density:	.8220g/cm3
Molecular Formula:	C7H16O
Molecular Weight:	116.20

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:
Stable under normal temperatures and pressures.

Conditions to Avoid:
Incompatible materials.

Incompatibilities with Other Materials:
Strong oxidizing agents - strong acids - acid chlorides - acid anhydrides.

Hazardous Decomposition Products:

Carbon monoxide, carbon dioxide.
Hazardous Polymerization: Has not been reported.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 111-70-6: MK0350000
LD50/LC50:
CAS# 111-70-6: Inhalation, mouse: LC50 =6600 mg/m3/2H; Oral, mouse: LD50 = 1500 mg/kg; Oral, rabbit: LD50 = 750 mg/kg; Oral, rat: LD50 = 500 mg/kg; Skin, rabbit: LD50 = 2 gm/kg.
Carcinogenicity:
1-HEPTANOL -
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology:
No data available.
Teratogenicity:
No data available.
Reproductive Effects:
No data available.
Neurotoxicity:
No data available.
Mutagenicity:
Mutation:
Other Studies:
No data available.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:
Not available.
Environmental Fate:
Not available.
Physical/Chemical:
Not available.
Other:
Not available.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants: Not listed.
RCRA D-Series Chronic Toxicity Reference Levels: Not listed.
RCRA F-Series: Not listed.
RCRA P-Series: Not listed.
RCRA U-Series: Not listed.
Not listed as a material banned from land disposal according to RCRA.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT
No information available
IMO
Shipping Name: TOXIC LIQUID, ORGANIC, N.O.S.

Hazard Class: 6.1
UN Number: 2810
Packing Group: III

IATA
Shipping Name: TOXIC LIQUID, ORGANIC, N.O.S.*
Hazard Class: 6.1
UN Number: 2810
Packing Group: III

RID/ADR
Shipping Name: TOXIC LIQUID, ORGANIC, N.O.S.
Dangerous Goods Code: 6.1(25C)
UN Number: 2810

Canadian TDG
No information available.

**** SECTION 15 - REGULATORY INFORMATION ****

FEDERAL

TSCA
CAS# 111-70-6 is listed on the TSCA inventory.

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

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

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

TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.

SARA
Section 302 (RQ)
None of the chemicals in this material have an RQ.

Section 302 (TPQ)
None of the chemicals in this product have a TPQ.

SARA Codes
CAS # 111-70-6: acute, flammable.

Section 313
No chemicals are reportable under Section 313.

Clean Air Act:
This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.

Clean Water Act:
None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

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

STATE
Not present on state lists from CA, PA, MN, MA, FL, or NJ.
California No Significant Risk Level:

None of the chemicals in this product are listed.

INTERNATIONAL

European Labeling in Accordance with EC Directives

Hazard Symbols: XN

Risk Phrases:

Safety Phrases:

S 26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

S 36/37/39 Wear suitable protective clothing, gloves and eye/face protection.

Canada

CAS# 111-70-6 is listed on Canada's DSL/NDSL List.

CAS# 111-70-6 is not listed on Canada's Ingredient Disclosure List.

Exposure Limits:

CAS# 111-70-6:. OEL-RUSSIA:STEL 10 mg/m3;Skin

**** SECTION 16 - ADDITIONAL INFORMATION ****

Additional Information:

No additional information available.

MSDS Creation Date: 3/01/1994 Revision #1 Date: 10/10/1996

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

**** MATERIAL SAFETY DATA SHEET **** **** MATERIAL SAFETY DATA SHEET ****

2-Ethyl-1-hexanol, 99%
59765

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: 2-Ethyl-1-hexanol, 99%

Company Identification: Acros Organics N.V.
Janssen Pharmaceuticalaan 3a
2440 Geel, Belgium
For information in North America, call: 800-ACROS-01
For information in Europe, call: 0032(0) 14575211
For emergencies in the US, call CHEMTREC: 800-424-9300
For emergencies outside the US, call: 0032(0) 14575299

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
104-76-7	2-Ethyl-1-hexanol, 99%		203-234-3

Hazard Symbols: XN

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Appearance: clear colourless liquid.

Target Organs: None.

Potential Health Effects
The toxicological properties of this material have not been investigated. Use appropriate procedures to prevent opportunities for direct contact with the skin or eyes and to prevent inhalation.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:
Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids.
Skin:
Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes.
Ingestion:
DO NOT induce vomiting. Allow the victim to rinse his mouth and then to drink 2-4 cupfuls of water, and seek medical advice.

Inhalation:
Remove from exposure to fresh air immediately.
Notes to Physician:
Treat symptomatically.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:
As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion.
Extinguishing Media:
In case of fire, use water, dry chemical, chemical foam, or alcohol-resistant foam.
Autoignition Temperature: 270°C (518.00°F)
Flash Point: 77°C (170.60°F)
NFPA Rating: health-2; flammability-2; reactivity-0
Explosion Limits, Lower: 1.10 vol %
Upper: 7.40 vol %

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks:
Absorb spill with inert material, (e.g., dry sand or earth), then place into a chemical waste container. Clean up spills immediately, observing precautions in the Protective Equipment section.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:
Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Avoid contact with eyes, skin, and clothing. Avoid ingestion and inhalation.
Storage:
Store in a cool, dry place. Keep container closed when not in use.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:
Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits. Use process enclosure, local exhaust ventilation, or other engineering controls to control airborne levels.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
2-Ethyl-1-hexanol, 99%	none listed	none listed	none listed

OSHA Vacated PELs:
2-Ethyl-1-hexanol, 99%:
No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes:
Wear safety glasses and chemical goggles if splashing is possible.

Skin:
Wear appropriate protective gloves and clothing to prevent skin exposure.

Clothing:
Wear appropriate protective clothing to minimize contact with skin.

Respirators:
Wear a NIOSH/MSHA-approved (or equivalent) full-facepiece airline respirator in the positive pressure mode with emergency escape provisions.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State:	Not available.
Appearance:	Not available.
Odor:	None reported.
pH:	Not available.
Vapor Pressure:	0.36 hPa @ 20 C
Vapor Density:	Not available.
Evaporation Rate:	Not available.
Viscosity:	10 mPas 20°C
Boiling Point:	183.0 - 186.0°C @ 760.00mm Hg
Freezing/Melting Point:	-76.0°C
Decomposition Temperature:	Not available.
Solubility:	0.1g/100ml (20 c)
Specific Gravity/Density:	.8330g/cm3
Molecular Formula:	C8H18O
Molecular Weight:	130.23

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:
Stable under normal temperatures and pressures.

Conditions to Avoid:
Incompatible materials, strong oxidants.

Incompatibilities with Other Materials:
Strong oxidizing agents - strong acids.

Hazardous Decomposition Products:
Carbon monoxide, irritating and toxic fumes and gases, carbon dioxide.

Hazardous Polymerization: Has not been reported.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 104-76-7: MP0350000
LD50/LC50:
CAS# 104-76-7: Oral, mouse: LD50 = 2500 mg/kg; Oral, rabbit: LD50 = 1180 mg/kg; Oral, rat: LD50 = 2049 mg/kg; Skin, rabbit: LD50 = 1970 mg/kg.
Carcinogenicity:
2-Ethyl-1-hexanol, 99% -
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:
Not available.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants: Not listed.
RCRA D-Series Chronic Toxicity Reference Levels: Not listed.
RCRA F-Series: Not listed.
RCRA P-Series: Not listed.
RCRA U-Series: Not listed.
Not listed as a material banned from land disposal according to RCRA.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT
No information available
IMO
Not regulated as a hazardous material.
IATA
Not regulated as a hazardous material.
RID/ADR
Not regulated as a hazardous material.
Canadian TDG
No information available.

**** SECTION 15 - REGULATORY INFORMATION ****

FEDERAL
TSCA
CAS# 104-76-7 is listed on the TSCA inventory.
Health & Safety Reporting List
CAS# 104-76-7: Effective Date: June 1, 1987
Chemical Test Rules
CAS# 104-76-7: Testing required by: manufacturers; processors (40 CFR
Section 12b
CAS# 104-76-7: export notification required - Section 4
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
SARA
Section 302 (RQ)
None of the chemicals in this material have an RQ.

Section 302 (TPQ)
None of the chemicals in this product have a TPQ.
SARA Codes
CAS # 104-76-7: acute, chronic, flammable.
Section 313
No chemicals are reportable under Section 313.
Clean Air Act:
This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.
OSHA:
None of the chemicals in this product are considered highly hazardous by OSHA.
STATE
2-Ethyl-1-hexanol, 99% can be found on the following state right to know lists: Florida, Pennsylvania, Massachusetts.
California No Significant Risk Level:
None of the chemicals in this product are listed.
INTERNATIONAL
European Labeling in Accordance with EC Directives
Hazard Symbols: XN
Risk Phrases:
Safety Phrases:
S 23 Do not inhale gas/fumes/vapour/spray.
S 24/25 Avoid contact with skin and eyes.
Canada
CAS# 104-76-7 is listed on Canada's DSL/NDSL List.
CAS# 104-76-7 is listed on Canada's Ingredient Disclosure List.
Exposure Limits:

**** SECTION 16 - ADDITIONAL INFORMATION ****

Additional Information:
No additional information available.
MSDS Creation Date: 3/01/1994 Revision #1 Date: 3/04/1996

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

**** MATERIAL SAFETY DATA SHEET **** **** MATERIAL SAFETY DATA SHEET ****

Calcium chloride dihydrate 77 - 80% cacl2 flakes for drying purposes
95445

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: Calcium chloride dihydrate 77 - 80% cacl2 flakes for drying purposes

None.

Company Identification: Acros Organics N.V.
Janssen Pharmaceuticalaan 3a
2440 Geel, Belgium
For information in North America, call: 800-ACROS-01
For information in Europe, call: 0032(0) 14575211
For emergencies in the US, call CHEMTREC: 800-424-9300
For emergencies outside the US, call: 0032(0) 14575299

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
10035-04-8	Calcium chloride dihydrate, 77-80% CaCl2, flakes for drying purposes	77-80%	unlisted

Hazard Symbols: XI

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Appearance: White hygroscopic platelets.
Caution! Causes respiratory tract irritation. May cause digestive tract irritation. Hygroscopic. May be harmful if swallowed. Causes eye and skin irritation.
Target Organs: None.

Potential Health Effects
Eye:
Causes eye irritation.
Skin:
Causes skin irritation.
Ingestion:
May cause severe gastrointestinal tract irritation with nausea, vomiting and possible burns. May be harmful if swallowed.
Inhalation:
May cause severe irritation of the upper respiratory tract with pain, burns, and inflammation.
Chronic:
No information found.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:
Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid immediately.

Skin:
Get medical aid. Immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes.

Ingestion:
Do NOT induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately.

Inhalation:
Get medical aid immediately. Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.

Notes to Physician:
Treat symptomatically and supportively.

Antidote:
None reported.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:
Substance is noncombustible.

Extinguishing Media:
Do not use water directly on fire. Substance is noncombustible; use agent most appropriate to extinguish surrounding fire.

Autoignition Temperature: Not available.
Flash Point: Not available.
NFPA Rating: Not published.
Explosion Limits, Lower: Not available.
Upper: Not available.

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:
Vacuum or sweep up material and place into a suitable disposal container. Clean up spills immediately, observing precautions in the Protective Equipment section.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:
Wash thoroughly after handling. Wash hands before eating. Use with adequate ventilation. Avoid breathing dust, vapor, mist, or gas. Do not get on skin or in eyes. Avoid ingestion and inhalation.

Storage:
Store in a cool, dry place. Store in a tightly closed container.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:
Use adequate ventilation to keep airborne concentrations low.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Calcium chloride dihydrate, 77-80% $CaCl_2$, flakes for drying purposes	none listed	none listed	none listed

OSHA Vacated PELs:
Calcium chloride dihydrate, 77-80% $CaCl_2$, flakes for drying purposes:
No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes:
Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133.

Skin:
Wear appropriate gloves to prevent skin exposure.

Clothing:
Wear appropriate protective clothing to minimize contact with skin.

Respirators:
Follow the OSHA respirator regulations found in 29CFR 1910.134. Always use a NIOSH-approved respirator when necessary.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State:	Solid
Appearance:	White hygroscopic platelets
Odor:	Odorless.
pH:	Not available.
Vapor Pressure:	0.01 mm Hg @ 20 C
Vapor Density:	Not available.
Evaporation Rate:	Negligible
Viscosity:	Not available.
Boiling Point:	Not available.
Freezing/Melting Point:	175°C
Decomposition Temperature:	Not available.
Solubility:	326 G/100ML (60°C)
Specific Gravity/Density:	.8350g/cm3
Molecular Formula:	$CaCl_2.2H_2O$
Molecular Weight:	147.02

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:
Stable under normal temperatures and pressures.
Conditions to Avoid:
Incompatible materials, exposure to moist air or water.
Incompatibilities with Other Materials:
Boric oxide + calcium oxide, bromine trifluoride; react with zinc to form explosive hydrogen gas; catalyzes exothermic polymerization of vinyl ether; explodes at roomtemperature when added to furan-2-peroxycarbolic acid; and undergoes an exothermic (heat-producing) reaction with water.
Hazardous Decomposition Products:
Hydrogen chloride.
Hazardous Polymerization: Will not occur.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 10035-04-8: EV9810000
LD50/LC50:
Not available.
Carcinogenicity:
Calcium chloride dihydrate, 77-80% $CaCl_2$, flakes for drying purposes
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology:
No data available.
Teratogenicity:
No data available.
Reproductive Effects:
No data available.
Neurotoxicity:
No data available.
Mutagenicity:
sln-smc 200 mmol/L dns-rat-ipr 2500 ¦mol/kg cyt-rat/ast 3500 mg/kg
Other Studies:
No data available.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:
Not available.
Environmental Fate:
Not available.
Physical/Chemical·
Not available.
Other:
Not available.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants: Not listed.
RCRA D-Series Chronic Toxicity Reference Levels: Not listed.

RCRA F-Series: Not listed.
RCRA P-Series: Not listed.
RCRA U-Series: Not listed.
Not listed as a material banned from land disposal according to RCRA.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT
No information available
IMO
Not regulated as a hazardous material.
IATA
Not regulated as a hazardous material.
RID/ADR
Not regulated as a hazardous material.
Canadian TDG
No information available.

**** SECTION 15 - REGULATORY INFORMATION ****

FEDERAL
TSCA
CAS# 10035-04-8 is not on the TSCA Inventory. It is a hydrate and exempt from TSCA Inventory requirements (40CFR270.3(u)(2)).
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
SARA
Section 302 (RQ)
None of the chemicals in this material have an RQ.
Section 302 (TPQ)
None of the chemicals in this product have a TPQ.
SARA Codes
CAS # 10035-04-8: acute.
Section 313
No chemicals are reportable under Section 313.
Clean Air Act:
This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.
OSHA:
None of the chemicals in this product are considered highly hazardous

by OSHA.

STATE

Not present on state lists from CA, PA, MN, MA, FL, or NJ.

California No Significant Risk Level:

None of the chemicals in this product are listed.

INTERNATIONAL

European Labeling in Accordance with EC Directives

Hazard Symbols: XI

Risk Phrases:

Safety Phrases:

S 22 Do not inhale dust.

S 24 Avoid contact with skin.

Canada

None of the chemicals in this product are listed on the DSL/NDSL list.

CAS# 10035-04-8 is not listed on Canada's Ingredient Disclosure List.

Exposure Limits:

**** SECTION 16 - ADDITIONAL INFORMATION ****

Additional Information:

No additional information available.

MSDS Creation Date: 2/19/1996 Revision #1 Date: 3/04/1996

HANDBOOK OF ENVIRONMENTAL DATA ON ORGANIC CHEMICALS

SECOND EDITION

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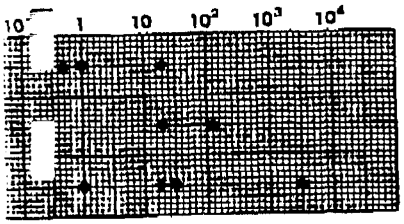
ISBN 0-442-28802-6

hy xide; diethyloxide)

emical synthesis; industrial solvent;
co l denaturant
p. 116/-123°C; b.p. 35°C; v.p. 442
.g. 0.7135 at 20/4°C; solub. 69,000
mg/l at 25°C; THC 652 kcal/mole,

p n, 1 ppm = 3.03 mg/cu m
gen ether odor



; ; 671; 678; 709; 774; 775; 804)
(316)

(269)
(256)
(30)
(30)

(181)

feed: 200-1,000 mg/l, acclimation:
(93)

8 ppm (1833)
fr water at 23°C, mild aeration

best fit 96 hr LC_{50}
r 96 hr ppm
100 >10,000
100
etic seawater at 23°C, mild aeration

best fit 96 hr LC_{50}
r 96 hr ppm
90 >10,000
(352)

42 0 ppm, 3 hr

rat: inhalation: lethal: 64,000 ppm
dog: inhalation: lethal: 106,000 ppm
monkey: inhalation: lethal: 71,600–192,500 ppm (211)
–Man: severe toxic effects: 8,000 ppm = 24,624 mg/cu m, 60 min
symptoms of illness: 2,000 ppm = 6,156 mg/cu m
unsatisfactory: >500 ppm = 1,539 mg/cu m (185)
nose irritation: 200 ppm (211)

ethylethylene *see* α-butylene

S-ethylethylcyclohexylthiocarbamate *see* Ro-Neet

ethylformate (ethylmethanoate)
CH_3CH_2OCHO

A. PROPERTIES: colorless liquid; m.w. 74.08; m.p. -79/-80°C; b.p. 54°C; v.p. 192 mm at 20°C, 300 mm at 30°C; v.d. 2.55; sp.gr. 0.924 at 25/4°C; solub. 105,000 mg/l at 20°C, 118,000 mg/l at 25°C; THC 392 kcal/mole, LHC 369 kcal/mole; sat.conc. 774 g/cu m at 20°C, 1,170 g/cu m at 30°C

B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.33 ppm, 1 ppm = 308 mg/cu m
–Odor threshold: recognition: 54–61 mg/cu m (610)

C. WATER POLLUTION FACTORS:
–Waste water treatment:
NFG,BOD, 20°C, 1-10 days observed, feed: 200–1,000 mg/l, acclimation: 365 + P: 30% removed (93)
–Impact on biodegradation processes:
BOD_{10} test is not affected at 1 g/l (30)
–Odor threshold: detection: 17 mg/kg (908)

D. BIOLOGICAL EFFECTS:
–Mammalia: rat: inhalation: no deaths: conc.vap., 5 min
5/6: 8,000 ppm, 4 hr
cat: inhalation: no deaths: 4,000 ppm, 4 hr
rat: single oral LD_{50}: 4.3 g/kg (211)
–Man: eye and nose irritation: 330 ppm (211)

ethylglycol *see* ethyleneglycolmonoethylether

ethylglycolacetate *see* ethyleneglycolmonoethyletheracetate

ethylguthion *see* azinphosethyl

S-ethylhexahydro-1H-azepine-1-carbothioate *see* molinate

2-ethyl-1-hexanol
$CH_3(CH_2)_3CH(C_2H_5)CH_2OH$

Uses: plasticizers for PVC resins; defoaming agent; wetting agent; organic synthesis; solvent mixtures for nitrocellulose, paints lacquers, baking finishes; textile finishing compounds; plasticizers; inks; rubber; paper; lubricants; photography; dry cleaning

A. PROPERTIES: colorless liquid; m.w. 130.23; m.p. −76°C; b.p. 183.5°C; v.p. 0.05 mm at 20°C; v.d. 4.49; sp.gr. 0.834 at 20/20°C; solub. 1,000 mg/l at 20°C;

B. AIR POLLUTION: 1 mg/cu m = 0.18 ppm, 1 ppm = 5.41 mg/cu m

–Odor: characteristic: quality: musty
hedonic tone: unpleasant to pleasant

T.O.C.: abs.perc.lim.: 0.075 ppm
50% recogn.: 0.138 ppm
100% recogn.: 0.138 ppm
O.I. 100% recogn.: 949 (19)

C. WATER POLLUTION FACTORS:

–Impact on biodegradation processes:

effect on respiration of glucose by mixed culture derived from activated sludge:

concentration mg/l	increase in lag period hours	respiration rate %	
1	0	100	
10	13	68	
100	110	0	
1,000	>200	0	(997)

–Water quality:

Kanawha river (USA): 13.11.1963: raw: 110 ppb
sand filtered: 8 ppb
21.11.1963: raw: not detectable
after aeration: 7 ppb
carbon filtered: not detectable (59)

Delaware river (U.S.A.): conc. range: winter: 3–5 ppb
summer: n.d. (1051)

–Waste water treatment:

A.C.: adsorbability: 0.138 g/g; 98.5% reduction, infl.: 700 mg/l, effl. 10 mg/l (32)

conventional municipal treatment: infl. 0.110 mg/l; effl. 0.008 mg/l; 86% removal (404)

Biodegradation at 0.1 mg/l:

	normal sewage	adapted sewage	
after 24 hr	0%	100%	
after 135 hr	100%	100%	(997)

–Reduction of amenities: T.O.C. = 0.27 mg/l (297)(403)

T.O.C. in water at room temp.: 1.3 ppm, range: 0.58–2.08 ppm, 13 judges
20% of population still able to detect odor at 0.61 ppm
10% of population still able to detect odor at 0.42 ppm
1% of population still able to detect odor at 0.12 ppm
0.1% of population still able to detect odor at 0.035 ppm (321)

D. BIOLOGICAL EFFECTS:

–Fish: rainbow trout: 96 hr LC_{50} (S): 32-37 mg/l (1500)

–Mammals:

rat: single oral LD_{50}: 3.2–6.4 g/kg
mouse: single oral LD_{50}: 3.2–6.4 g/kg
rat: inhalation: no deaths: 235 ppm, 6 hr (211)

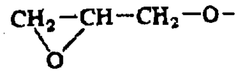
2-ethylhexylamine

$CH_3-(CH_2)_3-$

D. BIOLOGICAL EFFECTS:

–Toxicity threshold (cell multiplicatio
bacteria (*Pseudomonas putida*):
algae (*Mycrocystis aeruginosa*):
green algae (*Scenedesmus quadricau*
protozoa (*Entosiphon sulcatum*):
protozoa (*Uronema parduczi Chatto*

2-ethylhexylglycidylether (1-glycidylox



$CH_2-CH-CH_2-O-$ (with O bridging CH_2 and CH)

A. PROPERTIES: b.p. 118–120°C at 20 n

C. WATER POLLUTION FACTORS:

–BOD_5: 0.14 NEN 3235-5.4
–COD: 2.46 NEN 3235-5.3

D. BIOLOGICAL EFFECTS:

Fish: goldfish: LD_{50} (24 hr): 14 mg

ethylhydrosulfide *see* ethylmercaptan

ethylidenechloride *see* 1,1-dichloroetha

ethylidenecyanohydrin *see* lactonitrile

ethylidenedichloride *see* 1,1-dichloroet

ethylisoamylketone *see* ethyl-*sec*-amyl

ethylisobutylmethane *see* 2-methylhex.

ethylketone *see* diethylketone

D-N-ethyllactamidecarbanilate *see* carb

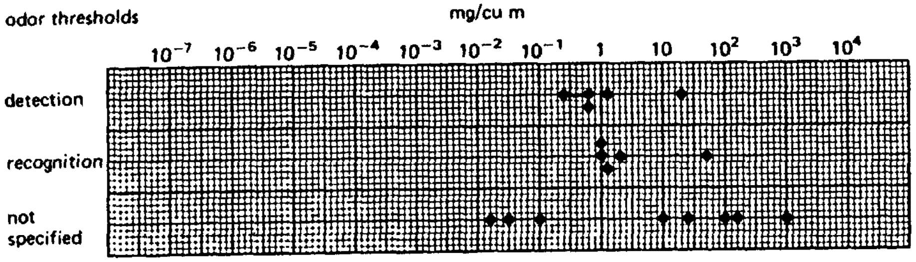
ethylmercaptan (ethanethiol; ethylhy
C_2H_5SH

Uses: LPG odorant; adhesive stabili

A. PROPERTIES: m.w. 62.13; m.p. −1
640 mm at 30°C; v.d. 2.14; solub
2,093 g/cu m at 30°C

B. AIR POLLUTION FACTORS: 1 mg/cu

Verschueren, K.



(19; 278; 279; 307; 602; 610; 613; 676; 704; 709; 749; 788; 828)

O.I. at 20°C = 368

C. WATER POLLUTION FACTORS:

–Oxidation parameters:

BOD_5: 46% ThOD (274)

: 0.1265 (30)

: 1.50; 1.61 (258)(260)

: 1.59 at 1,000 ppm, Warburg, sew. (267)

: 1.10 at 10–20 ppm, std. dil. sew (269)

BOD_{20}: 0.1732 (30)

COD: 81% ThOD (0.05 n $K_2Cr_2O_7$) (274)

$KMnO_4$: 0.070

0% ThOD (0.01 n $KMnO_4$) (274)

ThOD: 2.727

–Waste water treatment: A.C.: adsorbability: 0.155 g/g C; 71.8% reduction, infl.: 1,000 mg/l, effl.: 282 mg/l (32)

air flotation after chemical addition: 89% removal (173)

anaerobic lagoon:

lb COD/day/1,000 cu ft:	infl. mg/l;	effl. mg/l	
22	315	70	
48	315	100	(37)

A.S.: after 6 hr: 16.4% of ThOD
12 hr: 25.4% of ThOD
24 hr: 28.0% of ThOD (88)

reverse osmosis: 40% rejection from 0.01 M solution (221)

A.S., BOD, 20°C, 1–5 days observed, feed: 333 mg/l, 30 days acclimation: 84% removed (93)

D. BIOLOGICAL EFFECTS:

–Toxicity threshold (cell multiplication inhibition test):

bacteria (*Pseudomonas putida*):	220 mg/l	(1900)
algae (*Microcystis aeruginosa*):	17 mg/l	(329)
green algae (*Scenedesmus quadricauda*):	260 mg/l	(1900)
protozoa (*Entosiphon sulcatum*):	17 mg/l	(1900)
protozoa (*Uronema parduczi Chatton-Lwoff*):	144 mg/l	(1901)

–Bacteria: *E. coli*: no effect at 1 g/l

–Algae: *Scenedesmus*: toxic: 280 mg/l

–Arthropod: *Daphnia*: toxic: 440 mg/l (m30)

–Fish: creek chub: LD_0: 350 mg/l, 24 hr in Detroit river (243)

LD_{100}: 500 mg/l, 24 hr in Detroit river (243)

96 hr TLm: 370–490 mg/l at 10°C (451)

2-pentanol *see sec-act*-amylalcohol

3-pentanol

$CH_3-CH_2-CHOH-CH_2-CH_3$

A. PROPERTIES: m.w. 88.15; b.p. 114-
culated)

D. BIOLOGICAL EFFECTS:

–Fish:

guppy (*Poecilia reticulata*): 7 d L(

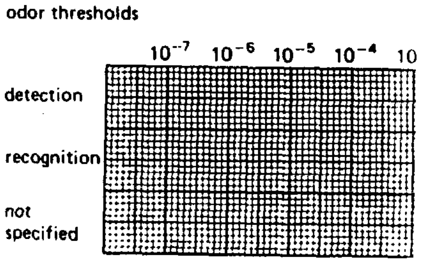
***tert*-pentanol** *see* 2-methyl-2-butanol

1-pentanolacetate *see prim*-amylacetat

2-pentanone (methyl-*n*-propylketone,
$CH_3COC_3H_7$

A. PROPERTIES: colorless liquid; m.w.
at 20°C, 16 mm at 25°C, 21 m
solub. 43,000 mg/l; sat. conc. 52 g

B. AIR POLLUTION FACTORS: 1 mg/cu



O.I.: at 20°C = 2,000

–Manmade sources: in exhaust of
ketone)

C. WATER POLLUTION FACTORS:

–Waste water treatment:

A.S.: after 6 hr: 0.4% of ThOD
12 hr: 0.8% of ThOD
24 hr: 1.8% of ThOD

A.C.: adsorbability: 0.139 g/g C,
mg/l

D. BIOLOGICAL EFFECTS:

–Mammalia: guinea pig: inhalation

3-pentanone *see* diethylketone

4-pentenal

$CH_2CH(CH_2)_2CHO$

(316)
HC cons.: ranking: <0.01
NO ox.: ranking: 0.2 (63)

: 0.08–3 ppb (101)
0% ile: 8 ppb
verage: 21 ppb
0% ile: 35 ppb (64)
ge: 0.05–0.35 ppm (102)
emitted HC.s (72)
<0.6–<0.7 ppm (196)

6.9–8.6 vol.% of total evaporated HC's
1.5–9.9 vol.% of total evaporated HC's
(398; 399; 400; 401; 402)
ir survey: 2.5 vol.% of total exhaust HC's
(391)

groundwater—in presence of the other com-
00 μl/l); biodegradation: 70% after 192 hr at
(956)
eous medium at 50°C: 31.4% degradation to
(1628)
6 hr: 0.7% of ThOD
2 hr: 0.5% of ThOD
4 hr: 0.7% of ThOD (88)

s up to 100 ppm after 96 hrs in artificial sea
(317)
0 min (211)

)

15; b.p. 239.4°C; spec.gr. 0.994 at 20/20°C;

std. dil. sew (256)

served, feed: 200–1,000 mg/l, acclimation:
(93)

---

reverse osmosis: 62.0% rejection from a 0.01 M solution (211)

2,4-pentanedione (acetylacetone; acetylmethane)
$CH_3COCH_2COCH_3$

A. PROPERTIES: colorless liquid; m.w. 100.11; m.p. −23.2°C; b.p. 139°C at 746 mm; sp.gr. 0.976; solub. 125,000 mg/l at 20°C, 515,000 mg/l at 80°C; THC 616 kcal/mole; log P_{oct} 1.90/2.25 (calculated)

B. AIR POLLUTION FACTORS:
–Odor: characteristic: quality: sour rancid
hedonic tone: unpleasant
absolute perception limit: 0.010 ppm
50% recogn.: 0.020 ppm
100% recogn.: 0.024 ppm
O.I.: 384.166

C. WATER POLLUTION FACTORS:
–Oxidation parameters:
BOD_5: 5.6% of ThOD
BOD_{10}: 40.0% of ThOD at 2.5 mg/l (405)
BOD_{15}: 62.8% of ThOD
BOD_{20}: 69.6

D. BIOLOGICAL EFFECTS:
–Toxicity threshold (cell multiplication inhibition test):

bacteria (*Pseudomonas putida*):	67 mg/l	(1900)
algae (*Microcystis aeruginosa*):	8.5 mg/l	(329)
green algae (*Scenedesmus quadricauda*):	2.7 mg/l	(1900)
protozoa (*Entosiphon sulcatum*):	11 mg/l	(1900)
protozoa (*Uronema parduczi Chatton-Lwoff*):	5.9 mg/l	(1901)

pentanenitrile *see* valeronitrile

pentanethiol *see* pentylmercaptan

pentanoic acid *see* *n*-valeric acid

***n*-pentanol** (*n*-butylcarbinol, *prim-n*-amylalcohol)
$C_5H_{11}OH$

Users and formulation: solvent mfg. of petroleum additives; urea-formaldehyde plastics processing; organic chemicals mfg.; raw material for pharmaceutical preparations. (347)

A. PROPERTIES: colorless liquid; m.w. 88.2; m.p. −78.9°C; b.p. 138°C; v.p. 2.8 mm at 20°C; v.d. 3.04; sp.gr. 0.824 at 20/20°; solub. 27,000 mg/l at 22°C; THC 795.7 kcal/mole; LHC 745 kcal/mole; log P_{oct} 1.40

B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.278 ppm, 1 ppm = 3.60 mg/cu m
–Odor: characteristic: quality: sweet
hedonic tone: pleasant

–Fish:
fatheads: soft water: TLm (25–96 hr): 48.5 mg/l
fatheads: hard water: TLm (25–96 hr): 42.3 mg/l
bluegills: soft water: TLm (25–96 hr): 35.1–32.0 mg/l
goldfish: soft water: TLm (25–96 hr): 94.4 mg/l
guppies: soft water: TLm (25–96 hr): 97.1 mg/l (158)
young Coho salmon: in artificial sea water at 8°C; mortality:
30/30 at 50 ppm after 24 hrs
2/30 (not significant) at 10 ppm after 24 up to 96 hrs (317)
–Mammals:
ingestion: rat: single oral LD_{50}: in the range of 3500 mg/kg (1546)

ethylbutanoate *see* ethylbutyrate

2-ethyl-1-butanol (3-methylolpentane; pseudohexylalcohol)
$CH_3CH_2(C_2H_5)CHCH_2OH$

A. PROPERTIES: colorless liquid; m.w. 102.2; m.p. -50°C; b.p. 150°C; v.p. 1.8 mm at 20°C; v.d. 3.54; sp.gr. 0.8328 at 20/20°C; solub. 4,300 mg/l at 20°C, 6,300 mg/l at 24°C;

B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.24 ppm, 1 ppm = 4.17 mg/cu m
–Odor: characteristic: quality: musty, sweet
hedonic tone: neutral
T.O.C.: abs. perc. lim.: 0.07 ppm
50% recogn.: 0.77 ppm
100% recogn.: 0.77 ppm
O.I. 100% recogn.: 1,701 (19)

C. WATER POLLUTION FACTORS:
–Waste water treatment:
A.C.: adsorbability: 0.17 g/g C; 85.5% reduction, infl.: 1,000 mg/l, effl.: 145 mg/l (32)
–Reduction of amenities: T.O.C. = 0.2 mg/l (299)(894)

D. BIOLOGICAL EFFECTS:
–Mammalia: rat: single oral LD_{50}: 1.85 g/kg
inhalation: no deaths: sat. vap.: 8 hr (211)

ethylbutyrate (ethylbutanoate)
$CH_3CH_2CH_2COOC_2H_5$

A. PROPERTIES: colorless liquid; m.w. 116.16; m.p. -93°C; b.p. 121°C; v.p. 11.3 mm at 20°C; v.d. 4.00; sp.gr. 0.88 at 20/4°C; solub. 6,800 mg/l at 25°C

B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.193 ppm, 1 ppm = 5.184 mg/cu m
–Odor: T.O.C.: 0.039 mg/cu m = 7.5 ppb (307)
detection: 0.28 mg/cu m (840)
recognition: 0.13–0.23 mg/cu m (610)
O.I. at 20°C = 1,982,000 (316)

C. WATER POLLUTION FACTORS:
–Odor threshold: detection: 0.001 mg/kg (889)
–Waste water treatment:
ion exchange: adsorption on Amberlite X AD-2: 100% retention, infl.: 100

D. BIOLOGICAL EFFECTS:
–Toxicity threshold (cell
bacteria (*Pseudomonas p*
algae (*Microcystis aerugi*
green algae (*Scenedesmus*
protozoa (*Entosiphon sul*
protozoa (*Uronema pard*

ethylchloride (monochloroet
C_2H_5Cl

Uses: manufacture of TE
alkylating agent; refrigeratio

A. PROPERTIES: colorless liqu
457 mm at 0°C, 700 mm
sp.gr. 0.92 at 0/4°C; solu
(calculated)

B. AIR POLLUTION FACTORS:
–Odor: characteristic; quali
threshold: recogniti
–Manmade sources:
glc's in rural Washington D

C. WATER POLLUTION FACTORS
–Waste water treatment:
evaporation from water at 2
50% after 21 min
90% after 79 min

D. BIOLOGICAL EFFECTS:
–Mammalia:
guinea pig: inhalation: hist
ppm, 540 min
normal: 1,000 ppm, 810
–Man: after 30 sec quickly in
weak analgesia after 12 min:
slight symptoms of poisoning

ethylcyclohexane

Uses: organic synthesis

A. PROPERTIES: colorless liquid;
0.787

C. WATER POLLUTION FACTORS:
–Biodegradation:
incubation with natural flora i
ponents of high-octane gaso

Detroit river water
(226)(243)
% soln) (211)

24 hr	48 hr	
2.6	1.2	
5.5	2.2	(331)

(226)

it of silver sensitized films and
(1828)

tical:
79.9% recovery
4.6% recovery

0.167
ited) = 0.554
D due to chemical oxidation.
ically occur with substituted
stimated this demand to be

effect
inhibitory
inhibitory

---

acclimated System 117 biodegradable

The compound proved to be strongly inhibitory to an unacclimated system at concentrations as low as 50 mg/l. Acclimation of the biomass to the compound eliminated any inhibitory effects. The data indicated biodegradation of 4-methylaminophenol sulfate proceeded at a moderate rate. (1828)

D. BIOLOGICAL EFFECTS:
–Algae: *Selenastrum capricornutum*: 0.1 mg/l: no effect
1.0 mg/l: no effect
10.0 mg/l: no effect (1828)
–Crustacean: *Daphnia magna*: LC_{50}: 0.019 mg/l (1828)
–Fish: *Pimephales promelas*: LC_{50}: 0.25 mg/l (1828)

methylamylalcohol (methylisobutylcarbinol; 4-methyl-2-pentanol; MIBC)
$(CH_3)_2CHCH_2CHOHCH_3$

Use: solvent for dyestuffs, oils, gums, resins, waxes, nitrocellulose and ethylcellulose; organic synthesis; froth flotation; brake fluids

A. PROPERTIES: colorless liquid; m.w. 102.2; m.p. -90°C; b.p. 132°C; v.p. 5 mm at 20°C, 13 mm at 33°C, 27 mm at 45°C; v.d. 3.52; sp.gr. 0.81 at 20/20°C; solub. 17 g/l at 20°C; sat.conc. 25 g/cu m at 20°C, 45 g/cu m at 30°C

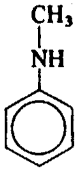
B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.239 ppm, 1 ppm = 4.17 mg/cu m
–Odor: characteristic: quality: sweet, alcohol
hedonic tone: unpleasant to pleasant
absolute perception limit: 0.33 ppm
50% recogn.: 0.52 ppm
100% recogn.: 0.52 ppm
O.I.: 12,634 (19)

C. WATER POLLUTION FACTORS:
–Oxidation parameters: BOD_5: 2.12 NEN 3235 5.4
COD: 2.60 NEN 3235 5.3 (277)

D. BIOLOGICAL EFFECTS:
–Fish: goldfish: LD_{50} (24 hr): 360 mg/l modified ASTM D 1345 (277)
–Mammalia: rat: single oral LD_{50}: 2.59 g/kg
inhalation: 5/6: 2,000 ppm, 8 hr (211)

methyl-*n*-amylketone *see* 2-heptanone

N-methylaniline



Use: organic synthesis; solvent; acid acceptor

A. PROPERTIES: yellow liquid; m.w. 107.15; m.p. -57°C; b.p. 195.7°C v.p. 0.3 mm at 20°C, 0.65 mm at 30°C; v.d. 3.70; sp.gr. 0.986 at 20/4°C; sat. conc. 1.8 g/cu m at 20°C, 3.7 g/cu m at 30°C; log P_{oct} 1.66/1.82

B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.23 ppm, 1 ppm = 4.45 mg/cu m
–Odor threshold conc.: recognition: 6.9 - 8.6 mg/cu m (610)

$CH_3(CH_2)_4CN$

A. PROPERTIES: colorless liquid; m.w. 97.16; m.p. -79.4°C; b.p. 163°C; sp.gr. 0.809 at 20/4°C

C. WATER POLLUTION FACTORS:

—Waste water treatment:

A.S.: after 6 hr: 1.5% of ThOD
12 hr: 2.9% of ThOD
24 hr: 5.1% of ThOD (89)

1-hexanethiol *see prim-n*-hexylmercaptan

hexanoic acid *see* caproic acid

***n*-hexanol** (*n*-hexylalcohol; amylcarbinol)

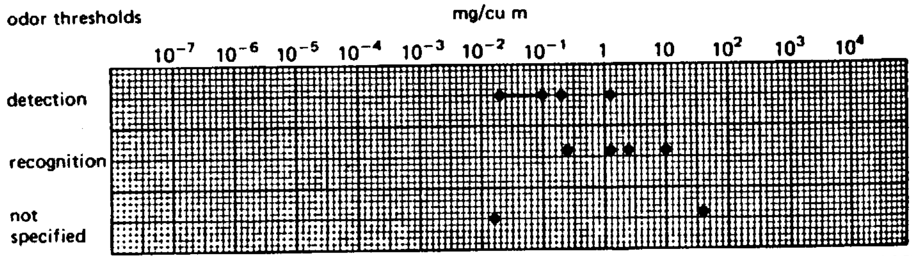
$CH_3(CH_2)_4CH_2OH$

Use: pharmaceuticals; solvent; plasticizer; intermediate for textile and leather finishing agent.

A. PROPERTIES: colorless liquid; m.w. 102.2; m.p. -51/-44°C; b.p. 158°C; v.p. 0.98 mm at 20°C; v.d. 3.52; sp.gr. 0.82 at 20/4°C; solub. 5,900 mg/l at 20°C; log P_{oct} 2.03

B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.24 ppm, 1 ppm = 4.25 mg/cu m

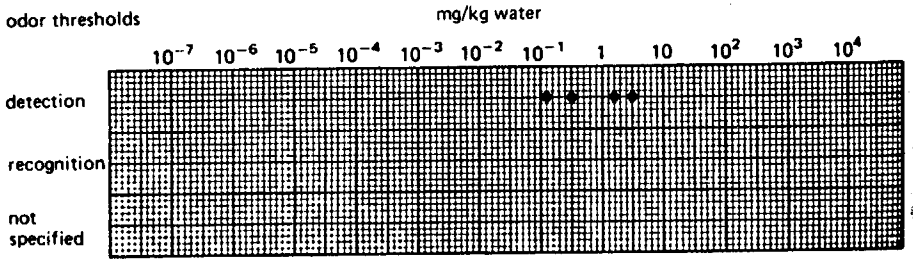
—Odor: characteristic: quality: sweet alcohol
hedonic tone: pleasant



(307; 610; 627; 643; 676; 761; 787; 828)

C. WATER POLLUTION FACTORS:

—BOD_5: 28% of ThOD
—COD: 94% of ThOD
—$KMnO_4$: acid: 8% of ThOD; alkaline; 2% of ThOD
—TOC: 100% of ThOD (220)



(326; 883; 888; 889; 894; 900)

—Waste water treatment:

A.C.: adsorbability: 0.191 g/g C; 9
mg/l

reverse osmosis: 47% rejection from

anaerobic lagoon: lb COD/day/1,00
22
48

ion exchange: adsorption on amberli
retention efficiency:

NFG, BOD, 20°C, 1-10 days observe
acclimation: 365 + P: 5

D. BIOLOGICAL EFFECTS:

—Toxicity threshold (cell multiplicatio
bacteria (*Pseudomonas putida*):
algae (*Microcystis aeruginosa*):
green algae (*Scenedesmus quadricaud*
protozoa (*Entosiphon sulcatum*):
protozoa (*Uronema parduczi Chatto*

2-hexanol (butylmethylcarbinol)

$CH_3CHOH(CH_2)_3CH_3$

A. PROPERTIES: colorless liquid; m.w.
20/4°C

B. AIR POLLUTION FACTORS:

—Odor threshold conc.: detection: 50

C. WATER POLLUTION FACTORS:

—A.S. after 6 hr: 3.4% of ThOD
12 hr: 2.9% of ThOD
24 hr: 3.7% of ThOD

D. BIOLOGICAL EFFECTS:

—Toxicity threshold (cell multiplicatio
bacteria (*Pseudomonas putida*):
algae (*Microcystis aeruginosa*):
green algae (*Scenedesmus quadricaud*
protozoa (*Entosiphon sulcatum*):
protozoa (*Uronema parduczi Chatton*

3-hexanol (ethylpropylcarbinol)

$CH_3CH_2CHOHCH_2CH_2CH_3$

A. PROPERTIES: colorless liquid; m.w. 10

C. WATER POLLUTION FACTORS:

—Waste water treatment:

A.S.: after 6 hr: 2.2% of ThOD
12 hr: 2.4% of ThOD
24 hr: 2.7% of ThOD

D. BIOLOGICAL EFFECTS:

—Toxicity threshold (cell multiplicatio
bacteria (*Pseudomonas putida*):

w. 97.16; m.p. -79.4°C; b.p. 163°C; sp.gr. 0.809

D
D
D (89)

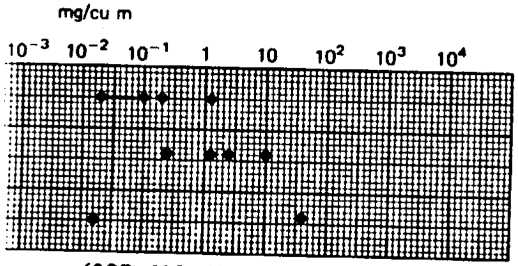
aptan

binol)

lasticizer; intermediate for textile and leather

w. 102.2; m.p. -51/-44°C; b.p. 158°C; v.p. 0.98
.82 at 20/4°C; solub. 5,900 mg/l at 20°C; log P_{oct}

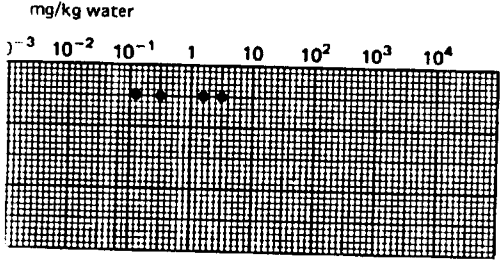
u m = 0.24 ppm, 1 ppm = 4.25 mg/cu m
weet alcohol
ne: pleasant



(307; 610; 627; 643; 676; 761; 787; 828)

line; 2% of ThOD

(220)



(326; 883; 888; 889; 894; 900)

–Waste water treatment:

A.C.: adsorbability: 0.191 g/g C; 95.5% reduction, infl.: 1,000 mg/l, effl.: 45 mg/l (32)

reverse osmosis: 47% rejection from a 0.01 M solution (221)

anaerobic lagoon:

lb COD/day/1,000 cu ft	infl. mg/l	effl. mg/l	
22	140	20	
48	140	30	(37)

ion exchange: adsorption on amberlite X AD-2: infl.: 200 ppm
retention efficiency: 85% effl.: 30 ppm (40)

NFG, BOD, 20°C, 1-10 days observed, feed: 200-1,000 mg/l
acclimation: 365 + P: 57% removed (93)

D. BIOLOGICAL EFFECTS:

–Toxicity threshold (cell multiplication inhibition test):

bacteria (*Pseudomonas putida*):	62 mg/l	(1900)
algae (*Microcystis aeruginosa*):	12 mg/l	(329)
green algae (*Scenedesmus quadricauda*):	30 mg/l	(1900)
protozoa (*Entosiphon sulcatum*):	75 mg/l	(1900)
protozoa (*Uronema parduczi Chatton-Lwoff*):	93 mg/l	(1901)

2-hexanol (butylmethylcarbinol)

$CH_3CHOH(CH_2)_3CH_3$

A. PROPERTIES: colorless liquid; m.w. 162.17; m.p. 136/140°C; sp.gr. 0.809 at 20/4°C

B. AIR POLLUTION FACTORS:

–Odor threshold conc.: detection: 50 mg/cu m (643)

C. WATER POLLUTION FACTORS:

–A.S. after 6 hr: 3.4% of ThOD
12 hr: 2.9% of ThOD
24 hr: 3.7% of ThOD (88)

D. BIOLOGICAL EFFECTS:

–Toxicity threshold (cell multiplication inhibition test):

bacteria (*Pseudomonas putida*):	63 mg/l	(1900)
algae (*Microcystis aeruginosa*):	32 mg/l	(329)
green algae (*Scenedesmus quadricauda*):	72 mg/l	(1900)
protozoa (*Entosiphon sulcatum*):	116 mg/l	(1900)
protozoa (*Uronema parduczi Chatton-Lwoff*):	335 mg/l	(1901)

3-hexanol (ethylpropylcarbinol)

$CH_3CH_2CHOHCH_2CH_2CH_3$

A. PROPERTIES: colorless liquid; m.w. 102.17; b.p. 135°C; sp.gr. 0.8188 at 20/4°C

C. WATER POLLUTION FACTORS:

–Waste water treatment:

A.S.: after 6 hr: 2.2% of ThOD
12 hr: 2.4% of ThOD
24 hr: 2.7% of ThOD (88)

D. BIOLOGICAL EFFECTS:

–Toxicity threshold (cell multiplication inhibition test):

bacteria (*Pseudomonas putida*):	105 mg/l	(1900)

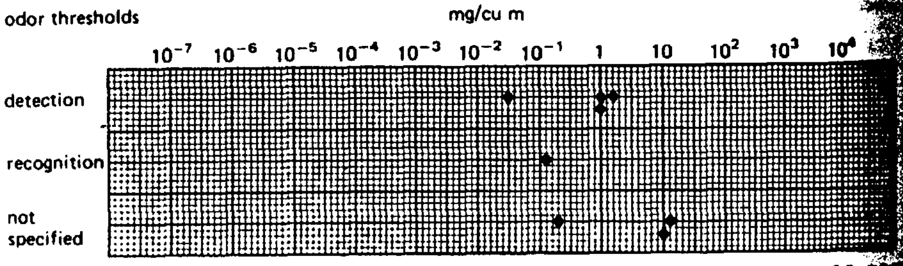
1-heptanethiol *see n*-heptylmercaptan

***n*-heptanoic acid** *see* enanthic acid

1-heptanol (*n*-heptylalcohol)
$CH_3(CH_2)_5CH_2OH$

A. PROPERTIES: colorless liquid; m.w. 116.20; m.p. -34°C; b.p. 176°C; v.p. 1 mm 42°C; v.d. 4.03; sp.gr. 0.82 at 20/4°C; solub. 900 mg/l at 18°C, 2,000 mg/l 20°C, 2,800 mg/l at 100°C; log P_{oct} 2.41 (calculated)

B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.21 ppm, 1 ppm = 4.83 mg/cu m



(307; 610; 634; 739; 780; 787; 824; 825;

O.I. at 20°C = 23,100

C. WATER POLLUTION FACTORS:
–BOD_5: 30% of ThOD
–COD 92% of ThOD
–$KMnO_4$ value: acid: 7% of ThOD, alkaline: 2% of ThOD
–Waste water treatment:
A.S.: after 6 hr: 7.9% of ThOD
12 hr: 20.4% of ThOD
24 hr: 28.9% of ThOD
reverse osmosis: 52% rejection from a 0.01 M solution

D. BIOLOGICAL EFFECTS:
–Toxicity threshold (cell multiplication inhibition test):
bacteria (*Pseudomonas putida*): 67 mg/l
algae (*Microcystis aeruginosa*): 3.5 mg/l
green algae (*Scenedesmus quadricauda*): 17 mg/l
protozoa (*Entosiphon sulcatum*): 31 mg/l
protozoa (*Uronema parduczi Chatton-Lwoff*): 17 mg/l
mexican axolotl (3–4 w after hatching): 48 hr LC_{50}: 52 mg/l
clawed toad (3–4 w after hatching): 48 hr LC_{50}: 44 mg/l

2-heptanone (*n*-amylmethylketone; methyl-*n*-amylketone)
$CH_3COC_5H_{11}$

A. PROPERTIES: colorless liquid; m.w. 114.18; m.p. -35/-27°C; b.p. 150°C; 2.6 mm at 20°C; v.d. 3.94; sp.gr. 0.82 at 15/4°C; solub. 4,300 mg/l; 6.8 g/cu m at 20°C, 13 g/cu m at 30°C

B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.214 ppm, 1 ppm = 4.66 mg/cu m

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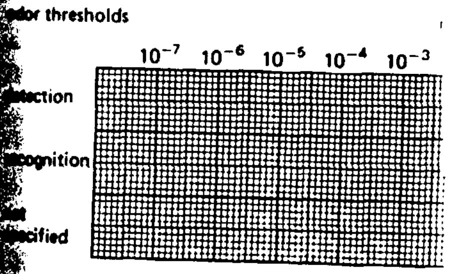


O.I. at 20°C = 171,000

ATER POLLUTION FACTORS:
–Waste water treatment:
NFG, BOD, 20°C, 1–10 days obse
365 + P: 17% removed
–BOD_{10}: 0.50 std. dil. sew.
–Odor threshold: detection: 0.14 mg/k
recognition: 3.0 mg/k

OLOGICAL EFFECTS:
–Mammals:
guinea pig: inhalation: irritation of the
death: 4,800 ppm after a f

ptanone (butylethylketone)
$H_5CO(CH_2)_3CH_3$

ROPERTIES: colorless liquid; m.w. 114
1.4 mm at 25°C; v.d. 3.93; sp.gr. 0.818

IR POLLUTION FACTORS: 1 mg/cu m =

ATER POLLUTION FACTORS:
–Waste water treatment:
A.S.: after 6 hr: 1.2% of ThOD
12 hr: 2.1% of ThOD
24 hr: 3.7% of ThOD
–Odor threshold: detection: 0.0075 mg/k

OLOGICAL EFFECTS:
–Mammals:
rat: single oral LD_{50}: 2.79 g/kg
inhalation: no deaths: 2,000 ppm,
deaths: 4,000 ppm,

ptanone (dipropylketone; butyrone)
$H_7)_2CO$

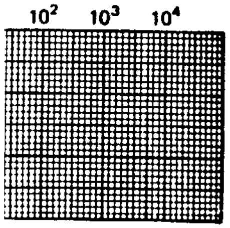
ROPERTIES: colorless liquid; m.w. 114.
mm at 25°C; v.d. 3.9; sp.gr. 0.817 at 20/4

R POLLUTION FACTORS: 1 mg/cu m = 0.

ATER POLLUTION FACTORS:
Waste water treatment:

p. 176°C; v.p. 1 mm at
t 18°C, 2,000 mg/l at

4.83 mg/cu m



); 787; 824; 825; 827)
(316)

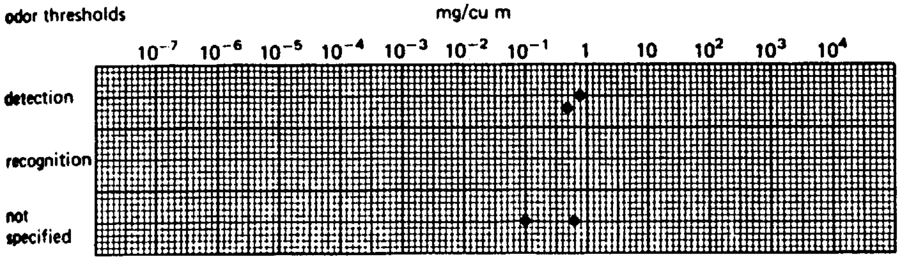
(220)

(88)
(221)

(1900)
(329)
(1900)
(1900)
(1901)
g/l
g/l (1823)

°C; b.p. 150°C; v.p.
,300 mg/l; sat. conc.

4.66 mg/cu m



(307; 772; 822; 842)

O.I. at 20°C = 171,000 (316)

C. WATER POLLUTION FACTORS:

–Waste water treatment:

NFG, BOD, 20°C, 1–10 days observed, feed: 100–1,000 mg/l, acclimation: 365 + P: 17% removed (93)

–BOD_{10}: 0.50 std. dil. sew. (256)

–Odor threshold: detection: 0.14 mg/kg (882)
recognition: 3.0 mg/kg (914)

D. BIOLOGICAL EFFECTS:

–Mammals:

guinea pig: inhalation: irritation of the mucous membrane: 1,500 ppm
death: 4,800 ppm after a few exposures (211)

3-heptanone (butylethylketone)

$C_2H_5CO(CH_2)_3CH_3$

A. PROPERTIES: colorless liquid; m.w. 114.18; m.p. -37/-39°C; b.p. 148.5°C; v.p. 1.4 mm at 25°C; v.d. 3.93; sp.gr. 0.818 at 20/4°C; solub. 14,300 mg/l at 20°C

B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.214 ppm, 1 ppm = 4.66 mg/cu m

C. WATER POLLUTION FACTORS:

–Waste water treatment:

A.S.: after 6 hr: 1.2% of ThOD
12 hr: 2.1% of ThOD
24 hr: 3.7% of ThOD (88)

–Odor threshold: detection: 0.0075 mg/kg (899)

D. BIOLOGICAL EFFECTS:

–Mammals:

rat: single oral LD_{50}: 2.79 g/kg
inhalation: no deaths: 2,000 ppm, 4 hr
deaths: 4,000 ppm, 4 hr (211)

4-heptanone (dipropylketone; butyrone)

$(C_3H_7)_2CO$

A. PROPERTIES: colorless liquid; m.w. 114.18; m.p. -32.6°C; b.p. 143°C; v.p. 1.2 mm at 25°C; v.d. 3.9; sp.gr. 0.817 at 20/4°C

B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.214 ppm, 1 ppm = 4.66 mg/cu m

C. WATER POLLUTION FACTORS:

–Waste water treatment:

n-octane
$CH_3(CH_2)_6CH_3$

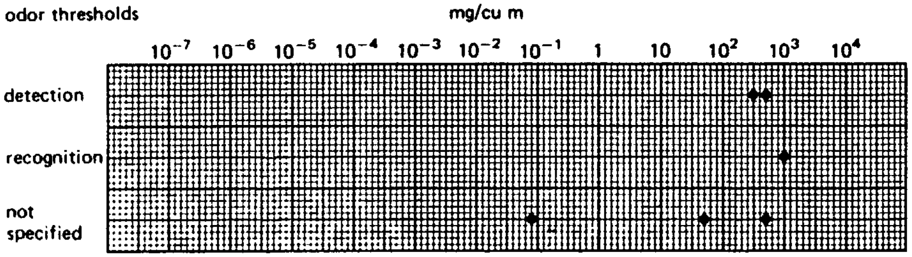
Manufacturing source: petroleum refining. (347)

Users and formulation: organic synthesis; solvent; rubber industry; paper processing ind. (347)

Natural sources (*water and air*): constituent in paraffin fraction of petroleum. (347)

A. PROPERTIES: m.w. 114.23; m.p. −56.5°C; b.p. 125.7°C; v.p. 11 mm at 20°C; 18 mm at 30°C; v.d. 3.93; sp.gr. 0.70 at 25/4°C; solub. 0.66 mg/l at 20°C (242)
in distilled water: 0.7 mg/l at 20°C (228)
in salt water: 2.5 mg/l at 20°C;
sat. conc. 62 g/cu m at 20°C, 108 g/cu m at 30°C

B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.21 ppm, 1 ppm = 4.75 mg/cu m



(73; 210; 278; 307; 708; 737; 749)

O.I. at 20°C = 100 (316)

C. WATER POLLUTION FACTORS:
−$BOD^{25\,°C}_{35\,d}$: 2.33 in seawater/inoculum: enrichment cultures of hydrocarbon oxidizing bacteria (521)
−ThOD: 3.50
−Biodegradation:
incubation with natural flora in the groundwater−in presence of the other components of high-octane gasoline (100 μl/l): biodegradation: 54% after 192 hr at 13°C (initial conc. 0.34 μl/l) (956)
−Reduction of amenities: T.O.C. = 10 mg/l (295)
−Control methods: calculated half life time based on evaporative loss for a water depth of 1 m at 25°C: 5.55 hr; 0.124 m/hr (330)
rotating disk contact aerator: infl. 214.6 mg/l, effl. 0.3 mg/l; elimination: >99% or 17,687 mg/m²/24 hr or 4,776 g/m³/24 hr (406)

D. BIOLOGICAL EFFECTS:
−Fish: young Coho salmon: no significant mortalities up to 100 ppm, in artificial sea water after 96 hrs at 8°C (317)
−Mammalia: mice: inhalation:
narcosis: 6,600–13,700 ppm, 30–90 min
no deaths or convulsions: 13,700 ppm (211)

octane dioic acid *see* suberic acid

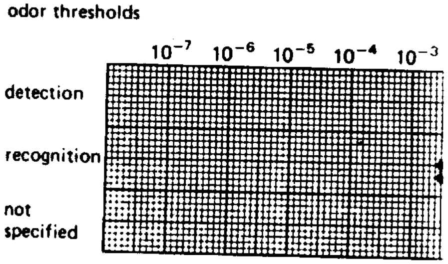
octanethiol *see* octylmercaptan

octanoic acid *see* caprylic acid

1-octanol (heptylcarbinol)
$CH_3(CH_2)_7OH$

A. PROPERTIES: colorless liquid; m.w. 1
54°C; v.d. 4.48; sp.gr. 0.824 at 20/4°

B. AIR POLLUTION FACTORS: 1 mg/cu m



(3

O.I.: at 20°C = 33,000

C. WATER POLLUTION FACTORS:
−Oxidation parameters:
BOD_5: 38% ThOD
1.088
1.1 std. dil.
33% ThOD
BOD^{25}_{35}: 1.45 in seawater/inoculum:
ing bacteria
COD: 98% ThOD
82% ThOD (0.05 n $K_2Cr_2O_7$)
$KMnO_4$ value: 0.110
acid: 6% ThOD
alkaline: 1% ThOD
ThOD: 2.95
−Reduction of amenities: T.O.C. = 0.13
taste and odor threshold: (tentative):
range: 0.00
T.O.C. in water: 0.13 ppm
−Waste water treatment: reverse osmosis

D. BIOLOGICAL EFFECTS:
−Toxicity threshold (cell multiplication
bacteria (*Pseudomonas putida*):
algae (*Microcystis aeruginosa*):
green algae (*Scenedesmus quadricauda*):
protozoa (*Entosiphon sulcatum*):
protozoa (*Uronema parduczi Chatton-L*
−Fish: sea lamprey: no effect at 5 mg/l,

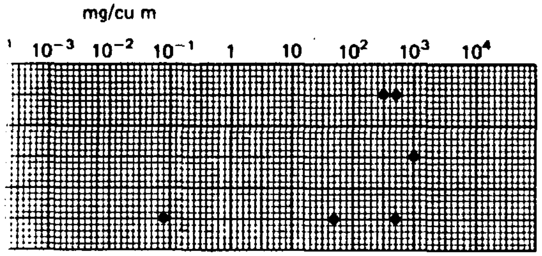
2-octanol (methylhexylcarbinol, caprylalco
$CH_3CHOH(CH_2)_5CH_3$

ın refining. (347)

synthesis; solvent; rubber industry; paper process- (347)

constituent in paraffin fraction of petroleum. (347)

ı). −56.5°C; b.p. 125.7°C; v.p. 11 mm at 20°C; 18
).70 at 25/4°C; solub. 0.66 mg/l at 20°C (242)
20°C (228)
20°C;
108 g/cu m at 30°C
g/cu m = 0.21 ppm, 1 ppm = 4.75 mg/cu m



(73; 210; 278; 307; 708; 737; 749)
(316)

/inoculum: enrichment cultures of hydrocarbon
(521)

in the groundwater–in presence of the other com-
line (100 µl/l): biodegradation: 54% after 192 hr
/l) (956)
:. = 10 mg/l (295)
half life time based on evaporative loss for a water
hr; 0.124 m/hr (330)
infl. 214.6 mg/l, effl. 0.3 mg/l; elimination: >99%
.776 g/m³/24 hr (406)

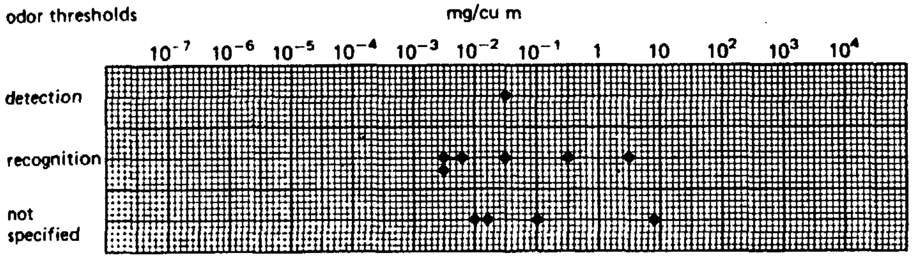
o significant mortalities up to 100 ppm, in artificial
(317)

30–90 min
700 ppm (211)

1-octanol (heptylcarbinol)
$CH_3(CH_2)_7OH$

A. PROPERTIES: colorless liquid; m.w. 130.23; m.p. −17°C; b.p. 195°C; v.p. 1 mm at 54°C; v.d. 4.48; sp.gr. 0.824 at 20/4°C; solub. 300 mg/l at 20°C; log P_{oct} 3.15

B. AIR POLLUTION FACTORS: 1 mg/cu m = 0.19 ppm, 1 ppm = 5.41 mg/cu m



(307; 610; 627; 663; 761; 786; 787; 795; 827)

O.I.: at 20°C = 33,000

C. WATER POLLUTION FACTORS:

–Oxidation parameters:
BOD_5: 38% ThOD (274)
1.088 (30)
1.1 std. dil. (27)
33% ThOD (220)
BOD^{25}_{35}: 1.45 in seawater/inoculum: enrichment cultures of hydrocarbon oxidizing bacteria (521)
COD: 98% ThOD (220)
82% ThOD (0.05 n $K_2Cr_2O_7$) (274)
$KMnO_4$ value: 0.110 (30)
acid: 6% ThOD
alkaline: 1% ThOD (220)
ThOD: 2.95 (30)

–Reduction of amenities: T.O.C. = 0.13 mg/l (294)
taste and odor threshold: (tentative): 0.13 mg/l (27)
range: 0.0087–0.56 mg/l (30)
T.O.C. in water: 0.13 ppm (326)

–Waste water treatment: reverse osmosis: 68% rejection from a 0.01 M solution (221)

D. BIOLOGICAL EFFECTS:

–Toxicity threshold (cell multiplication inhibition test):

bacteria (*Pseudomonas putida*):	>50 mg/l	(1900)
algae (*Microcystis aeruginosa*):	1.9 mg/l	(329)
green algae (*Scenedesmus quadricauda*):	6.3 mg/l	(1900)
protozoa (*Entosiphon sulcatum*):	44 mg/l	(1900)
protozoa (*Uronema parduczi Chatton-Lwoff*):	23 mg/l	(1901)

–Fish: sea lamprey: no effect at 5 mg/l, 24 hr (30)

2-octanol (methylhexylcarbinol, caprylalcohol)
$CH_3CHOH(CH_2)_5CH_3$

Appendix C

Field Forms

INTERA
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Serial No. SV____________

SITE VISITOR LOG SHEET

DATE	NAME (PRINT)/(SIGN)	REPRESENTING	(24 HOUR CLOCK)	
			ARRIVE	DEPART

C:\Corel\Office7\WPWin7\wpdocs\Document Stuff\Forms\sitevis.wpd

INTERA
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Page ______ of ______.

FLOW RATE DATA

Project Name:________________________

Project No.:_______________

Well:________________________________

Meter:_______________

DATE (mm/dd/yy)	TIME (hh:mm)	TOTALIZER		TIME INTERVAL (sec)	FLOW RATE (gpm)	COMMENTS
		BEGIN (gallons)	END (gallons)			

INTERA
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WATER LEVEL DATA

PAGE_____of_____

PROJECT NAME:________________________________ PROJECT NO.:______________________

WATER LEVEL INSTRUMENT:____

WELL	DATE	TIME	WATER LEVEL (BMP) (FT)	WATER LEVEL ELEVATION (MSL)	TECH	COMMENTS *

Note:

1. All water-level measurements listed are assumed to be indicative of static water-level conditions. If there is a possibility of any water level being influenced by development, purging, injection, etc., this should be noted as a comment.

2. When electric water tapes are used to measure the total depth of a well, the distance from the bottom of the probe to where the probe is able to detect water should be added to the total depth measurement.

* Total depth, weather conditions, previous purging, injection, etc.

INTERA
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Page ______ of __________

WATER QUALITY DATA

PROJECT NAME: ____ PROJECT NO.: ____________________

WATER QUALITY INSTRUMENT: ____

WELL	DATE	TIME	TOTAL WATER PURGED (gal)	TEMP ☐°C ☐°F	CONDUCTIVITY (µS)	pH	TECH	COMMENTS

Note: Water quality readings listed are assumed to be final water quality readings obtained at the end of development/redevelopment, at the time of ground-water sampling, or at any other time the well was sufficiently purged.

INTERA
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PROJECT NO.: ____________

DATE: ____________

SAMPLE SHIPMENT CONTROL CHECKLIST

	Yes	*No*	*NA*
Are all sample labels properly completed?	☐	☐	☐
Are all Sample Control Logs properly completed?	☐	☐	☐
Are all COCs properly completed?	☐	☐	☐
Are all duplicates, replicates, equipment blanks, and trip blanks recorded on the Sample Control Logs and the COCs?	☐	☐	☐
Is a trip blank included with the sample shipment?	☐	☐	☐
Have samples been checked against the Sample Contro Log and the COC?	☐	☐	☐
Are analyses specified on COCs?	☐	☐	☐
Are analysis turnaround times specified on COCs?	☐	☐	☐
Has courier signed COCs?	☐	☐	☐
Are COCs packaged with samples?	☐	☐	☐
Have copies of the COCs been retained for the project file?	☐	☐	☐
Are the samples properly preserved?	☐	☐	☐
Is the shipping container properly sealed with custody seals?	☐	☐	☐
Is the airbill properly completed?	☐	☐	☐
Has a copy of the airbill and/or courier receipt been retained for the project file?	☐	☐	☐
Is the delivery data specified (particularly if weekend delivery is required)?	☐	☐	☐
Is the address for the laboratory correct?	☐	☐	☐
Has the laboratory been notified of a weekend delivery?	☐	☐	☐

Signature: ____________________

SAMPLE CONTROL LOG

INTERA
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SAMPLE MEDIA = 01 - SURFACE WATER, 02 - POND BOTTOM WATER, 03 - POND BOTTOM SLUDGE
04 - SOIL, UNDERLYING SOIL, 05 - SURFACE WASTE, 06 - GROUND WATER,
07 - TANK WASTE, 08 - TRIP BLANK, 09 - FIELD BLANK.

FIELD SAMPLE NO.	LAB I.D.	SAMPLER'S INITIALS	DATE COLLECTED	TIME COLLECTED	SAMPLE MEDIA	REPLICATE/ DUPLICATE SAMPLE? (Y/N)	CORRESPONDING FIELD SAMPLE NO.	COM-POSITE? (Y/N)	COMMENTS

INTERA
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CHAIN-OF-CUSTODY FORM

Company Name:		Project Name:
Address:		Billing Address (if different):
City: State: Zip Code:		
Telephone: FAX #:		P.O. #:
Report To:	Sampler:	

Turnaround Time: ☐ 10 Working Days ☐ 4 Working Days ☐ 24 Hours
☐ 7 Working Days ☐ 3 Working Days ☐ 2 - 8 Hours
☐ 5 Working Days ☐ 2 Working Days

Client Sample I.D.	Date/Time Sampled	Matrix Desc.	# of Cont.	Cont. Type	Star's Sample #	Analyses Requested									Comments
1.															
2.															
3.															
4.															
5.															
6.															
7.															
8.															
9.															
10.															

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received By:	Date:	Time:

Samples Received in Good Condition? ☐ Yes ☐ No Samples Cold? ☐ Yes ☐ No Method of Shipment ______________ Page ___ of ___
Samples Pre-Preserved? ☐ Yes ☐ No ☐ N/A Custody Seal Intact? ☐ Yes ☐ No ☐ N/A

INTERA
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Page____of____

WELL FLUID PRODUCTION/INJECTION LOG

Project No.________________ Client____________________
Site____________________

DATE	TIME	RATE	VOLUME		COMMENTS	INITIALS
			CUM.	BATCH		

INTERA

Conversation Record

Call to: ______________________ Call from: ______________________

Date: ______________ Project Name and Number: ______________________

Subject: ______________________

Conversation: ______________________

INTERA
A Duke Engineering & Services Company

Page ______ of ________

PHOTOGRAPH LOG

Date:	Time:
Roll No.:	Photograph No.:
Photographer:	
Location:	
Subject:	
Distance/Direction:	
Purpose:	
Reference Point:	
Remarks:	

Date:	Time:
Roll No.:	Photograph No.:
Photographer:	
Location:	
Subject:	
Distance/Direction:	
Purpose:	
Reference Point:	
Remarks:	