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REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WORK PLAN - GROUP O
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

IWTP Sludge Drying Beds (Site 32)
WWTP Ponds (Site 33)
Miscellaneous IWTP SWMUs (Site 35)

February 1992

Prepared for:

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EXECUTIVE SUMMARY

As part of the U.S. Navy's Installation Restoration Program, this Remedial Investigation (RI)/Feasibility Study (FS) work plan has been prepared for the Industrial Wastewater Treatment Plant (IWTP) Sludge Drying Beds (Site 32), Wastewater Treatment Plant (WWTP) Ponds (Site 33), and the miscellaneous IWTP Solid Waste Management Units (SWMUs; Site 35) located at the Naval Air Station (NAS) in Pensacola, Escambia County, Florida. These three sites comprise operable unit 10, referred to herein as the Group O sites. Site 13 (Magazine Point Rubble Disposal Area) is located immediately east of the Group O sites, along the eastern shore of the Magazine Point Peninsula. Given the proximity of Site 13 to the Group O sites, and the possible relationships of potential contamination between them, the proposed Phase II investigation of Site 13 will be performed in conjunction with the Group O investigation. This work plan has been prepared by Ecology and Environment, Inc., (E & E) for the Southern Division, U.S. Navy, Naval Facilities Engineering Command, under Contract No. N62467-88-C-0200.

The Group O sites occupy about 26 acres of the basal portion of the Magazine Point Peninsula. Land surface elevations in the vicinity of these sites are about 5 feet above mean sea level. The three sites are nearly level with a slight slope northward and eastward toward Pensacola Bay. On or immediately adjacent to these sites are 23 shallow (approximately 15 feet deep), five intermediate (approximately 40 feet deep), and four deep (approximately 65 feet deep) groundwater monitoring wells, and seven (approximately 25 feet deep) groundwater recovery wells.

Two other sites are located immediately adjacent to the Group O sites. The southern portion of Site 11 (North Chevalier Disposal Area) occupies the shoreline and land along the southern end of Bayou Grande west of the Magazine Point Peninsula; and the northern end of Site 30 (Buildings 649 and 755) occupies the mouth of the small creek, west of the Magazine Point Peninsula, that flows into Bayou Grande (see Figure 2-2).

Historical analytical information indicates that groundwater contamination at the Group O site complex is primarily limited to the shallow and intermediate zones. Two general areas of groundwater contamination in these zones are located east of the former sludge drying beds and in the vicinity of the former surge pond. The primary contaminants of concern at the Group O site complex are metals, volatile organic compounds (VOCs), and acid/base-neutral extractable organic compounds (BNAs). Although soil sampling at the sites has been limited, previous soil analytical results indicate that the areas underneath the now capped-off sludge drying beds and former surge pond are affected by VOCs and BNAs. In addition, the existence of other contaminated soil areas is possible given the nature of past site activities. The only known potential sources of this contamination are the past and/or present activities associated with the IWTP--the IWTP sludge drying beds and WWTP ponds are known to have received potentially hazardous materials (primarily phenols, solvents, and metal plating wastes). Consequently, the scope-of-work at sites 32, 33, and 35 will encompass a full-scale RI/FS effort.

The Group O investigation will provide the quantitative data base necessary to support the screening and evaluation of potential remedial alternatives, as well as fully identify the horizontal and vertical extents of Contamination. The main goals of the investigation are as follows:

- Determine the present physical condition(s) of the Group O sites and identify the extent to which these conditions may be related to or affected by site contamination.

- Identify, to the greatest extent possible, all of the historical and current sources of contamination at the Group O sites, including those in addition to the former sludge drying beds and the former surge pond.

- Determine the source, nature, magnitude, and extent of potential surface water and sediment contamination in the small drainage ditch at the southern end of the Group O site complex.

- Determine the source, nature, magnitude, and lateral/vertical extents of known/suspected areas of soil and groundwater contamination;

- Initiate the Risk Assessment and FS program for the sites.

In order to meet the above objectives, the Group O RI will include the following tasks:

- Aerial photograph analysis and contaminant source survey. Determine past and present site activities related to known/suspected contamination;

- Overall physical reconnaissance, organic vapor analyzer survey, radiation survey, and habitat/biota survey. Assess and evaluate current site conditions and determine the extent to which, if any, these conditions are related to or affected by known/suspected contamination;

- Soil/gas survey. Determine the location of potential soil and shallow groundwater contamination at the Group O site complex;

- Surface water, sediment, and soil sampling. Determine the presence of and characterize the full spectrum of site contamination of these media:

- Installation of shallow and intermediate monitoring wells. Provide additional sampling locations within known/suspected areas of contamination in the shallow and intermediate zones (the limited extent of contamination in the deep zone does not require additional wells);

- Collection of groundwater samples from several existing and all newly installed wells. Provide additional data for delineating the extent of and characterizing site contamination;

- Biota and air sampling (if required by the results of the above tasks). Assess the extent to which these receptors/ media may be affected by site contamination.

- o Hydrologic assessment. Expand the current information on aquifer properties underneath the sites and determine groundwater flow rates and direction in each aquifer zone;

- o Engineering survey. Provide accurate identification of all site sampling locations and cultural and topographic features.

Based on the results of the tasks identified above, during the RI E & E will initiate the appropriate Risk Assessment and FS activities. Risk Assessment activities will be directed toward identification of contaminants of concern, as well as identification of data gaps that must be eliminated to support the eventual completion of a Baseline Risk Assessment for the site.

FS activities, which will be required for the Group 0 sites, will be directed toward the identification of any remaining data gaps that must be eliminated to support the eventual completion of a comprehensive FS for the sites. In addition, if warranted, E & E will evaluate the RI results to identify whether any interim remedial measures (IRMs) are required and, if so, develop recommendations for implementation of these IRMs.

The results of the Group 0 and Site 13 investigations will be incorporated in a single RI report. In addition, all available and relevant information from the Phase II investigation of sites 11 and 30 will be included in the RI report. The RI report will provide all the information necessary for the development and completion of an FS.

1. INTRODUCTION

The purpose of this work plan is to outline the procedures and methodologies to be used in conducting a Remedial Investigation (RI)/Feasibility Study (FS) at the Industrial Wastewater Treatment Plant (IWTP) Sludge Drying Beds (Site 32), Wastewater Treatment Plant (WWTP) Ponds (Site 33), and the miscellaneous IWTP Solid Waste Management Units (SWMUs; Site 35) located at the Naval Air Station (NAS) in Pensacola, Escambia County, Florida. (These three sites comprise operable unit 10). Site 13 (Magazine Point Rubble Disposal Area) is located immediately east of the Group O sites, along the east shoreline of Magazine Point Peninsula. Given the proximity of this site to the Group O sites, and the possible relationships of potential contamination between them, the proposed Phase II investigation of Site 13 will be performed in conjunction with the Group O investigation (see Ecology and Environment, Inc., [E & E] 1991c).

This work plan has been prepared by E & E for the Southern Division, U.S. Navy, Naval Facilities Engineering Command, under Contract No. N62467-88-C-0200. The work plan has been developed based on information and file documents provided by the Navy (see Table 1-1), and on information gathered by E & E during preliminary site inspections conducted during January 1989.

Historical analytical information indicates that groundwater in some areas of the Group O site complex is contaminated primarily with volatile organic compounds (VOCs) and metals. The only known potential sources of this contamination are the past and/or present activities associated with the IWTP; the IWTP sludge drying beds and WWTP ponds are known to have received potentially hazardous materials, and

Table 1-1

SUMMARY OF PREVIOUS INVESTIGATION DOCUMENTS
NAS PENSACOLA SITES 32, 33, AND 35

Date	Title	Author
1/82	HWSI, Groundwator Monitoring Program, NAS Ponsacola, Florida	Missimer and Associates, Inc.
12/82	Evaluation of Groundwater Contamination Potential from the PNAS Surge Pond	Missimer and Associates, Inc.
1/83	Somi-Annual Groundvator Monitoring Program and Outline of Groundwater Assessment Plan	Missimer and Associatos, Iac.
6/03	Initial Assessment Study of NAS Ponsacola	NEESA
10/83	HSWI Groundvator Monitoring Program, NAS Ponsacola: Modifications to Monitoring Plan and Outline of Assessment Program	Missimer and Associatos. Inc.
2/84	Annual Groundvator Monitoring Roport: Hazardous Waste Surface Impoundment - NAS Ponsacola	Missimer and Associatos. Inc.
7/84	Verification Study: Assessment of Potential Groundvator Pollution at Ius Ponsacola	Goraghty and Miller, Iac.
1/85	Water Quality Assessment Program at IWTP (Phase I)	Goraghty and Miller, Inc.
9/85	Roport of Subsurface Investigation for tho Proposed Part "B" Certification of tho Surge Pond Dike - NAS Ponsacola	Larry M. Jacobs and Associatos, Inc., for Harmon Engineering, Inc.
12/85	Water Quality Assessment Program at tho IWTP (Phase II)	Goraghty and Miller, Inc.
1986	Characterization Study, Assessment of Potential Groundwator Pollution at Naval Air Station Pensacola	Goeaghty and Miller, Inc.
10/86	Geotechnical Subsurface Investigation - NAS Ponsacola	Ponsacola Testing, Inc., for Jones, Edmunds, and Associatos, Inc.
4/87	Quarterly Roport, Corrective Action Program - IWTP	Goraghty and nillor, Inc.
9/07	Comprehensive Groundwator Monitoring Evaluation and Case Development Inspection Report, NAS Ponsacola IWTP	V.S. Environmental Protection Agency, Environmental Services Division
10/87	Lithologic Logs at NAS Ponsacola - IWTP	Goraghty and Miller, Inc.
1/6/00	Hazardous Waste Surface Impoundment and Sludge Drying Beds Closure Permit Number HF17-134657 (Polishing and Stabilization Ponds)	Florida Department of Environmental Regulation
2/80	Quarterly Roport on Groundvator Monitoring IWTP - NAS Ponsacola	Goraghty and nillor, Inc.

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Table 1-1 (Cont.)

Date	Title	Author
8/88	Semi-Annual Report - Corrective Action and Compliance Monitoring Program - Surge Pond Operation Permit IWTP - NAS Pensacola	Geraghty and Miller, Inc.
9/88	Report of Findings of the Acid Investigation, Wastewater Treatment Plant - NAS Pensacola	Geraghty and Miller, Inc.
11/88	RCRA Closure of Industrial Sludge Drying Beds and Surgo Pond Specifications - NAS Pensacola	Environmental Safety and Design, Inc./Allen and Hoshall
11/7/88	Hazardous Waste Surface Impoundment Closure Permit Number HF17-148989 (Surge Pond)	Florida Departmont of Environment Regulation
12/88	Second Semi-Annual Report - Corrective Action and compliance Monitoring Progam/Surge Pond Operation Permit - NAS Pensacola	Geraghty and Miller, Inc.
3/89	Quarterly Roport on Groundwater Monitoring WWTP - NAS Pensacola	Geraghty and Miller, Inc.
4/20/89 6/10/89	Certification of Closure Activities - Polishing and Stabilization Ponds and Sludge Drying Beds	Environmental Safety and Design, Inc.. and James N. Speakman
5/16/89	Soil Sampling Analytical Results - Sludge Drying Beds	General Engineering Laboratories
6/89	Quarterly Roport on Groundwater Monitoring at WWTP - NAS Pensacola	Ecology and Environment, Inc.
7/20/89	Soil Sampling Analytical Results - Surge Pond	General Engineering Laboratories
9/89	Quarterly Report on Groundwater Monitoring at WWTP - NAS Pensacola	Ecology and Environment, Inc.
11/89	Quarterly Report on Groundwater Monitoring at WWTP - NAS Pensacola	Ecology and Environment, Inc.
12/18/89	Certification of Closure Activities - Surge Pond	Environmental Safety and Design, Inc., and James N. Speakman
2/90	Quarterly Report on Groundwater Monitoring at WWTP - NAS Pensacola	Ecology and Environment, Inc.
4/90	Groundwater Monitoring Well Completion Report (Draft)	Ecology and Environment, Inc.
5/90	Quarterly Report on Groundwater Monitoring at WWTP - NAS Pensacola	Ecology and Environment, Inc.

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Table 1-1 (Cont.)

Date	Title	Author
5/90	Appendix IX Report for Monitoring Wells GM-66 and UG-1 at WWTP - NAS Pensacola	Ecology and Environment, Inc.
6/90	Groundwater Flow Rate and Direction Dotermination Report tor the IWTP - NAS Pensacola	Ecology and Environment, Inc.
8/90	Quarterly Report on Groundwater Monitoring at WWTP - NAS Pensacola	Ecology and Environment, Inc.
12/90	Quarterly Report on Groundwater Monitoring at WWTP - NAS Pensacola	Ecology and Environment, Inc.
1/91	Quarterly Report on Groundwater Uonitoring at WWTP - NAS Pensacola	Ecology and Environment, Inc.
5/9 1	Quarterly Report on Groundwater Monitoring at WWTP - MAS Pensacola	Ecology and Environment, Inc.
5/9 1	Appendix IX Report for Monitoring Wells GM-66 and UG-1 at WWTP - NAS Pensacola	Ecology and Environment, fnc.
5/91	Groundwater Flow Rate and Direction Determination Report for the IWTP - NAS Pensacola	Ecology and Environment, Inc.
9/91	Quarterly Report on Groundwater Monitoring at WWTP - NAS Pensacola	Ecology and Environment, Inc.
3/90-2/91 (Monthly)	Monthly Operation and Maintenance Reports WWTP Groundwater Remediation	Ecology and Environment, Inc.
9/91	Permit HF17-170951 to Conduct Post-Closure Activities at the Regulated Units at IWTP	Florida Department ot Environmental Regulation
12/91	Quarterly Report on Groundwater Monitoring at WWTP - NAS Pensacola	Ecology and Environment, Inc.

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Source: Ccology and Environment. Inc., 1991.

contamination in the vicinity of these two sites has been documented. Consequently, the scope-of-work at sites 32, 33, and 35 will encompass a full-scale RI/FS effort.

The scope-of-work detailed in this work plan will be implemented utilizing the procedures described in the U.S. Environmental Protection Agency's (EPA's) 1991 document, Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA 1991). These procedures ensure a logical progression through the RI/FS and are as follows:

- Preliminary site assessment;
- Scoping the RI/FS;
- Site characterization;
- Treatability investigations;
- Development, screening, and detailed analysis of remedial alternatives;
- Remedy selection and design; and
- Record of decision.

As a result of the extensive investigative work performed at the Group 0 site complex over the past several years, the Group 0 investigation differs from the other NAS Pensacola site investigations by focusing on the formal confirmation and quantification of the full spectrum of site contaminants. The Group 0 investigation will provide the quantitative data base necessary to support the screening and evaluation of potential remedial alternatives, as well as fully identify the horizontal and vertical extents of contamination. The main goals of the investigation are as follows:

- Identify the historical and current sources of contamination at the Group 0 sites, including sources in addition to the former sludge drying beds and former surge pond;
- Determine the source, nature, magnitude, and lateral and vertical extents of known/suspected areas of surface water, sediment, soil, and groundwater contamination; and

- o Evaluate and select the most appropriate remediation techniques for the Group 0 sites.

The results of the Group 0 and Site 13 investigations will be incorporated into a single RI report. In addition, any available and relevant information from the Phase II investigations of adjacent sites 11 (North Chevalier Disposal Area) and 30 (Buildings 649 and 755) will also be incorporated into the RI report. The RI report will provide all the information necessary for the development and completion of an PS.

The following will be used as guidance documents during performance of the RI/FS tasks: June 1990 Project Management Plan (PMP), June 1990 Site Management Plan (SMP), July 1990 General Realth and Safety Plan (GRSP), and July 1990 Generic Quality Assurance Project Plan (GQAPP).

1.1 PROJECT MANAGEMENT PLAN

The PMP, previously submitted to the Navy, defines the technical approach and schedule as well as the qualifications of personnel who will be directing and performing the RI/FS. This work plan will incorporate and reference applicable technical and schedule sections, as appropriate, and will follow E & E's project management guidelines (see Section 8).

1.2 SITE MANAGEMENT PLAN

The SMP, previously submitted to the Navy, defines the management procedures for field activities on both the site and program level. The management and implementation of all field activities conducted as part of the RI/FS of sites 32, 33, and 35 will follow the SHP, and any updated versions. Data Quality Objectives (DQOs), and all Applicable or Relevant and Appropriate Requirements (ARARs) have been considered in developing the initial phases of fieldwork described here, and will be updated and revised for any subsequent phases of fieldwork.

1.3 GENERAL HEALTH AND SAFETY PLAN

A comprehensive GHSP and individual site-specific safety plan (SSP) have been developed to provide readily available emergency information and preventative safety measures. The GHSP and the SSP comply with the Occupational Safety and Health Administration (OSHA) 1990 document, Guidelines for Hazardous Waste Operations. The Group O SSP is presented in Appendix A.

The GHSP, previously submitted to the Navy, outlines health and safety procedures and protocols to be followed during all field investigations at each of the 39 sites on NAS Pensacola. The plan includes: standard operating procedures (site entry, decontamination, etc.); hazard communication and training (safety training, briefings, documentation, etc.); safety equipment and instrumentation (monitoring, personnel protective equipment, etc.); and hazard evaluation by contaminant class (metals, organics, etc.); and hazard evaluation for each task (drilling, sampling, etc.). The GHSP will be periodically updated, as required, during the course of this program.

The GHSP and SSP also define the toxicological properties and health hazards associated with each site. The SSP includes emergency action information pertinent to the safety of the field personnel and of the public (hospitals, ambulatory units, poison control centers, fire departments, and police/sheriff departments). The SSP also identifies first-aid and personal safety equipment and provides recommended site security precautions.

1.4 GENERIC QUALITY ASSURANCE PROJECT PLAN

A GQAPP has been prepared to outline and delineate all investigative procedures and policies. This comprehensive document will be referenced for all field and laboratory procedures for this program and was used to develop the Site-Specific Quality Assurance Plan (SQAP).

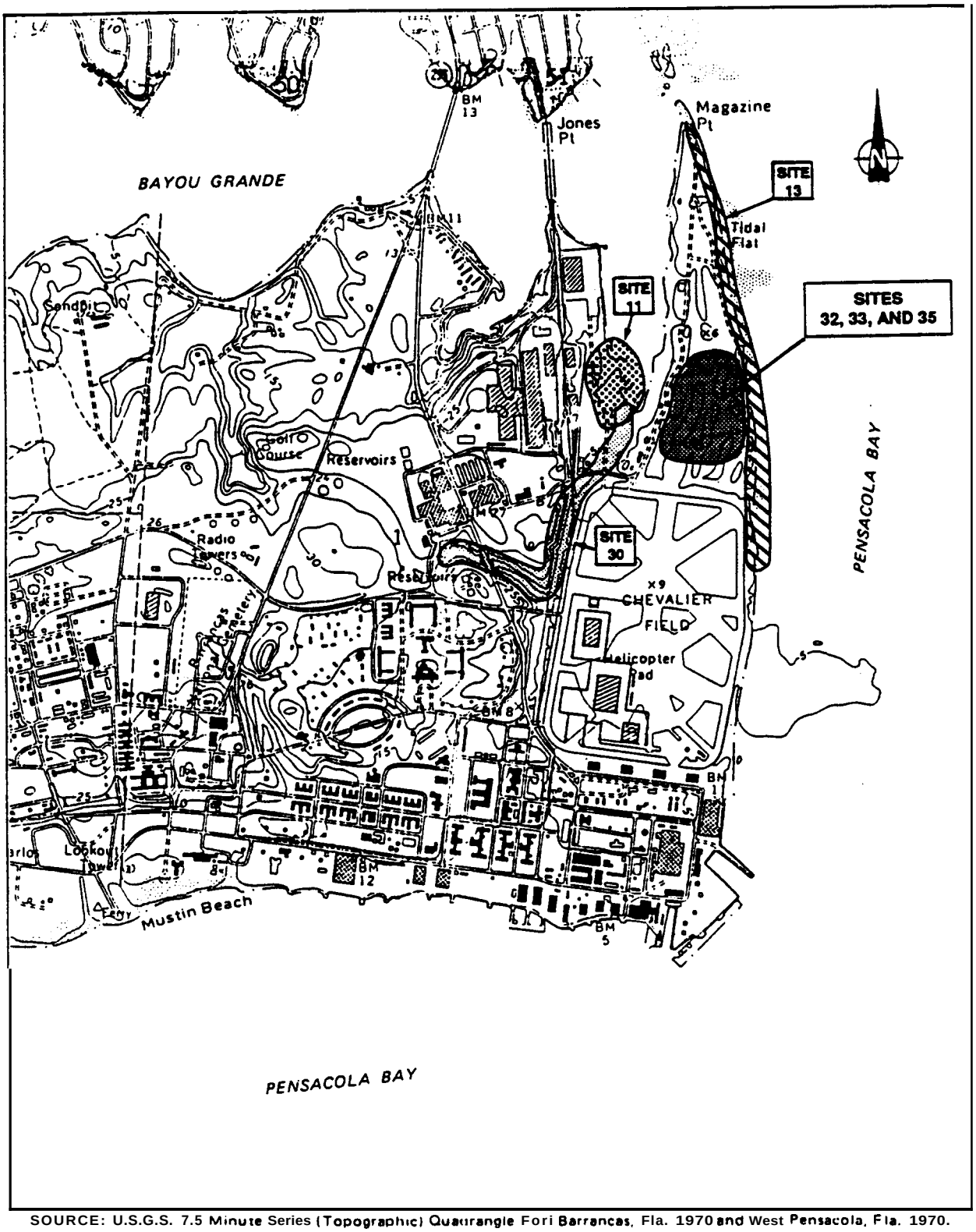
The SQAP, presented in Appendix B, provides site-specific quality assurance/quality control (QA/QC) measures used to obtain accurate and precise data for all site investigation activities. The SQAP addresses all phases of the investigation from development of the initial sampling plan through verification and reporting of the analytical results. All of the QA/QC procedures described in the GQAPP and SQAP are in accordance with applicable professional technical standards, EPA requirements, and specific Navy goals and requirements for this project. All samples will be collected, handled, packaged, preserved, and transported in accordance with the GQAPP and SQAP, and with Navy and EPA procedures.

2. SITE BACKGROUND AND SETTING

2.1 SITE DESCRIPTION

The IWTP Sludge Drying Beds (Site 32), WWTP Ponds (Site 33), and the miscellaneous IWTP SWMUs (Site 35) lie approximately 750 feet north of Chevalier Field (see figures 2-1 and 2-2). The Group 0 sites occupy about 26 acres of the basal portion of the Magazine Point Peninsula. Three sites are immediately adjacent to the Group 0 site complex: Site 13 occupies the eastern border of the Magazine Point Peninsula, immediately adjacent to the IWTP; the northern end of Site 30 occupies the distal end of a small unnamed creek west of the Group 0 sites; and Site 11 occupies the shoreline and adjacent land area along the southern arm of Bayou Grande (see Figure 2-2). Land surface elevations in the vicinity of the Group 0 sites are about 5 feet above mean sea level (MSL); the Group 0 sites are nearly level with a slight slope northward and eastward toward Pensacola Bay. Surface soils, in areas exposed at each of the three sites, are classified by the U.S. Department of Agriculture's (USDA) Soil Conservation Service as undifferentiated coastal soils bordering salt water: coastal dune land and beach tidal marsh (USDA 1955). On or adjacent to these sites are 23 shallow, five intermediate, and four deep groundwater monitoring wells, and seven groundwater recovery wells (see Table 2-1).

Land use at NAS Pensacola consists of various military housing, training, and support facilities as well as large industrial complexes for major repairs and refurbishment of aircraft engines and frames. The Magazine Point Peninsula is primarily used for the IWTP facility but also houses several ordnance bunkers relatively close to the IWTP. The majority of the peninsula north of the IWTP is restricted to public



SOURCE: U.S.G.S. 7.5 Minute Series (Topographic) Quadrangle Fort Barrancas, Fla. 1970 and West Pensacola, Fla. 1970. photorevised 1987.

SCALE

0 ½ 1 MILE

Figure 2-1 LOCATION MAP — NAS PENSACOLA SITES 32, 33, AND 35

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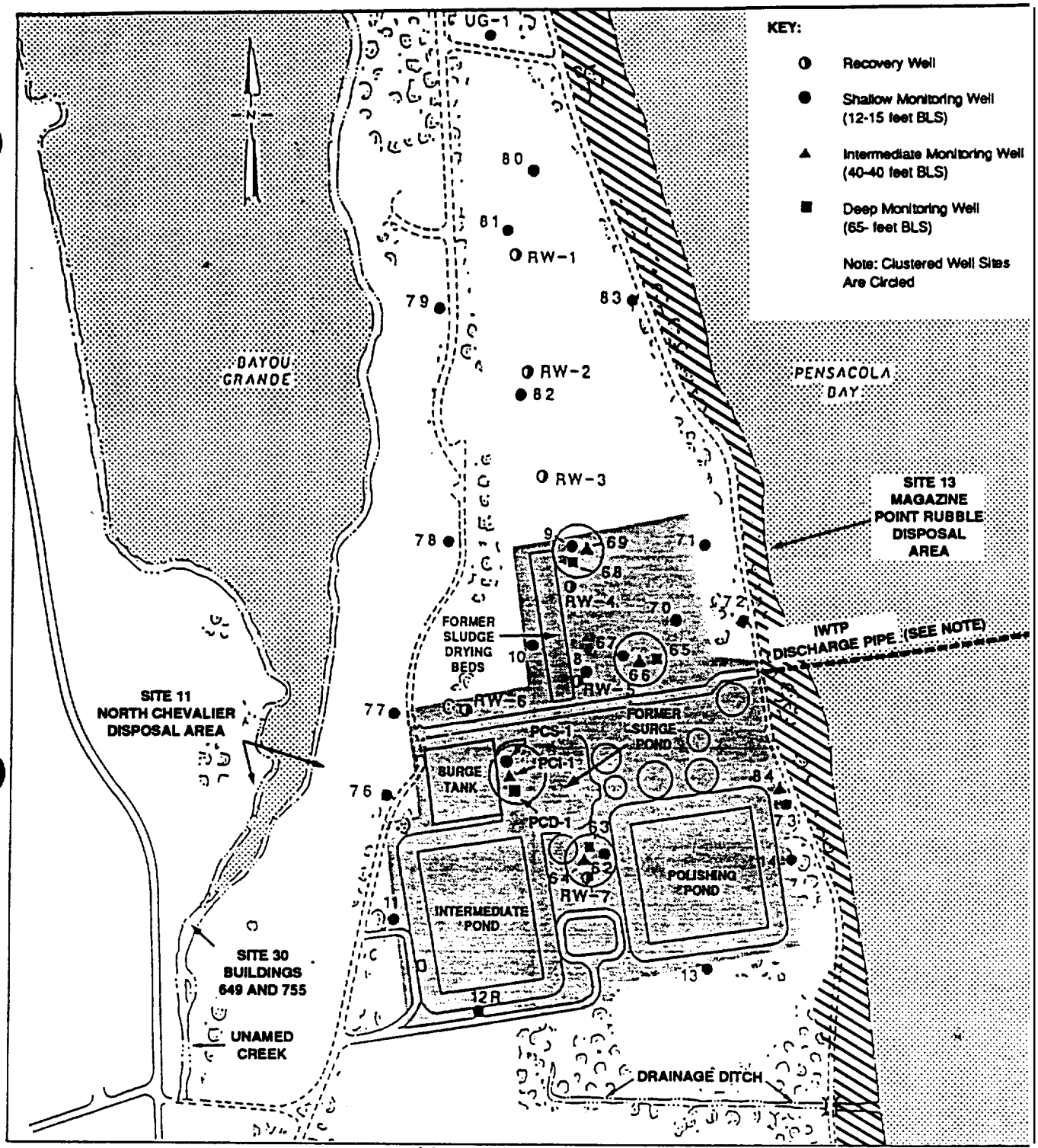

SOURCE: Geraghty & Miller, Inc., 1988; Ecology and Environment, Inc. 1991

SCALE

0 300 600 FEET

shaded area Encompasses Sites 32, 33, and 35

IWTP Industrial Wastewater Treatment Plant

Nolo: Discharge point for this pipe located approximately 2,500' out In the Pensacola Bay.

Figure 2-2 SITE MAP — NAS PENSACOLA, SITES 32, 33, AND 35

Table 2-1

CONSTRUCTION DETAILS OF MONITORING AND RECOVERY WELLS INSTALLED BY E & E, GERAGHTY AND MILLER, INC., AND MISSIMER AND ASSOCIATES, INC., AT NAS PENSACOLA SITES 32, 33 AND 35

Well Designation	Installation Date	Construction Material	Diameter (in)	Total Depth Drilled (ft)	Screened Interval (ft)	Depth to Filter Pack (ft)	Surface Elevation (ft msl)	TOC Elevation (ft msl)
Monitoring Wells								
OM-8	3/84	PVC	2	12.0	9.5 - 12.0	5.5	5.7	6.12
GM-9	3/84	PVC	2	12.0	9.3 - 11.8	5.3	5.0	5.65
GM-10	3/84	PVC	2	12.0	9.5 - 12.0	5.5	5.4	5.83
GM-11	3/84	PVC	2	12.0	9.3 - 11.8	5.5	5.5	6.00
GM-12R	4/88	PVC	2	15.0	11.0 - 14.0	NA	7.7	9.83
GM-13	3/84	PVC	2	12.0	9.5 - 12.0	5.5	4.7	5.09
OM-14	3/84	PVC	2	12.0	8.9 - 11.4	5.0	3.5	4.56
OM-62	8/85	PVC	2	15.0	12.5 - 15.0	4.0	5.0	7.11
GM-63	8/85	PVC	2	65.0	61.5 - 65.0	56.0	4.7	6.97
GM-64	8/85	PVC	2	40.0	37.5 - 40.0	35.0	4.6	6.26
OM-65	8/85	PVC	2	65.0	62.5 - 65.0	58.0	4.7	6.67
OM-66	8/05	PVC	2	40.0	37.5 - 40.0	31.0	5.5	7.48
GM-67	8/85	PVC	2	15.0	12.5 - 15.0	8.0	4.5	6.38
GM-68	8/85	PVC	2	65.0	62.5 - 65.0	56.0	1.9	7.00
GM-69	8/85	DVC	2	40.0	31.5 - 40.S	32.0	5.3	7.85
Ow-70	8/85	PVC	2	15.5	12.5 - 15.0	7.0	5.1	7.15
GM-71	8/85	PVC	2	12.5	10.0 - 12.5	7.0	4.6	6.76
an-72	8/85	PVC	2	12.5	10.0 - 12.5	7.0	5.3	7.61
GM-73	8/85	PVC	2	ls.o	12.5 - 15.0	7.0	10.1	12.36

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Key at end of table.

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Table 2-1 (Cont.)

Well Desig-nation	Installation Date	Construction Hatorial	Diametor (in)	Total Depth Drilled (ft)	Screened Interval (ft)	Depth to Filter Pack (ft)	Surface Elevation (ft msl)	TOC Elevation (ft msl)
GH-76	NA	PVC	2	13.5	11.0 - 13.5	6.0	7.1	7.88
GM-77	NA	PVC	2	13.5	11.0 - 13.5	5.0	4.2	4.71
GH-78	NA	PVC	2	13.0	10.5 - 13.0	8.0	5.5	7.02
GM-79	NA	PVC	2	12.5	10.0 - 12.5	7.0	2.7	4.65
GM-80	NA	PVC	2	13.5	11.0 - 13.5	8.0	4.2	4.63
GM-81	NA	PVC	2	12.5	10.0 - 12.5	8.0	2.4	4.33
GM-82	NA	PVC	2	12.5	10.0 - 12.5	7.0	2.4	4.45
GM-83	NA	PVC	2	12.5	10.0 - 12.5	8.0	2.9	4.84
GM-84	NA	PVC	2	48.0	43.0 - 48.0	38.0	10.0	11.84
PCD-1	3/90	PVC	4	70.0	65.0 - 69.75	64.0	NA	NA
PCI-1	3/90	PVC	4	45.0	40.0 - 44.75	39.0	NA	NA
PCS-1	3/90	PVC	4	20.0	15.0 - 19.75	14.0	NA	NA
UG-1	1981	Stainless Steel	2	10.4	5.4 - 10.4	NA	7.6	8.48
Recovery Wells								
RW-1	10/86	PVC	2	30.0	15.0 - 30.0	NA	2.4	4.91
RW-2	10/86	PVC	2	37.0	22.0 - 37.0	NA	3.3	5.88
RW-3	10/86	PVC	2	37.0	22.0 - 37.0	NA	2.8	5.64
RW-4	10/86	PVC	2	39.0	24.0 - 39.0	NA	5.0	3.44
RW-5	10/86	PVC	2	39.0	24.0 - 39.0	NA	5.2	4.22
RW-6	10/86	PVC	2	39.5	24.5 - 39.5	NA	3.7	2.66
RW-7	10/86	PVC	2	39.0	24.0 - 39.0	NA	4.7	3.35

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Koy:

[a]GM-12 was originally installed in March 1984 but was damaged and replaced with GM-12R in April 1988.
NA = Not available.
PVC = Polyvinyl chloride.

Source: Ecology and Environment, Inc.. April 1990; Goraghty and Miller, Inc., 1985b, 1987b, 1988.

access. The IUTP is separated from residential areas by Bayou Grande to the north, Pensacola Bay to the east, and NAS Pensacola industrial complexes to the west and south. The nearest residential area is on base, approximately 3,000 feet southvest of the IVTP.

The coastal waters surrounding NAS Pensacola are classified as Class III waters (NBESA 1983). The Florida Department of Environmental Regulation (FDER) defines Class III waters as "waters to be used for recreational purposes, including such body contact activities as swimming and water skiing; and for the maintenance of a well-balanced fish and wildlife population" (FDER 1990). Surface water bodies at or near the IWTP include Bayou Grande, Pensacola Bay, and the surface drainage ditch south of the IVTP facility. Bayou Grande and Pensacola Bay are used for recreational purposes (i.e., boating and swimming) as well as commercial and sport fishing.

2.2 CLIMATOLOGY

The NAS Pensacola is located in an area that typically experiences a mild, subtropical climate. This climate is a result of the latitude (approximately 30° North) and the stabilizing effect of the adjacent Gulf of Mexico (Volfe et al. 1988). Appendix C contains a National Oceanographic and Atmospheric Administration (NOM) climatic table which presents the normals, means, and extremes of temperature, sky cover, humidity, precipitation, and winds in Pensacola. The average annual temperature ranges from 55° Fahrenheit (P) in the winter to 81° F in the summer. Although the annual temperature range is fairly stable, actual daily values can be more extreme, ranging from less than 7° F in the winter to more than 102° P in the summer. Thunderstorms occur during approximately half the days during the summer months and can cause a 10° to 20° F drop in temperature in only a few minutes (Volfe et al. 1988).

Precipitation rates in the NAS Pensacola vicinity are relatively high with an average annual rainfall of approximately 60 inches. Rainfall amounts are highest in July and August during almost daily thunderstorms (averaging 7 inches per month), and lowest during spring and fall

(averaging 4 inches per month; Kennedy 1982). High intensity thunderstorms are common, producing as much as 3 to 4 inches of rainfall during a single hour. Evaporation rates are also highest in the summer months, which reduces the potential recharge resulting from heavy summer rains. Spring and fall rains are generally less intense, but longer in duration, producing less surface runoff and higher rates of infiltration and net recharge.

Wind velocities are generally moderate except during thunderstorms (Carlisle 1960). Prevailing winds are northerly during the winter and southerly during the summer. An ocean-land temperature differential produces a daily clockwise rotation of the surface wind direction near the coast, commonly known as the sea-breeze effect (Flood and Associates 1978). Hurricanes and tornadoes are infrequent but can cause substantial damage to the nearshore environment. Six hurricanes have passed within 50 miles of Pensacola since 1980.

2.3 BIOLOGICAL RESOURCES

The NAS Pensacola facility consists of approximately 5,800 acres and encompasses approximately 15 terrestrial and aquatic habitats. The majority of the land on the eastern side of the facility is developed for military use or is designated as a historical or cultural resource. However, the NAS Pensacola installation has approximately 3,500 acres in natural or semi-natural (pine plantation) condition, primarily in the western portion of the facility.

2.3.1 Regional Biological Resources

2.3.1.1 Terrestrial

Vegetation. The primary vegetated communities of the NAS Pensacola facility can be considered one of two types: north Florida coastal strand communities, and sand pine scrub communities. The north Florida coastal strand communities are stabilized coastal dunes with a sand substrate, and are characterized by sea oats (Unilola paniculata), beach pennywort (Hydrocotyle bonariensis), beach morning-glory (Ipomoea

stolonifera), twin live *oak* (Quercus geminata), yucca (Yucca aloifolia), and prickly pear cactus (Opuntia sp.) This community type has been ranked by the Florida Natural Areas Inventory (FNAI) as locally restricted and vulnerable to extinction due to developmental activities. This community type can have three to five distinct habitat types (Uolfe et al. 1988).

The sand pine scrub community occurs on older coastal dune formations with deep, fine white sand substrate. Sand pine (Pinus clausa), scrub *oak* species (Quercus geminata, Q. chapmanii, Q. myrtifolia, and Q. inopina), ground lichens (Cladonia spp.), and rosemary (Ceratiola ericoidcs) are some of the more characteristic plant species of this community. This community type has been ranked by FNAI as imperiled statewide because of its rarity and because of its vulnerability to extinction due to spme artificial or biological factor. Three to five distinct habitats may be recognized (Uolfe et al. 1988).

Two other community types may be found in the western portions of the NAS Pensacola facility. These are flatvoods and sandhill communities. Flatwoods occupy areas which were ocean bottoms in recent geologic times. Dominant overstory species include longleaf pine (Pinus palustris), slash pine (Pinus elliottii), and saw palmetto (Serenoa repens). Platwoods communities also occupy depressional areas and small creeks and drainage courses, but the overstory vegetation is usually replaced by pond cypress (Taxodium ascendens), black titi (Cliftonia monophylla), swamp titi (Cyrilla racemiflora), and other wetland species. Open wet savannah areas within flatwoods are dominated by the herbaceous species such as butterwort (Pinguicula spp.), pitcher-plants (Sarracenia spp.), bladderworts (Utricularia spp.), milkworts (Polygala spp.), and sundews (Drosera spp.; Wolfe et at. 1988).

Sandhill communities are found in dry soils vhich are lower in fertility than flatwoods soils. The overstory of this community type is dominated by longleaf pine (Pinus palustris), turkey oak (Quercus laevis), bluejack *oak* (Q. marilandica), post *oak* (Q. stellata), and southern red *oak* (Q. falcata). The understory is dominated by wild persimmon

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(Diospyros virginiana) and Pensacola hawthorn (Crataegus lacrimata). The more abundant herbaceous plants found in sandhill communities are bracken fern (Pteridium aquilinum) and wire grass (Aristida stricta). These habitats were verified with walk-through surveys and ground truthing by the Navy in March of 1986 (Navy 1986).

Preshvater Wetland Vegetation. Much of the geological material underlying the NAS Pensacola facility is deep, porous sand often containing relatively impermeable clay lenses. In combination with high annual rainfall, this geologic condition causes the formation of small areas of perched groundwater. In areas with relatively steep slopes, groundwater seepage escapes into well defined stream channels, as found near Site 30 (Buildings 649 and 755). In gently sloping areas, the presence of perched groundwater conditions results in the formation of wetland bogs, as found near Sherman Field. Wetland or seepage bogs are characterized by herbaceous plant species as described in the sections above for flatwoods and sandhill communities. Most of these communities and other vegetative communities east of Sherman Field have been considerably altered by development on the base that has changed surface and/or groundwater flow (NEESA 1983).

Shrub bogs are found within flatwoods, downslope of herbaceous bogs. These evergreen bogs are dominated by black titi and/or swamp titi. Associated species include sweet pepperbush (Clethra alnifolia), dahoon holly (Ilex cassine), and fetterbushes (Lyonia spp.; Wolfe et al. 1988).

Intermittent streams found on NAS Pensacola have lost most of the original vegetation associated with this habitat. For example, at Site 30, the stream flows from the mixed hardwood swamp into Bayou Grande has lost a considerable amount of vegetation along the stream banks and near Bayou Grande as a result of base development. In areas unaffected by development, hardwoods dominate the canopy around the stream. Such species as sweetbay (Magnolia virginiana), star anise (Illicium floridanum), and spiked cat brier (Smilax bona-nox) are dominants of seepage streams (Wolfe et al. 1988).

Biota surveys must be conducted for any wetland or stream habitat that is influenced by a site to determine which specific flora and fauna may be affected by site activities.

Birds. A literature search reveals 250 possible bird species associated with the area. Thirteen of these species are endangered and seven are species of concern (see Appendix D). In March 1986, the Navy conducted a survey and found 23 species of birds on the NAS Pensacola facility. The Navy recorded moderate size rookeries of the great blue heron and found large numbers of nesting osprey in the southwestern portions of the NAS Pensacola facility. Because of the large number and diversity of habitats found around the facility and considering that the survey was conducted during a predominantly non-mating season, it is likely that there are more species of birds using the facility and surrounding waters as feeding and nesting sites than have been reported.

Reptiles and Amphibians. During the 1986 survey conducted by the Navy, only four out of a possible 30 species of reptiles and amphibians associated with the area were identified on the NAS Pensacola facility, none of which are endangered. A recent check of the FNAI files confirms that the gopher tortoise (Gopherus polyphemus) is likely to occur in suitable habitats on the western portions of the facility (see Appendix D). A majority of the reptiles and amphibians that may be found on the facility can be expected to use the surface water bodies in some stage of their life cycle; therefore, any contamination of surface water bodies can be detrimental to resident populations of reptiles and amphibians.

2.3.1.2 Aquatic

Freshwater. Little is known of the flora and fauna inhabiting the streams, svamps, and bogs found on NAS Pensacola. These habitats may have been significantly altered for drainage control and base development. Some of the species associated with aquatic habitats are creek chub (Semotilus atromaculatus), mosquitofish (Gambusia affinis), and darters (Etheostoma sp.). Birds, mammals, reptiles, and amphibians

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that associate with aquatic habitats may also be found in and around those sites with surface waters (Wolfe et al. 1988).

Coastal Wetland. Estuarine wetlands occur principally along the low energy shores of Bayou Grande. The habitat type is usually dominated by saltmarsh cordgrass (Spartina alterniflora) or black needlerush (Juncus roemerianus). A biota survey of these and other potential habitat areas will be conducted to determine the extent of estuarine flora and fauna. Seagrass beds are reported to be present within Big Lagoon along the southwestern portion of the NAS facility. These grassbeds are composed primarily of Thalassia testudinum, Syringodium filiforme, and Ralodule beaudettei. Seagrass beds in the area surrounding the facility have not been historically mapped and very little is known of their composition, locality, or areal extent. Grass beds of unknown species composition extending along the north shore of Pensacola Bay in the 1950s disappeared by 1961. An examination of historical aerial photographs may elucidate past distributions of seagrasses (see Section 5.1.2).

Plankton. The only existing study of the phytoplankton and zooplankton in the waters surrounding the NAS Pensacola facility was conducted by the Navy in March of 1986. The phytoplankton has been characterized as low in productivity (as compared to other Gulf coast estuaries), and mainly dominated by the diatoms Navicula tripuncata, Bacteriastrum spp., Chaetocerus spp., Thalassionema nitzschoides, and Hemiaulus spp. The zooplankton is primarily dominated by Calonoid copepods and benthic invertebrate larvae. This study is very limited due to the fact that samples were collected with undefined methods and only during the early spring. In addition, this sampling protocol does not define population fluctuations that are characteristic of low population abundances commonly found in estuaries during the summer months. Examination of the zooplankton data results in the same conclusions. It should be pointed out that any contamination entering Pensacola Bay from either groundwater or surface water sources may be accumulated in the invertebrate larvae that predominate most estuarine water bodies.

Benthos. Marine soft-sediment communities are found adjacent to the northern, eastern, and southern areas of the NAS Pensacola facility in Pensacola Bay. Although no intensive benthic surveys vere conducted along the perimeter of the facility, surveys at nearby sites by FDER and the Navy have described the benthic communities vithin Pensacola Bay as a whole. FDER collected benthic samples in most of Pensacola Bay and found that the sediments were dominated by polychaetes (Aricidea spp., Capitella spp., various spionids and Iiaploscoloplos spp.) and bivalves (Anodontia alba and Tellina spp.) during most of the year (FDER 1988a; Navy 1986). Four of the FDER stations were located in the vicinity of the IWTP discharge pipe outfall (see Figure 2-2). One station vas located south of Bayou Grande and 100 yards offshore (background station), a second station vas sampled 200 yards offshore from the IVTP (station 2), a third station was established 100 yards offshore from the IVTP (station 3), and the fourth vas located just below the outfall (station 4). Shannon-Weaver Diversity Index Values (H') vere highest at the background station (H' = 3.25); values for stations 2, 3, and 4 vere respectively 2.75, 2.13, and 2.33. Total density was highest at the background station (1,237 individuals) and decreased vith increasing proximity to the outfall (732, 598, and 189 individuals). Species richness vas 15 at the background station, 10 at stations 2 and 4, and 9 at station 3. The data indicate that the benthic community may have been negatively influenced by the sewage outfall.

Samples collected by the Navy (1986) indicate a low density yet moderate diversity of benthic infuanal organisms when compared to other estuarine systems within and around the turning basin. A complete comparison of the Navy's data cannot be made to other literature at this time because their data are not given in numbers per unit area. However, the Navy's data reveal that very few deep dvelling organisms reside in the areas around the turning basin, and a lack of deep dvelling benthic organisms may be an indication of a benthic community under stressed conditions (Luckenbach et al. 1988).

Fish and Shellfish. Early studies of Pensacola Bay have identified 180 bony fish species and seven cartilaginous fish species (Cooley 1978). The 13 most abundant species were spot (Leiostomus xanthurus), pinfish (Lagodon rhomboides), Atlantic croaker (Micropogonias undulatus), gulf menhaden (Brevoortia patronus), bay anchovy (Anchoa mitchilli), longspine porgy (Stenotus caprinus), silver perch (Bairdiella chrysoura), southern hake (Urophycis floridana), inshore lizardfish (Synodus foetens), gafftopsail catfish (Bagre marinus), sand seatrout (Cynoscion arenarius), and spotted hake (Urophycis regia; Heil 1989).

Fish diversity was highest in the more saline waters near the NAS Pensacola facility during spring and summer. In the lower salinity waters of East Bay, diversity was lowest in summer and highest during the winter months. Fish population density was the highest in the more saline waters, with peaks throughout the summer (Cooley 1978). Moderate densities of the blue crab (Callinectes sapidus), shrimp (Penaeus duorarum, P. setiferus, and P. aztecus), and oysters (Crassostrea virginica) have been collected throughout Pensacola Bay (Heil 1989). Shrimp are caught in greater numbers near NAS because of the higher salinities. Blue crabs and oysters are more readily caught in the East Bay area. In fact, the only legal shellfishing areas recognized by the Florida Department of Natural Resources (FDNR) are in the East Bay area. Scallops (Aequipecten irradians) are collected only within grassbed areas. No information is available at this time on any locations where or if scallops may be collected by the general public at the facility, or the number harvested. The nearest seagrass beds to the NAS facility are located in the Big Lagoon along the southwest portion of the facility.

Sport and Commercial Fishing. A moderate amount of commercial fishing occurs in Escambia county, accounting for 2% of the total Florida landings for 1980 to 1985 (Navy 1986). The dominant finfish species in terms of total weight was the black mullet. The most economically important species of finfish was the red snapper. E & E examined the commercial landing data for Escambia County for 1987 and 1988 (Heil 1989) and found that the most important commercial species by weight

were: black mullet (24% of county landings), brown shrimp (21%), vermillion snapper (19.5%), red snapper (7.6%), porgies (4.7%), and amberjack (4%). Other less important commercial fish that were caught were Spanish mackerel, sand seatrout, black grouper, spotted seatrout, bluecrabs, and squid. These data, as well as the Navy's data, also suggest that a significant tuna fishery may be developing in the Pensacola Bay area (0 pounds landed in 1983, 1,582 pounds in 1987).

Sport Fisheries data are not available in the state of Florida at this time due to the lack of a state saltwater fishing license (Heil 1989). A telephone survey conducted by the U.S. Fish and Wildlife Service (USFWS) ranks the spotted seatrout as a primary fish species sought by fisherman in 1987. Other species that were sought included: king mackerel, red drum, spanish mackerel, grouper, red snapper, flounder, and sand seatrout. It is likely that the sport fishing catch equals or exceeds commercial landings for species sought by both interests (Navy 1986).

The estuarine system is a very important element in the life history of most of the commercial and sport fishing species sought. Betveen 65 and 90% of all commercially valuable fish species are estuarine dependent during some phase of their life cycle. Shrimp, bluecrab, and shellfish are knovn to release larvae that feed in and around estuaries until settlement. During early life history stages, the juveniles reside within seagrass beds or other protected habitats until maturity. Any contamination of the water or sediments around NAS Pensacola could be detrimental to fish and shellfish population structure, or could be accumulated by the organisms residing near the facility.

Marine Mammals. Few mammals have been sighted within the area of the NAS Pensacola facility; most of the 13 species of mammals reported for the northeastern Gulf of Mexico stay predominantly in Gulf waters. The Atlantic bottlenose dolphin (Tursiops truncatus), however, has been sighted regularly off the NAS Pensacola facility. Manatees have been sighted irregularly, with one recent sighting in the area recorded by the FNAI in October 1988. A goosebeaked whale (Ziphius cavirostris) was

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reported stranded on Santa Rosa Island, and a pilot whale (Globicephala macrorhynchus) was found stranded on a beach near Pensacola (Navy 1986). Although no surveys of marine mammals have been conducted, it can be assumed that they are are quantatively ranked as uncommon to common in abundance within the waters surrounding the NAS Pensacola facility.

Threatened and Endangered Species. A number of threatened and endangered species have been identified in the vicinity of the NAS Pensacola facility (see Appendix D). Many rare, threatened, and endangered species are associated with the wetland or bog habitats found on NAS Pensacola. A total of 57 occurrences for six plant species were recorded in an inventory conducted by FNAI (1988b) of the NAS Pensacola facility (see Appendix D). Host of these plants were found in the area around Sherman Field and habitats to the west. Any site remediation and. more importantly, any assessment of environmental endangerment must consider the water level requirements of rare and endangered plant species and the foraging activities of birds in the waters surrounding the NAS Pensacola facility, as well as animals nesting and feeding on the facility grounds. Complete biota surveys may be animals necessary to determine the presence of threatened or endangered species and potential pathways of contamination to these species.

2.3.2 Site-Specific Biological Resources

The IWTP facility, primarily comprising sites 32, 33, and 35, occupies an area that is adjacent to both Bayou Grande and Pensacola Bay on the northeast side of NAS Pensacola. A coastal strand community surrounds the IWTP facility and possesses an overstory dominated by pines and scrub *oaks* and an understory dominated by a variety of species including saw palmetto, ground lichens, rosemary, and yucca. On-site vegetation has been considerably altered by construction of the IWTP facility. Within the confines of the IWTP facility, the dominant vegetation consists of cultivated grass species that are present in unpaved and unused areas.

The USFWS National Wetland Inventory Hap for Fort Barancas, Florida, indicates several aquatic and wetland habitats in the vicinity of sites 32, 33, and 35. These include Pensacola Bay and associated intertidal habitat (E2FLM) located east of the IWTP; three palustrine forested (PF04A) wetlands to the south; and Bayou Grande and associated estuarine emergent (E2EM5P), scrub-shrub/emergent (E2 $\frac{SS3}{EM1}$ C), and forested/emergent (E2 $\frac{F04}{EM5}$ P) wetlands to the west of the complex. In addition, there is a vide freshwater drainage ditch located approximately 500 feet south of the polishing tank. This ditch is known to contain a large population of Carolina lilaeopsis (Lilaeopsis carolinensis), a candidate for inclusion on the federal list of endangered and threatened plant species.

The unvegetated intertidal area of Pensacola Bay may be utilized by shorebirds as foraging and resting habitat. The abundant supply of benthic invertebrates within these areas typically attracts a variety of species including terns, sandpipers, gulls, plovers, villets, and sanderlings. Raccoon also may occasionally scavenge in these areas.

The three forested wetlands south of the IWTP are most likely dominated by slash pine and characteristic associates such as sweet bay, swamp titi, and swamp tupelo (Nyssa biflora). Typical wildlife species common to these habitats include raccoon, possum, cottontail rabbit, red-bellied woodpecker, red-shoulder hawk, and eastern diamondback rattlesnake.

Typical plant species of the estuarine emergent marshes and scrub-shrub wetlands include black needlerush (Juncus roemerianus), smooth cordgrass (Spartina alterniflora), southern cattail (Typha domingensis), and marsh elder (Iva frutescens). Slash pine, yaupon (Ilex vomitoria), and wax myrtle (Myrica cerifera) occur in the forested wetlands, landvard of the marsh and scrub-shrub habitats. Wildlife species frequently found in these communities include wading birds, waterfowl, marsh wrens, fiddler crabs, marsh snails, periwinkle, isopods, amphipods, and raccoon.

All of the above habitats potentially may be affected by sites 32, 33, and 35.

2.4 SURFACE WATER HYDROLOGY

2.4.1 General Occurrence and Significance of Surface Water

The NAS Pensacola facility is located on a coastal peninsula bounded by Bayou Grande to the north, Pensacola Bay to the south and east, and Big Lagoon to the southwest. Pensacola Bay and Big Lagoon are partially separated from the Gulf of Mexico by Santa Rosa Island and Perdido Key, both of which are barrier islands.

Surface soils consist primarily of permeable sands which allow rapid infiltration of precipitation. This direct infiltration limits stream formation and constitutes the major source of recharge to the underlying Sand-and-Gravel Aquifer.

There are no naturally occurring perennial streams on NAS Pensacola; however, there are approximately 10 naturally occurring intermittent streams and numerous man-made drainage pathways which include many stormwater outfalls. Discharge is mainly to the south into Pensacola Bay; however, some small intermittent streams discharge into Bayou Grande to the north from Sherman Field and Chevalier Field (U.S. Geological Survey [USGS] 1970a; 1970b).

The southwestern and northern portions of NAS Pensacola contain areas of freshwater wetlands. These are particularly sensitive areas formed by the intersection of the water table with the land surface. These systems are defined by and dependent upon a dynamic water-cycle, with periodic inundation and exposure corresponding to seasonal fluctuations in the water table.

The discharge of surface waters into Pensacola Bay, Bayou Grande, and the coastal wetland areas presents the potential for transport of contaminants into these systems. This could have a significant impact on seagrass and other sensitive plant communities, as well as on shell

fishing, recreational fishing, and swimming in these coastal zones. Discharges, either through the surface water or groundwater into wetland areas found on site could also have a significant impact on the biotic communities that are dependent on those habitats.

2.4.2 Site-Specific Surface Water Hydrology

The four surface water bodies that lie in close proximity to sites 32, 33, and 35, include a small unnamed creek, an arm of Bayou Grande, Pensacola Bay, and a small surface drainage ditch south of the IWTP facility (see Figure 2-2). The small unnamed creek is mainly fresh-water, with its source being derived largely from groundwater seepage. This small creek flows to the north into the arm of Bayou Grande vhich is brackish or marine. The portion of the creek adjacent to the three sites, Bayou Grande, and Pensacola Bay are all subject to tidal fluctuations in water levels. The small drainage ditch appears to receive surface runoff from the southern portion of the site, and flows east tovards Pensacola Bay.

Given that shallow groundwater in this area discharges into these surface water bodies and potentially into the drainage ditch south of the sites, any contamination associated with these sites may impact the surface water. Rainfall runoff from contaminated soils could also have an impact on surface water quality.

The whole of the Magazine Point Peninsula lies entirely within the 100-year floodplain (Federal Emergency Management Agency 1987).

2.5 PHYSIOGRAPHY AND REGIONAL HYDROGEOLOGY

2.5.1 Physiography

NAS Pensacola is located in the Gulf Coastal Lowlands Subdivision of the Coastal Plain Province physiographic division (Brooks 1981). The 5,800-acre facility is located on a peninsula bounded on the east and south by Pensacola Bay and Big Lagoon, and on the north by Bayou Grande. The most prominent topographic feature on the peninsula is an escarpment or

bluff which parallels the southern and eastern shorelines and on which Fort Barrancas was built. In the eastern portion of NAS Pensacola the bluff runs north-south just to the west of Chevalier Field. Seaward of the escarpment is a nearly level marine terrace with surface elevations of approximately 5 feet above MSL. The central part of the peninsula, located landward of the escarpment, is a broad, gently rolling upland area with surface elevations up to 40 feet MSL (USGS 1970a and 1970b). Sandy soils occur throughout the NAS Pensacola area. As a result, most of the rainfall infiltrates directly into the subsurface. Consequently there are few streams or surface water bodies on the peninsula.

2.5.2 Regional Eydrogeology

There are three principal hydrogeologic units of importance which underlie the NAS Pensacola. These are, in descending order, the Surficial Aquifer, the Intermediate System, and the Floridan Aquifer System. A geologic cross-section illustrating the regional distribution of these hydrogeologic units in northwest Florida is presented in Appendix E (see Figure E-1).

2.5.2.1 Surficial/Sand-and-Gravel Aquifer

The Surficial Aquifer occurs from land surface to a depth of approximately 300 feet at NAS Pensacola and is composed of a sequence of unconsolidated to poorly indurated clastic deposits (Wagner et al. 1984). In this portion of Florida, the Surficial Aquifer constitutes an important source of water supply and is called the Sand-and-Gravel Aquifer (Southeastern Geological Survey (SEGS] 1986). Based on the total dissolved solids (TDS) content of groundwater from wells in southern Escambia County that tap the Sand-and-Gravel Aquifer (Clemens et al. 1989), the groundwater is classified as Class G-1 (FDER 1988b). The sediments making up this aquifer belong to all or part of the Pliocene to Holocene Series which, in this area, consist mainly of the Citronelle Formation overlain by a thin cover of marine terrace deposits. Given that the Sand-and-Gravel Aquifer is contiguous with land surface and recharge occurs principally by the direct infiltration

of precipitation, the aquifer is particularly susceptible to contamination from surface sources. In the NAS Pensacola vicinity, the Sand-ad-Gravel Aquifer is made up of three zones based on contrasting permeabilities. These zones are referred to as the surficial zone, the low permeability zone, and the main producing zone (Vilkins et al. 1985).

Surficial Zone. The surficial zone is contiguous with land surface and contains groundwater under water table or perched water table conditions. The results of numerous borings conducted at NAS Pensacola (Geraghty and Hiller, Inc. [G & M] 1984; 1986) indicate that the surficial zone ranges in thickness between 40 and 70 feet and consists of tan and brown, fine- to medium-grained quartz sand (see Figure E-2 in Appendix E). Depth to the water table within the surficial zone is variable depending on location and ranges from less than 1 foot near surface water bodies to more than 20 feet in areas of higher elevation. In general, the direction of groundwater flov is controlled by the topography and by discharge to surface vater bodies. Consequently, shallov groundwater in the surficial zone moves toward areas of lover elevation and/or the nearest surface water body. Overall, the surficial zone has a high permeability. Numerous aquifer (slug) tests and laboratory permeability tests conducted on wells in or sediments from the surficial zone at NAS Pensacola (G 6 H 1986) yielded hydraulic conductivity values ranging from 16 to 56 ft/day. Eorizontal ground-water flow velocities in the surficial zone will depend on site-specific hydraulic conductivities and horizontal hydraulic gradients; however, velocities would generally be expected to be high.

Low Permeability Zone. Underlying the surficial zone is a zone of lover permeability sediments dominated by clay and silt-sized material (see Figure E-2). This zone is referred to as the low permeability zone. At NAS Pensacola this zone is generally composed of gray to blue, sandy, silty, slightly fossiliferous (shelly) clay, and clayey sand ranging in thickness from 8 to 40 feet (G & M 1984; 1986).

The results of laboratory permeability tests conducted on samples from this zone indicate that vertical hydraulic conductivities are low, ranging from 4.2 x 10^{-5} to 9.9 x 10^{-2} ft/day. Thus, the low permeability zone probably functions as a confining or semi-confining unit inhibiting the flow of groundwater between the surficial zone and the underlying main producing zone. The low permeability zone has been encountered in at least 16 borings at widely spread locations throughout NAS Pensacola (G & M 1984; 1986). Although additional boring or geophysical techniques would be required to confirm its presence at a given location, it is likely that this unit is ubiquitous at NAS Pensacola. Few if any wells are open to the low permeability zone at NAS Pensacola; thus, no information is available regarding groundwater flow direction.

Main Producing Zone. The bottom portion of the Sand-and-Gravel Aquifer is called the main producing zone and consists mainly of sand and gravel interbedded with thin beds of silt and clay (see Figure E-2). The depth at which the main producing zone is encountered is somewhat variable, ranging from 60 to approximately 120 feet below land surface (BLS) at NAS Pensacola. This zone generally has the highest permeability characteristics due to thicker and more persistent sand and gravel beds, and is tapped by most of the major wells in the Pensacola area (Wilkins et al. 1985). NAS Pensacola has three supply wells which produce water from this zone; however, due to high iron content in the water, the wells are infrequently used (G & M 1986). The principal sources of water for NAS Pensacola are wells located at Corry Field, approximately 3 miles to the north. The thickness of the main producing zone can be highly variable; however, it is estimated to be up to approximately 300 feet at NAS Pensacola (Wilkins et al. 1985). Few wells are open to the main producing zone at NAS Pensacola. As a result, the direction of groundwater flow within this zone across NAS Pensacola has not been determined. However, the regional flow direction is assumed to be generally southward under ambient conditions. Pumpage of the supply wells would locally cause groundwater in this zone to flow toward the wells.

As a result of the overlying low permeability zone, groundwater within the main producing zone occurs under confined or semi-confined conditions. At one nested well location on NAS Pensacola (east of Building 648), the water level elevation in a well open to the main producing zone is approximately 7 feet lover than that in an adjacent well open to the surficial zone (G & M 1986). This indicates that a downward hydraulic gradient exists between these two zones. Thus, a potential exists for vertical groundwater flow from the surficial to the main producing zone at this location. However, in topographically lower areas on NAS Pensacola, at sites near Pensacola Bay and Bayou Grande, the opposite condition has been observed. In these areas, water level elevations in the main producing zone are higher than those in the surficial zone, indicating an upward flow potential from the main producing zone in these lov lying areas. Thus the overall potential for flow between the surficial and main producing zones at NAS Pcnsacola is dependent on site location and land surface elevations.

2.5.2.2 Intermediate System

The lover limit of the Sand-and-Gravel Aquifer coincides with the top of a regionally extensive and vertically persistent hydrogeologic unit of much lower permeability. This unit is referred to as the Intermediate System. In the vicinity of NAS Pensacola the top of the Intersediate System generally lies within the sediments termed Miocene Coarse Clastics or corresponds to the top of the Upper Member of the Pensacola Clay and occurs at a depth of approximately 300 feet (Wilkins et al. 1985). In general, the Intermediate System consists of fine-grained sediments and functions as an effective confining unit which retards the exchange of water between the overlying Sand-and-Gravel Aquifer and the underlying Floridan Aquifer System (SEGS 1986). For the most part, the entire sequence is poor to non-water bearing. However, relatively thin beds of sand exist within the unit which may yield small quantities of water. In the NAS Pensacola area the Intermediate System is approximately 1,100 feet thick and is composed of the lower portion of the

Miocene Coarse Clastics, the Upper Member of the Pensacola Clay, the Escambia Sand Member of the Pensacola Clay, and the Lower Member of the Pensacola Clay, all of Miocene Age.

2.5.2.3 Floridan Aquifer System

Immediately underlying the Intermediate System and occurring at a depth of approximately 1,500 feet BLS at NAS Pensacola is the Floridan Aquifer System. The Floridan Aquifer in this area is composed of the Middle to Lower Miocene Chickasawhay Limestone and undifferentiated Tampa Stage Limestone. Groundwater within the Floridan Aquifer in this area is highly mineralized and is not used for water supply (Wagner et al. *1984).*

2.5.3 Regional Geologic Structure

Three distinguishable geologic structures influence the hydrogeology of the northwest Florida region. .These are, from west to east, the Gulf of Mexico Sedimentary Basin, the Chattahoochee Anticline, the Apalachicola Embayment, and the Ocala Arch (see Figure E-3 in Appendix E).

In the central part of the study area, the Apalachicola Embayment (Pressler *1947)* is the dominant geologic structure. This embayment is a relatively shallow trough that widens to the southwest. The sediments deposited in the embayment are gently downwarped about an axis that plunges to the south-southwest (Schmidt *1984).* Schmidt *(1984)* summarized previous studies of the structure and concluded that the embayment or low area existed in the Late Jurassic and Early Cretaceous and originated as a basement graben, and was filled in with sediments by the end of the Early Cretaceous. By Middle Cretaceous, the area appears synclinal again, probably due to nondeposition in a current swept strait. From Early Miocene until Recent, the depression slowly filled in and in Pleistocene to Recent times became covered by the prograding Apalachicola River delta (Schmidt 1984).

North of the Apalachicola Embayment is a positive structural feature called the Chattahoochee Anticline. This broad elongate structural high crests in Jackson County, plunges to the southwest, and extends to the north into Alabama and Georgia (see Figure E-3). The origin of the Chattahoochee Anticline is uncertain. It may be only a relative high,

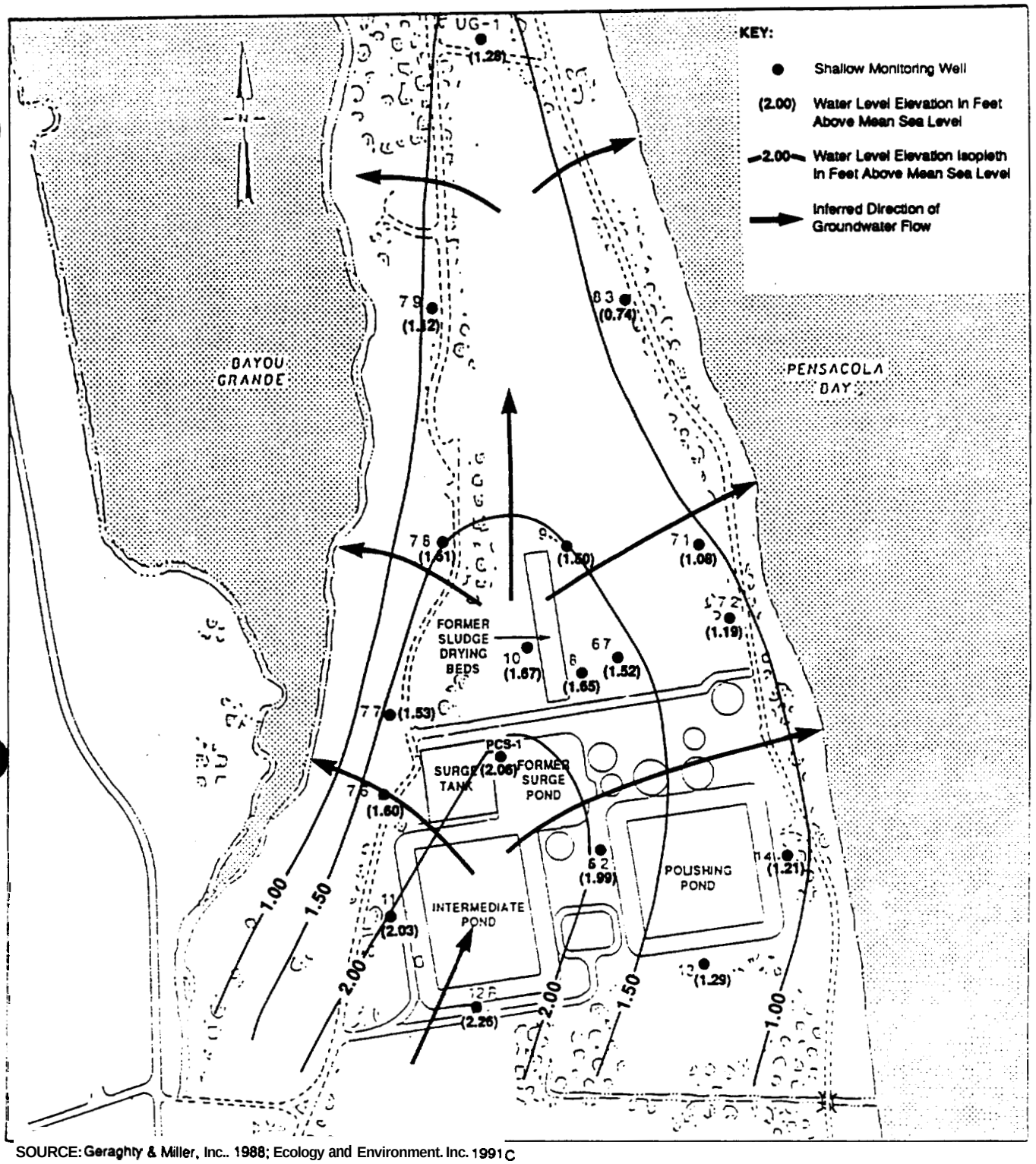
its occurrence due to subsidence of surrounding areas by sediment loading, or it may represent a region of uplift extending down to pre-Mesozoic basement rocks (Schmidt and Scott 1984).

The southern extension of the Chattahoochee Anticline lies between the Apalachicola Embayment and a larger, more regionally extensive negative feature called the Gulf of Mexico Sedimentary Basin. The transition between the two structural lows occurs in the Okaloosa County area (Clark and Schmidt 1982). It is because of the Gulf of Hcxico Sedimentary Basin that most of the strata in the western portion of northwest Florida dip to the southwest. (Barksdale 1988)

Consequently, given that NAS Pensacola is located west of the Appalachicola Embayment, the Gulf of Hexico sedimentary basin has been the primary structural influence for the regional geology of the area.

2.5.4 Site Hydrogeology

Figure B-3 in Appendix E presents a generalized geologic cross-section of the surficial zone of the Sand-and-Gravel Aquifer in the Group O site complex area. In the vicinity of sites 32, 33, and 35, the surficial zone of the Sand-and-Gravel Aquifer is present from land surface to a depth of approximately 38 to 48 feet. The surficial zone, as identified from well cuttings and split-spoon samples collected during the installation of IWTP groundwater monitoring wells GM-62 through GH-69, and PCS-1, PCI-1, and PCD-1, respectively, consists predominantly of white to light brown, fine- to medium-grained quartz sand (G & M 1987b; E & E 1991g). In the vicinity of sites 32, 33, and 35, 18 groundwater monitoring wells are open to the uppermost surficial zone ("shallow zone" wells, approximately 15 feet deep) and five groundwater monitoring vells are open to the lower surficial zone ("intermediate zone" wells, approximately 40 feet deep; E & E 1991g). Water levels observed in the shallow and intermediate zone vells indicate that the water table occurs approximately 1 to 4 feet BLS, depending on tidal influence and land surface elevation (G & M 1988a; 1988b; E & E 1991g). On the basis of studies conducted by E & E (1991g), the direction of groundwater flow within the shallov zone is shown in Figure 2-3. In the vicinity of



SOURCE: Geraghty & Miller, Inc.. 1988; Ecology and Environment. Inc. 1991C

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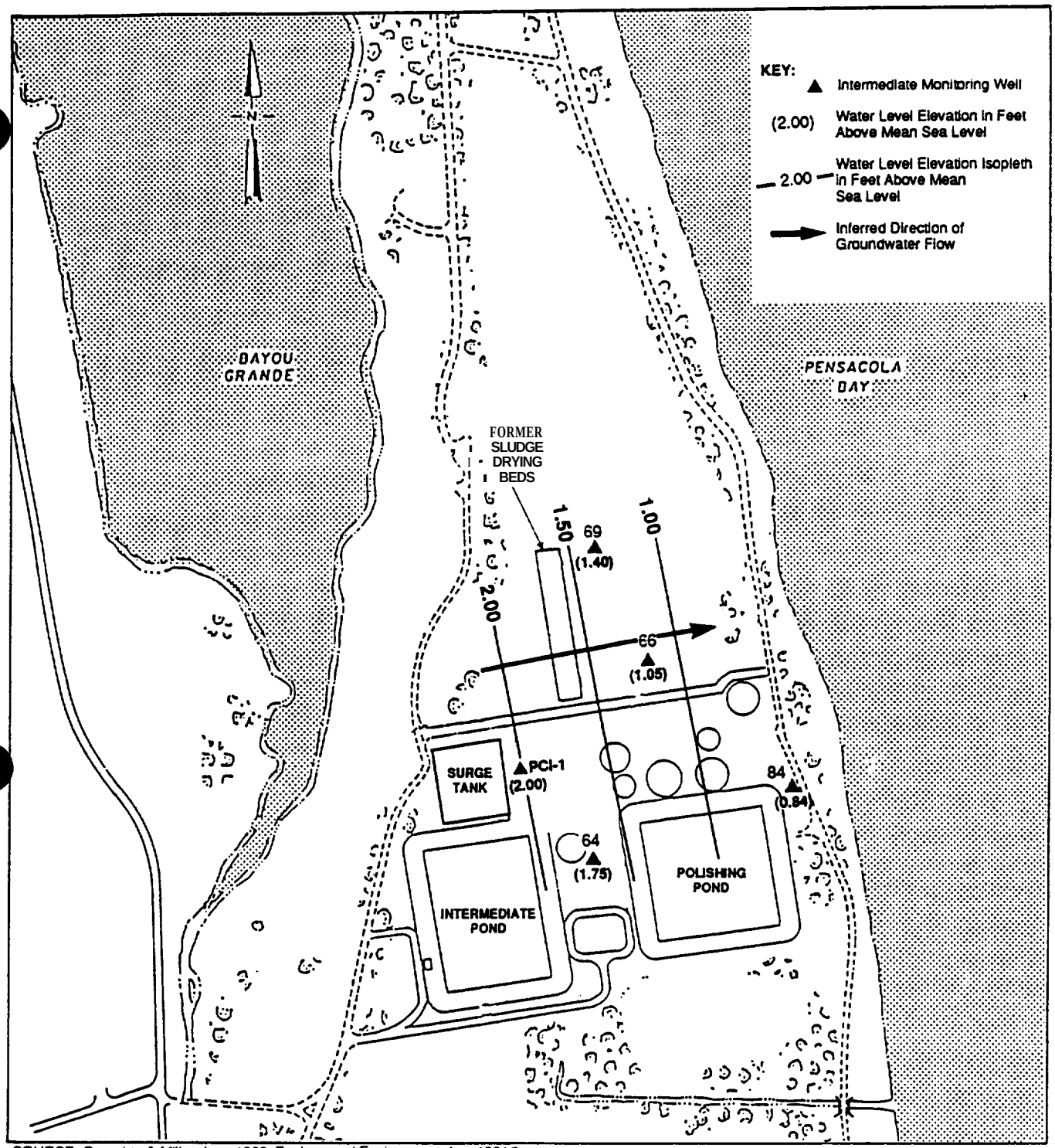
Figure 2-3
WATER LEVEL ELEVATION MAP FOR THE SHALLOW ZONE (3/28/91)
NAS PENSACOLA SITES 32, 33, AND 35

sites 32, 33, and 35, groundwater flow in the shallow zone is toward either Bayou Grande or Pensacola Bay, depending on proximity to either water body. Groundwater flow in the intermediate zone, shown on Figure 2-4, is to the east towards Pensacola Bay. Additionally, the direction of groundwater flow within the surficial zone can locally be influenced by operation of a seven-well recovery system installed in the surficial zone in the vicinity of the IWTP by G & M (1987b) to treat contaminated groundwater (G & M 1987a). From February 1987 through November 1988, the recovery system was operated at an average withdrawal rate of 1.86 million gallons per month (G & M 19883). During this period, surficial zone groundwater flow in the vicinity of sites 32, 33, and 35 was observed to be locally redirected to the recovery well system (G 6 M 1988d). The groundwater recovery system operated at peak to moderate efficiency from December 1988 to July 1990. Pumpage from the recovery well system ceased in July 1990 but was resumed following pump repair in December 1991.

Table 2-2 presents a summary of groundwater flow rates for the Sand-and-Gravel Aquifer underlying the IWTP. Based on hydraulic conductivities calculated by E & E (1991a), the average estimated groundwater flow rate in the shallow zone is 0.0950 feet/day (ft/day) or 34.67 feet/year (ft/yr), and 0.0027 ft/day (0.9855 ft/yr) in the intermediate zone (E & E 1991g).

In the vicinity of sites 32, 33, and 35, the low permeability zone of the Sand-and-Gravel Aquifer immediately underlies the surficial zone and extends to a depth of approximately 55 to 60 feet BLS. Lithologies observed during installation of monitoring wells GH-63, GH-65, GH-68, and PCD-1 indicate the low permeability zone in the vicinity of sites 32, 33, and 35 consists predominantly of gray, clayey silt-containing shell fragments. No groundwater monitoring wells exist in the vicinity of the three sites that are open to this zone. Consequently, the direction of'groundwater flov vithin the low permeability zone is, at present, unknown. On the basis of observed lithologies, this zone



SOURCE: Geraghty & Miller, Inc., 1988; Ecology and Environment, Inc. 1991C

SCALE

0 300 600 FEET

Figure 2-4
WATER LEVEL ELEVATION MAP FOR THE INTERMEDIATE ZONE (3/28/91)
NAS PENSACOLA SITES 32, 33, AND 35

Table 2-2

GROUNDWATER FLOW RATES

Average Estimated Transmissivity (T) (ft/day)	Average Estimated Hydraulic Conductivity (K) (ft/day)	Horizontal Hydraulic Gradient	Average Estimated Groundwater Flow Rate (V)	
			(ft/day)	(ft/yr)
Shallow Zone				
57.07	23.15	0.00115	0.0950	34.67
Intermediate Zone				
1.26	0.50	0.0015	0.0027	0.9855
Deep zone				
33.00	13.52	0.00004	0.0019	0.6935

14[NASP]UH1305:T0220/1111/14

Note: Averages calculated using slug and pumping test results from March 1990 aquifer testing (E & E 1990b).

Source: Ecology and Environment, Inc., 1991d.

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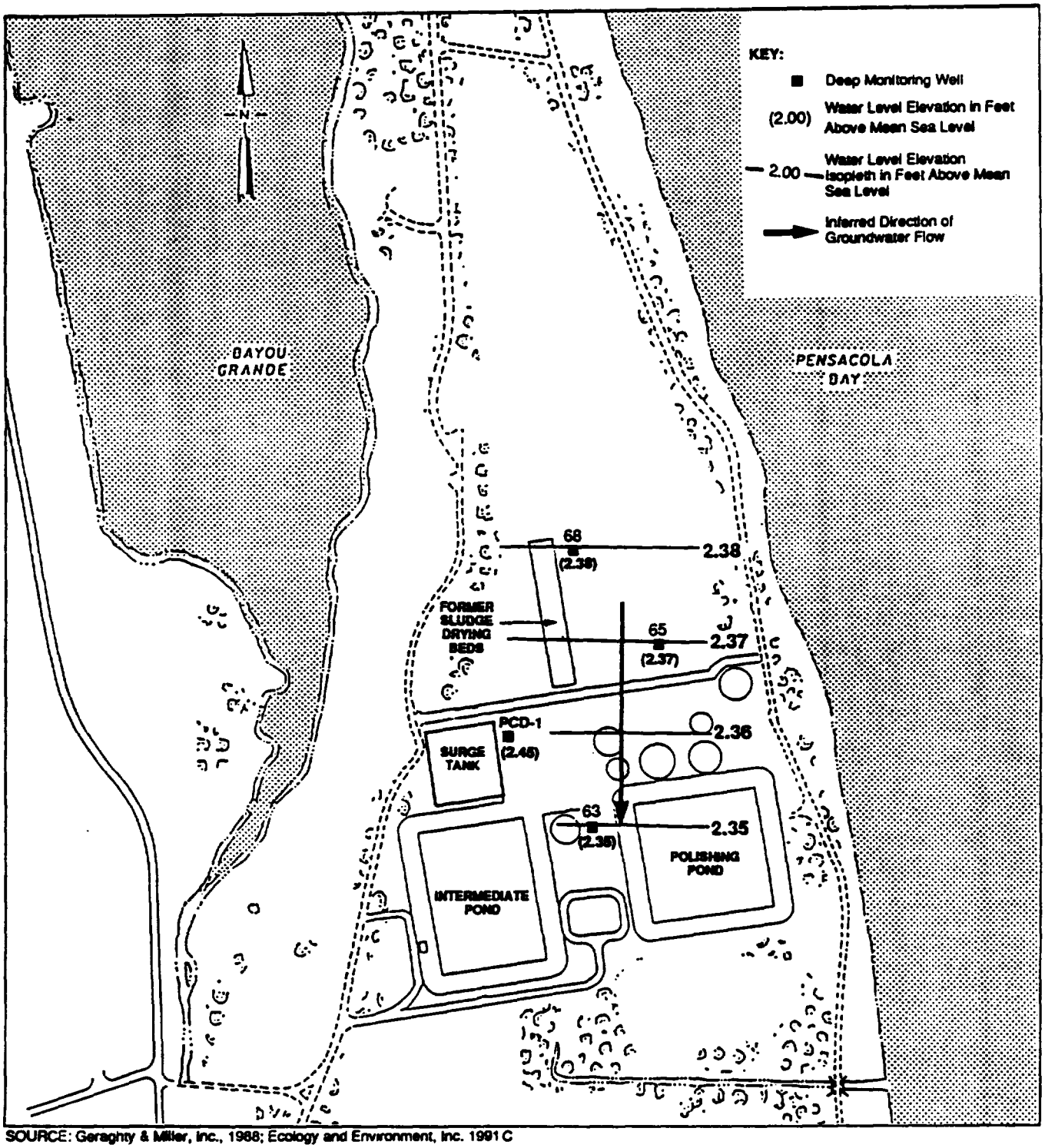
appears to function as a confining or semiconfining unit that restricts groundwater flow between the surficial zone and the underlying main producing zone of the Sand-and-Gravel Aquifer.

The main producing zone of the Sand-and-Gravel Aquifer directly underlies the low permeability zone in the vicinity of sites 32, 33, and 35 (G & M 1987b; E & E 1991g). The main producing zone occurs at approximately 55 to 60 feet BLS, and consists of gray, fine- to medium-grained sand to a depth of at least 120 feet.

Monitoring wells GM-63, GM-65, GM-68, and PCD-1 are screened between 62 and 70 feet and are open to the main producing zone ("deep zone" wells). Water level elevations in these wells have been observed to be higher (approximately 0.3 to 0.9 foot) than the elevations in the nearby shallow monitoring wells, indicating an upward hydraulic gradient (and, therefore, a potential for groundwater flow) between the main producing zone and the surficial zone (E & E 1991g).

The direction of groundwater flow within the main producing zone at these sites is shown in Figure 2-5. Groundwater flow appears to be generally toward the south, based on a small number of water level elevation measurements made on the monitoring wells open to this zone (E & E 1991g). An NAS Pensacola supply well (Well No. 2) is located approximately 0.75 mile west-southwest of sites 32, 33, and 35. This supply well is screened between 105 and 160 feet BLS, and thus is open to the main producing zone. The well is utilized by NAS Pensacola for backup water supply only during periods of peak demand. However, during these periods of pumping, the direction of flow in the main producing zone at the IWTP would probably be directed toward the supply well. Based on a hydraulic conductivity calculated by E & E (1990f), the average estimated groundwater flow rate in the main producing zone is 0.0019 ft/day (0.6935 ft/yr; E & E 1991g).



SOURCE: Geraghty & Miller, Inc., 1988; Ecology and Environment, Inc. 1991C

SCALE

0 300 600 FEET

figure 2-5
WATER ELEVATION MAP FOR THE DEEP ZONE (3/28/91)
NAS PENSACOLA SITES 32, 33, AND 35

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2.6 SITE HISTORY

2.6.1 General

The following site history narrative was prepared based on documents obtained by E & E and listed in Table 1-1. The IWTP Sludge Drying Beds (Site 32), WWTP Ponds (Site 33), and miscellaneous IWTP SWMUs (Site 35) were constructed in 1971 during an upgrading of the existing IWTP to provide tertiary treatment of industrial wastes and secondary treatment of domestic wastes produced by NAS Pensacola (Naval Energy and Environmental Support Activity [NEESA] 1983). By the end of 1973, the IWTP was receiving and treating wastes generated by many of the industrial activities performed at NAS Pensacola.

In 1979 during maintenance of a clogged industrial waste line, a pump failure occurred at the final industrial waste lift station causing an industrial waste spill of approximately 80,000 gallons into a nearby ditch (Site 30), which subsequently leads to Bayou Grande. The lift station is located approximately 2,000 feet southwest of the Group 0 sites; therefore, the incident is unlikely to have affected the Group 0 sites. However, the nature of the waste spilled is indicative of the types of waste treated at the IWTP. This spill, of unknown specific content, resulted in a minor fish kill (NEESA 1983). The spill was investigated by FDER and was considered a minor incident. The Navy was required to pay a fine to FDER but no further investigation was required (Campbell 1991).

By 1981, the IWTP Surge Pond was designated a Hazardous Waste Surface Impoundment (HWSI) and was receiving an average daily inflow of 880,000 gallons. The wastewater was described as containing high concentrations of organic solvents, phenols, chromium electroplating wastes (which included cyanide and various heavy metals), and wastes from an on-base chemical conversion coating process for aluminum. Missimer and Associates, Inc., (M & A) estimated seepage from the surge pond to be potentially as high as 5,800 gallons per day (M & A 1982). In accordance with Resource Conservation and Recovery Act (RCRA) requirements, four shallow monitoring wells were installed by M & A. Three of the

monitoring wells (DG-1, DG-2, and DG-3) vere installed in the vicinity and immediately northwest of the surge pond. The fourth monitoring well (UG-1) was installed approximately 1,800 feet north of the surge pond to function as a background monitoring well (see Appendix P). This well is not a true background well as it is hydraulically downgradient of the IVTP. However, the well vas agreed upon as a background well by the Navy, EPA, and PDER during the preparation of the closure permit. Recent analytical results from well UG-1 indicate that groundwater in this area has not been impacted by the IWTP.

It was subsequently discovered that these wells had not been placed in a manner to meet compliance requirements. Therefore, under the guidance of the EPA, three additional downgradient shallow monitoring wells (DG-4, DG-5, and DG-6) were installed in 1983 by M & A at the toe of the dike surrounding the surge pond (see Appendix F). Monitoring wells UG-1, DG-1, and DG-4 through DG-6 were subsequently designated as RCRA detection monitoring wells.

In October 1983, a sulfuric acid storage tank, located in the chemical storage area near the northeast corner of the surge pond, ruptured, resulting in a sulfuric acid spill of approximately 2,200 gallons. The spill vas cleaned up using sand as an absorbent and lime as a neutralizing agent. Acid-contaminated sand vas placed in the southern cell of the sludge drying beds. The spill area was washed down with water onto sandy areas adjacent to the spill area, and the water was allowed to infiltrate (G & M 1988c). In 1984, the IVTP sludge drying beds were removed from operation.

In 1984, G & H initiated the first of two phases of a vater quality assessment program at the IVTP. During Phase I, the extent and degree of groundvater contamination present in the upper portion of the shallov groundvater system at the IVTP were investigated. G & M installed seven additional shallow monitoring wells (GH-8 through GH-14) adjacent to the former IWTP sludge drying beds and WWTP ponds. Samples were collected by G & M from the seven newly installed shallow monitoring vells (DG-8 through DG-14) and the existing RCRA detection monitoring wells (UG-1,

DG-1, and DG-4 through DG-6) on three occasions between February and October of 1984 and analyzed for dissolved metals, cyanide, and volatile organic compounds (VOCs). In addition, each of the samples collected from the RCRA detection monitoring wells were also analyzed for base/neutral and acid extractable organic compounds (BNAs). In accordance with the agreement between the Navy and the Northwest District FDER, a groundwater sample collected from monitoring well DG-6 was analyzed for Appendix VIII parameters (now referred to as Appendix IX parameters), including pesticides and polychlorinated biphenyls (PCBs).

On January 7, 1985, FDER issued the U.S. Navy Public Works Department a temporary RCRA operation permit (permit no. HT17-68087) for the surge pond. This temporary permit was used until a permanent permit was issued in September 1987 (permit no. HO17-12-7026).

In 1985, based on the results of the Phase I study, G & M conducted a Phase II investigation of the horizontal and vertical extent of groundwater contamination at the site. During the investigation, G & M installed 14 additional shallow groundwater monitoring wells (GM-62, GM-67, GM-70 through GM-73, and GM-76 through GM-83) in the vicinity and north of the IWTP. In addition, four intermediate wells (GM-64, GM-66, GM-69, and GM-75) and four deep wells (GM-63, GM-65, GM-68, and GM-74) were installed at the locations of shallow monitoring wells GM-62, GM-67, GM-70, and GM-76, respectively. The intermediate wells were screened in the lower portions of the surficial aquifer and the deep wells were screened in the upper portion of the underlying, confined, main producing zone of the Sand-and-Gravel Aquifer.

In September 1985, groundwater samples were collected from monitoring wells DG-2, DG-3, GM-8 through GM-14, and GM-62 through GM-83 and analyzed for VOCs and BNAs. The analytical results for this sampling event are discussed in Section 2.6.2.

In 1986, G & M implemented a Corrective Action Program at the IWTP to comply with the specific conditions in the FDER Temporary Operating Permit No. HT17-68087. The Corrective Action Program involved the

installation of seven recovery wells in the surficial aquifer to recover contaminated groundwater associated with the surge pond and sludge drying beds. The system design involved in-line spacing of recovery wells to create a composite cone of depression in the shallow groundwater that would capture the contaminant plume and minimize the potential for inducing saltwater intrusion. The need to minimize saltwater intrusion was due to concern over introducing brackish water with high total dissolved solids and thus adversely impacting the biological treatment process used at the IWTP. Operation of the recovery system began in February 1987.

Prior to startup of the recovery system, the five shallow and two intermediate monitoring wells located in the vicinity of the IUTP and the seven newly installed recovery wells were sampled and analyzed for VOCs and BNAs. The results of these analyses are discussed in Section 2.6.2.

During the week of January 20, 1987, EPA conducted a comprehensive groundwater monitoring evaluation. BPA collected groundwater samples from seven shallow monitoring wells (UG-1, DG-4, DG-6, GM-12, GM-71, GH-73, and GH-80) and one main producing zone monitoring well (GM-68), and analyzed for metals, VOCs, and BNAs. The results of the analyses are discussed in Section 2.6.2.

On September 29, 1987, FDER issued the U.S. Navy Public Works Center a permit to operate the surge pond as a RCRA HWSI (permit no. H017-127026). The permit required that the Corrective Action System continue to operate. In addition, as a specific condition of the RCRA operation permit, a quarterly groundwater monitoring program was initiated, with the first quarterly groundwater samples collected and analyzed in November and December of 1987.

In January and November of 1988 respectively, FDER issued the U.S. Navy Public Works Center closure permits for the following: polishing pond, stabilization pond, and the sludge drying beds (permit no. HF17-134657) and the surge pond (permit no. HF17-148989; FDER 1988c; 1988d). In

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accordance with the closure requirements stated in the permits, liquids were removed from each of the surface impoundments (ponds) and processed through the wastewater treatment plant. Naturally dewatered sludge remaining in these surface impoundments and sludge drying beds were removed and transported to a permitted hazardous waste facility near Emelle, Alabama. The sides and bottom of each surface impoundment were washed, and the remaining sediments were also removed and transported to the same permitted hazardous waste facility. In addition, the clay liner (soil cement liner for the surge pond) and/or subsoil beneath each waste unit was sampled for pollutants known or suspected to have been in the waste stream (FDER 1988c; 1988d). The analytical results of this soil sampling are presented in Section 2.6.2.

These soil sampling analytical results indicated that only low levels of phenols were present in the clay liner and soils beneath the polishing and stabilization ponds. As a result, these two surface impoundments were given clean-closure status (Campbell 1991). However, several contaminants were detected in the soil samples collected from beneath the sludge drying beds and surge pond. Consequently, each of these waste units were capped with a low permeability material (clay for the surge pond and asphalt for the sludge beds), and a monitoring program was developed to ensure the effectiveness and integrity of the caps (Campbell 1991).

In February 1988, shallow monitoring wells DG-1, DG-2, DG-6; intermediate monitoring well GM-75; and deep monitoring well GM-74 were plugged and abandoned to facilitate the construction of a surge tank (in the area of these wells) to replace the surge pond (G & M 1988a). These wells were properly abandoned in accordance with the guidelines of the Northwest Florida Water Management District (NWFWMD; G & M 1988a).

In April of 1988, G & M investigated the source of acidic groundwater present at the IWTP in the vicinity of the inactive sludge beds. G & M installed three temporary shallow and intermediate monitoring wells based on historic information regarding a 1983 sulfuric acid spill at the IWTP. G & M measured groundwater pH and specific conductance in the

temporary monitoring wells; in a number of existing permanent shallov, intermediate, and deep monitoring wells; and in two recovery wells in the vicinity of the suspected acid spill area. Based on the results of the analyses, G 6 M concluded that only the intermediate zone of the surficial aquifer was affected by the acid spill at that time and that recovery well RW-5 was recovering the acid plume (G & M 1988c).

In December 1988, G & M subaitted the second semi-annual report for the corrective action and compliance monitoring programs. G & M reported that the recovery well system had pumped approximately 43 million gallons of contaminated groundwater and was pumping at a rate of about 64 gallons per minute. The report concluded that the downward trend in VOC concentrations, the large volume of recovered water, and the groundwater flow maps indicated that the system was capturing contamination and abating further contaminant migration from the source; however, a recommendation was made to add five recovery wells to enhance the effectiveness of the system.

In Hay 1989, monitoring of the IWTP Corrective Action Program was transferred from G & M to E & E.

During March 1990, E & E installed a monitoring well cluster (including shallow monitoring well PCS-1, intermediate monitoring well PCI-1, and deep monitoring well PCD-1) adjacent to the former surge pond to replace the wells abandoned for the construction of the new surge tank. These three new wells were included in the May 1990 quarterly groundwater sampling. The current work at the Group 0 sites includes the maintenance of the recovery system and periodic groundwater sampling. Since the startup of the recovery system in 1987, numerous problems occurred primarily with the recovery pumps. The pumps operate continuously. In many instances the groundwater levels fell below the pump intakes, damaging the pumps and/or motors, and the pumps (or motors) then had to be replaced. Between July 1990 and November 1991, the recovery system vas inoperative due to continuing maintenance associated with this problem. In November 1991, E & E installed six centrifugal pumps, motors, and associated piping at four of the recovery

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system locations (recovery wells RU4 through RW7). The recovery system in currently operable. A draw-down protector, which shuts the pump off if the water level in the well falls below the pump intake, is scheduled to be installed in some of the recovery wells. The existing pumps at recovery wells RW1, RW2, and RW3 are also scheduled to be repaired and returned to service.

In compliance with the 1987 RCRA HWSI permit issued to the Navy for the Group O sites, E 6 E has conducted nine quarterly groundwater monitoring episodes at the Group O sites since May 1989. No overall interpretive reports have been developed from these sampling efforts although the September 1991 quarterly analytical report included a brief narrative of the results (E 6 E 1991h). In general, several metals, VOCs, BNAs, chloride, and sulfide have been consistently detected in several on-site monitoring wells. The analytical results for these sampling events are presented in Appendix G, and are discussed in conjunction with the analytical results of other previous investigations in Section 2.6.2.2. In accordance with the September 1991 FDER permit (no. HF17-170951) requirements, the monitoring program at the IWTP has been changed from quarterly to semi-annual monitoring. The Appendix IX analyses have also been eliminated from the monitoring program.

Between October 1990 and February 1991, E 6 E conducted Phase I investigations of adjacent sites 11, 13, and 30 (E 6 E 1991f; 1991e; 1991d). The results of these investigations are discussed in Section 2.6.2.3.

2.6.2 Previous Analytical Results

2.6.2.1 Soil

To fulfill the requirements of the closure permits issued for the former sludge drying beds and the former surge pond, the clay liner for the surge pond and the subsoil beneath the former surge pond, the sludge drying beds, and the polishing and stabilization ponds were sampled for several known or suspected contaminants (see Section 2.6.1).

The soil sampling analytical results indicated that only low levels of phenols were present in the clay liner and soils beneath the polishing and stabilization ponds (see Appendix G). As a result, these two surface impoundments were given clean-closure status (Campbell 1991). However, detectable concentrations of cyanide (0.3 mg/kg); 1,3-dichlorobenzene (18 µg/kg); 1,4-dichlorobenzene (14 µg/kg); and toluene (10 µg/kg) were present in the soils beneath the sludge drying beds. In addition, detectable concentrations of cyanide (1.2 mg/kg); 1,2-dichlorobenzene (28 µg/kg); 1,3-dichlorobenzene (67 µg/kg); and 1,4-dichlorobenzene (10 µg/kg) were present in the soils beneath the surge pond (General Engineering Laboratories 1989a; 1989b).

2.6.2.2 Groundwater

The following is a compilation and evaluation of the existing groundwater analytical data that have been collected at the Group O sites. These data have been collected as part of the various RCRA permit requirements the facility has operated under for the last eight years, and as part of efforts to characterize the nature and extent of contamination at the facility (see also Section 2.6.1). In consideration of the magnitude of the available groundwater analytical data and the numerous parameter suites that have been sampled for on a regular basis, this discussion will be divided into four major contaminant groups: metals, other inorganics, VOCs, and BNAs. For reference during the discussion, Appendix G presents summary tables for the sampling analytical results of the previous eight years. It should be noted that the majority of these tables list only those parameters that were detected during a specific sampling event, not the entire suite of parameters that were analyzed for during that event.

Under the various RCRA permits, the IWTP site monitoring wells have been designated either as point-of-compliance (POC), corrective action (CA), or background (well UG-1 only). The POC and CA wells monitor three depth zones within the Sand-and-Gravel Aquifer: shallow zone (15 feet deep), intermediate zone (40 feet deep), and deep zone (65 feet deep; see Section 2.5). As part of the permit requirements, POC wells, CA

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wells, and the background well have generally been sampled for different analytical suites. Tables 2-3 through 2-6 present on-site monitoring well designations and depths, the analytical suites the wells were sampled for, and the dates the wells were sampled.

Given the large number of parameters that have been detected in samples collected from these IWTP wells, this discussion will generally be limited to those parameters that have been detected at concentrations exceeding established groundwater standards. To aid in this effort, tables 2-7 through 2-22 present summary analytical results of all those parameters that have been detected at levels exceeding the applicable Florida Primary Drinking Water Standards (FPDWSs; FDER 1991b) in samples collected from one or more wells during one or more sampling events over the last eight years.

Metals. In general, only POC wells have been consistently sampled for metals; however, CA wells have been consistently sampled for sodium (see tables 2-3 and 2-4). Several metals have been detected at concentrations exceeding the applicable FPDWSs. These include sodium, cadmium, chromium, lead, arsenic, and mercury. It should be noted that during the July and October 1984 sampling events (see Table 2-3), samples were filtered prior to preservation in order to analyze for dissolved metals; during all other sampling events, samples were unfiltered and were analyzed for total metals.

Sodium was the most commonly detected metal at the IWTP, and has been detected at concentrations exceeding the FPDWS of 160 mg/L in samples collected from shallow zone wells PCS-1, GM-14, GM-71, GM-72, GM-76, and GM-77; intermediate zone wells PCI-1, GM-64, GM-66, GM-68, and GM-84; and deep zone wells PCD-1, GM-63, GM-65, and GM-68 (see Figure 2-2 and Table 2-7). Concentrations in the shallow zone samples ranged from 1.48 mg/L (GM-77, May 1989) to 3,201 mg/L (GM-71, March 1989) and were consistently higher in shallow zone samples collected from well GM-76. Concentrations in the intermediate zone samples ranged from 3.8 mg/L (GM-64, May 1989) to 14,000 mg/L (GM-84, March 1991); and were consistently higher in intermediate zone samples collected from wells

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nbl. 2-3

WELLS SAMPLED AND ANALYZED FOR METALS
NAS PENSACOLA SITES 32, 33, AND 35

Monitoring Well (Depth)	Wall Designation	Sampling Date (Month/Year) 11/83	2/84	5/84	7/84	10/84	9/85	4/86	1/87	2/87	5/67	6/87	12/87	2/88	4/88
UG-1 (S)	CA/POC	X[a]			X[b]				X					X[c]	
DG-1 (S)	POC				X[b]										
DG-2 (S)	POC														
DG-3 (S)	POC														
DG-4 (S)	POC				X[b]				X				X	X[c]	X
DG-5 (S)	POC				X[b]									X[c]	
DG-6 (S)	POC				X[b]				X					X[c]	
GM-8 (S)	POC					X									
GM-9 (S)	POC					X									
GM-10 (S)	POC					X									
GM-11 (S)	POC					X									
GM-12 (S)	POC					X			X						
GM-13 (S)	POC					X									
GM-14 (S)	POC					X									
GM-62 (S)	CA														
GM-63 (D)	CA														
GM-64 (I)	CA														
GM-65 (D)	CA														
GM-66 (I)	CA														
GM-67 (S)	CA														
GM-68 (D)	CA								X						
GM-69 (I)	CA														
GM-71 (S)	CA								X						
GM-72 (S)	CA														
GM-73 (S)	N/A								X						
GM-74 (D)	CA														
GM-75 (I)	CA/POC													X[c]	
GM-76 (S)	CA														
GM-77 (S)	CA														
GM-78 (S)	CA														
GM-79 (S)	CA														
GM-80 (S)	N/A								X						
GM-83 (S)	CA														
GM-84 (I)	CA														
MW1-6	CA														
PCS-1 (S)	POC														
PCI-1 (I)	POC														
PCD-1 (D)	POC														

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Table 2-3 (Cont.)

Monitocing Well (Depth)	well Designation	Sampling Date (Month/Year) 6/88	8/88	11/88	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
UG-1 (S)	CA/POC			X[c]	X	X	X[b]	X[b]		X[b]	X	X[b]		X[b]	X[b]
DG-1 (S)	POC														
Mi2 (S)	POC														
Mi3 (S)	POC														
DG-4 (S)	POC		X[c]	X[c]											
DG-5 (S)	POC	X[c]	X[c]	X[c]											
DG-6 (S)	POC														
GK-8 (S)	POC				X	X	X[b]	X[b]	X[b]	X[b]	X	X[b]		X[b]	X[b]
On-9 (S)	POC				X	X	X[b]	X[b]	X[b]	X[b]	X	X[b]		X[b]	X[b]
GM-10 (S)	POC				X	X	X[b]	X[b]	X[b]	X[b]	X	X[b]		X[b]	X[b]
GM-11 (S)	POC				X	X	X[b]	X[b]	X[b]	X[b]		X[b]		X[b]	X[b]
GK-12 (S)	POC				X	X	X[b]	X[b]	X[b]	X[b]		X[b]		X[b]	X[b]
GM-13 (S)	POC				X	X	X[b]	X[b]	X[b]	X[b]		X[b]		X[b]	X[b]
GM-14 (S)	POC				X	X	X[b]	X[b]	X[b]	X[b]		X[b]		X[b]	X[b]
GM-62 (S)	CA										X				
GM-63 (D)	CA										X				
GM-64 (I)	CA										X				
GM-65 (D)	CA										X				
GM-66 (I)	CA										X				
GM-67 (S)	CA										X				
On-68 (D)	CA										X				
GM-69 (I)	CA										X				
GM-71 (S)	CA														
GM-72 (S)	CA														
GM-73 (S)	N/A														
On-74 (D)	CA														
GM-75 (I)	CA/POC														
GM-76 (S)	CA														
GM-77 (S)	CA														
GM-78 (S)	CA														
GM-79 (S)	CA														
on-80 (S)	N/A														
GM-83 (S)	CA														
GM-84 (I)	CA														
RW1-6	CA			X											
PCS-1 (S)	POC									X[b]			X[b]	X[b]	X[b]
PCI-1 (I)	POC									X[b]			X[b]	X[b]	X[b]
PCD-1 (D)	POC									X[b]			X[b]	X[b]	X[b]

14[NASP]UH1305:T0220/1127/0

Key at end of table.

Table 2-3 (Cont.)

14[WASP]UH1305:T0220/1127/0

Key:

[a] = Iron and manganese only.
[b] = Includes cyanide.
[c] = Manganese only.

N/A = Not applicable.
CA = Corrective Action.
POC = Point of Compliance.
(S) = Shallow.
(I) = Intermediate.
(D) = Deep.

Source: Ecology and Environment, Inc., 1991.

Table 2-4

WELLS SAMPLED AND ANALYZED FOR
PH, SPECIFIC CONDUCTANCE, SODIUM, AND CHLORIDE
NAS PENSACOLA SITES 32, 33, AND 35

Monitoring Well (Depth)	Well Designation	Sampling Date (Month/Year) 11/83	2/84	5/84	7/8 4	10/84	9/85	4/86	2/87	5/87	8/87	12/87	2/88	4/88
UG-1 (S)	CA/POC	X[a]										X	X	
DG-1 (S)	POC	X[a]												
DG-2 (S)	POC													
DG-3 (S)	POC													
DG-4 (S)	POC	X[a]												
DG-5 (S)	POC	X[a]												
DG-6 (S)	POC	X[a]												
GM-8 (S)	POC													
GM-9 (S)	POC											X	X	
GM-10 (S)	POC													
GM-11 (S)	POC													
GM-12 (S)	POC													
GM-13 (S)	POC													
GM-14 (S)	POC													
GM-62 (S)	CA													
GM-63 (D)	CA											X	X	
GM-64 (I)	CA											X	X	
GM-65 (D)	CA											X	X	
GM-66 (I)	CA											X	X	
GM-67 (S)	CA											X	X	
GM-68 (D)	CA											X	X	
GM-69 (I)	CA											X	X	
GM-71 (S)	CA											X	X	
GM-72 (S)	CA											X	X	
GM-74 (D)	CA											X	X	
GM-76 (S)	CA											X	X	
GM-77 (S)	CA											X	X	
GM-78 (S)	CA											X	X	
GM-79 (S)	CA											X	X	
GM-83 (S)	CA											X	X	
GM-84 (I)	CA													
RW1-6	CA											X	X	
PCS-1 (S)	POC													
PCI-1 (I)	POC													
PCD-1 (D)	POC													

14[NASP]UH1305:T0220/1125/0

Key at end of table.

Table 2-4 (coat.)

Monitoring Well (Depth)	Well Designation	Sampling Date (Month/Year) 6/88	8/88	11/88	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
UG-1 (S)	CA/POC	X	X	X		X[a]	X[a]	X[a]		X[a]	X[a]	X[a]		X[a]	X[a]
DG-1 (S)	POC														
DG-2 (S)	POC														
DG-3 (S)	POC														
DG-4 (S)	POC														
DG-5 (S)	POC														
DG-6 (S)	POC														
GM-8 (S)	POC					X[a]	X	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]
GM-9 (S)	POC	X	X			X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]
GM-10 (S)	POC					X[a]	X	X	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]
GM-11 (S)	POC					X[a]	X[a]	X[a]	X[a]	X[a]		X[a]	X[a]	X[a]	X[a]
GM-12 (S)	POC					X[a]	X[a]	X[a]	X[a]	X[a]		X[a]	X[a]	X[a]	X[a]
GM-13 (S)	POC					X[a]	X[a]	X[a]	X[a]	X[a]		X[a]	X[a]	X[a]	X[a]
GM-14 (S)	POC					X[a]	X[a]	X[a]	X[a]	X[a]		X[a]	X[a]	X[a]	X[a]
GM-62 (S)	CA										X		X	X[a]	X
GM-63 (D)	CA	X	X		X	X	X	X	X	X	X	X	X	X[a]	X
GM-64 (I)	CA	X	X		X	X	X	X	X	X	X	X	X	X[a]	X
GM-65 (D)	CA	X	X		X	X	X	X	X	X	X	X	X	X[a]	X
GM-66 (I)	CA	X	X		X	X	X	X		X	X	X		X[a]	X
GM-67 (S)	CA	X	X		X	X	X	X	X	X	X	X	X	X[a]	X
GM-68 (D)	CA	X	X		X	X	X	X	X	X	X	X	X	X[a]	X
GM-69 (I)	CA	X	X		X	X	X	X	X	X	X	X	X	X[a]	X
GM-71 (S)		X	X		X	X		X	X	X		X	X	X	X
GM-72 (S)	CA	X	X		X	X		X	X	X		X	X	X	X
GM-74 (D)	CA	X	X												
GM-76 (S)	CA	X	X		X	X		X	X	X		X	X	X	
GM-77 (S)	CA	X	X		X	X		X	X	X		X	X	X	
GM-78 (S)	CA	X	X		X	X		X	X	X		X	X	X	
GM-79 (S)	CA	X	X		X	X		X	X	X		X	X	X	
GM-83 (S)	CA	X	X		X	X		X	X	X		X	X	X	
GM-84 (I)	CA				X	X	X	X	X	X		X	X	X	
RW1-6	CA	X	X		X	X		X	X	X					
PCS-1 (S)	POC									X[a]	X[a]		X[a]	X[a]	X[a]
PCI-1 (I)	POC									X[a]	X[a]		X[a]	X[a]	X[a]
PCD-1 (D)	POC									X[a]	X[a]		X[a]	X[a]	X[a]

14[NASP]UH1305:T0220/1125/0

Key:

[a] = Includes sulfate.

CA = Corrective Action.
POC = Point of Compliance.
(S) = Shallow.
(I) = Intermediate.
(D) = Deep.

Source: Ecology and Environment, Inc., 1991.

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Table 2-5

WELLS SAMPLED AND ANALYZED FOR
VOCs (EPA 624) AND/OR BNAs (EPA 625)
NAS PENSACOLA SITES 32, 33, AND 35

Monitoring Well (Depth)	Well Designation	Sampling Date (Month/Year) 11/83	2/84	5/84	7/84	10/84	9/85	4/86	1/87	2/87	5/87	8/87	12/87	2/88	4/88
UG-1 (S)	CA/POC	X[a]			X	X			X						
DG-1 (s)	POC	X[a]			X	X								X	
DG-2 (S)	POC						X						X	X	
DG-3 (S)	POC						X								
DG-4 (S)	POC	X[a]			X	X			X				X	X	X
DG-5 (S)	POC	X[a]			X	X								X	
DG-6 (S)	POC	X[a]	X	X	X	X			X					X	
GM-8 (S)	POC				X	X	X								
GM-9 (S)	POC				X	X	X			X	X	X	X	X	
GM-10 (S)	POC				X	X	X								
GM-11 (S)	POC				X	X	X								
GM-12 (S)	POC				X	X	X		X						
GM-13 (S)	POC				X	X	X								
GM-14 (S)	POC				X	X	X								
GM-62 (S)	CA						X						X	X	
GM-63 (D)	CA						X						X	X	
GM-64 (I)	CA						X						X	X	
GM-65 (D)	CA						X						X	X	
GM-66 (I)	CA						X			X	X	X	X	X	
GM-67 (S)	CA						X			X	X	X	X	X	
GM-68 (D)	CA						X		X				X	X	
GM-69 (I)	CA						X			X	X	X	X	X	
GM-70 (S)	N/A						X								
GM-71 (S)	CA						X		X						
GM-72 (S)	CA						X								
GM-73 (S)	N/A						X		X						
GM-74 (D)	CA						X						X	X	
GM-75 (I)	CA/POC						X						X	X	
GM-76 (S)	CA						X								
GM-77 (S)	CA						X								
GM-78 (S)	CA						X								
GM-79 (S)	CA						X								
GM-80 (S)	N/A						X		X						
GM-81 (S)	N/A						X								
GM-82 (S)	N/A						X								
GM-83 (S)	CA						X								
GM-84 (I)	CA							X				X	X	X	
RW1-6	CA														
PCS-1 (S)	POC														
PCI-1 (I)	POC														
PCD-1 (D)	POC														

Key at end of table.

14[NASP]UH1305:T0220/1124/0

Table 2-5 (Cont.)

Monitoring Well (Depth)	Well Designation	Sampling Date (Month/Year) 6/88	8/88	11/88	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
UG-1 (S)	CA/POC			X	X	X	X	X		X	X	X		X	X
DG-1 (S)	POC														
DG-2 (S)	POC	X	X												
DG-3 (S)	POC														
DG-4 (S)	POC														
DG-5 (S)	POC	X	X	X											
DG-6 (S)	POC														
GM-8 (S)	POC				X	X	X	X	X	X	X	X	X	X	X
GM-9 (S)	POC	X	X		X	X	X	X	X	X	X	X	X	X	X
GM-10 (S)	POC				X	X	X	X	X	X	X	X	X	X	X
GM-11 (S)	POC				X	X	X	X	X	X		X	X	X	X
GM-12 (S)	POC				X	X	X	X	X	X		X	X	X	X
GM-13 (S)	POC				X	X	X	X	X	X		X	X	X	
GM-14 (S)	POC				X	X	X	X	X	X		X	X	X	X
GM-62 (S)	CA	X	X		X	X	X	X	X	X	X	X	X	X	X
GM-63 (D)	CA	X	X		X	X	X	X	X	X	X	X	X	X	X
GM-64 (I)	CA	X	X		X	X	X	X	X	X	X	X	X	X	X
GM-65 (D)	CA	X	X		X	X	X	X	X	X	X	X	X	X	X
GM-66 (I)	CA	X	X		X	X	X	X		X	X	X	X	X	X
GM-67 (S)	CA	X	X		X	X	X	X	X	X	X	X	X	X	X
GM-68 (D)	CA	X	X		X	X	X	X	X	X	X	X	X	X	X
GM-69 (I)	CA	X	X		X	X	X	X	X	X	X	X	X	X	X
GM-70 (S)	N/A														
GM-71 (S)	CA														
GM-72 (S)	CA														
GM-74 (D)	CA	X	X												
GM-75 (I)	CA/POC	X	X												
GM-76 (S)	CA														
GM-77 (S)	CA														
GM-78 (S)	CA														
GM-79 (S)	CA														
GM-80 (S)	N/A														
GM-81 (S)	N/A														
GM-82 (S)	N/A														
GM-83 (S)	CA														
GM-84 (I)	CA	X	X		X	X	X	X	X	X		X	X		
BM1-6	CA			X											
PCS-1 (S)	POC									X	X	X	X	X	X
PCI-1 (I)	POC									X	X	X	X	X	X
PCD-1 (D)	POC									X	X	X	X	X	X

Key at end of table.

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Table 2-5 (Cont.)

14[NASP]UH1305:T0220/1124/0

Key:

[a] = Phenols only.

N/A = Not applicable.
CA = Corrective Action.
POC = Point of Compliance.
(S) = Shallow.
(I) = Intermediate.
(D) = Deep.

Source: Ecology and Environment, Inc., 1991

Table 2-6

WELLS SAMPLED AND ANALYZED FOR APPENDIX VIII OR IX NAS PENSACOLA SITES 32, 33, AND 35

Monitoring Well (Depth)	Well Designation	Sampling Date (Month/Year) 11/63	2/84	5/84	7/84	10/84	9/85	4/86	2/87	5/87	8/87	12/87	2/88	4/88
UG-1 (S)	CA/POC													
DG-4 (S)	POC											X		
DG-6 (S)	POC				X									
GM-66 (I)	CA													

Monitoring Well (Depth)	Well Designation	Sampling Date (Month/Year) 6/88	8/88	11/88	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
UG-1 (S)	CA/POC								X				X		
DG-4 (S)	POC														
DG-6 (S)	POC														
GM-66 (I)	CA								X				X		

14[NASP]UH1305:T0220/1126/0

Note: Appendix VIII is tho former title for Appendix IX.

Key:

CA = Corrective Action.
POC = Point of Compliance.
(S) = shallow.
(I) = Intermediate.
(D) = Deep.

Source: Ecology and Environment, Inc., 1991.

3200940

Table 2-7

SUMMARY OF SODIUM CONCENTRATIONS IN GROUNDWATER SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35
(All results in mg/L)

Monitoring Well	Sampling Date (Month/Year)									
	8/84	10/84	9/85	1/87	12/87	2/88	6/88	8/88	11/88	3/89
GM-14	NR	NR	NR	NS	NR	NR	NR	NR	NR	200
GH-63	NS	NS	NA	NS	470	420	789	448	NR	515
GH-64	NS	NS	NA	NS	330	200	86	142	NR	55
GH-65	NS	NS	NA	NS	120	110	110	76	NR	100
GH-66	NS	NS	NA	NS	640	670	527	465	NR	662
GH-68	NS	NS	NA	88	61	67	72	79	NR	57
GH-69	NS	NS	NA	NS	510	500	561	598	NR	669
GM-71	NS	NS	NA	18	9.8	5.7	4	7	NR	3,201
GM-72	NS	NS	NA	NS	79	42	44	73	NR	2,793
GM-76	NS	NS	NA	NS	210	190	207	501	NR	22
GH-77	NS	NS	NA	NS	53	43	40	303	NR	117
GM-84	NS	NS	NR	NS	NA	NA	NA	NA	NR	4.450
PCS-1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
PCI-1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
PCD-1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

14[NASP]UH1305:T0220/1131/17

Key at end of table.

Table 2-7 (Coat.)

Honitoring Well	Sampling Date (Month/Year)									
	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/9 1	10/91
OM-14	**184**	**180**	164	**140**	120	NS	130	56	25	31
GM-63	604	449	479	560	510	550	*560*	480	**500**	480
GM-64	*3.B*	105	241	320	210	310	290	320	320	380
On-65	**1.78**	1,070	88.9	120	**180**	180	92	93	96	92
OH-66	6.83	160	**842**	820	670	580	730	670	680	640
GM-68	69	600	693	77	81	90	84	81	89	84
OX-69	879	**618**	693	690	**600**	**620**	**670**	580	610	570
GM-71	258	**NS**	110	6.7	12	**NS**	150	6.2	3.2	4.6
an-72	288	NS	21.4	17	13	**NS**	60	83	19	*1.2*
on-76	39.1	**NS**	136	100	64	**NS**	**110**	**110**	110	**110**
OM-77	1.48	**NS**	46.5	44	28	**NS**	1,100	200	**150**	12
an-84	10,200	4,470	5,540	4,300	4,400	**NS**	4,700	14,000	**NS**	**NS**
PCS-1	**NS**	**NS**	**NS**	NS	19	1.4	5.2	220	6.1	**15**
PCI-1	**NS**	**NS**	**NS**	**NS**	120	310	*310*	**360**	270	260
PCD-1	**NS**	NS	**NS**	**NS**	130	160	**190**	**180**	180	**180**

14[NASP]UN1305:T0220/1131/17

Note: Bold numbers indicate value exceeds FPDWS ot 160 mg/L.

Key:

NS = Monitoring well did not exist, or existed and was not sampled.
NA = Monitoring well sampled but sample not analysed tor this parameter.
NR = No data reported.

Source: Ecology and Environment, Inc., 1991.

3200950

Table 2-8

SUMMARY OF CADMIUM CONCENTRATIONS IN GROUNDWATER SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35 (All results in µg/L)

Monitoring Well	Sampling Date (Month/Year)										
	7/84	10/84	9/85	1/87	2/87	5/87	8/87	12/87	2/88	6/88	8/88
GM-66	NS	**NS**	NA	NS	NA	NA	NA	**NA**	NA	**NA**	NA

Monitoring Well	Sampling Date (Month/Year)											
	11/88	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
GM-66	NR	--	NA	NA	NA	43	NA	31	NA	57	NA	NA

14[NASP]UH1305:T0220/1132/10

Note: Bold numbers indicate value exceeds FPDWS of 10 µg/L.

Key:

NS = Monitoring well did not exist, or existed and was not sampled.
NA = Monitoring well sampled but sample not analyzed for this parameter.
NR = No data reported.
-- = Parameter not detected.

Source: Ecology and Environment, Inc., 1991.

Table 2-9

SUMMARY OF CHROMIUM CONCENTRATIONS IN GROUNDWATER SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35 (All results in µg/L)

Monitoring Well	Sampling Date (Month/Year)										
	7/84	10/84	9/85	1/87	2/87	5/87	8/87	12/87	2/88	6/88	8/88
GM-66	NS	NS	NA	**NS**	NA	NA	**NA**	**NA**	**NA**	**NA**	**NA**

Monitoring Well	Sampling Date (Month/Year)											
	11/88	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
GM-66	NR	NA	**NA**	NA	**NA**	**210**	**NA**	**240**	**NA**	**360**	**NA**	**NA**

Note: Bold numbers indicate value exceeds FPDWS of 50 µg/L.

Key:

NS = Monitoring well did not exist, or existed and was not sampled.
NA = Uonitocing well sampled but sample not analyzed for this parameter.
NR = No data reported.

Source: Ecology and Environment, Inc., 1991.

320a951

Table 2-10

SUMMARY OF LEAD CONCENTRATIONS IN GROUNDWATER SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35
(All results in µg/L)

Monitoring Well	Saapling Date (Month/Year)										
	7/84	10/84	9/85	1/87	2/87	5/87	8/87	12/87	2/88	6/88	8/88
GM-66	NS	NS	NA	US	NA	**NA**	**NA**	**NA**	NA	**NA**	**NA**

Monitoring Well	Sampling Date (Month/Year)											
	11/88	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
CM-66	NR	NA	NA	NA	**NA**	2.6	**NA**	NA	**NA**	400	NA	**NA**

14[NASP]UH1305:T0220/1134/10

Note: Bold numbers indicate value exceeds PPDWS of 50 µg/L.

Key:

NS = Monitoring well did not exist, or existed and was not sampled.
NA = Monitoring well sampled but sample not analyzed for this parameter.
NR = No data reported.

Source: Ecology and Environment, Inc., 1991.

Table 2-11

SUMMARY OF ARSENIC CONCENTRATIONS IN GROUNDWATER SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35
(All results in µg/L)

nonitoring Well	Sampling Date (Month/Year)									
	1/84	10/84	9/8 5	1/87	12/87	2/88	6/88	8/88	11/88	3/89
UG-1	NA	NA	NS	--	NS	NA	NA	NA	NA	--

Nonitorinq Well	Sampling Date (Month/Year)									
	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/9 1	10/91
UG-1	--	--	--	--	**51**	--	2.6	--	--	NA

14[NASP]UH1305:T0220/1135/15

Note: Bold numbers indicate value exceeds FPDWS of 50 µg/L.

Key:

NS = Monitoring well did not exist, or existed and was not sampled.
NA = Monitoring well sampled but sample not analysed for this parameter.
-- = Parameter not detected.

Source: Ecology and Environment, Lnc., 1991.

Table 2-12

SUMMARY OF MERCURY CONCENTRATIONS IN GROUNDWATER SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35 (All results in µg/L)

Monitoring well	Sampling Date (Month/Year)									
	7/84	10/84	9/85	1/87	12/87	2/88	6/88	8/88	11/88	3/89
GM-11	NS	NS	NS	NS	NS	NS	NS	NS	NS	--

Monitoring Well	Sampling Date (Month/Year)									
	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
GM-11	--	0.22	4.4	--	--	NS	--	--	--	NA

14[NASP]UH1305:T0220/1136/15

Note: Bold numbers indicate value exceeds FPDWS of 2 µg/L.

Key:

NS = Monitoring well did not exist, or existed and was not sampled.
-- = Parameter not detected.

Source: Ecology and Environment, Inc., 1991.

Table 2-13

SUMMARY OF VINYL CHLORIDE CONCENTRATIONS IN GROUNDWATER
SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35
(All results in ug/L)

Monitoring Well	Sampling Date (Month/Year)													
	2/84	7/84	10/84	9/85	4/86	1/87	2/87	5/87	8/87	12/87	2/88	4/88	6/88	8/88
W-1	NR	10	32	NS	NR	NS	NR	NR	NR	NS	--	IS	US	US
W-2	NR	NS	NS	1	NR	IS	NR	NR	NR	2(J)	--	NS	NS	NS
w-4	NR	20	16	NS	--	--	NR	NR	--	2(J)	250(E)	--	NS	--
DG-5	NR	--	9	NS	NR	no	NR	NR	NR	NS	7(J)	NR	--	--
DG-6	--	--	13	US	NR	--	NR	NR	NR	NS	--	NS	NS	NS
on-8	NR	NR	NP	NA	NP	NS	NR	NR	NR	NS	NS	NR	NR	NR
OH-9	NR	NS	21	NA	NR	NS	NR	NR	NR	--	--	NR	NR	NR
ox-10	NR	NS	7	NA	NR	US	NR	NR	NR	NS	NS	NR	NR	NR
GM-64	NS	NS	NS	--	NR	US	NR	NR	NR	2(J)	--	NR	NR	NR
On-66	NS	NS	NS	27	NR	NS	146	--	--	270	170	NR	NR	NR
GM-69	NS	NS	NS	3	NR	NS	17	--	--	22	13	NR	NR	NR
ox-75	NS	NS	US	1	NR	US	NR	NR	NR	3(J)	2(J)	NS	NS	IS

14[NASP]UH1305:T0220/1137/2

Key at end of table.

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Table 2-13 (Cont.)

Monitoring Well	Sampling Date (Month/Year)											
	11/88	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/9 1	10/91
DG-1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DG-2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DG-4	--	NR	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DG-5	--	NR	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DG-6	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
GM-8	NR	7	--	--	--	180	(L)	74	--	--	--	--
OH-9	NR	--	--	--	--	--	--	--	--	--	--	--
GM-10	NR	--	--	--	--	--	--	--	--	--	--	--
61-64	NR	4	--	--	--	--	--	--	--	--	--	--
OH-66	NR	380	--	--	180(J)	240(D)	--	180	--	--	--	--
OH-69	NR	14	--	9(J)	11	12	--	(L)	(L)	(L)	--	(L)
GM-75	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

14[NASP]UH1305:T0220/1137/2

Note: Bold numbers indicate value exceeds FPDWS of 1 ug/L.

Key:

NS = Monitoring well did not exist, or existed and was not sampled.
NA = Monitoring well sampled but sample not analyzed for this parameter.
NR = No data reported.
-- = Parameter not detected.
(L) = Present below tho detection Limit.
(J) = Estimated value; compound present below tho detection limit.
(E) = Concontration exceeded calibrated range of instrument.
(D) = Compound analyzed at a secondary dilution factor.

Source: Ecology and Environment, Lnc., 1991.

Table 2-14

SUMMARY OF 1,1-DICHLOROETHENE CONCENTRATIONS IN GROUNDWATER SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35
(All results in µg/L)

Monitoring Well	Sampling Date (Month/Year)												
	2/84	5/84	7/84	10/84	9/85	1/87	2/87	5/87	8/87	12/87	2/88	6/88	8/88
DG-1	NS	NS	--	800	NS	NS	NR	NR	NP	NS	--	NA	NA
Do-6	8	<10	--	25	NS	--	NR	NR	NR	NS	--	NS	NS
GM-8	NS	NS	--	--	NA	NS	NR	NR	NP	NR	NR	NR	NR
GU-9	NS	NS	125	(L)	NA	NS	11	NR	NP	--	--	NR	NR
GM-64	NS	NS	NS	NS	--	NS	NR	NR	NR	--	--	9	NR
GM-66	NS	NS	NS	NS	160	NS	446	NR	NR	390	320(E)	500	NR
GM-67	NS	NS	NS	NS	--	NS	--	NR	NR	--	--	NR	NR
an-69	NS	NS	NS	NS	--	NS	NR	NR	NR	2(J)	--	NR	NR

14[NASP]UH1305:T0220/1138/6

K o at end of table.

3200954

Table 2-14 (Cont.)

Monitoring Well	Sampling Date (Month/Year)											
	11/88	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
DG-1	NS	NS	NS	NS	NS	NS	NS	NS	NS	IS	NS	NS
DG-6	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
GM-8	NR	125	35	--	--	--	--	--	--	--	--	--
GM-9	NR	--	--	--	--	--	--	--	--	--	--	--
GM-64	NR	--	--	--	--	--	--	--	--	--	--	--
GM-66	NR	310	1,100	**320(J)**	**320**	**350(E)**	(L)	**260**	(L)	(L)	--	(L)
GM-67	NR	--	--	--	--	--	--	--	--	--	--	--
GM-69	NR	--	--	--	--	--	--	**98**	--	--	--	--

14[NASP]UH1305:T0220/1138/6

Note: Bold numbers indicate value exceeds CPDWS of 7 µg/L.

Key:

NS = Monitoring well did not exist, or existed and was not sampled.
NA = Monitoring well sampled but sample not analyzed for this pararotor.
NR = No data reported.
-- = Parameter not detected.
(L) = Present below the detection limit.
(J) = Estimated value; compound present below tho dotoction limit.
(E) = Concentration exceeded calibrated range of instrument.

Source: Ecology and Environment, Inc., 1991.

Table 2-15

SUMMARY OF 1,2-DICHLOROETHANE CONCENTRATIONS IN GROUNDWATER SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35
(All results in µg/L)

Monitoring Well	Sampling Date (Month/Year)										
	7/84	10/84	9/85	1/87	2/87	5/87	8/87	12/87	2/88	6/88	8/88
GM-9	**9,600**	<3	NA	NS	--	--	--	--	--	--	--
GM-64	NS	NS	--	NS	NR	NR	NR	--	--	**4**	--

Monitoring Well	Sampling Date (Month/Year)											
	11/88	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
GM-9	NR	--	--	--	--	--	--	--	--	--	--	--
GM-64	NR	--	--	--	--	--	--	--	--	--	--	--

14[NASP]UH1305:T0220/1139/10

Note: Bold numbers indicate value exceeds FPDWS of 3 µg/L.

Key:

NS = Monitoring well did not exist, or existed and was not sampled.
NA = Monitoring well sampled but sample not analysed for this parameter.
NR = No data reported.
-- = Parameter not detected.

Source: Ecology and Environment, Inc., 1991.

3200955

Table 2-16

SUMMARY 01 CHLOROFORM CONCENTRATIONS I1 GROUNDWATER SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35
(All results in µg/L)

Monitoring Well	Sampling Date (Month/Year)								
	7/8 4	10/84	9/85	1/87	12/87	2/88	6/88	8/88	11/88
DG-1	NR	320	NS	NS	IS	--	NS	NS	NS

Monitoring Well	Sampling Date (Month/Year)										
	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
DG-1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

14[NASP]UH1305/T0220/1140/15

Note: Bold numbers indicate value exceeds FPDWS of 100 ug/L.

Key:

NS = Monitoring well did not exist, or oxistod and was not sampled.
NR = No data reported.
-- = Parameter not dotocted.

Source: Ecology and Environment, Inc., 1991.

Table 2-17

SUMMARY OF CARBON TETRACHLORIDE CONCENTRATIONS IN GROUNDWATER SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35
(All results in µg/L)

Monitoring Well	Sampling Date (Month/Year)									
	2/84	7/8 4	10/84	9/85	1/87	12/87	2/88	6/88	8/88	11/88
DG-1	NA	NR	425	IS	US	NS	--	IS	NS	NS
DG-6	NR	NR	9	NS	--	IS	--	IS	NS	NS

Monitoring Well	Sampling Date (Month/Year)										
	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/9 1	10/91
DG-1	NS	NS	IS	NS	US	IS	US	NS	IS	NS	IS
W-6	NS	NS	NS	NS	NS	IS	NS	NS	IS	IS	US

14[NASP]UH1305:T0220/1141/15

Note: Bold numbers indicate value exceeds FPDWS of 3 µg/L.

Key:

NS = Monitoring well did not exist, or existed and was not sampled.
NA = Monitoring well sampled but sample not analyzed for this parameter.
NR = Io data reported.
-- = Parameter not detected.

Source: Ecology and tnvironmont, Inc., 1991.

3200953

Table 2-18

SUMMARY OF TRICHLOROETHENE CONCENTRATIONS IN GROUNDWATER SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35
(All results in µg/L)

Monitoring Well	Sampling Date (Month/Year)											
	2/84	5/84	7/84	10/84	9/85	1/87	2/87	5/87	8/87	12/87	2/88	6/88
UG-1	NR	NR	--	NR	NS	--	NR	NR	NR	NS	--	--
DG-1	NR	NR	--	20	NS	NS	NR	NR	NR	NS	--	IS
DG-2	NR	NR	NS	NS	6	NS	NR	NR	NR	--	--	NS
Mi-4	NR	NR	--	13	NS	--	NR	NR	NR	--	1(J)	NS
DG-6	58	21	20	32	NS	--	NR	NR	NR	NR	--	NS
GM-8	NR	NR	--	--	NA	NS	NR	NR	NR	NS	NS	NR
GM-9	NR	NR	60	(L)	NA	NS	7	1	NR	--	--	--
GM-12R	NR	NR	NR	NR	NA	--	NR	NR	NR	NS	NR	NR
GM-65	NS	NS	NS	NS	4	NS	NR	NR	NR	50	--	--
GM-66	NS	NS	NS	NS	2,600	NS	15,907	24,750	13,600	10,000	4,200(E)	6,300
GM-67	NS	NS	NS	NS	SO	NS	78	8	NR	--	--	--
GM-68	NS	NS	NS	NS	10	--	NR	NR	NR	--	--	--
GM-69	NS	NS	NS	NS	3	NS	8	6	NR	--	--	--
GM-70	NS	NS	NS	NS	7	NS	NS	NS	NS	NS	NS	NS

14[NASP]UH1305:T0220/1142/5

Key at end of table.

Table 2-18 (Cont.)

Nonitoring Well	Sampling Date (Month/Year)												
	8/88	11/88	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
UG-1	--	--	--	--	--	6(B)	--	--	--	--	--	--	--
DG-1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DG-2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
vv-4	--	--	--	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
W-6	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
GM-8	NS	NS	56	1(J)	--	1(J)	--	--	--	--	--	--	--
On-9	--	NS	--	--	--	4(J,B)	--	--	--	--	--	--	--
GM-12R	NR	NS	NR	--	--	6(B)	--	--	NA	--	--	--	--
GM-65	--	NS	--	--	--	--	--	--	--	--	--	--	--
GM-66	5,000	NA	8,900	6,500	11,000	8,400(E)	--	--	7,300(E)	140	8,200	12,000	4,500
GH-67	--	NS	--	--	--	2(J,B)	--	--	--	--	--	--	--
GN-68	--	NS	--	--	--	4(J,B)	--	--	--	--	--	--	--
GM-69	--	NS	--	--	--	1(J)	--	--	--	--	--	--	--
OH-70	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

14[NASP]UH1305:T0220/1142/5

Note: Bold numbers indicate value exceeds FPDWS of 3 µg/L.

Key:

NS = Nonitoring well did not exist, or existed and was not sampled.
NA = Monitoring well sampled but sample not analyzed for this parameter.
NR = No data reported.
-- = Parameter not detected.
(L) = Present below tho dotaction limit.
(J) = Estimated value; compound present below tho detection limit.
(B) = Compound also present in method blank.
(E) = Exceeds calibration limit.

Source: Ecology and Cnvironmont, fnc., 1991.

320095 7

Table 2-19

SUMMARY OF 1,1,1-TRICHLOROETHANE CONCENTRATIONS IN GROUNDWATER SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35
(All results in mg/L)

Monitoring Well	Sampling Date (Month/Year)										
	7/84	10/84	9/85	1/87	2/87	5/87	8/87	12/87	2/88	6/88	8/88
DG-1	110	5,900	NS	NS	NR	NR	NR	NS	--	**NS**	NS
Mi-6	330	103	NS		**NR**	**NR**	**NR**	NS	--	NS	NS
cn-e	--	--	NA	**NS**	NR	**NR**	NR	**NS**	**NS**	**NR**	NR
GM-9	11,500	(L)	NA	NS	356	NR	NR	--	--	--	--

Monitoring Well	Sampling Date (Month/Year)											
	11/88	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
DG-1	NS	NS	NS	NS	NS	NS	NS	**NS**	NS	NS	NS	NS
DG-6	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	NS	NS	NS
GM-8	NR	1,200	6	--	--	--	--	--	--	--	--	--
GM-9	NR	--	--	--	--	--	--	--	--	--	--	--

14[NASP]UH1305/T0220/1143/11

Note: Bold numbers indicate value exceeds FPDWS of 200 ug/L.

Key:

NS = Monitoring well did not exist, or existed and was not sampled.
NA = Monitoring well sampled but sample not analyzed for this parameter.
NR = No data reported.
-- = Parameter not detected.
(L) = Present below tho detection limit.

Source: Ecology and Environment, Inc., 1991.

Table 2-20

SUMMARY OF TETRACHLOROETHENE CONCENTRATIONS IN GROUNDWATER SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35
(All results in ug/L)

Monitoring Well	Sampling Date (Month/Year)												
	2/84	5/84	7/81	10/84	9/85	1/87	2/87	5/87	8/87	12/87	2/88	6/88	8/88
DG-1	NS	NS	—	500	NS	NS	NR	NR	NR	NS	—	NS	NS
Do-2	NS	NS	NS	NS	17	NS	NR	NR	NR	—	—	NS	NS
DG-3	NS	NS	NS	NS	10	NS	NS	NS	NS	NS	NS	NS	NS
DG-4	NS	NS	—	11	NS	—	NR	NR	NR	—	—	—	—
DG-6	6	<10	—	38	NS	—	NR	NR	NR	NS	—	NS	NS
an-8	NS	NS	—	NR	NA	NS	NR	NR	NR	NS	NS	NR	NR
OK9	NS	NS	675	4	NA	NS	42	23	NR	—	—	—	—
GM-62	NS	NS	NS	NS	6	NS	NR	NR	NR	—	—	—	—
GM-63	NS	NS	NS	NS	6	NS	NR	la	NR	—	—	—	—
GM-64	NS	NS	NS	NS	9	US	NR	la	NR	—	—	—	—
GM-66	NS	NS	NS	NS	5	NS	8	—	—	4(J)	4(J)	—	—
OK69	NS	NS	NS	NS	—	NS	NR	NR	NR	—	—	—	—
an-81	NS	NS	NS	NS	78	NS	NS	NS	NS	NS	NS	NS	NS
an-82	NS	NS	NS	NS	19	NS	NS	NS	NS	NS	NS	NS	NS
GM-83	NS	NS	NS	NS	25	NS	NR	NR	NR	NA	NA	NA	NA

14[NASP]UH1305:T0220/1144/2

Key at end of table.

Table 2-20 (Cont.)

Monitoring well	Sampling Date (Month/Year)											
	11/88	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
DG-1	NS	NS	NS	NS	NS	NS	NS	NS	Ns	NS	NS	NS
DG-2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DG-4	NR	NS	NS	NS	NS	NS	NS	Ns	NS	NS	NS	NS
DG-6	NS	NS	NS	Ns	NS	NS	Ns	NS	NS	NS	Ns	NS
GM-8	NR	**138**	22	9	1(J)	—	—	—	—	(L)	—	—
GM-9	NR	—	—	—	—	—	—	—	—	—	—	—
GM-62	NR	—	—	—	—	—	—	—	—	—	—	—
GH-63	NR	—	—	—	—	—	—	—	—	—	—	—
GM-64	NR	—	—	—	—	—	—	—	—	—	—	—
GM-66	NR	—	—	—	—	4(J)	—	—	—	—	—	—
GH-69	NR	4	6	7	7	(L)	(L)	—	—	—	—	—
GH-81	NS	NS	NS	NS	NS	NS	Ns	NS	NS	NS	NS	NS
GM-82	NS	Ns	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
GM-83	NR	NS	NA	NS	NA	NA	NA	NS	NA	NA	NA	NA

14[NASP]UH1305:T0220/1144/2

Note: Bold numbers indicate value exceeds FPDWS of 3 ug/L.

Key:

NS = Monitoring well did not exist, or existed and was not sampled.
NA = Monitoring well sampled but sample not analyzed €or this parameter.
NR = NO data reported.
— = Parameter not detected.
(L) = Present below the detection limit
(J) = Estimated value; compound present below tho detection limit.

Source: Ecology and Environment, Inc., 1991.

Table 2-21

SUMMARY OF BENZENE CONCENTRATIONS IN GROUNDWATER SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35
(All results in µg/L)

Monitoring Well	Sampling Date (Month/Year)											
	2/84	5/84	7/84	10/84	9/85	1/87	2/87	5/87	8/87	12/87	2/88	6/88
w-4	NS	IS	NS	2	NS	—	NR	NR	NR	3(J)	0.4(J)	NS
W-5	NS	NS	NS	2	NS	NS	NR	NR	NR	NS	—	NR
DG-6	3.5	<10	ND	2	IS	—	Nu	NR	NR	NS	—	NS
On-a	—	—	—	—	NA	NS	—	—	—	—	—	—
GM-66	NS	IS	NS	NS	—	NS	—	—	—	—	—	—
OH-67	NS	NS	NS	IS	NR	NS	NR	NR	2	—	—	—
GM-69	NS	NS	NS	NS	3	NS	9	3	NR	6	5	—

Monitoring Well	Sampling Date (Month/Year)												
	8/88	11/88	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
w-4	NR	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Do-5	NR	NR	NR	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
W-6	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
GM-8	—	—	—	—	—	—	(L)	—	(L)	—	—	750	350
Ow-66	—	NR	—	—	—	—	2(J)	—	—	—	—	—	—
GM-67	—	NA	—	—	—	—	—	—	—	—	—	—	—
Ow-69	—	NA	3	—	3(J)	—	—	—	(L)	—	—	—	—

14[NASP]UH1305:T0220/1145/4

Note: Bold numbers indicate value exceeds FPDWS of 1 µg/L.

Key:

NS = Monitoring well did not exist, or existed and war not sampled.
NA = Monitoring well sampled but sample not analyzed for this parameter.
NR = No data reported.
— = Parameter not detected.
(L) = Present below tho detection limit.
(J) = Estimated value; compound present below tho dotoctioa limit.

Source: Ecology and Environment, Inc., 1991.

Table 2-22

SUMMARY OF 1,4-DICHLOROBENZENE CONCENTRATIONS IN GROUNDWATER SAMPLES COLLECTED AT NAS PENSACOLA SITES 32, 33, AND 35 (All results in µg/L)

Monitoring Well	Sampling Date (Month/Year)													
	2/84	5/84	7/84	10/84	9/85	1/87	2/87	5/87	8/87	12/87	2/88	4/88	6/88	8/88
GM-69	NS	NS	NS	NS	1,350	NS	165	NA	473	880	710	NS	588	800
GM-8	NS	NS	NA	NA	30	NS	NS	NS	NS	NS	NS	NS	NS	NS
DG-1	NS	NS	200	387	NS	NS	NS	NS	NS	NS	15	NS	NS	NS
DG-6	37.6	77	120	182	NS	90	NS	NS	NS	NS	--	NS	NS	NS
DG-4	NS	NS	--	98	NS	30	NS	NS	NS	63	45	88	NS	--
DG-5	NS	NS	6(J	170	NS	NS	NS	NS	NS	NS	14	NS	--	--
DG-2	NS	NS	NS	NS	170	NS	NS	NS	NS	66	12	NS	NS	NS
GM-9	NS	NS	ND	ND	4,000	NS	127	NA	--	--	--	NS	--	--
GM-10	NS	NS	NA	NA	110	NS	NS	NS	NS	NS	NS	NS	NS	NS
GM-67	NS	NS	NS	NS	200	NS	128	NA	95	--	--	NS	--	--

14[NASP]UH1305:T0220/1158/3

Key at end of table.

Table 2-22 (Cont.)

Monitoring Well	Sampling Date (Month/Year)											
	11/88	3/89	5/89	8/89	11/89	3/90	5/90	8/90	11/90	3/91	7/91	10/91
GM-69	NS	1,510	410	560	250	140	550	330(E)	200	390	390	300(E)
On-8	NS	424	130	66	25	2,800	2,600	860	190	3,800(E)	820	250
Mi-1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mi-6	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Do-4	--	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mi-5	--	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DG-2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
GM-9	NS	7	4(J)	--	--	--	--	--	(L)	(L)	(L)	(L)
an-10	NS	13	11	10	5(J)	(L)	(L)	(L)	(L)	(L)	(L)	--
GM-67	NS	11	8(J)	4(J)	8(J)	(L)	(L)	(L)	(L)	(L)	12	10

14[NASP]UH1305:T0220/1158/3

Note: Bold numbers indicate value exceeds FPDWS of 75 µg/L.

Key:

NS = Monitoring well did not oxirt, or existed and was not sampled.
NA = Monitoring well sampled but sample not analysed Cor this parameter.
-- = Parameter not detected.
(L) = Present below tho dotoction limit.
(J) = Estimated value; compound present below tho dotoction limit.
(E) = Concontration exceeded calibrated range of instrument.

Source: Ecology And Environment, Inc., 1991.

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GM-66, GM-69, and GM-84. Concentrations in the deep zone samples ranged from 1.78 mg/L (GM-65, May 1989) to 1,070 mg/L (GM-65, August 1989) and were consistently higher in deep zone samples collected from well GM-63. Overall, sodium concentrations tended to be higher in samples from intermediate zone wells. Overall, there have been no significant trends in sodium concentrations in any of the three depth zones.

Cadmium, chromium, and lead were detected at concentrations exceeding the respective FPDWSs of 10 µg/L, 50 µg/L, and 50 µg/L in samples collected from intermediate zone well GM-66 (see tables 2-8, 2-9, and 2-10, respectively). Cadmium concentrations ranged from 31 µg/L (August 1990) to 57 µg/L (March 1991); chromium concentrations ranged from 210 µg/L (March 1990) to 360 µg/L (March 1991); and lead concentrations ranged from 2.6 µg/L (March 1990) to 400 µg/L (March 1991). Overall, the trends in samples from well GM-66 indicate that these metals concentrations are increasing over time.

Arsenic was detected at concentrations slightly exceeding the FPDUS of 50 µg/L only in the sample collected from shallow zone well UG-1 (51 µg/L, May 1990; see Table 2-11). Arsenic has been detected only once in this well during subsequent sampling, and the concentration was below the FPDWS.

Mercury was detected at a concentration exceeding the FPDWS of 2 µg/L in only one sample, which was collected from shallow zone well GM-11 (4.4 µg/L, November 1989; see Table 2-12). During subsequent sampling of this well, the mercury concentration has been below the detection limit.

The Florida Secondary Drinking Water Standards (FSDWSs) for two metals (manganese and iron) have been exceeded in samples from several IWTP wells. Manganese has been detected at concentrations exceeding the applicable FSDWS of 50 µg/L: shallow zone wells UG-1, DG-1, DG-2, DG-3, DG-4, DG-5, DG-6, GM-8, GM-9, GM-10, GM-12R, GM-13, GM-14, and PCS-1; intermediate zone wells GM-64, GM-66, GM-69, GM-75, and PCI-1; and deep zone wells GM-63, GM-65, GM-68, and PCD-1 (see Figure 2-2 and Appendix G). Iron has been detected at concentrations exceeding the FSDWS of 300

µg/L: shallow zone wells GH-8, GH-9, GH-10, GM-12R, GH-14, GH-62, GM-67, and PCS-1; intermediate zone wells GM-66, GM-69, and PCI-1; and deep zone wells GM-63, GM-65, GM-68, and PCD-1 (see Figure 2-2 and Appendix G). Overall, manganese and iron concentrations tended to be higher in the intermediate zone samples, and there is no significant trend in concentrations of either metal over time.

Other **Inorganics.** In general, only the CA wells have been sampled consistently for other inorganic parameters (e.g., sulfate, chloride, cyanide, and nitrate; see Table 2-4). Of these parameters, only sulfate and chloride have been detected at concentrations exceeding the applicable FSDWSs (FDER 1991b).

Chloride was detected at concentrations exceeding the FSDWS of 250 mg/L in samples collected from shallow zone wells GH-71, GH-72, GH-76, and GH-77; intermediate zone wells GM-64, GH-66, GH-84, and PCI-1; and deep zone wells GM-63, GH-65, and PCD-1 (see Figure 2-2 and Appendix G). Sulfate was detected at concentrations exceeding the FSDWS of 250 mg/L in a sample from only one well, GH-66 (see Appendix G). Overall, both chloride and sulfate concentrations tended to be higher in the intermediate zone samples, and there is no significant trend in concentrations of either parameter over time.

Volatile Organic **Compounds.** In general, all of the POC wells and those CA wells located near the central portion of the Group O site complex were consistently sampled for VOCs (see Table 2-5). Several VOCs were detected at concentrations exceeding the applicable FPDWSs (FDER 1991b). These VOCs included vinyl chloride; 1,1-dichloroethene; 1,2-dichloroethane; chloroform; carbon tetrachloride; trichloroethene; 1,1,1-trichloroethene; tetrachloroethene; and benzene. The following discussion of VOC concentrations excludes those parameters that were present below the detection limit.

Vinyl chloride vas detected at concentrations exceeding the FPDWS of 1 µg/L in samples collected from shallov zone wells DG-1, DG-2, DG-4, DG-5, DG-6, GM-8, GH-9, and GH-10; and intermediate zone wells GH-64,

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GM-66, GM-69, and GM-75 (see Figure 2-2 and Table 2-13). The concentrations in the shallow zone samples ranged from 1 µg/L (DG-2, September 1985) to 250 µg/L (DG-4, February 1988), and the samples which exhibited the consistently highest concentrations were from shallow zone well GM-8. The concentrations in the intermediate zone samples ranged from 1 µg/L (GM-75, September 1985) to 380 µg/L (GM-66, March 1989), and the samples which exhibited the consistently higher concentrations were from intermediate zone wells GM-66 and GM-69. Overall, vinyl chloride concentrations were highest in the intermediate zone samples, and the overall trend from March 1990 to the present indicates that concentrations are decreasing.

1,1-Dichloroethene was detected at concentrations exceeding the FPDWS of 7 µg/L in samples collected from shallow zone wells DG-1, DG-6, GM-8, GM-9, and GM-67; and intermediate zone wells GM-64, GM-66, and GM-69 (see Figure 2-2 and Table 2-14). The concentrations in the shallow zone samples ranged from 8 µg/L (DG-6, February 1984) to 800 µg/L (DG-1, October 1984), and the samples which exhibited consistently higher concentrations were from shallow zone well GM-8. The concentrations in the intermediate zone samples ranged from 9 µg/L (GM-64, June 1988) to 1,100 µg/L (GM-66, May 1989), and the samples which exhibited consistently higher concentrations were from intermediate zone well GM-66. Overall, 1,1-dichloroethene concentrations were higher in the intermediate zone samples, and since May 1989, concentrations in the shallow and intermediate zones appear to have been decreasing.

1,2-Dichloroethane was detected at concentrations exceeding the FPDWS of 3 µg/L in samples collected from shallow zone well GM-9 (9,600 µg/L, July 1984) and intermediate zone well GM-64 (4 µg/L, June 1988; see Table 2-15). Since the dates referred to above, neither of the respective wells has yielded samples containing detectable levels of 1,1-dichloroethane.

Chloroform was detected at a concentration exceeding the FPDWS of 100 µg/L in a single sample collected from shallow zone well DG-1 (320 µg/L, October 1984; see Table 2-16). Chloroform was sampled for in this well

only once since October 1984, and was present below the detection limit (February 1988).

Carbon tetrachloride vas detected at concentrations exceeding the FPDVS of 3 µg/L in shallow zone vells DG-1 (425 µg/L, October 1984) and DG-6 (9 µg/L; see Table 2-17). Carbon tetrachloride was sampled for in these wells only once since October 1984, and vas present below the detection limit (February 1988).

Trichloroethene was detected at concentrations exceeding the FPDVS of 3 µg/L in samples collected from shallov zone wells UG-1 (also in the associated method blank), DG-1, DG-2, DG-4, DG-6, GH-8, GM-12R (also in the associated method blank), and GH-67; intermediate zone vells GH-66 and GH-69; and deep zone wells GH-65 and GH-68 (see Figure 2-2 and Table 2-18). Concentrations in shallow zone samples ranged from 6 µg/L (DG-2, September 1985) to 78 µg/L (GH-67, February 1987), and were consistently higher in samples from shallow zone wells DG-6 and GH-67. Concentrations in intermediate zone samples ranged from 3 µg/L (GH-69, September 1985) to 24,750 µg/L (GH-66, Hay 1987), and were consistently higher in samples from intermediate zone well GH-66. Concentrations in deep zone samples ranged from 4 µg/L (GH-65, September 1985) to 50 µg/L (GH-65, December 1987), and were consistently higher in samples from deep zone well GM-65. Overall, the intermediate zone samples exhibited higher concentrations than either the shallov or deep zone samples. In general, concentrations of trichloroethene in the intermediate zone samples appear to have increased since August 1988, whereas concentrations in the shallov and deep zone samples appear to have decreased over time.

1,1,1-Trichloroethane was detected at concentrations exceeding the FPDVS of 200 µg/L in shallow zone wells DG-1, DG-6, GH-8, and GH-9 (see Figure 2-2 and Table 2-19. Concentrations ranged from 6 µg/L (GH-8, October 1984) to 11,500 µg/L (GH-9, July 1984). The highest concentrations of this VOC were detected in the DG series vells in 1984, but during subsequent sampling of these wells (February 1988) the compound was present only below the detection limit. The concentrations of 1,1,1-trichloroethane have decreased in both GH-8 and GH-9 samples, and since August

1989 have been below the detection limit in samples from both of these wells.

Tetrachloroethene has been detected at concentrations exceeding the FPDUS of 3 µg/L in samples collected from shallow zone wells DG-1, DG-2, DG-4, DG-6, GM-8, GM-9, GM-62, and GM-83; intermediate zone wells GM-64, GH-66, and GM-69; and deep zone well GM-63 (see Figure 2-2 and Table 2-20). Concentrations in shallow zone samples ranged from 4 µg/L (GM-9, October 1984) to 675 µg/L (GM-9, July 1984), and were consistently higher in samples from shallow zone wells GM-8 and GM-9. Concentrations in intermediate zone samples ranged from 4 µg/L (GM-69, November 1988) to 9 µg/L (GM-64, September 1985), and were consistently higher in samples from intermediate zone well GM-69. Tetrachloroethene was detected in a sample from deep zone well GM-63 during only one sampling event (September 1985), and has been present below detection limits in samples from that well since. In general, tetrachloroethene concentrations in shallow zone samples were higher than those in intermediate zone samples; however, the concentrations have decreased in samples from both of these zones since September 1985.

Benzene has been detected at concentrations exceeding the FPDWS of 1 µg/L in samples collected from shallow zone wells DG-4, DG-5, DG-6, GM-8, and GM-67; and intermediate zone wells GM-66 and GM-69 (see Figure 2-2 and Table 2-21). Concentrations in shallow zone samples ranged from 2 µg/L (DG-4, October 1984) to 750 µg/L (GM-8, June 1988). Concentrations in intermediate zone samples ranged from 2 µg/L (GM-66, March 1990) to 9 µg/L (GM-69, February 1987), and were consistently highest in samples from intermediate zone well GM-69. Overall, benzene concentrations in the shallow and intermediate zone samples have decreased over time, with the exception of the most recent shallow-zone well GM-8 sample (July 1991), which exhibited a markedly higher benzene concentration.

Extractable Organic Compounds. All of the POC wells and those CA wells located near the central portion of the Group O site complex were consistently sampled for BNAs (see Table 2-5). The most consistently

detected BNA compounds belong to the dichlorobenzene group, including 1,2-dichlorobenzene; 1,3-dichlorobenzene; and 1,4-dichlorobenzene (see Appendix G). Of all the dichlorobenzene isomers, an PPDVS has only been established for 1,4-dichlorobenzene (75 µg/L; PDER 1991b). 1,4-Dichlorobenzene was detected at concentrations exceeding the PPDVS in samples collected from shallow wells DG-1, DG-2, DG-4, DG-5, DG-6, GM-8, GH-9, GH-10, GH-67; and intermediate well GH-69 (see Figure 2-2 and Table 2-22). The concentrations in shallow zone samples ranged from 7 µg/L (GH-9, March 1989) to 4,000 µg/L (GH-9, Harch 1985) and were consistently higher in samples from shallow zone well GM-8. The concentration in samples from intermediate zone well GH-69 ranged from 140 µg/L (March 1990) to 1,510 µg/L (March 1989). In general, there is no significant concentration trend in either shallow or intermediate zone samples from intermediate zone well GM-69. Eowever, the concentrations of the dichlorobenzene isomers reviewed as a group were greater in samples from shallow zone wells than in samples from intermediate zone wells, and the overall trends in both of these zones is towards decreasing concentrations.

2.6.2.3 Adjacent Site Results

Site 11. E & E's Phase I analytical results indicate that metals, total recoverable petroleum hydrocarbons (TRPHs), VOCs, polynuclear aromatic hydrocarbons (PAHs), and phenols were the primary contaminants in soils and groundwater in the portion of Site 11 near Bayou Grande (E & E 1991f). These contaminants, detected in the soil and groundwater on the east side of Bayou Grande, may be related to the Group O sites.

Site 13. Elevated levels of TRPHs, PAHs, and phenols were detected in Site 13 soils immediately east of the Group O sites, and elevated levels of VOCs and PAHs were present in groundwater immediately northeast (hydraulically downgradient) of the IWTP (E & E 1991e). This contamination is likely directly related to a Group O source.

Site 30. Surface water and sediment in the northern portion of the creek on Site 30 exhibited elevated levels of metals, TRPHs, PAHs, and

phenols (E & E 1991d). This contamination is not believed to be related to the Group 0 sites, but is likely due to a Site 11 source.

2.6.3 Conclusions

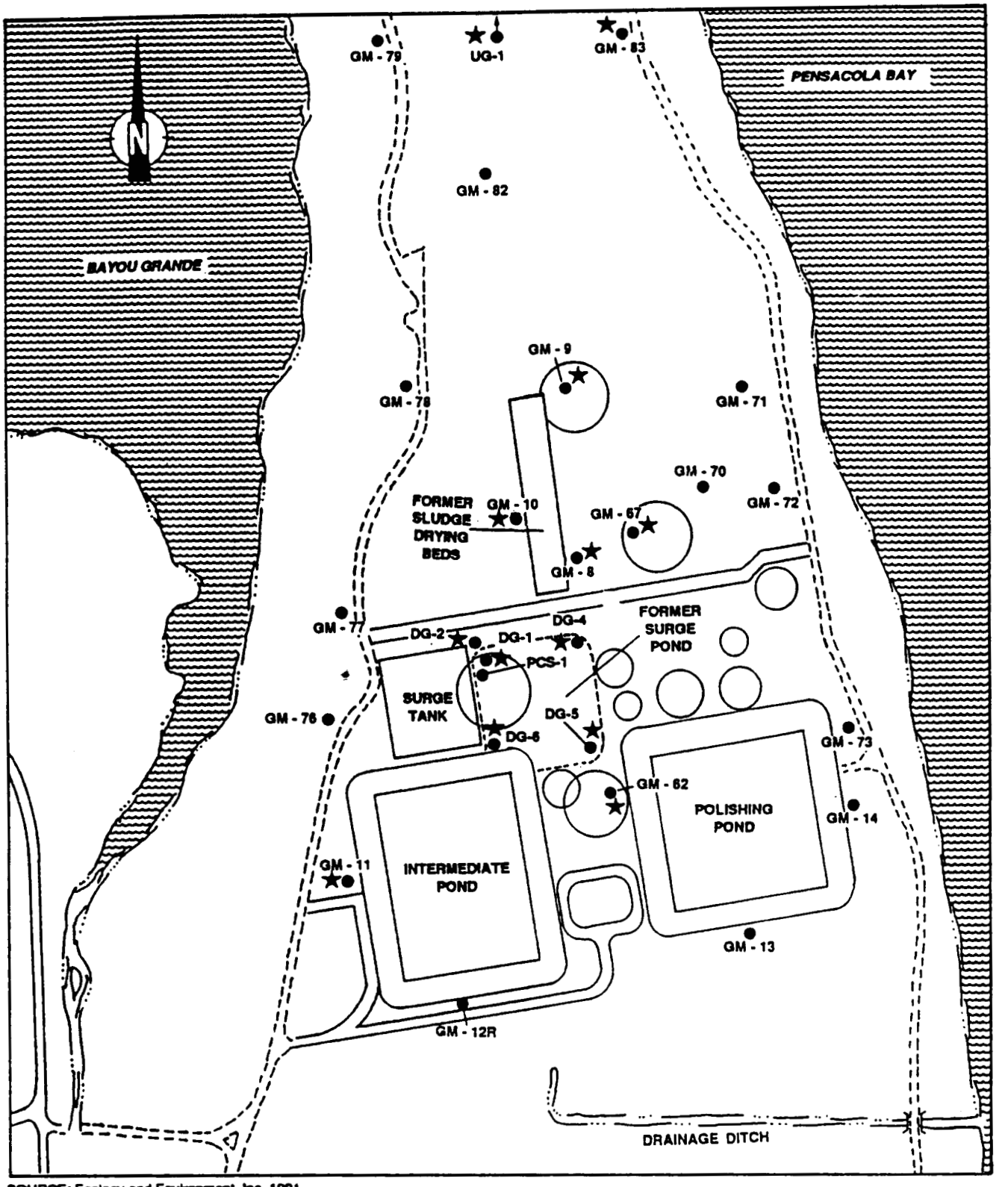
2.6.3.1 Soil

The soils underlying the area of the former sludge drying beds and surge pond appear to be the most affected by historical and/or current IWTP activities. However, given the magnitude and types of wastes historically and/or currently processed at the IWTP, and the potential for leaks from treatment piping, etc., or spills of chemicals used in the treatment process (e.g., the former acid spill; see Section 2.6.1), there may be additional areas of affected soils. Currently, the presence and location of potentially contaminated soils, other than soils underlying the former sludge drying beds and surge pond, are unknown. Therefore, proposed soil sampling will be presented and discussed in Section 5.2.2.

2.6.3.2 Groundvater

The analytical results discussed above indicate that, currently and historically, groundwater contamination is widespread in the shallow and intermediate zones at the Group 0 sites. Levels of contamination in the deep zone have historically been very low and limited in extent. Furthermore, none of the groundwater samples collected from deep zone wells in the past three years have exceeded the applicable FPDWS for any parameter (excluding sodium).

Figures 2-6 and 2-7 show the locations of shallow and intermediate groundwater samples that exhibited contaminant concentrations (excluding sodium) at levels exceeding the applicable FPDWSs. There appear to be two primary areas of groundwater contamination in these zones: in the vicinity (primarily east) of the former sludge drying beds and in the vicinity of the former surge pond.



SOURCE: Ecology and Environment, Inc. 1991

SCALE

0 300 600 FEET

KEY:

● Shallow Monitoring Well (12 - 15 Feet BLS)

Clustered Well Sites

★ Shallow Groundwater Sample Collected Which Exhibited One or More Parameter Concentrations Exceeding the Applicable FPDWSs (excluding sodium)

NOTE: Wells DG-1 through DG-9 have been abandoned.

Figure 2-6 LOCATIONS OF SHALLOW GROUNDWATER SAMPLES HAVING CONTAMINANT CONCENTRATIONS EXCEEDING FLORIDA PRIMARY DRINKING WATER STANDARDS NAS PENSACOLA SITES 32, 33, AND 35

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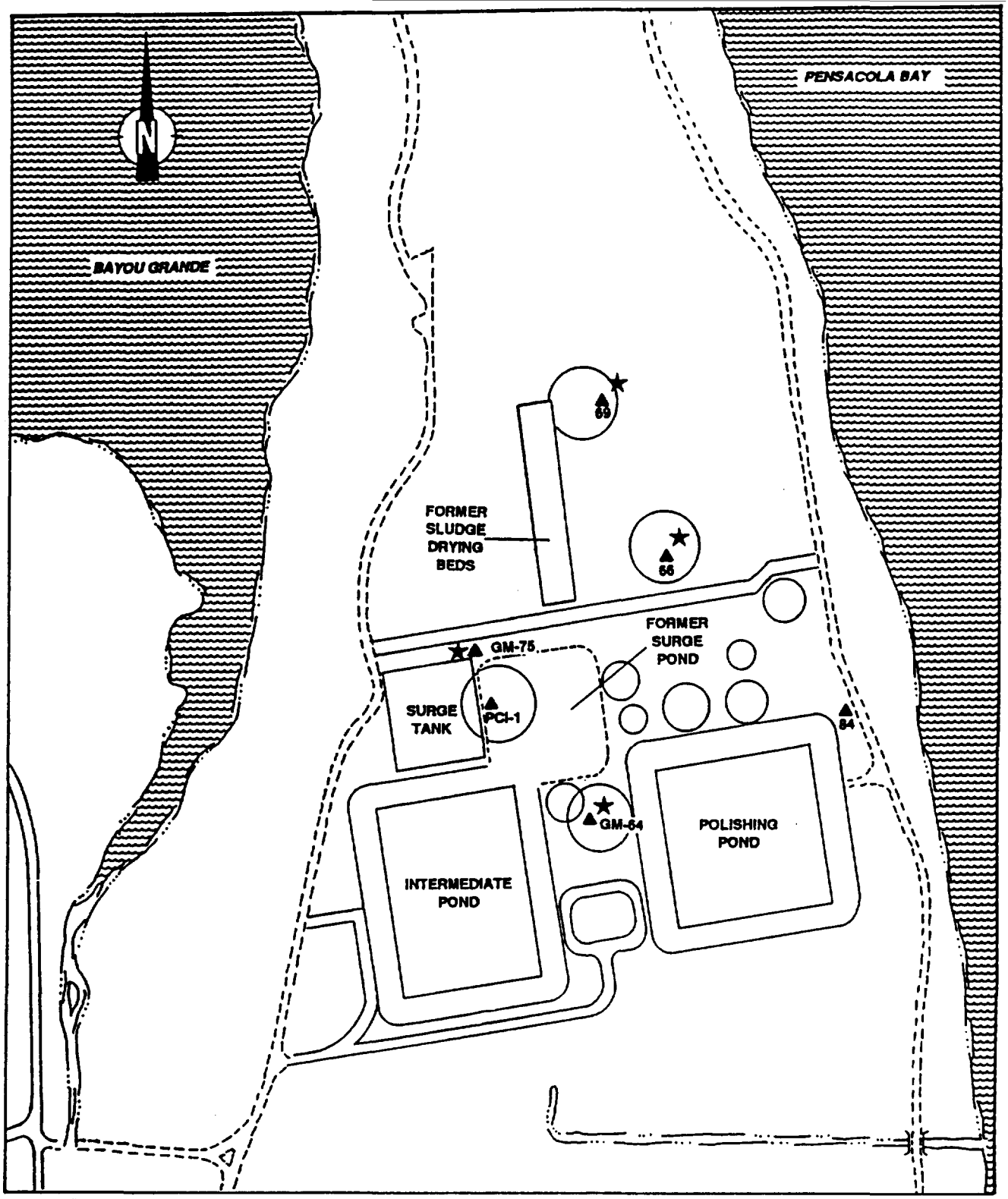


SOURCE: Ecology and Environment, Inc. 1991

SCALE

0 300 600 FEET

KEY:

▲ Intermediate Monitoring Well (40 - 40 Feet BLS)

Clustered Well Sites

★ Intermediate Groundwater Sample Collected Which Exhibited One or *More* Parameter Concentrations Exceeding h e Applicable FPDWSs (excluding sodium)

NOTE: Well GM-75 has been abandoned.

Figure 2-7 LOCATIONS OF INTERMEDIATE GROUNDWATER SAMPLES HAVING CONTAMINANT CONCENTRATIONS EXCEEDING FLORIDA PRIMARY DRINKING WATER STANDARDS NAS PENSACOLA SITES 32, 33, AND 35

In general, the highest concentrations of metals (excluding sodium) that exceeded primary and secondary standards were detected in samples collected from wells located in close proximity to the former sludge drying beds and the former surge pond (see figures 2-6 and 2-7). Given that the majority of samples were not filtered prior to acid preservation, some of these metals concentrations may be due to acid preservative leaching of metals from suspended aquifer matrix material in the samples. Considering that cadmium, chromium, lead, arsenic, and mercury were detected at levels exceeding the applicable FPDWSs in individual wells, and that the CA wells have not been sampled for metals (excluding sodium) on a regular basis, the distribution of metals concentrations which are above groundwater standards cannot be determined. In addition, it is unclear if the arsenic detected in well UG-1, located at the northern end of Magazine Point Peninsula, is related to the IWTP site activities. The distribution of iron and manganese above the applicable FSDWSs in the shallow and intermediate zones can only be approximated.

The highest sodium concentrations in the shallow zone occurred immediately west of the surge tank and east of the former sludge drying beds; in the intermediate zone east of the former sludge drying beds and northeast of the polishing pond; and in the deep zone in the area between the intermediate and polishing pond (see Figure 2-2). As the site complex is bounded on the east and west by saltwater bodies, the sodium distributions probably reflect the presence of the saline/freshwater interface in the shallow zone east and west of the site complex and an increase in saline water with depth in the central portion of the site complex.

The distribution of chloride appears to be closely related to the distribution of sodium (discussed above), and clearly supports the likelihood that the highest concentrations of these two parameters reflect the presence of the saline/freshwater interface east and west of the site complex and an increase in saline water with depth.

In general, the highest concentrations of VOCs in the shallow, intermediate, zone occurred east of the former sludge drying beds and

immediately east of the surge tank, corresponding to the location of the former surge pond (see figures 2-6 and 2-7). Although the shallow zone appears to have enough wells for preliminary characterization purposes, the nature and extent of groundwater VOC contamination in the intermediate zone cannot be adequately determined using the existing well network only. In general, the concentrations of VOCs have tended to decrease over time, which may reflect the effects of the groundwater recovery treatment system. However, with the exception of benzene and trichloroethene, the recent inoperation of this system (see also Section 2.6.1) does not appear to have affected VOC concentrations.

In general, the highest concentrations of BNAs in the shallow zone occurred immediately east of the sludge drying beds and east of the present surge tank; and in the intermediate zone immediately east of the northern end of the sludge drying beds. Significant BNA levels, however, were detected in samples from intermediate zone wells located east of the southern end of the sludge drying beds, immediately west of the former surge pond, and in the area between the intermediate and polishing ponds (south of the former surge pond).

The sources of these contaminants are likely associated with the types of wastes that have been processed at the IWTP (primarily solvents, phenols, and metals). Although extensive data are available, the information is insufficient to determine the overall extent of groundwater contamination, principally occurring in the shallow and intermediate zones. In order to adequately characterize and delineate the full extent of groundwater contamination, additional sampling points, which are hydraulically downgradient of areas of known contamination, are needed in the shallow zone in the interior of the site complex (west, east, and north of the former sludge drying beds and east of the former surge pond). Selected intermediate zone sampling locations are required hydraulically upgradient, cross-gradient, and downgradient from areas of known contamination in order to determine the lateral extent of contamination in that zone. To determine the vertical

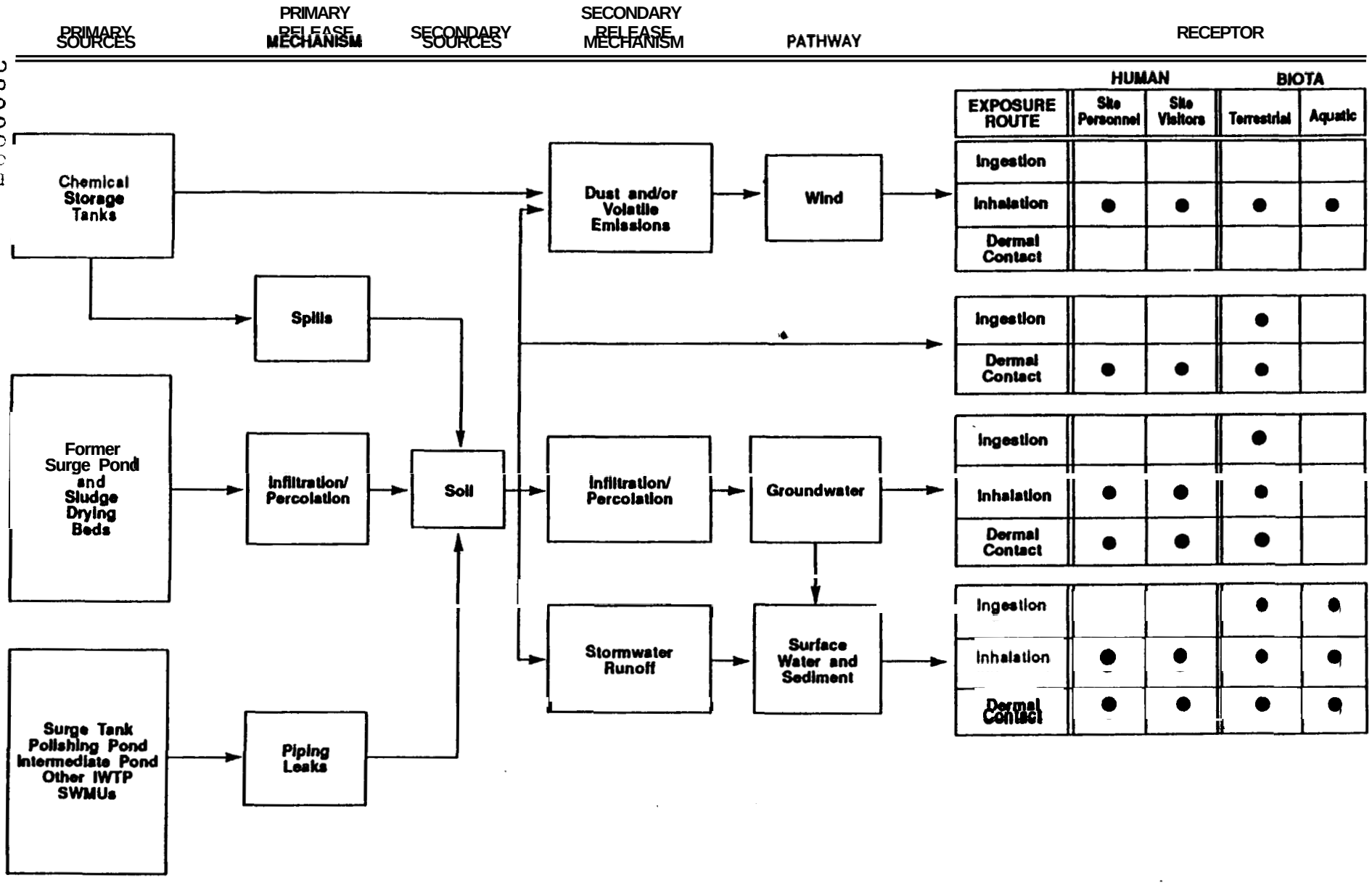
extent of groundwater contamination, intermediate wells should be located, to the greatest extent possible, adjacent to shallow wells. Additional groundwater sampling locations will be presented and discussed in sections 5.2.3 and 5.2.4.

3. INITIAL EVALUATION

The following section provides a general discussion of the overall environment of contamination/potential contamination, including contaminant sources, release mechanisms, migration pathways, and potential receptors, at the Group 0 sites. Figure 3-1 presents a conceptual model (flow chart) of the exposure pathways at these sites; this model was developed based on an evaluation of the physical setting and site history.

The primary sources of contamination at the Group 0 site complex are the chemicals, contained in storage tanks, used in the industrial waste treatment process; the wastes and wastewaters formerly contained in the former sludge drying beds and surge pond (currently inactive); and the wastes and wastewaters contained in various, currently active IWTP structures that are part of the waste treatment process (including the surge tank, the polishing pond, and the intermediate pond).

The chemical storage tanks (primarily containing sulfuric acid, sulfur dioxide, chlorine, caustic soda, alum, lime, and polymer) are located adjacent to the entrance road to the IWTP and north of the polishing pond (see Figure 2-2). The primary release mechanisms associated with these structures are spills related to accidental mishandling of the chemicals or storage tank leakage (see Section 2.6.1). Such releases of chemicals contaminate the immediately contacted soils; the generally permeable soils at the Group 0 site complex allow rapid infiltration to the shallow groundwater; and the groundwater in turn provides a viable contaminant migration pathway (see Figure 3-1). In addition, dust from affected soils and volatile emissions from affected soils or directly from process chemicals (e.g., sulfuric acid) may act as secondary



SOURCE: Ecology and Environment, Inc., 1991.

Figure 3-1 CONCEPTUAL SITE MODEL - NAS PENSACOIA SITES 32, 33, AND 35

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release mechanisms; wind action further distributes the contaminated dust and particulate air emissions to potential receptors.

The former sludge drying beds and surge pond are now closed, capped, and inactive. However, the contaminants in wastes and wastewaters that were introduced to these units prior to their closure have been detected in groundwaters underlying the site complex (see Section 2.6.2). These groundwaters may now be acting as the contaminant migration pathway to potential receptors (see Figure 3-1). The primary release mechanisms for the chemical contaminants from these units were presumably infiltration and percolation of liquid waste through the base of the surge pond, and percolation of contaminants via precipitation infiltration under the sludge drying beds. This downward percolation of contaminant-laden liquids likely affected subsurface soils, creating that secondary source of contamination. This secondary source (subsurface soils) is particularly significant now that both units have been capped and the precipitation infiltration release mechanism has been eliminated.

The surge tank, the polishing pond, the intermediate pond, and several other smaller IWTP SWMUs are currently used in the industrial and domestic waste treatment processes, and complex underground and aboveground piping is utilized to connect these various treatment units. Consequently, the primary release mechanisms for contaminants from these units are leaks from the units themselves or piping leaks which release wastes and wastewaters. These mechanisms create secondary contaminant sources--soil and groundwater (see Figure 3-1). Except where the leaked materials contact paved surfaces, percolation of contaminants contained in wastewaters via precipitation infiltration through the permeable subsurface soils to the shallow groundwater is inevitable. Furthermore, contamination from piping leaks of surface and/or near surface soils could be secondarily released by stormwater runoff. Stormwater drainage at the site, although generally minimal due to permeable surface soils at the sites, may act as the migration pathway to potential receptors.

At the Group O site complex, stormwater drainage directs flow towards the small ditch draining the southern portion of the site complex, which drains to Pensacola Bay (see Figure 2-2).

Potential receptors of contamination at the Group O site complex consist of IWTP personnel, site visitors, and terrestrial and aquatic biota (see Figure 3-1). If wind is the distributing agent, all of the potential receptors could be affected. Contamination of sediment and surface water at the IWTP could potentially affect site personnel, site visitors, and terrestrial and aquatic biota to some degree. If the primary migration pathway is soil, the expected potential receptors are site personnel, site visitors, and terrestrial biota. Although groundwater contamination has been documented at the Group O site complex, these groundwaters are not utilized for consumption or irrigation. Thus, there are no direct potential receptors of contamination via groundwater at the Group O site complex. However, analysis of groundwater flow directions (see Section *2.5.4)* indicates that groundwater in the shallow zone may discharge to Bayou Grande and Pensacola Bay, and some component of this shallow zone flow may also discharge to the small drainage ditch at the southern end of the complex. Therefore, groundwater may affect potential receptors at these discharge points. In addition, those surface waters which are near groundwater discharge points and/or stormwater drainage pathways (e.g., Pensacola Bay, Bayou Grande, and the drainage ditch) may directly affect all of the potential receptors to some degree.

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4. WORK PLAN RATIONALE

This section of the Group O investigation work plan presents E & E's planned approach to the Group O site complex investigation. The investigation will be directed toward the formal confirmation and quantification of the full spectrum of site contaminants--in addition to fully identifying the horizontal and vertical extents of contamination, the investigation will also supplement the quantitative data base necessary to support the screening and evaluation of potential remedial alternatives.

In general, E & E's evaluation of analytical data collected as part of previous Group O site investigations indicates the following:

- Metals concentrations exceeding FPDWSs or FSDWSs were' present in the shallow and intermediate zones of the Sand-and-Gravel Aquifer in the area surrounding the former sludge drying beds and in the vicinity of the former surge pond. Although some of the metals occurrences may reflect the fact that turbid groundwater samples were not filtered prior to acid preservation, some contamination has likely occurred as a result of former waste treatment activities.

- The occurrence of sodium appears to be related to the natural saline/freshwater distribution at the site complex and is closely related to the distribution of chloride.

- VOC and BNA concentrations exceeding FPDWSs were present primarily in the shallow and intermediate zones of the Sand-and-Gravel Aquifer east of the former sludge drying beds and in the vicinity of the former surge pond.

The sources of these contaminants are likely associated with the various IWTP processes primarily treating wastes such as solvents, phenols, and metals. Although extensive analytical data are available, there remain

significant gaps in the data for the Group O sites which need to be defined and addressed in order to complete the RI process. For the Group O sites, these data gaps are:

- Lack of complete and detailed records of all historical and current site activities, and the extent to which these activities may be related to potential contaaination at the Group O site complex.

- Lack of comprehensive and specific understanding of current site conditions, including location and documentation of all current potential sources, primary and secondary release mechanisms, and potential receptors.

- Lack of data regarding the presence, nature, magnitude, and extent of potential surface vater and/or sediment contamination in the on-site drainage ditch, and the extent to which any potential contamination may affect the area of Pensacola Bay proximal to the outlet of the drainage ditch.

- Lack of sufficient data regarding the presence, nature, magnitude, and extent of potential soil contamination at the Group O site complex, other than in those areas directly underlying the former sludge drying beds and the former surge pond.

- Lack of sufficient data to characterize the full spectrum of groundwater contaminants and determine the full extent of groundwater contamination, primarily in the shallow and intermediate zones, at the Group O site complex.

Given the data gaps stated above, the objectives of the Group O RI will be as follows:

- Determine the present physical condition(s) of the Group O sites and identify the extent to which these conditions may be related to or affected by site contamination.

- Identify, to the greatest extent possible, all of the historical and current sources of contamination at the Group O sites, including those not related to the former sludge drying beds and the former surge pond.

- Determine the source, nature, magnitude, and extent of potential surface water and sediment contamination in the small drainage ditch at the southern end of the Group O site complex.

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- Determine the source, nature, magnitude, and lateral/vertical extents of known/suspected areas of soil and groundwater contamination;

- Initiate the Risk Assessment and FS program for the sites.

In order to meet the above objectives, the Group O RI will include the following tasks:

- [illegible] ph[illegible] r[illegible] ana[illegible] and contaminant source [illegible] determine [illegible] present site activities related [illegible] kno[illegible]/suspected contamination;

- Overall physical reconnaissance, OVA survey, radiation survey, and habitat/biota survey. Assess and evaluate current site conditions and determine the extent to which, if any, these conditions are related to or affected by known/suspected contamination;

- Soil/gas survey. Determine the location of potential soil and shallow groundwater contamination at the Group O site complex;

- Surface water, sediment, and soil sampling. Determine the presence of and characterize the full spectrum of site contamination of these media;

- Installation of shallow and intermediate monitoring wells. Provide additional sampling locations within known/suspected areas of contamination in the shallow and intermediate zones (the limited extent of contamination in the deep zone does not require additional wells);

- Collection of groundwater samples from several existing and all newly installed wells. Provide additional data for delineating the extent of and characterizing site contamination;

- Biota and air sampling (if required by the results of the above tasks). Assess the extent to which these receptors/media may be affected by site contamination.

- Hydrologic assessment. Expand the current information on aquifer properties underneath the site and determine groundwater flow rates and direction in each aquifer zone;

- Engineering survey. Provide accurate identification of all site sampling locations and cultural and topographic features.

The specific scope of work associated with each of the above elements is described in sections 5.1 and 5.2. In developing the specific scopes of work, the previous analytical results have been evaluated regarding all requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA; Superfund) and Superfund Amendments and Reauthorization Act (SARA), as well as all other ARARs. For the Group O sites, these ARARs include, but are not limited to, the folloving:

- RCRA;
- Clean Vater Act (CVA);
- Safe Drinking Vater Act (SDVA);
- 40 CFR Parts 264, 265, 270, and 271 (Corrective Action for SWMUs at Hazardous Vaste Management Facilities; Proposed Rule);
- Chapter 17-3, Florida Administrative Code (FAC; Vater Quality Standards);
- Chapter 17-301, PAC (Surface Waters of the State);
- Chapter 17-302, FAC (Surface Vater Quality Standards);
- Chapter 17-550, FAC (Drinking Vater Standards, Monitoring, and Reporting); and
- Chapter 17-770, FAC (State Underground Petroleum Environmental Response).

Based on the results of the tasks identified above, during the RI E 6 E will initiate the appropriate Risk Assessment and FS activities. Risk Assessment activities will be directed tovard identification of contaminants of concern, as well as identification of data gaps that must be eliminated to support the eventual completion of a Baseline Risk Assessment for the site.

FS activities, which will be required for the Group O sites, will be directed toward the identification of data gaps that must be eliminated to support the eventual completion of a comprehensive FS for the sites.

In addition, if warranted, E & E will evaluate the RI results to identify whether any interim remedial measures (IRMs) are required and, if so, develop recommendations for implementation of these IRMs.

5. RI/FS TASKS

5.1 PHYSICAL SURVEY

5.1.1 Contaminant Source Survey

A detailed contaminant source survey will be performed at IWTP in order to obtain a comprehensive understanding of potential contaminant source(s) at the site. The survey will focus on existing information in NAS Pensacola files, previous investigative reports, and interviews with current and former employees of the NAS Pensacola facility. Based on the information obtained from these sources, on-site past and/or present waste streams(s) and waste stream-related activities, on-site buildings and associated activities, on-site past and/or present underground utilities, and potential former and/or existing ambient sources of contamination will be delineated. All background source survey work will be conducted in close communication with the facility Installation Restoration (IR) coordinator as the survey may need to access repositories and/or individuals at several locations among the various tenant commands.

The identification of possible past and/or current waste streams, including volumes, disposal methods, and/or any leaks, that may have occurred at or impacted the site will be based on a review of the historical aerial photograph analyses and on-site field observations. The compilation of a list of former and existing on-site buildings/ structures and delineation of all associated activities will include the development of a detailed summary table and the provision of former and existing building/structure plans, if available. The evaluation of former and existing underground utilities at the site will include

determining the former and current use of each utility structure. All former and existing utilities will be shown graphically on a site map (see Engineering Survey, Section 5.2.8) based on the detail available in the data base. Finally, the identification of potential former and existing ambient contaminant sources will involve an evaluation of existing files and literature to determine whether any normal daily activities at each facility, such as aircraft operations, may have created potential, lov-level ambient contaminant source(s).

At the IVTP, specific contaminant source survey tasks, which focus on historical activities, will include identification of:

- The location of all previous and current underground/ aboveground piping associated with the various stages of the waste treatment process;
- The types of chemicals used currently and formerly in the waste treatment process;
- The specific location, to the greatest extent possible, of all previous spills/leaks at the IVTP;
- The location, to the greatest extent possible, of all historical outfalls associated with the treatment process; and
- The location of all on-site underground storage tanks and the nature of the substances stored in each.

5.1.2 Aerial Photograph Analysis

Prior to the initiation of fieldwork, E & E will examine all available aerial photographs of NAS Pensacola for past and present conditions, features, and developments that may have direct relevance to the fieldwork methodology. The aerial photograph analysis task will involve assembling and stereoscopically analyzing historical photographic imagery and topographic maps available for the site areas. For the purpose of supporting the development of field investigation strategies, efforts will be made to obtain photographs of an appropriate scale that will allow for analysis of past and present surface conditions, drainage, and land use. Photographs shoving the history of site

activities will be analyzed to obtain information regarding the evolution of site features which may have affected hydrologic conditions. The historical perspective gained by studying aerial photographs will provide insight applicable to such tasks as field reconnaissance and monitoring well placement. In addition, the analysis of historical and current aerial photographs, performed in conjunction with the geophysical investigation, will aid in accurately determining the extent of the formerly used area at each of the sites.

5.1.3 Utilities Survey

Prior to conducting any augering, boring, drilling, or excavation activities, E & E will locate all underground cables, pipes, utilities, or other obstructions that may become damaged or otherwise hinder fieldwork. The appropriate authorities (e.g., NAS Pensacola Public Works and Southern Bell) will be contacted to identify the location of all underground utilities in the site area. In addition, E & E will examine available maps and documents and will conduct a metal detector survey on site to determine the presence of any other potentially hazardous subsurface features. If appropriate and applicable, other surface geophysical techniques may be used to locate deeper obstructions not readily detected with a metal detector. The locations of all underground utilities or obstructions will be marked with surveyors' flags, day-glow paint, or by other methods as appropriate.

5.1.4 Overall Physical Reconnaissance

A field reconnaissance survey will be conducted on and around sites 32, 33, and 35. Available aerial photographs and maps will be used as guides in locating surface features. Visual inspections will be made regarding surface conditions, vegetation, and surface drainage patterns.

During the reconnaissance survey, the field team will identify areas that present the most suitable conditions for the establishment of grid survey baselines. The use of a grid system as part of the field investigation is discussed in the following sections.

The reconnaissance survey team will utilize radiation and air monitoring equipment during walkovers of each of the three site areas, in accordance with sections 6.1.1 and 6.3.6 of the GQAPP. In the event that any "hot spots" or other signs of contamination (e.g., stained soil) are located, the area(s) will be flagged and identified on a site map for future reference. All findings of the physical reconnaissance will be mapped in detail and recorded in the field logbook.

5.1.5 OVA Surface Emissions Survey

During the establishment of the soil gas survey grid network (discussed in Section 5.1.8), an emissions survey will be conducted using an organic vapor analyzer (OVA) as air monitoring equipment. The survey will be conducted in accordance with Section 6.1.1 of the GQAPP. Measurements will be made at each established grid point, and readings will be recorded in the field logbook.

5.1.6 Radiation Survey

During the establishment of the soil gas survey grid network, a radiation survey will be conducted using a micro-R-meter and gamma scintillation detector. Both of these instruments detect gamma radiatien. The micro-R-meter reads in units of microRoentgens per hour and is useful in determining human exposure rates. The gamma scintillation detector reads in counts per minute. Any hot spots detected will be further investigated using a survey ratemeter with: 1) a pancake Geiger Huller probe--detects alpha, beta, and gamma radiation; and 2) a zinc sulfide probe--detects alpha radiation at a higher efficiency than the Geiger Huller probe. The survey will be conducted in accordance with Section 6.3.6 of the GQAPP. Heasurements will be made at each established grid point, and readings will be recorded in the field logbook.

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5.1.7 Habitat/Biota Survey

During the physical reconnaissance, an E & E biologist/ecologist will determine the on-site terrestrial and aquatic habitats, and the surrounding habitats which may be affected by off-site contaminant migrations. During the walkover survey, rare, threatened, and endangered species and their potential habitats will be identified, and an evaluation will be made of general site conditions to support viable populations of plants and animals. A habitat/biota survey will be conducted for sites 32, 33, and 35, as well as an evaluation of the literature. If necessary, additional surveying will be conducted to identify known pathways and receptors in the site areas.

5.1.8 Soil Gas Survey

A soil gas survey will be conducted at sites 32, 33, and 35. The previously investigated and closed asphalt-capped former sludge drying bed area will not be included in this survey; however, the asphalt-paved roadways will be included in the survey. The survey will be conducted in accordance with Section 6.5 of the GQAPP; the soil gas probes will be installed using a Geoprobe Model 8M van-mounted hydraulic sampling device or, if necessary, will be installed manually. Measurements will be made at each established grid point, and readings will be recorded in the field logbook.

Performance of the soil gas survey will initially require the establishment of a grid system over the study area. The grid spacing will be based on 50-foot centers. Two baselines (providing an x and y axis) will be located using a transit survey instrument and flagged at 50-foot intervals. The grid system for the study area will then be completed using a Brunton compass and tape measure. For planning purposes, it is estimated that soil gas samples will be collected from approximately 275 locations (points). Because of the closure status of the former sludge drying beds, no soil gas points will be located in the asphalt cap over that area.

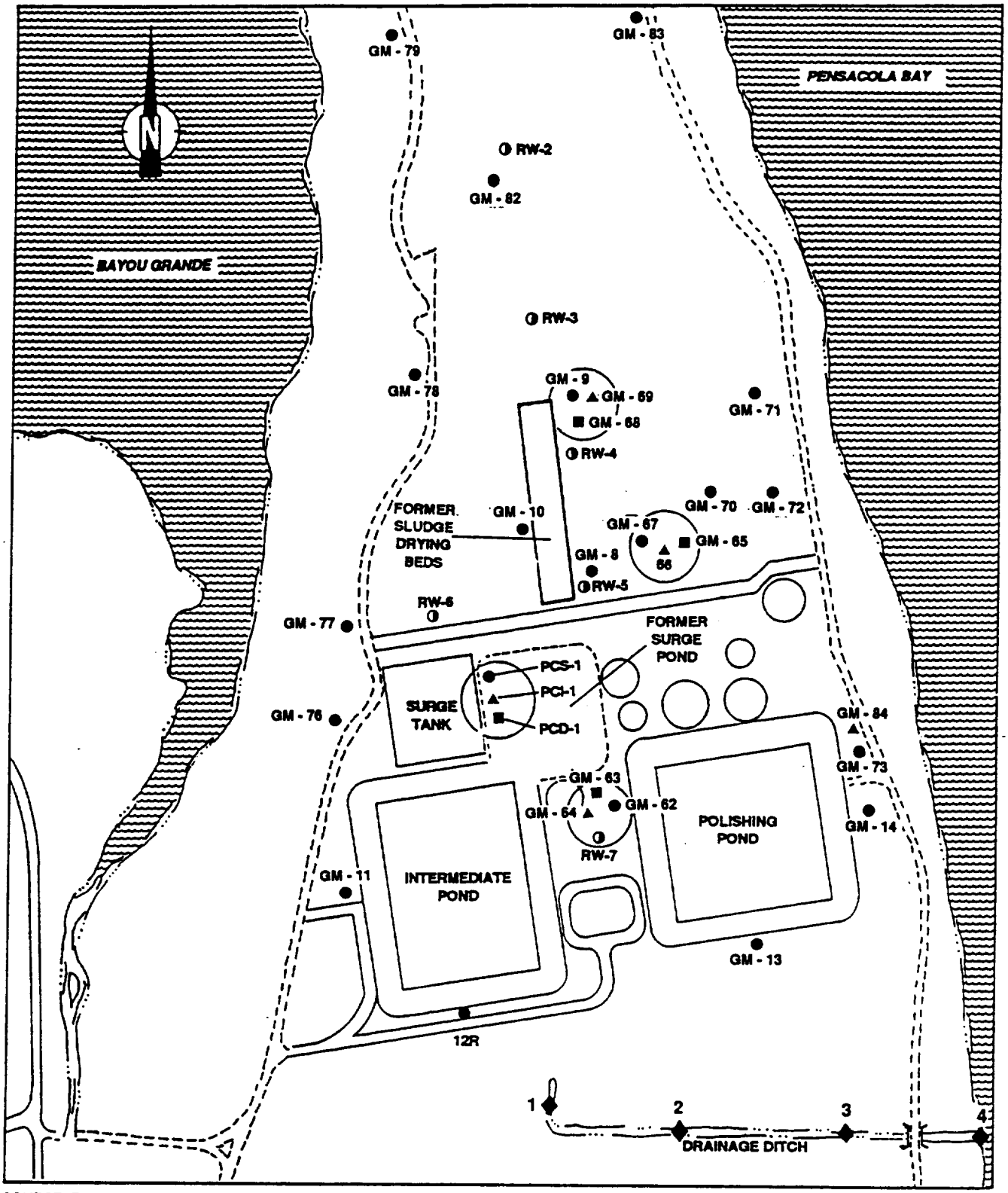
VOCs are possible soil and known groundwater contaminants; therefore, the soil gas survey should be an effective indicator of any areas of potential VOC contamination. Data generated from the soil gas survey will be used with other background data to identify any areas of potential VOC soil or other areas of groundwater contamination. The interpretation of these data will be used in the development of rationales for soil sampling and groundwater monitoring well placement strategies. Any potentially contaminated areas identified by soil gas readings will be subject to confirmation by the proposed laboratory analyses.

5.2 SAMPLING AND ANALYSIS

Figure 5-1 shows the proposed surface water and sediment sampling locations for the Group 0 site complex. Figure 5-2 shows the proposed shallow monitoring well locations, and Figure 5-3 shovs the proposed intermediate monitoring well locations. Table 5-1 summarizes the sampling and analytical requirements, including QA/QC samples, for the RI of the Group 0 sites. Tables 5-2 and 5-3 provide the specific rationale for each proposed Group 0 surface vater and sediment sample, and monitoring well location, respectively, and for the analytical suite associated with each proposed sampling location. The proposed soil samples will be collected at locations determined based on the soil gas survey results.

The sample location reference numbers listed in Table 5-2 correspond to the location numbers on Figure 5-1; the sample location reference numbers listed in Table 5-3 correspond to the location numbers on figures 5-2 and 5-3. The analytical suite designations used in tables 5-2 and 5-3 correspond to the designations used and defined in Table 5-1.

It is proposed to sample all newly installed wells for analytical suite A during the RI to provide a uniform, time-synchronous perspective on Group 0 groundwater conditions. This perspective will be critical to



SOURCE: Ecology and Environment, Inc. 1991

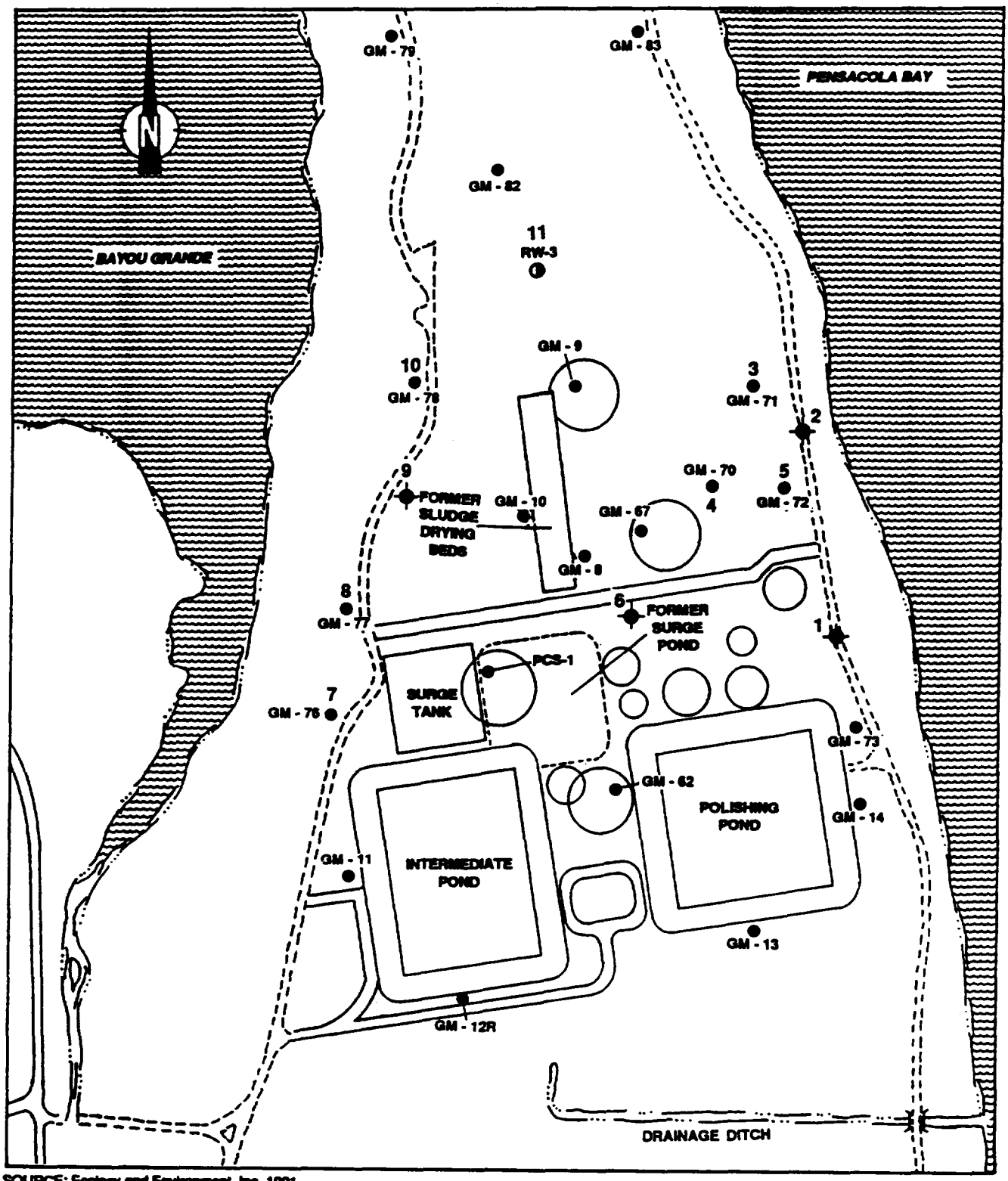
SCALE

0 300 600 FEET

KEY:

- Recovery Well
- Shallow Monitoring Well (12- 15 Feet BLS)
- Intermediate Monitoring Well (40 - 40 Feet BLS)
- Deep Monitoring Well (65 Feet BLS
- 2 Location Reference Number
- Clustered Well Sites
- Tentative Surface Water and Sediment Sampling Location

Figure 5-1 TENTATIVE SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS NAS PENSACOLA SITES 32, 33, AND 35



SOURCE: Ecology and Environment, Inc. 1991

SCALE

0 300 600 FEET

KEY:

● Shallow Monitoring Well (12 - 15 Feet BLS)

2 Location Reference Number

Clustered Well Sites

Note: Two additional shallow monitoring wells will be installed in locations based on the soil gas survey results.

Tentative Shallow Monitoring Well Location (see note below)

Recovery Well

Figure 5-2 TENTATIVE SHALLOW MONITORING WELL AND SAMPLING LOCATIONS NAS PENSACOLA SITES 32, 33, AND 35

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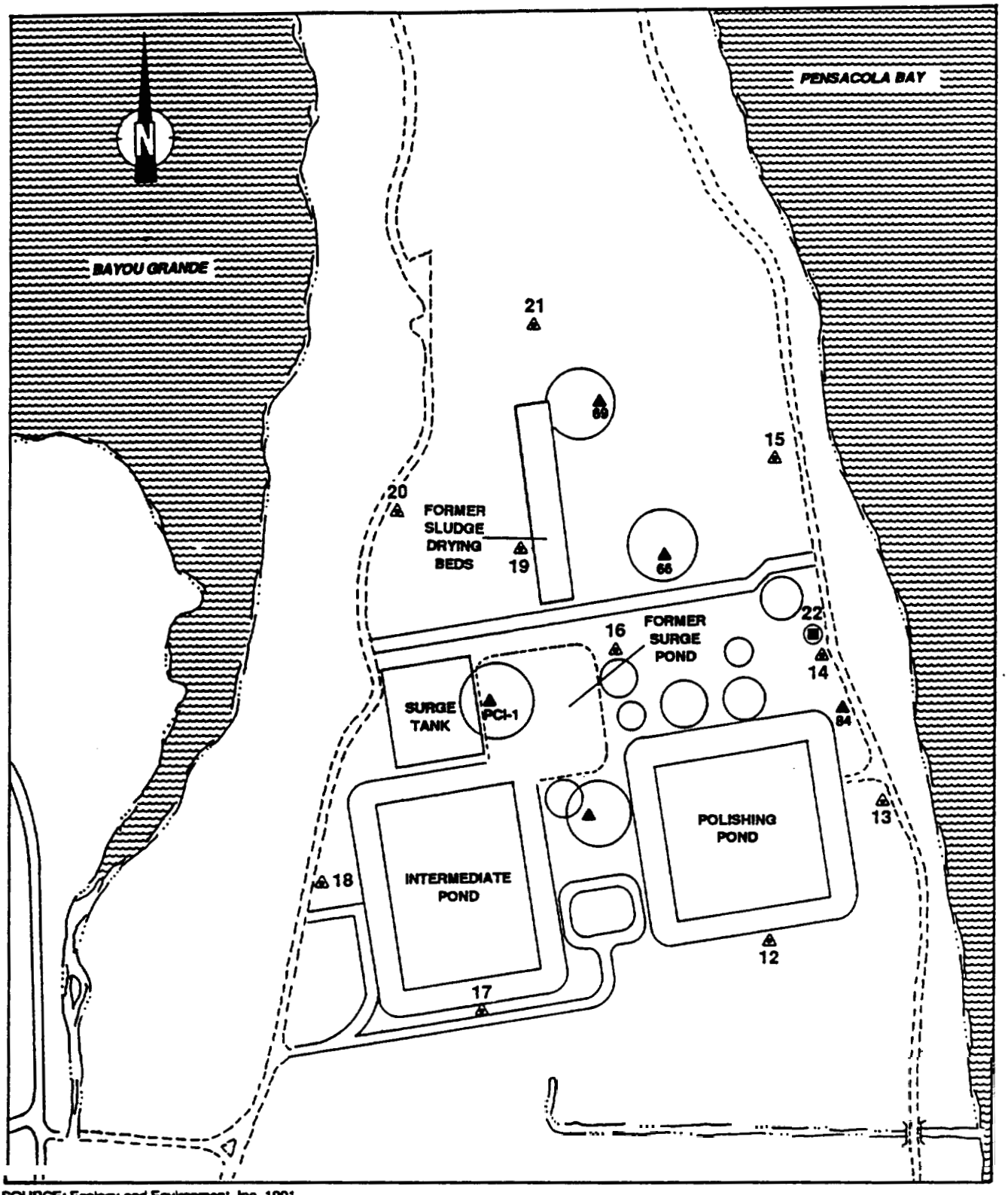

SOURCE: Ecology and Environment, Inc. 1991

SCALE

0 300 600 FEET

KEY:

▲ Intermediate Monitoring Well (40 - 40 Feet BLS)

12 Location Reference Number

Clustered Well Site

A Tentative Intermediate Monitoring Well Location

Tentative Deep Monitoring Well Location

Figure 5-3 TENTATIVE INTERMEDIATE AND DEEP MONITORING WELL AND SAMPLING LOCATIONS NAS PENSACOLA SITES 32, 33, AND 35

Table 5-1

RI SAMPLING AND ANALYTICAL REQUIREMENTS
NAS PENSACOLA SITES 32, 33, AND 35

Medium	No. of Samples[a]	Dupli-cates	Trip Blanks[b]	Preservative Blanks[b]	Field Blanks	Rinsate Blanks	Total[a]	Analytical Suite[c,d]
Surface Water	4	1	--	--	1	1	7	A
	(1)	--	1	--	--	--	(1),1	B
	(2)	NR[e]	NR	NR	NR	NR	(2)	C
Sediment	4	1	--	NR	NR	1	6	A
	(1)	--	1	NR	NR	--	(1),1	B
	(2)	NR	NR	NR	NR	NR	(2)	D
Soil[f]	36	5	--	NR	NR	--	41	A
	(1)	--	3	NR	NR	--	(1),3	B
	2	NR	NR	NR	NR	NR	2	E
	(12)	NR	NR	NR	NR	NR	(12)	D
	2	NR	NR	NR	NR	NR	2	F
Groundwater[g]	24	3	--	1	3	3	33	A
	(1)	--	3	--	--		(1),3	B
	(9)	NR	NR	NR	NR	NR	(9)	C
TOTAL	68	10	8	1	4	5	98	
	(29)	NR	NR	NR	NR	NR	(29)	

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Key:

[a]The number of samples shown in parentheses will be analyzed for the additional parameters indicated.

[b]Trip blanks will be analyzed for Appendix IX volatile organic compounds (VOCs) only. Preservative blanks will be analyzed for Target Compound List (TCL) VOCs, dissolved Target Analyte List (TAL) metals, and cyanide.

[c]Analytical suite designations are as follows:

A = TCL VOCs; TCL base-neutral/acid extractable organic compounds (BNAs); TCL pesticides and polychlorinated biphenyls (PCBs); TAL metals (total [i.e., unfiltered] and dissolved [i.e., millipore-filtered], water only); cyanide; gross alpha, beta, and gamma radioactivity; total organic carbon; total Kjeldahl nitrogen (TKN; surface water and sediment only); grain size (sediment only); hardness (water only); and alkalinity (water only).

B = Appendix IX VOCs, BNAs, dioxins, pesticides, PCBs, organophosphorus pesticides, herbicides, total metals, cyanide, and sulfide.

C = Total suspended solids, TDS (groundwater only), ammonia nitrogen, orthophosphate phosphorus, dissolved oxygen (in field), 5-day biological oxygen demand (BOD_5), and chemical oxygen demand (COD).

D = pH, alkalinity, percent moisture, grain size (soil only), BTU content, ash content, total organic halogens, sulfur, ignitability, and cation exchange capacity.

E = Grain size.

F = Permeability.

[d]Specific constituents encompassed by the various chemical groups included within the above-listed analytical suites are identified in tables 9-5 through 9-13 of the GQAPP.

[e]NR = Not required.

[f]12 boring locations x 3 depth intervals = 36 samples; and 2 locations x 1 depth interval = 2 samples.

[g]7 existing wells + 17 new on-site wells (6 shallow, 10 intermediate, and 1 deep) = 24 samples.

Source: Ecology and Environment, Inc., 1991.

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Table 5-2

RATIONALE FOR PROPOSED RI SURFACE WATER
AND SEDIMENT SAMPLE LOCATIONS
NAS PENSACOLA SITES 32, 33. AND 35

Location Reference Number(s)	Sample Type(s)[a]	Location Rationale	Analytical Suite(s)[b]	Analytical Rationale
1-4	SW SD	Primary surface drainage pathway for southern portion of site complex: direct connection with Pensacola Bay	A	Characterize full spectrum of potential contaminants
			C, D	Support potential site remediation activities
			B (1 only)	Satisfy RCRA requirements

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Kay :

[a]SW = Surface water: SD = sediment.
[b]Specific parameters includad within aach analytical suite are given in Table 5-1.

RCRA = Resource Conservation and Recovery Act.

Source: Ecology and Environment, Inc., 1991.

Tabla 5-3

RATIONALE FOR PROPOSED RI MONITORING WELL LOCATIONS AND GROUNDWATER SAMPLE ANALYSES NAS PENSACOLA SITES 32, 33, AND 35

Location Reference Number(s)	Sample Typo(s)	Location Rational.	Analytical Suites[b]	Analytical Rational.
1	SGW	Dotormino tho prosonco, naturo, and oxtont of porriblo shallow groundwator contamination east (hydraulically downgradiont) of formor surge pond.	A	Characterize full spectrum of potontial contaminants.
2, 3, 4, 5	SOW	Determine tho presence, naturo, and extent of porsiblo shallow groundwator contamination hydraulically downqradiont of formor rludgo dryinq bods.	A C (4 only)	Charactoriro full spectrum of potontial contaminants. Support potontial site romodiation planning activitios.
6	SGW	Determine tho prosonco, naturo, and oxtont of possiblo shallow groundwater contamination east of formor surge pond--high VOCs and BNAs detected in this area--and near area of formor acid spill.	A C	Characterise full spectrum of potontial contaminants. Support potontial site remediation planning activities.
7, 8	SOW	Dotormino tho prosonco, naturo, and oxtont of possiblo shallow qroundwator contamination west (hydraulically downqradiont) of formor surge pond.	A	Charactoriro full spectrum of potontial contaminants
9, 10	SOW	Dotormino tho presence, naturo, and oxtont of porriblo shallow qroundwator contamination west (hydraulically downqradiont) of formor sludge dryinq bods.	A C (9 only)	Characterise full spectrum of potontial coptaminants. Support potontial site romodiation planning activities.
11 (Recovery Well 3, see Figure 5-2)	SOW	Dotormino tho prosonco, naturo, and oxtont of porriblo shallow qroundwator contamination north (hydraulically downgradient) of formor rludgo dryinq beds.	A C	Characterise full spectrum of potontial contaminants. Support potontial site romodiation planninq activities.
13, 14, 15	IGW	Dotormino tho eastern oxtont of possible intermediate depth groundwater contamination. Proposed wells are located downgradient of formor sludge dryinq bods, former surge ponds, and intermediate and polishing ponds.	A C (14 and 15)	Charactoriro full spectrum of potential contaminants. Support potential site romodiation planning activitios.

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Key at end of table.

Table 5-3 (Cont.)

Location Reference Number(s)	Sample Type(s)	Location Rationale	Analytical Suitos[b]	Analytical Rationale
12, 17	IGW	Determine the southern extent of possible intermediate depth groundwater contamination. Proposed wells are located cross-gradient from intermediate and polishing ponds.	A	Characterize full spectrum of potential contaminants.
16	IGW	Determine the presence, nature, and extent of possible intermediate dopth groundwater contaminatioh east (hydraulically downgradient) of the former surge pond.	A	Characterize full spectrum of potontial contaminants.
			B	Satisfy RCRA requirements.
			C	Support potential site remediation planning activities.
18	IGW	Determine the western extent of possible intermediate depth groundwater contamination. Proposed well is located hydraulically upgradient from intermediate pond.	A	Characterize full spectrum of potential contaminants.
19, 20	IGW	Determine the western extent of possible intermediate depth groundwater contamination. Proposed wells are located hydraulically upgradient of former sludge drying beds.	A	Characterize full spectrum of potential contaminants.
			C (19 only)	Support potential site remediation planning activities.
21	IGW	Determine the northern extent of possible intermediate depth groundwater contamination. Proposed well is located hydraulically cross-gradient from former sludge drying beds.	A	Charactorire full spectrum of potential contaminants.
22	DGW	Determine the presence, nature, and extent of possible deep zone groundwater contamination. Proposed well clustered with a shallow and intermediate well located cross-(shallow) and down-(intermediate) gradiont of the former surge pond.	A	Characteriro full spectrum of potential contaminants.
			C	Support potential site remediation activities.

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Key:

[a]SGW = Groundwater sample from shallow monitoring well; IGW = groundwator sample from intermediate monitoring well; DGW = groundwater sample from deep monitoring well.
[b]Specific parameters included within each analytical suite aro given in Table 5-1.

VOC = Volatile organic compound.
BNA = Extractable organic compound.
RCRA = Resource Conservation and Recovery Act.

Source: Ecology and Environment, Inc., 1991.

properly evaluate the groundwater migration pathway. In addition, during Phase II field activities at NAS Pensacola Site 1, soil borings, shallov monitoring wells, and intermediate monitoring wells will be completed at three background locations across the base (B & E 1991b). The analytical results from these background locations will help provide a perspective on the occurrences of potential contaminants at Group O, as well as aid in evaluating the impact of potential base-wide ambient contaminant sources.

Table 5-1 indicates that one sample from each medium will be additionally analyzed for analytical suite B (Appendix IX parameters). It should be noted that for these samples, suite A analyses will be performed only for parameters not encompassed by Appendix IX (e.g., gross alpha, beta, and gamma radioactivity). Furthermore, it should be noted that trip blanks will not be analyzed for the full Appendix IX suite of parameters, but only the Appendix IX VOCs. Finally, it should also be noted that the number of required trip blanks shown on Table 5-1 reflects the total number of trip blanks required to be collected for both the suite A and B samples.

As noted above, tables 5-2 and 5-3 provide specific rationales for proposed surface water, sediment, and groundwater sampling locations and analyses. In general, sampling locations are selected based on an existing data evaluation in accordance with one of the following criteria:

- Area of known contamination;
- Area of potential contamination; or
- Known or suspected area of no contamination.

Sampling locations selected according to the first criterion are required to identify the full spectrum of potential on-site contaminants, as well as the maximum levels of occurrence. Locations selected according to the second criterion are required to delineate the distribution of contamination on site and in the site vicinity.

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Locations selected according to the third criterion are required to confirm that the extent of contamination has been completely delineated. The specific, detailed rationales provided in tables 5-2 and 5-3 for each sampling location or group of locations clearly meet one or more of the three general criteria defined above.

All three of the above criteria must be met in order to complete a Baseline Risk Assessment and Feasibility Study for the site. Furthermore, in most instances, meeting the above criteria requires that the collected samples be analyzed for the full suite of parameters in analytical suite A. However, in some cases (e.g., evaluation of site surface soils to determine the extent, if any, to which airborne particles act as a contaminant migration pathway), a more limited analytical program (e.g., grain size only in soils collected at the surface) is warranted.

Finally, to support potential remediation planning activities for this site, selected samples from each medium also must be analyzed for those parameters which directly control the viability of various remedial alternatives (see analytical suites C and D, Table 5-1).

5.2.1 Surface Water and Sediment Sampling

During the investigation sampling, surface water samples will be collected at four locations, and corresponding sediment samples will be collected at the same four locations. As shown on Figure 5-1, three of the surface water and sediment sampling locations are located at regular intervals in the small drainage ditch at the southern end of the Group O site area. The fourth combined surface water and sediment sample will be collected at the outlet of the ditch to Pensacola Bay. Surface water samples will be collected in accordance with Section 6.9.1 of the GQAPP. Surface water samples collected at locations in surface water bodies where the water is shallower than 1 foot will be collected at the surface using a glass or stainless steel beaker or similar sampling device. Samples collected from water deeper than 1 foot will be

collected within 1 foot of the bottom using a Kemmerer or similar sampling device. During collection of surface water samples, the surface water pH, temperature, specific conductance, dissolved oxygen, and turbidity will be measured and recorded in the field notebook. In addition, the water depth and tidal stage for each sample will be recorded in the field notebook. Equipment decontamination will be conducted in accordance with Section 6.10 of the GQAPP.

Sediment samples will be collected in accordance with Section 6.9.2 of the GQAPP. Sediment samples will be collected from the surface to 0.4 foot below the surface at each location. Sediment samples will be collected using either a stainless steel trowel, a bucket-type mud auger, an Eckman dredge, or other coring device. The composition of sediment materials retrieved will be recorded in the field notebook. Equipment decontamination activities will be conducted in accordance with Section 6.10 of the GQAPP.

All four surface water and all four sediment samples will be analyzed for the analytical parameters included in analytical suite A (see tables 5-1 and 5-2). In addition, one of the four surface water samples and one of the four sediment samples will be analyzed also for the Appendix IX parameters included in analytical suite B (sample location 1 [surface water] and sample location 3 [sediment]); two of the four surface water samples will be analyzed also for the parameters included in analytical suite C (sample locations 1 and 4); and two of the four sediment samples will be analyzed also for the parameters included in analytical suite D (sample locations 1 and 4; see Figure 5-1 and tables 5-1 and 5-2).

The number and types of sediment field QA/QC samples to be collected were determined in accordance with Section 11.1 of the GQAPP.

5.2.2 Soil Sampling

During the soil boring and monitoring well installation activities (Section 5.2.3), soil samples will be collected at 12 locations across the Group O sites. These locations will be based on an evaluation of

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the soil gas survey results. Soil borings will be completed using hollow-stem auger methods, and soil samples will be collected using split-spoon samplers in accordance with Section 6.6.2 of the GQAPP. At each soil boring location, composite samples will be collected from each of the following depth intervals: 0 to 0.5 foot BLS, 0.5 foot to 2.5 feet BLS, 2.5 to 5 feet BLS, and then every 5-foot interval to the water table. For the purpose of estimating sample numbers, the depth to the water table is assumed to be 5 feet BLS over the entire area of the Group 0 sites. In addition to the 12 soil sampling locations described above, two surface soil sampling locations will be selected based on the OVA surface emissions survey results (see Section 5.1.5). These two surface soil samples will be analyzed to determine the extent, if any, to which airborne particles may be a contaminant migration pathway. At each of these two locations, a surface soil sample will be collected by compositing material from the surface to a depth of 4 inches. During drilling of the proposed deep well, two 2-foot Shelby-tube samples of the low permeability zone will also be collected.

All soil sampling, compositing, and lithologic logging activities will be performed in accordance with Section 6.6 of the GQAPP. Equipment decontamination will be performed in accordance with Section 6.10 of the GQAPP.

Thirty-six of the 40 soil samples will be analyzed for the parameters included in analytical suite A (12 sample locations; see Table 5-1). Two of the 40 soil samples (not included in the 36 discussed above) will be analyzed for grain size (analytical suite E). In addition, two of the 40 soil samples (not included in the 36 discussed above) will be analyzed for permeability (analytical suite F). Furthermore, one soil sample will be analyzed also for analytical suite B (Appendix IX parameters), and 12 of the 38 soil samples will be analyzed also for the remediation parameters included in analytical suite D.

5.2.3 Permanent Monitoring Well Installation and Development

A total of 17 permanent monitoring wells will be installed at the Group O sites. These wells will be located and designed to supplement the existing data regarding the lateral and vertical extents of groundwater contamination. The number and target completion depths of these wells are as follows:

- Six shallow wells, all of which will be approximately 20 feet deep.
- Ten intermediate wells, all of which will be approximately 40 feet deep.
- One deep well, which will be approximately 65 feet deep.

Figures 5-2 and 5-3 show the locations of the proposed shallov, intermediate, and deep-depth monitoring wells at the Group O site complex, and Table 5-3 provides the detailed rationale for the selection of each of the monitoring well locations and target depths.

To further characterize the nature and delineate the extent of any surficial zone contamination, and to detect the presence of any floating product at the Group O sites, the six shallow wells will be completed into the upper portion of the surficial zone of the Sand-and-Gravel Aquifer such that the well screen brackets the water table. Two of the six shallow monitoring wells will be installed in locations based on the soil gas survey results. The intermediate and deep wells will be installed to investigate the vertical extent of possible groundwater contaminants, particularly any dense non-aqueous phase liquids (DNAPLs) at the Group O sites. The 10 intermediate wells will be completed into the lower portion of the surficial zone immediately above the first confining/semi-confining unit. All of the intermediate wells will be clustered with one proposed or existing shallow well to assist in delineating the vertical extent of any contamination at that location, as well as to determine the vertical hydraulic gradients between the monitored zones (see figures 5-2 and 5-3). The deep zone well will be

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completed into the upper portion of the main producing zone of the Sand-and-Gravel Aquifer.

The shallow wells will be installed using hollow-stem auger methods and will be constructed of 4-inch-diameter,, flush-threaded, polyvinyl chloride (PVC) casing terminating in 10 feet of 0.015-inch, factory-slotted screen. The justification for using PVC as a well construction material is presented in Appendix H.

To prevent the downward migration of possible shallow contaminants during drilling, the intermediate and deep wells will be installed using either hollow-stem auger or hydraulic rotary methods through 8-inch-diameter, PVC surface casings. The surface casing will be grouted in place and allowed to set 24 hours prior to drilling the well borehole to the target depth, in accordance with Section 6.7.4 of the GQAPP. The intermediate and deep wells installed through the surface casings will be constructed in the same manner as the shallow wells. All drilling and finished monitoring well construction will be conducted in accordance with sections 6.7.2 and 6.7.3 of the GQAPP. In addition, all Group O newly installed wells will either be protected above surface grade with a steel surface casing and locking wellhead cover, or, in heavily traveled or paved areas, will be protected at surface grade with a flush-mount security cover and locking cap. In conjunction with the drilling of the well boreholes, continuous split-spoon samples will be collected to the target completion depth of the wells, in accordance with Section 6.7.2.3 of the GQAPP. Where wells are constructed in clusters, split-spoon samples will only be collected during drilling of the deepest well.

After installation, each of the new monitoring wells will be developed using a submersible pump and/or bailer, in accordance with Section 6.7.5 of the GQAPP. Development waste will be contained in 55-gallon drums, labeled, and moved to a storage area on NAS Pensacola, as directed by the Navy (see also Section 5.2.10).

All drilling equipment will be decontaminated prior to use and between installation of each well in accordance with Section 6.10 of the GQAPP. All borehole cuttings and drilling fluids will be stored in 55-gallon drums, labeled, and moved to a storage area on NAS Pensacola, as directed by the Navy (see also Section 5.2.10).

5.2.4 Groundwater Sampling

During the investigation, groundwater samples will be collected from existing monitoring wells GH-70, GH-71, GH-72, GH-76, GM-77, and GH-78, the existing recovery well RU-3, and the 17 newly installed monitoring wells on the Group O site complex (see figures 2-2, 5-2, and 5-3). Purging and sampling of each well will be conducted in accordance with sections 6.8.2 and 6.8.3 of the GQAPP, respectively. Equipment decontamination activities will be conducted in accordance with Section 6.10 of the GQAPP.

All 24 groundwater samples will be analyzed for the parameters included in analytical suite A. In addition, one of the 24 samples (sample location 16; see Figure 5-3) will be analyzed also for the Appendix IX parameters included in analytical suite B, and nine of the 24 samples (sample locations 4, 6, 9, 11, 14, 15, 16, and 19) will be analyzed also for the parameters included in analytical suite C (see figures 5-2 and 5-3 and tables 5-1 and 5-3).

All shallow monitoring wells will be checked for floating and/or sinking immiscible hydrocarbons with an oil/water interface probe. All intermediate and deep monitoring wells will be checked for sinking immiscible hydrocarbons with an oil/water interface probe.

The number and types of groundwater field QA/QC samples to be collected were determined in accordance with Section 11.1 of the GQAPP.

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5.2.5 Biota Sampling

Formal biological sampling proximate to the Group O sites will be conducted during the ecological risk assessment activities at sites 40 (Bayou Grande Area) and 42 (Pensacola Bay). If the need for specific on-site biological sampling at the Group O site complex is required, a separate biological sampling plan will be prepared which outlines sample locations, sampling methodologies, analytical parameters, etc.

5.2.6 Air Sampling

Formal air sampling will be performed, only as required, based on the results of the soil gas survey, the OVA surface emissions survey, and the surface soil grain size analyses.

5.2.7 Hydrologic Assessment

The main objective of the RI hydrologic assessment is to further delineate the complexities and zones of the underlying aquifer at the Group O site complex. The hydrologic assessment at the Group O site complex will include a wellhead elevation survey of all the newly installed permanent monitoring wells; static water level measurements in all the on-site wells and on-site and/or adjacent surface water bodies; detailed pumping tests of two existing recovery wells and one proposed intermediate well; short-term specific capacity and/or slug tests on all the newly installed permanent wells; and measurement of currents, wind, and/or stream flow at appropriate surface water locations.

All of the on-site existing and newly installed monitoring wells will be surveyed during the engineering survey (Section 5.1.8) and referenced to a USGS benchmark, in accordance with Section 6.7.6 of the GOAPP. In addition, staff gauges will be placed in all surface water bodies on site and will be surveyed relative to the same datum as the wells.

At the Group O site complex, static water levels will be measured in all the existing and proposed on-site wells and in the water bodies on at

least four occasions: once during the sampling of the newly installed wells; once approximately two to four weeks after sampling to obtain an estimate of the short-term temporal variability in water levels; once during a low tidal phase; and once during a high tidal phase. The measurements taken during opposing tidal phases will be collected on the same day in order to evaluate tidal influences on vater level elevations at the Group O sites.

Limited aquifer testing will be conducted on the Group O sites utilizing one existing recovery well (RW-5; see Figure 2-2) and all of the newly installed monitoring wells. For the one recovery well and one proposed intermediate well (proposed well location no. 16; see Figure 5-3), the aquifer testing will consist primarily of multi-well pumping tests.

The procedure for the proposed multi-well pumping tests involves withdrawing groundwater at a constant, known rate from a designated production well (i.e., RW5 and the proposed intermediate well) until the pumping water level stabilizes, and simultaneously measuring the effect of this pumping/withdrawal on water levels in designated adjacent monitoring wells. To assess the potential for vertical leakage, monitoring wells open to depth zones other than the production well will also be monitored to observe the pumping effects (e.g., intermediate and deep wells adjacent to the recovery wells will be monitored during the recovery well pumping tests). At the Group O sites, these pumping tests will be conducted for a minimum of eight hours, or until observable drawdowns in adjacent observation wells have occurred and stabilized. Additionally, the recovery of the water levels in the production and observation wells will be monitored after the pump is turned off until the water level equilibrates to the initial static level. Drawdown and recovery data from each pumping test will be plotted to produce time versus drawdown graphs which will be used to calculate estimates of hydraulic conductivity (K), transmissivity (T), and groundvater flow velocity (V) for each of the monitored depth zones. The analytical technique used to calculate these aquifer properties will account for the conceptual model of the hydrogeologic conditions at the site;

however, commonly used techniques for determining these parameters are presented in Theis (1935), Cooper and Jacob (1946), Jacob (1963), and Lohman (1972).

For all newly installed monitoring wells, the aquifer testing will consist primarily of performing short-term specific capacity tests on wells that are capable of sustaining a measurable yield. The specific capacity testing at the Group 0 sites will be conducted immediately following the development of the newly installed wells, after the water levels have fully recovered and stabilized. The procedure for specific capacity testing involves measuring the initial static water level in the well and then withdrawing groundwater from the well at a constant rate for a designated period. The water levels during pumping are noted, and the pump is turned off. The water level recovery in the well is then recorded continuously over time until the water level equilibrates to the initial static level. In addition to measuring drawdown in the developing well during the specific capacity testing, water levels will be measured in adjacent shallow, intermediate, and/or deep monitoring wells to determine the extent to which the respective, monitored zones may be hydraulically connected.

Injection or withdrawal-type slug tests will be performed on newly installed wells that are not capable of sustaining a measurable yield. The procedure for slug testing involves measuring the initial static water level in the well and then injecting or withdrawing a known volume from the well, using a solid stainless steel cylinder, to create an instantaneous change in water level. The water level is then recorded continuously over time until the water level equilibrates to the initial static level.

The purposes of the specific capacity and slug testing are to obtain site-specific, single-point, first estimate values for hydraulic conductivity (K), transmissivity (T), and groundwater flow velocity (V) for each of the monitored depth zones. Techniques for determining these aquifer parameters utilizing these types of aquifer test results are presented in Cooper ~~et al~~. (1967), Lohman (1972), and Bouwer and Rice

(1976). During each of these tests, a calibrated tape and/or electronic data logger will be used to monitor and record the water levels in the well(s) being tested or observed.

At each surface water sampling location in the small drainage ditch, the prevailing current direction and velocity, vater depth, and tidal phase will be recorded during the sampling. In addition, in order to evaluate tidal effects on this water body, these measurements will be recorded at these same locations during high tide, low tide, and mid tide. In addition, stream velocity, discharge, and stream elevation data for the drainage ditch will be recorded at the same time that water levels are measured in the on-site monitoring wells. A rain gauge will be installed at or near the site and monitored regularly over the course of the fieldwork.

5.2.8 Bngineering Survey

A comprehensive engineering survey will be conducted to accurately identify all site sampling locations and cultural and topographic features. All sampling and monitoring well locations will be identified both horizontally and vertically. All monitoring well elevations will be surveyed relative to a spot elevation benchmark located in the northern portion of the site complex, or a USGS benchmark located on Chevalier Field which is located south of the Group 0 sites. Loran or latitude and longitude coordinates will be used in the survey to illustrate any data points located offshore. In addition, any utilities, aboveground structures, and improvements (such as pavement) will be located. Any pertinent information found during the contaminant source survey (Section 5.1.1) will be incorporated into this survey. The survey also will delineate topographic variability using contour intervals of 2 feet. All engineering survey information will be integrated with any existing computer-aided design *(CAD)* base maps so that all updated, site-related information can be precisely and efficiently added to the base map. The development of a CAD base map will include the addition of previous data point locations (i.e.,

coordinates of latitude and longitude). The survey drawing will be produced in mylar and blueline copies; the CAD file for the drawing will be kept on diskette.

5.2.9 Field Quality Assurance/Quality Control

5.2.9.1 Documentation

Field activities and sample management will entail certain strict documentation requirements as described in Section 7 of the GQAPP.

5.2.9.2 Field QA/QC Samples

Samples collected for laboratory analysis (both screening and nonscreening) during all phases of fieldwork will require the preparation of field QA/QC samples as described in Section 6.12 of the GQAPP. The estimated numbers of required field QA/QC samples are shown in Table 5-1.

5.2.10 Decontamination And Waste Hanagement Procedures

5.2.10.1 Decontamination Procedures

All equipment decontamination procedures for sites 32, 33, and 35 will be performed in accordance with Section 6.10 of the GQAPP.

5.2.10.2 Waste Management Procedures

Investigation-derived wastes will be handled in accordance with the procedures described in the EPA guidance document Management of Investigation-Derived Waste During Site Inspection (EPA 1991b). All water generated during monitoring well purging and development activities on sites 32, 33, and 35 will be containerized and then discharged into the WWTP, or will be containerized, labeled, and moved to a storage area on NAS Pensacola, as directed by the Navy.

Any excess soil auger cuttings generated by soil boring or monitoring or will be containerized, labeled, and moved to a storage area on NAS Pensacola, as directed by the Navy.
Other investigation-derived wastes, such as potentially contaminated clothing and disposable materials, will be containerized, labeled, and moved to a storage area on NAS Pensacola.

5.3 LABORATORY QUALITY ASSURANCE/QUALITY CONTROL

Laboratory QA/QC procedures are designed to ensure the accuracy, precision, completeness, representativeness, and comparability of all analytical data. Laboratory QA/QC has been addressed both in the GQAPP and GSMP. All phases of fieldwork will incorporate a different level of data quality and requisite laboratory QA/QC. These levels are discussed in detail in the GQAPP and GSHP.

5.4 GROUNDWATER MODELING

Following completion of the hydrologic assessment, E & E will use the data generated in the previous field investigative tasks to conduct limited computer modeling of groundwater. The two scenarios that will be considered to assess the potential for off-site Contamination include:

- Estimated future plume movement without any remedial actions/effects (e.g., No Further Action); and
- Estimated total time periods required to extract contaminants from the aquifer in order to meet previously established standards for drinking water (ARARs) for a total contaminant mass at variable pumping rates.

Using hydrogeologic data generated from previous tasks, the flow velocity fields will be calculated for both remedial and nonremedial scenarios utilizing the three-dimensional, finite-difference groundvater flow model MODFLOW. The flow velocity fields will then be entered into the two-dimensional, solute transport model RANDOMWALK to estimate

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cleanup times for the remedial scenarios and plume movement rates for the no remedial action scenario.

MODFLOW was selected based on its capability in simulating groundwater flow in two or three (if necessary) dimensions. RANDOMWALK was selected as the solute transport model because of its capability in simulating various contaminant transport mechanisms and its relative ease in creating grid configurations. Both models have been successfully applied to hazardous waste site cleanups and have been extensively field verified.

To obtain a prediction of plume extent without remediation, E & E will illustrate contaminant transport simulations for the current time and for one, five, and ten years into the future. Additional simulations will include different remedial pumping scenarios for both organic and inorganic contamination. E & E then will use information generated by these computer simulations for remedial alternative development.

5.5 BASELINE RISK ASSESSMENT

As part of the Remedial Activities Investigation, a baseline risk assessment will be conducted to determine the level of effort required in the FS for remedial actions. This baseline risk assessment will be initiated during the later stages of the investigation, and the results will be included in the report. The baseline risk assessment will provide an evaluation of the potential threat to human health and the environment, in the absence of any remedial action, by providing the basis for determining whether or not remedial action is necessary and the justification for performing any remedial actions. The risk assessment will be performed in accordance with EPA's 1989 documents, Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual (Part A), and Volume II - Environmental Evaluation Manual (Interim Final).

The baseline risk assessment identifies and characterizes the toxicity and levels of hazardous substances present in the media of concern

(e.g., air, groundwater, soil, surface water, sediment, or biota), the environmental fate and transport mechanisms within the media of concern (e.g., physical, chemical, 'biological degradation processes, and hydrogeological conditions), the potential human and environmental receptors, the potential exposure routes and the extent of actual or expected exposure, the extent of impact or threat (i.e., risk characterization), and the level or levels of uncertainty associated with all of the above. The complexity of the site will determine the level of effort required to conduct the baseline risk assessment. The conclusions of the baseline risk assessment will determine the level of effort required in the risk assessment to be conducted during the FS. The baseline risk assessment can be divided into four tasks: contaminant identification, exposure assessment, toxicity assessment, and risk characterization.

5.5.1 Contaminant Identification

The main purpose of this step is to screen available information on the hazardous vastes present at the site and to identify contarinants of concern for subsequent focus during the risk assessment process. The identification of contaminants of concern will be conducted in accordance with the previously referenced risk assessment guidance document (EPA 1989).

5.5.2 Exposure Assessment

This subtask involves the identification of actual or potential pathways, characterization of potentially exposed populations, and determination of the extent of exposure. Identification of potential exposure pathways helps to conceptualize the migration of contaminants from an existing source to an existing or potential point of contact. An exposure pathway may consist of four elements:

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1) A source mechanism of chemical release into the environment;

2) An environmental transport medium (e.g., air, groundwater, biota);

3) A potential contact point with the medium of concern; and

4) An exposure route to the population from the contact point.

The purpose of this analysis is to provide decision makers with an understanding of both the current risks and potential future risks if no action is taken. Therefore, as part of this evaluation, a reasonable maximum exposure scenario that reflects the type(s) and extent(s) of exposures that could occur should be developed based on the expected future use of the site.

The final step in the exposure assessment is to integrate the information and develop a quantitative estimate of the expected exposure levels resulting from the actual or potential release of contaminants from the site.

5.5.3 Toxicity Assessment

This step considers:. (1) the types of adverse human or environmental effects associated with contaminant exposure; (2) the relationship between the magnitude of exposure(s) and the adverse effects; and (3) related uncertainties such as the evidence for a particular chemical's potential carcinogenicity in humans. Typically this process relies heavily on existing toxicity information and rarely involves the development of new data on toxicity or dose-response relationships. Existing toxicity information in the Integrated Risk Information System (IRIS) will be utilized during the toxicity assessment process.

5.5.4 Risk Characterization

In the final stages of the baseline risk assessment, a characterization of the potential adverse effects to human health or environment of each

derived scenario is developed and summarized. By integrating information developed during the exposure and toxicity assessments, estimates of risk can be developed to include carcinogenic risks, noncarcinogenic risks, and environmental risks.

To characterize environmental risks, the potential exposures to the surrounding ecological receptors must be identified, and the potential effects associated vith such exposure(s) must be determined. Important factors to examine include disruptive effects to populations (plant and animal) and the extent of perturbations to the ecological community.

The following data will be obtained for each site as part of the baseline risk assessment:

- Distance to the closest residence (on or off NAS Pensacola);
- Type of barrier, if any, to prevent access;
- Approximate population within 0.25 mile of the site (including NAS Pensacola);
- Sensitive land uses in the vicinity of the site (e.g., schools, hospitals, retirement homes, etc.);
- Activities (recreational and/or occupational) vhich take place near the sites, and the estimated number of people involved;
- Records of any environmental and/or health complaints regarding the sites; and
- Log of any actions taken by a health unit regarding health issues, complaints, and concerns.)

The results of the baseline risk assessment may indicate that the site poses little or no threat to human health or the environment. In such cases, the FS should be appropriately scaled down or eliminated. The results of the Remedial Activities Investigation and baseline risk assessment will serve as the primary basis for documenting a No Further Action decision.

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It should be emphasized that all the tasks conducted as part of the baseline risk assessment will be performed on an interactive basis between the various disciplines required (i.e., hydrogeologists, chemists, risk assessors, etc.), the Navy, and the reviewing regulatory agencies (i.e., FDER and EPA) and that the goal of these tasks is to produce appropriate, sufficient, and high quality data to complete the baseline risk assessment.

5.6 TREATABILITY STUDY

As indicated in Table 5-1, a number of the analyses to be performed on the samples collected during the investigation may be required in support of a potential treatability study. However, the proposed analyses are preliminary and will likely be adjusted based on the results of the investigation and the baseline risk assessment. Characterization of samples in terms of parameters listed in Table 5-1, together with treatability tests, will provide the basic data required for the evaluation of physical, chemical, and biological remedial technologies. Some of the treatability tests that may be examined are incineration tests, solubility tests, soil leaching tests, and coagulation-flocculation jar tests.

5.7 FEASIBILITY STUDY

The FS will be initiated toward the end of the investigation. Further details on the specific tasks to be performed as part of the FS will be described in detail after the fieldwork has been completed. However, it is anticipated that where contaminated media are identified on site, the general approach described below will be followed.

As part of the initial FS scoping activities, E & E will prepare a summary of field data collected during the RI to compare and evaluate the concentrations of the contaminants of concern against the cleanup criteria developed. E & E will prepare a qualitative and quantitative summary of contamination for each of the scenarios identified during the

risk assessment evaluation. These summaries will serve as a basis for screening, development, and evaluation of remedial action technologies.

5.7.1 Screening of Applicable Remedial Technologies

E & E will screen and develop applicable technologies for each medium for the remediation of any on-site contamination. In the process of screening applicable technologies, E & E will consider all ARARs and identify problems, and determine pathways of contamination using a receptor-oriented approach based on the potential threat to public health, public welfare, and the environment. In this summary, pathways will be outlined for each medium of concern. E & E will identify an appropriate general response action such as contaminant removal, treatment, disposal, and so on, and the applicable remedial technologies for each. The identification of technologies will be based on technical selection criteria and E 6 E's engineering judgment.

5.7.2 Assessment of Applicable Remedial Technologies

During the assessment process, E & E will consider the relative applicability of each technology for each medium of concern (e.g., air, surface water, sediment, soil, and groundwater). The general approach will be to screen or eliminate those remedial technologies that may be difficult to implement, rely on unproven technologies, or may not achieve the remedial objectives established in the earlier stage of the RI/FS within a reasonable time period. During the screening process, E & E will review all site-related data to identify conditions and waste characteristics that may limit or promote the use of certain remedial technologies. Criteria such as environmental, institutional, and public health impacts, and technical feasibility will be applied. A discussion of the applicable technologies will be provided for each general response action. For the Group 0 sites where known contamination is present in soil and groundwater and the potential for air, surface water, and sediment contamination exists, E & E will review available technology for each media including in situ, on-site, and off-site

treatment approaches. In general, the applicable technologies for each medium will probably include, but may not be limited to:

- **Air.** Capping, collection and adsorption, collection and thermal oxidation, and controlled dispersion.
- **Surface Water.** Pollution source control, self purification, enhanced biological degradation, chemical precipitation, physical filtration, physical-chemical adsorption, aeration, air stripping, and chemical oxidation.
- **Sediment.** Dredging, aerobic and anaerobic biological degradation, thermal oxidation, fixation, stabilization, and disposal.
- **Soil.** Excavation, hydraulic barrier containment, physical barrier containment, aerobic and anaerobic biological degradation, thermal oxidation, fixation, and stabilization.
- **Groundwater.** Physical or hydraulic barrier containment, recovery, existing **IWTP** treatment, enhanced biological degradation, chemical precipitation, filtration, physical-chemical adsorption, sparging, air stripping, chemical oxidation, and thermal destruction.

The discussion will include comments, as appropriate, concerning the reliability and implementability of the technology.

5.7.3 Risk Assessment

Based on the results of the baseline risk assessment conducted during the Remedial Activities Investigation, E & E will perform a detailed risk analysis to determine the acceptable levels of risk. This will allow the Navy to balance the increase in costs associated with each alternative against gains in safety. The risk analysis will include consideration of site contaminant toxicity, transport mechanisms, persistence in the environment, and impacts on human health and the environment.

5.7.4 Development and Evaluation of Remedial Action Alternatives

During the preceding task, remedial technologies will be assessed independently without consideration to potential advantages or disadvantages of technologies applied in combination. In this task, individual technologies which have passed the initial screening process will be assembled into remedial action alternatives for the site. Each alternative, consisting of an individual technology or a combination of several technologies, represents a workable number of technologies that together adequately address all site problems. During the assembly and evaluation of the alternatives, criteria including technical feasibility, environmental and public health, institutional impacts, and comparative costs will be considered.

5.7.5 Selection of Recommended Remedial Action Alternatives

During this task, E & E will select a single remedial action alternative for the remediation of the site. The alternatives assembled during the preceding task will be compared using technical, environmental, and economic criteria. E & E will consider present worth of total costs, environnental effects, technical aspects, the extent to which alternatives comply with ARARs, community effects, and other factors when comparing alternatives. E & E will apply these evaluation criteria uniformly to each alternative along with any additional criteria that may result from the Navy project coordination. E & E will discuss the selected alternative in a statement of the relative advantages of the alternative over the other alternatives considered.

5.8 REPORT

Following completion of the RI, E & E will prepare a formal RI report to summarize the results of the Group O site complex investigation as well as the results of the Site 13 (Magazine Point Rubble Disposal Area) Phase II investigation. The baseline risk assessment will be included as a separate section in the RI report.

In addition, following any treatibility studies and FS work, formal reports will be produced for these efforts. These reports will include detailed narratives associated with the respective tasks.
For all reports, E & E will prepare a 90% draft, for submittal to the Navy only, which summarizes the activities and results of the investigation tasks performed. Upon receipt of comments from the Navy concerning the 90% draft reports, E & E will prepare a 100% draft report for the Navy and EPA, FDER, and Technical Review Committee (TRC) review. The EPA/FDER/TRC review comments will be incorporated into draft final reports which will be resubmitted to the EPA/FDER/TRC for final approval. The draft final report will then become final if no further comments are received from the EPA/FDER/TRC.

The RI report will be written as an independent document, complete in its own right, and fully supportive of the conclusions which it contains. Where appropriate, public participation issues will be summarized, as will interim remedial measures necessary to protect against continued degradation of conditions at the site(s). Information used in analyses, but supplemental to the analytical results, will be provided in a series of appendices.

Monthly progress reports during all field activities will be submitted to keep the Navy apprised of fieldwork status and site conditions. Current and planned activities, as well as cost tracking, will be provided.

6. DOCUMENT REVISION

Periodic updating of all administrative documents (GQAPP, SMP, HSP, PHP, and work plan) will be necessary due to changes in site conditions and/or program conditions or requirements. Revised documents will undergo the same review process (e.g., Navy and EPA/FDER/TRC) as the original documents.

7. PROJECT SCHEDULE

Figure 7-1 shows the project schedule for the RI. The length of time for the investigation is subject to the schedule in the Federal Facilities Agreement Site Management Plan (FFASMP). The schedule in the FFASMP will be updated yearly.

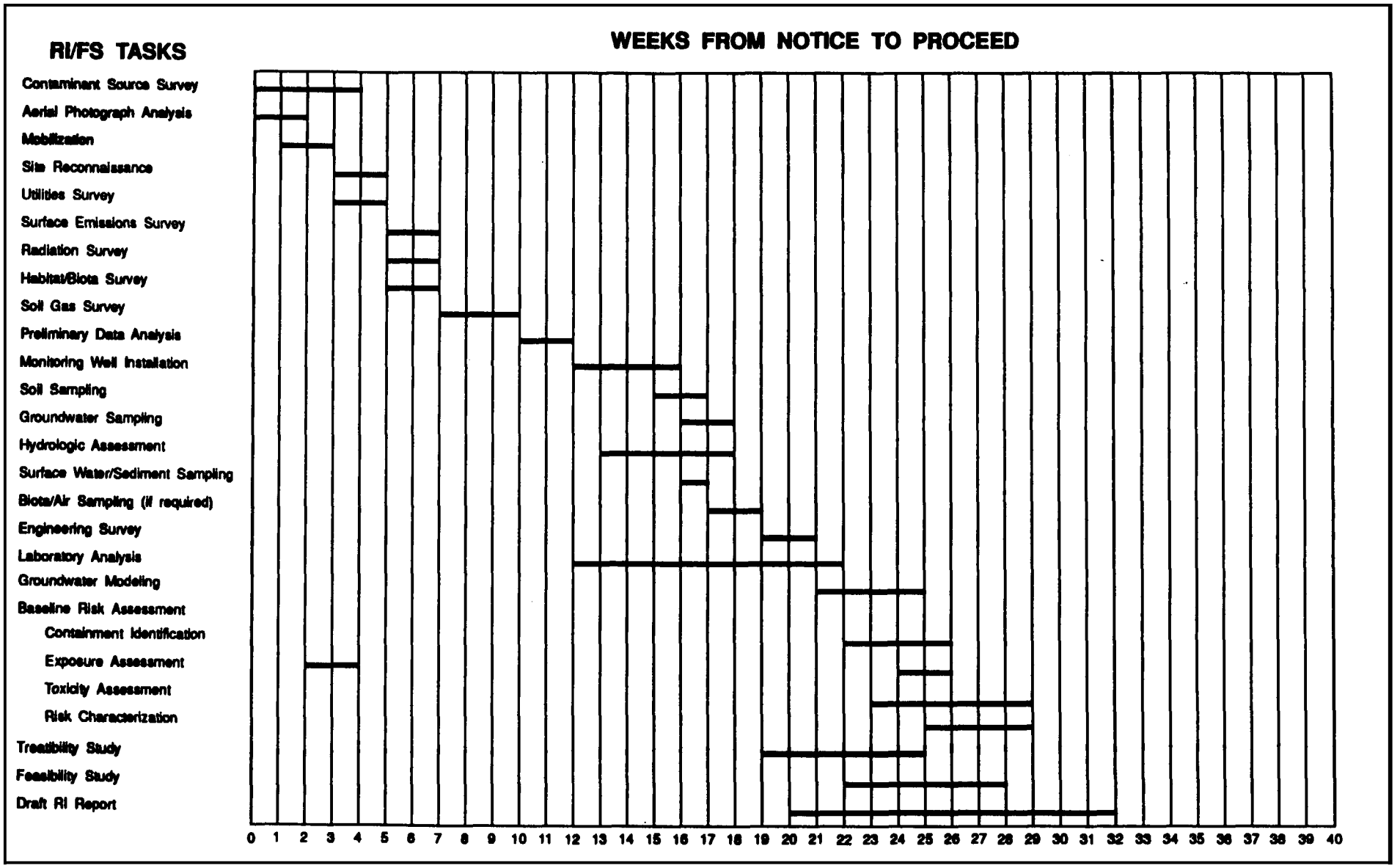

Figure 7-1 PROJECT SCHEDULE – NAS PENSACOLA SITES 32, 33, AND 35

3201011

8. PROJECT MANAGEMENT

Project management will be an ongoing process throughout this investigation. This process includes preparation of monthly project status reports, coordination of schedules, mobilizations, and other project incidentals with the Navy, management of project staff, coordination with the E & E support groups (e.g., publications, laboratory), and ongoing project review by E & E technical managers and directors. These project management steps are described in detail in the PHP submitted to the Navy.

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10. FLORIDA PROFESSIONAL GEOLOGIST SEAL

I hereby affix my seal to the Remedial Investigation/Feasibility Study Work Plan, Group 0, Naval Air Station, Pensacola, Florida, in accordance with Chapter 492 of the Florida Statutes and applicable rules and regulations developed pursuant thereto:

Name: John D. Barksdale

License Number: P.G. No. 1150

State: Florida

Expiration Date: Jul'y 31, 1992

_____

John D. Barksdale

_____

Date

A

APPENDIX A

SITE-SPECIFIC SAFETY PLAN

ecology and environment, inc.

SITE SAFETY PLAN

Version 988

A. GENERAL INFORMATION

Project Title: IWTP RI/FS

Project No.: UH1305

TDD/Pan No.:

Project Manager: John Barksdale

Project Dir.: Rick Rudy

Location(s): Waste Water Treatment Facility (WWTP; Sites 32, 33, and 35)

Prepared by: Amy Twitty

Date Prepared: December 16, 1991

Approval by: Sybil Newchurch

Date Approved: December 16, 1991

Site Safety Officer Review:

Date Reviewed:

Scope/Objective of Work: Fieldwork will include physical surveys, soil gas survey, soil sampling, and ground-water sampling.

Proposed Date of Field Activities: March 1992

Background Info: Complete: [X] Preliminary (No analytical data available) [ ]

Documentation/Summary:

Overall Chemical Hazard:	Serious [		Moderate	I
	Low	[X	Unknown	1
Overall Physical Hazard	Serious [		Moderate	X]
	Low	[	Unknown	1

B. SITE/WASTE CHARACTERISTICS

Waste Type(s):

Liquid	[X]	Solid	[X]	Sludqo	[ ]	Gas/Vapor	[X]

Characteristic(s):

Flammable/ Ignitable	[X]	Volatile	[X]	Corrosive	[1	Acutely Toxic	[ ]
Explosive	[ ]	Reactive	[1	Carcinogen	[X]	Radioactive*	[ ]

Other:

Physical Hazards:

Overhead	[X 1	Confined* Space	[ ]	Below Grade	[1	Trip/Fall	[X 1
Puncture	[ ]	Burn	[ ]	Cut	[ ]	Splash	[X]
Noise	[X]	Other: Sites are areas near active air fields.					

*Requires completion of additional form and special approval from tho Corporate Health/Safety group. Contact RSC or HQ.

Site History/Description and Unusual Features (see Sampling Plan for detailed description): Sites 32, 33, and 35 were constructed in 1971 during upgrading of the WWTP to provide tertiary treatment of industrial waste and secondary treatment of domestic waste produced by NAS Pensacola. Groundwater at these sites is known to be contaminated with VOCs and metals.

Locations of Chemicals/Wastes: Subsurface

Estimated Volume of Chemicals/Wastes: Unknown

Site Currently in Operation Yes: [X] No: [ ]

C. HAZARD EVALUATION

List Hazards by Task (i.e., drum sampling, drilling, etc.) and number them. (Task numbers are cross-referenced in Section D)

Physical Hazard Evaluation:

1) Physical Surveys - Traffic, slips, trips, falls
2) Surface Water and Sediment Sampling - Splash, personal contamination
3) Monitoring Well Installation - Overhead, noise
4) Soil Sampling - Personal Contamination, overhead
5) Groundwater Sampling - Splash, personal contamination
6) Decontamination Procedures - Using solvents

Chemical Hazard Evaluation:

Compound	PEL/TWA	Route of Exposure	Acute Symptoms	Odor Threshold	Odor Description
Methylene chloride	500 ppm	Inh, Cong	Dizzy, naus, vomit	214 ppm	Sweet odor
1,1,1-trichloroethane	350 ppm	Inh, Ing, Con	Dizzy, naus, vomit	20-100 ppm	Chloroform-like
Isopropyl Alcohol	400 ppm	" " "	Drowsiness, head	7.5-200 ppm	Rubbing alcohol
Nitric Acid	2 ppm	" " "	Corrosive	0.3-1 ppm	Acrid
Napthalene	10 ppm	" " "	Naus, sweat	0.3 ppm	Mothballs
Benzene	1 ppm	" " "	Naus, dizzy, vomit	4.68	Sweetic
Vinyl chloride	1 ppm	Inh, Con	Clear, rough	260 ppm	Sweet
1,1-dichloroethane	100 ppm	Inh, Ing, Con	CNS depression	300 ppm	Solvent
Tetrachloroethane	1 ppm	" " "	Dizzy, naus, vomit	2.9	Aromatic
Toluene	200 ppm	Inh, Ing, Abs	Fatigue, hood	0.17 ppm	Sweetic
Xylene	100 ppm	" " "	Head, naus, cough	0.05 ppm	
1,2-dichlorobenzene	300 mg/kg	" " "	Head, vomit, naus	2-30 ppm	Camphor/mothballs
1,2-dichloroethane	50 ppm	" " "	Naus, head, vomit	6 ppm	Sweetish
Chromium	1 mg/m^3	Inh, Ing	none	N/A	N/A

Note: Complete and attach a Hazard Evaluation Shoot for major known contaminant.

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D. SITE SAFETY WORK PLAN

Site Control: Attach map, use back of this page, or sketch of site showing hot zone, contamination reduction, zone, etc.

Perimeter identified? [yes] Site secured? [no]

Work Areas Designated? [yes] Zone(s) of Contamination Identified? [no]

Personnel Protection (TLD badges required for all field personnel):

Anticipated Level of Protection (Cross-reference task numbers to Section C):

	A	B	C	D
Task 1				X
Task 2				X
Task 3				X
Task 4				X
Task 5				X
Task 6				X

Modifications: Based on HNu/OVA readings, level D for task 1 only. Modified level D with tyveck, neoprene gloves and boots, and safety glasses for tasks 2 through 6. APR available with cartridges when level C upgrade is necessary.

- Level D: O_2 <19.5% or >25%, explosive atmosphere >10% LEL, organic vapors above background levels, particulates >_____ mg/m^3, other _____
- Level C: O_2 <19.5% or >25%, explosive atmosphere >25% LEL (California-20%), unknown organic vapor (in breathing zone) >1 ppm, particulates >_____ mg/m^3, other _____
- Level B: O_2 <19.5% or >25%, explosive atmosphere >25% LEL (California-20%), unknown organic vapors (in breathing zone) >5 ppm, particulates >_____ mg/m^3, other _____
- Level A: O_2 <19.5% or >25%, explosive atmosphere >25% LEL (California-20%), unknown organic vapors >500 ppm, particulates >_____ mg/m^3, other _____.

Air Monitoring (daily calibration unless otherwise noted):

Contaminant of Interest	Type of Sample (area, personal)	Monitoring Equipment	Frequency of Sampling
VOCs	Area	HNu	Continuous
Radiation		Mini Rad	
Explosive Gases	"	O_2/Explosimeter	"

(Expand if necessary)

Decontamination Solutions and Procedures for Equipment, Sampling Gear, etc.:
Trisodium phosphate wash, tap water rinse, isopropanol rinse, organic-free water rinse, and allow to air dry.

Teflon implements used for the collection of samples for metals analysis will include a 10% nitric acid solution rinse after the tap water rinse and will be followed by a tap water rinse, isopropanol rinse, and organic-free water rinse.

Personnel Decon Protocol: Boot and glow wash - trisodium phosphato wash with clean water rinse. Expendables will be double-bagged and drummed for disposal. Field personnel will take a hygienic shower, off site, following each day's fieldwork.

Decon Solution Monitoring **Procedures,** if Applicable: Decontamination will be performed in a well-ventilated area upwind of the sampling zone.

Special Site Equipment, Facilities, or Procedures (Sanitary Facilities and Lighting Must Meet 29 CFR 1910.120):

Site Entry Procedures and Special Considerations: E & E's "Buddy System" will be employed at all times during fieldwork activities. Personnel will exercise caution in the vicinity of nearby roadways. If above background radiation levels are encountered, team members will evacuate the sampling area and contact the corporate health physics group to reassess the site.

Work Limitations (time of day, weather conditions, etc.) and Heat/Cold Stress Requirements:

All fieldwork activities will be performed during daylight hours. Team members will take breaks as needed to prevent heat stress and replace fluids. Cooling vests may be used to prevent heat stress.

General spill Control, if applicable: N/A

Investigation-Derived Material Disposal (i.e., expendables, decon waste, cuttings):

All fieldwork waste materials will be double-bagged, drummed, labeled and transported to a designated location for final disposal by the Navy.

Sample Handling Procedures Including Protective Wear:

During all handling of samples, all field team members will wear surgical gloves. Goggles will be worn during sample preservation with acids.

Team Member*	Responsibility
To be determined	Team Leader
	Site Safety Officer/Sampler
	Sampler
	Sampler

*All entries into exclusion zone require *buddy* System use. All E & E field staff participate in medical monitoring program and have completed applicable training per 29 CFR 1910.120. Respiratory protection program meets requirements of 29 CFR 1910.134, and ANSI Z88.2 (1980).

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a. EMERGENCY INFORMATION

(Use supplemental shoots, if necessary)

LOCAL RESOURCES

(Obtain a local telephone book from your hotol, if possible.)

Ambulance On Base — 904-452-4138, Off Base — 911

Hospital Emergency Room NAS Dispensary - Building 3600 - 904-452-2733, Baptist Hospital 904-434-4811

(Life Flight)

Poison Control Center

Police (include local, county sheriff, state) 911

Fire Department 911

Airport

U.S. Coast Guard Emergency - 904-453-8178, General Information 904-4534282

Laboratory E L E ASC 1-716-631-0360

Fed. Express 1-800-238-5355

Client Contact U.S. Navy Southern Division, Engineer-In-Charge, 1-803-743-0571

Site Contact NAS Pensacola Environmental Coordinator, W. Dewayne Ray — 904-452-4515

SITE RESOURCES

Site Emergency Evacuation Alarm Method N/A

Water Supply Source on sit.

Telephone Location, **Number** To be dotorminod on site

Cellular Phone, if available To be dotorminod on site

Radio

Other On-site warehouse number to be dotorminod

EMERGENCY CONTACTS

1. Dr. Raymond Harbison (Univ. of Florida) ..... (501) 221-0465 or (904) 462-3277, 3281
   Alachua, Florida 1501) 370-8263 (24 hours)

2. Ecology and Environment, Inc.. Safety Director
   Paul Jonmaire ..... (716) 684-8060 (office)
   (716) 655-1260 (home)

3. Regional Office Contact ..... S.Newchurch... 878-2336 (homo)
   877-1978 (office)

4. Office Manager ..... R.Rudy..... 893-7245 (home)

1. Twenty-four hour —— ring service: (501) 370-8263

What to report:

- State: "this is an emergency."
- Your name, region, and site.
- Telephone number to roach you.
- Your location.
- Name of person injured or exposed.
- Nature of emergency.
- Action taken.

2. A toxicologist, (Drs. Raymond Harbison or associate) will contact you. Repeat the information given to the answering service.

3. If a toxicologist does not return your call within 15 minutes, call tho following persons in order until contact is made:

A. 24 hour hotline - (716) 684-8940
b. Corporate Safety Director - Paul Jonnaire - home @ (716) 655-1260
c. Assistant Corp. Safety Officer - Steven Sherman - home @ (716) 688-0084

EMERGENCY ROUTES

(NOTE: Field Team must Know Route(s) Prior to Start of Work)

Directions to hospital (include map) from sites 32, 33, and 35

NAS Dispensary - Follow Taylor Road west to Duncan Road. Turn loft onto Duncan Road and follow it south to tho intersection with Turner Street. Turn left on Turner Street. The NAS Dispensary is located on Turner Street in Building 3600.

Baptist Hospital - Take Duncan Road (Navy Blvd.) north to exit the base. Navy Blvd. becomes HWY 98 and curves to the east. Follow Navy Blvd./Hwy. 98 east approx. 3 mi to Pace Blvd. Turn loft (north) on Pace Blvd. and proceed approx. 1 mi to Cervantes St. (Hwy. 90). Turn right on Cervantes/Hwy. 90 and follow this road for about 8 blocks and turn loft (north) onto E street. The hospital is about 6 blocks north on the loft.

Emergency Egress Routes to Got Off-Sit. Emergency egress routes will be located if emergency exit routes become blocked by construction, etc.

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F. EQUIPMENT CHECKLIST

PROTECTIVE GEAR

Level A	No.	Level B	No.
SCBA		SCBA	
SPARS AIR TANKS		SPARE AIR TANKS	
ENCAPSULATING SUIT (Type _____)		PROTECTIVE COVERALL (Type _____)	
SURGICAL GLOVES		RAIN SUIT	
NEOPRENE SAFETY BOOTS		BUTYL APRON	
BOOTIES		SURGICAL GLOVES	
GLOVES (Type _____)		GLOVES (Type _____)	
OUTER WORK GLOVES		OUTER WORK GLOVES	
HARD HAT		NEOPRENE SAFETY BOOTS	
CASCADE SYSTEM		BOOTIES	
5-MINUTE ESCAPE COOLING VEST		HARD HAT WITH FACE SHIELD	
		CASCADE SYSTEM	
		MANIFOLD SYSTEM	
Level C		**Level D**	
ULTRA-TWIN RESPIRATOR		ULTRA-TWIN RESPIRATOR (Available)	X
POWER AIR PURIFYING RESPIRATOR		CARTRIDGES (Type GMC-H)	X
CARTRIDGES (Type _____)		5-MINUTE ESCAPE MASK (Available)	
5-MINUTE ESCAPE MASK		PROTECTIVE COVERALL (Type TYVEK)	X
PROTECTIVE COVERALL (Type _____)		RAIN SUIT	
RAIN SUIT		NEOPRENE SAFETY BONDS	
BUTYL APRON		BOOTIES	X
SURGICAL GLOVES		WORK GLOVES	
GLOVES (Type _____)		HARD HAT	X
OUTER WORK GLOVES		SAFETY GLASSES	X
NEOPRENE SAFETY BOOTS			
HARD HAT WITH PACE SHIELD			
BOOTIES			
HARDHAT			

INSTRUMENTATION	No.	DECON EQUIPMENT	bo.
OVA		WASH TUBS	X
THERMAL DESORBER		BUCKETS	X
O2/EXPLOSIMETER W/CAL. KIT	X	SCRUB BRUSHES	X
PHOTOVAC TIP		PRESSURIZED SPRAYER	X
HNu (Probe 10.2 ev)	X	DETERGENT (Type _____)	
MAGNETOMETER		SOLVENT (Type _____)	
PIPE LOCATOR		PLASTIC SHEETING	X
WEATHER STATION		TARPS AND POLES	
DRAEGER PUMP, TUBES _____		TRASH BAGS	X
BRUNTON COMPASS		TRASH CANS	
MONITOX CYANIDE		MASKING TAPE	X
HEAT STRESS MONITOR		DUCT TAPE	X
NOISE EQUIPMENT _____		PAPER TOWELS	X
PERSONAL SAMPLING PUMPS		FACE MASK	
		FACE MASK SANITIZER	
		FOLDING CHAIRS	
		STEP LADDERS	
RADIATION EQUIPMENT		DISTILLED WATER	X
DOCUMENTATION FORMS			
PORTABLE RATEMETER			
SCALER/RATEMETER		SAMPLING EQUIPMENT	
NaI Probe		8 OZ. BOTTLES	X
ZnS Probe		HALF-GALLON BOTTLES	X
GM Pancake Probe		VOA BOTTLES	X
GM Side Window Probe		STRING	
MICRO R METER		HAND BAILERS	X
ION CHAMBER		THIEVING RODS WITH BULBS	
ALERT DOSIMETER		SPOONS	X
POCKET DOSIMETER		KNIVES	
MINI RAD	X	FILTER PAPER	
FIRST AID EQUIPMENT		PERSONAL SAMPLING PUMP SUPPLIES	
FIRST AID KIT	X		
OXYGEN ADMINISTRATOR			
STRETCHER			
PORTABLE EYE WASH	X		
BLOOD PRESSURE MONITOR			
FIRE EXTINGUISHER	X		

VAN EQUIPMENT	NO.	MISCELLANEOUS (Cont.)	NO.
TOOL KIT	X		
HYDRAULIC JAM			
LUG WRENCH			
TOW CHAIN			
VAN CHECK OUT			
Gas			
Oil			
Antifreeze			
Battery			
Windshield Wash			
Tire Pressure			
		SHIPPING EQUIPMENT	
MISCELLANEOUS		COOLERS	X
PITCHER PUMP		PAINT CANS WITH LIDS, 7 CLIPS EACH	
SURVEYOR'S TAPE		VERMICULITE	X
100 FIBERGLASS TAPE		SHIPPING LABELS	X
300 NYLON ROPE	X	DOT LABELS: "DANGER"	
NYLON STRING		"UP"	
SURVEYING FLAGS	X	"INSIDE CONTAINER COMPLIES ..."	
FILM		"HAZARD GROUP"	
WHEEL BARROW		STRAPPING TAPE	X
BUNG WRENCH		BOTTLE LABELS	X
SOIL AUGER		BAGGIES	X
PICK		CUSTODY SEALS	X
SHOVEL		CHAIN-OF-CUSTODY FORMS	X
CATALYTIC HEATER		FEDERAL EXPRESS FORMS	X
PROPANE GAS		CLEAR PACKING TAPE	X
BANNER TAPE			
SURVEYING METER STICK			
CHAINING PINS & RING			
TABLES			
WEATHER RADIO			
BINOCULARS			
MAGAPHONE			

ecology and environment, inc.

ON-SITE SAFETY MEETING

Project _____ TDD/Pan _____

Date _____ Tin _____ Job No. _____

Address _____

Specific Location _____

Type of Work _____

_____

SAFETY TOPICS PRESENTED

Protective Clothing/Equipment _____

Chemical Hazards _____

Radiation Hazards _____

Physical Hazards _____

Emergency Procedures _____

_____

Hospital/Clinic _____ Telephone _____

Hospital Address _____

Special Equipment _____

Other _____

Checklist

1. Emergency information reviewed? _____ and made familiar to all team members? _____
2. Route to nearest hospital driven? _____ and its location known to all team members? _____
3. Site safety plan readily available and its location known to all team members? _____

Meeting shall bo attended by all personnel who will be working within the exclusion area. Daily informal update meetings cill bo held when site tasks and/or conditions change.

ATTENDEES

(Expand on back of sheet if necessary)

Name Printed	Signature

Meeting Conducted by: _____ _____

(Print) (Signature)

_____ _____

(Site Safety Coordinator) (Team Leader)

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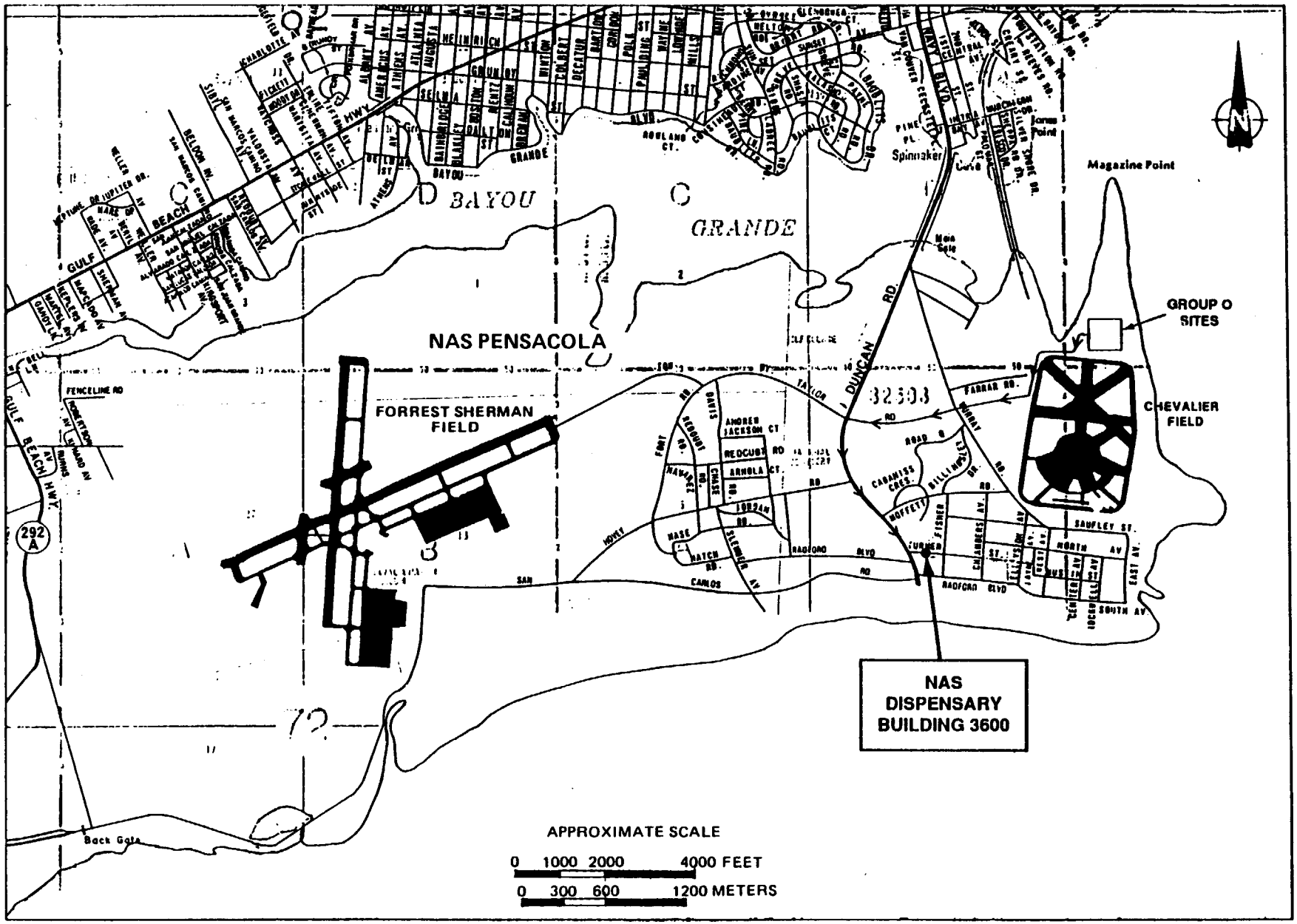

Figure A-1 LOCATION OF NAS DISPENSARY

ECOLOGY AND ENVIRONMENT, INC.,
STANDARD OPERATING PROCEDURES FOR EMERGENCIES DUE TO HEAT AND HEAT STRESS MONITORING

Field operations durlng the summer months can create a variety of hazards to the employee. Heat cramps. heat exhaustion, and heat stroke can be experienced and, If not remedied, can threaten life or health. Therefore, It Is Important that all employees be able to recognize symptoms of these conditions and be capable of arresting the problem as quickly as possible.

THE EFFECTS OF HEAT

As the result of normal oxidatlon processes within the body, a predictable amount of heat is generated. If the heat Is liberated as It is formed, there Is no change in body temperature. If the neat is liberated more rapldly, the body cools to a point at which the productlon of heat is accelerated ana the excess is available to bring the body temperature back to normal.

Interference with the elimination of heat leads to its accumulation and thus to the elevation of body temperature. As a result, the person is said to have a fever. When such a condition exists, it producer a vlclous cycle In which certain body processes speed up and generate addltlonal heat. Then the body must eliminate not only the normal but also the addltlonal quantltles of heat.

Heat produced within the body is brought to the surface largely by the bloodstream and escapes to the cooler surroundings by conduction arid radlatlon. If air movement or a breeze strikes the body, additional heat is lost by convection. However, when the temperature of the surrounding air becomes equal to or rises above that of the body, all of the heat must be lost by vaporization of the moisture or sweat from the skin surface. As the air becomes more humid (contains more moisture), vaporlzatlon from the skin slows down. Thus, on a day when the temperature Is 95 lo 100°F, with high humidity and little or no breeze, condltlons are ideal for the retention of heat within the body. It is on such a day or. more commonly, a succession of such days (a heat wave) that medical emergencies due to heat are likely to Occur. Such emergencies are classified in three categories: heat cramps, heat exhaustion, and heat stroke.

HEAT CRAMPS

Heat cramps usually affect people who work in hot environments and perspire a great deal. Loss of salt from tlie body causes very painful cramps of tlie leg and abdominal muscles. Heat cramps also may result from drinking iced water or other drinks either too quickly or in too large a quantity.

Heat Cramp Symptoms. The symptoms of heat cramp are:

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- Muscle cramps In legs and abdomen,
- Paln accompanying the cramps ,
- Faintnerr , and
- Profuse perspIration.

Heat Cramp Emergency Care. Remove the patlent to a cool place. Give him slps of liquids such as "Catorade" or its equlvalent. Apply manual pressure to the cramped muscle. Remove the patient to a hospital If there is any Indlcation of a more serious problem.

HEAT EXHAUSTION

Heat exhaustlon occurs In Indlvlduals workln In hot cnvlronments, and may be associated wlth heat cramps. Heat exhaurtlon Is caused by the pooling of blood In the vessels of the skln. The heat la transported from the Interior of the body to the surface by the blood. The blood vessels In the skln become dilated and a large amount of blood Is pooled In the skln. This condltion, plus the blood pooled In the lower extremities when an Indlvldual Is In an upright posltion, may lead to an Inadequate return of blood to the heart arid eventually to physical collapse.

Heat Exhaustlon Symptoms. The symptoms of heat exhaustion are:

- Weak pulse;
- Rapld and usually shallow breathing;
- Generalized weakness:
- Pale, clammy skln;
- Profuse perspiratlon;
- Dizzlness;
- Unconsciousness; and
- Appearance of havln fainted (the patlent responds to the same treatment administered in cases of falntln).

Heat Exhaustlon Emergency Care. Remove the patient to a cool place and remove as much clothing as possible. Administer cool water, "Catorade," or its equivalent. It possible, fan the patlent continually to remove heat by convection, but do not allow chilling or overcooling. Treat the patient for shock, and remove him to a medical facility If there is any indlcatlon of a more serious problem.

HEAT STROKE

Heat stroke is a profound disturbance of the heal-regulating mechanism, associated with high fever and collapse. Sometimes this condition results in convulsions, unconsciousness, and even death. Direct

exposure to sun, poor air circulation, poor physical condition, and advanced age (over 40) bear directly on the tendency to heat stroke. It is a serious threat to life and carries a 20% mortality rate. Alcoholics are extremely susceptible.

Heat Stroke Symptoms. The symptoms of heat stroke are:

- Sudden onset;
- Dry, hot, and flushed skin;
- Dilated pupils;
- Early loss of consciousness;
- Full and fast pulse:
- Breathing deep at first, later shallow and even almost absent;
- Muscle twitching, growing into convulsions: and
- Body temperature reaching 105 to 106°F or higher.

Heat Stroke Emergency Care. Remember that this is a true emergency. Transportation to a medical facility should not be delayed. Remove the patient to a cool environment if possible, and remove as much clothing as possible. Assure an open airway. Reduce body temperature promptly--preferably by wrapping in a wet sheet or else by dousing the body with water. If cold packs are available, place them under the arms, around the neck, at the ankles, or at any place where blood vessels that lie close to the skin can be cooled. Protect the patient from injury during convulsions, especially from tongue biting.

AVOIDANCE OF HEAT-RELATED EMERGENCIES

Please note that, in the case of heat cramps or heat exhaustion, "Gatorade" or its equivalent is suggested as part of the treatment regime. The reason for this type of liquid refreshment is that such beverages will return much-needed electrolytes to the system. Without these electrolytes, body systems cannot function properly, thereby increasing the represented health hazard. Therefore, when personnel are working in situations where the ambient temperatures and humidity are high--and especially in situations where protection Levels A, B, and C are required--the site safety officer must:

- Assure that all employees drink plenty of fluids ("Gatorade" or its equivalent);
- Assure that frequent breaks are scheduled so overheating does not occur; and
- Revise work schedules, when necessary, to take advantage of the cooler parts of the day (i.e., 5:00 a.m. to 1:00 p.m., and 6:00 p.m. to nightfall).

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If protective clothing must be worn, especially Levels A and B, the suggested guidelines for ambient temperature and maximum wearing time par excursion are:

Ambient Temperature (°F)	Maximum Wearing Time per Excursion (Minutes)
Above 90	15
85 to 90	30
80 to 85	60
70 to 80	90
60 to 70	120
50 to 60	180

One method of measuring the effectiveness of employees' rest-recovery regime is by monitoring the heart rate. The "Brouha guideline" is one such method:

- During a three-minute period, count the pulse rate for the last 30 seconds of the first minute, the last 30 seconds of the second minute, and the last 30 seconds of the third minute.
- Double the count.

If the recovery pulse rate during the last 30 seconds of the first minute is at 110 beats/minute or less and the deceleration between the first, second, and third minutes is at least 10 beats/minute, the work-recovery regime is acceptable. If the employee's rate is above that rpcclfled, a longer rest period is required, accompanied by an increased intake of fluids.

Mallinckrodt
Material Safety Data

Emergency Phone Number: 314-982-5000

Mallinckrodt provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. Individuals receiving this information must exercise their independent judgment in determining its appropriateness for a particular purpose.

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Mallinckrodt, Inc., Science Products Division. P.O. Box M, Paris, KY 40361.

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ISOPROPYL ALCOHOL

PRODUCT IDENTIFICATION;

Synonyms: 2-propanol; sec-propyl alcohol; isopropanol

Formula CAS No.: 67-630

Molecular Weight: 60.10

Chemical Formula: $(CH_3)_2$ CHOH

Hazardous Ingredients: Not applicable.

PRECAUTIONARY MEASURES

WARNING! FLAMMABLE LIQUID. HARMFUL IF SWALLOWED OR INHALED. AFFECTS CENTRAL NERVOUS SYSTEM. CAUSES IRRITATION.

Keep away from heat, sparks and flame.
Keep container closed.
Use with adequate ventilation.
Avoid breathing vapor.
Wash thoroughly after handling.
Avoid contact with eyes, skin and clothing

EMERGENCY/FIRST AID

If swallowed, give rater to drink. Induce vomiting if medical help is not immediately available. Never give anything by mouth to an unconscious person. If inhaled. remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give orygen. In care of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes. In all cases call a physician.
SEE SECTION 5.

DOT Hazard Class: Flammable Liquid

SECTION 1 Physical Data

Appearance: Clear, colorless liquid.

Odor: Rubbing alcohol.

Solubility. Infinite in water.

Boiling Point: 82°C (180°F).

Melting Point: -89°C (-128°F).

Specific gravity: 0.79

Vapor Density (Air = 1): 2.1

Vapor Pressure (mm Hg): 33 @ 20°C (68°F)

Evaporation Rate: (n-BUAC = 1) 2.83

SECTION 2 Fire and Explosion Information

Fire:
Flammable Liquid
Flashpoint: 12°C (53°F). (closed cup).
Autoignition temperature: 399°C (750°F).
Flammable limits in air, % by volume:
lel: 2.4 uel: 12.0.

Explosion:
Above flash point, vapor-air mixtures are explosive within flammable limits noted above. Contact with strong oxidizers may cause fire or explosion.

Fire Extinguishing Media:
Water spray, dry chemical, alcohol foam, or carbon dioride. Water spray may be used to keep fire exposed containers cool.

Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with lull facepiece operated in the pressure demand or other positive pressure mode. Water may be used to flush spills away from exposures and to dilute spills to non-flammable mixtures. Vapors can flow along surfaces to distant ignition source and flash back.

SECTION 3 Reactivity Dab

Stability:
Stable under ordinary conditions o luse and stongc. Heat and sunlight can contribute to instability.

Hazardous Decomposition Products:
Toric gases and vapors such as carbon monoxide may be released in a fire involving isopropyl alcohol.

Hazardous Polymerization:
Will not occur.

Incompatibilities:
Heat, flame, strong oxidizers, acetadehyde, chlorine, ethylene oxide. hydrogen-palladium combination. hydrogen peroxide-sulfuric acid combination, potassium tert-butoxide, hypochlorous add. isocyanates, nitroform, phosgene, oleum and perchloric acid.

SECTION 4 Leak/Spill Disposal Information

Remove all sources of ignition. Ventilate area o lleak or spill. Clean-up personnel require protective clothing and respiratory protection from vapors. Small spills may be absorbed on paper towels and evaporated in a fume hood. Allow enough time lor fumes to clear hood, then ignite paper in a suitable location away from combustible materials. Contain and recover liquid for reclamation when possible. Larger spills and lot sizes can be collected as hazardous waste and atomized in a suitable RCRA approved combustion chamber, or absorbed with vermiculite, dry sand, earth or similar material for disposal as hazardous waste in a RCRA approved facility.

Ensure compliance with local, state and federal regulations.

NFPA Ratings: Health: 1 Flammability: 3 Reactivity 0

SECTION 5 Health Hazard Information

A. EXPOSURE / HEALTH EFFECTS

Inhelation:
May cause irritation of the nose and throat. Exposure to high concentrations has a narcotic effect. producing symptoms of drowsiness, headache, staggering. unconsciousness and possibly death.

Ingestion:
May cause drowsiness, unconsciousness, and death. Gastrointestinal pain, cramps, nausea, vomiting. and diarrhea may also result. The single lethal dose lor a human adult = about 250 mls (S.AX Sixth Edition).

Skin Contact:
Has a defatting action of the skin that can cause irritation. May cause irritation with a stinging effect and burning sensation.

Eye Contact:
Vapors may irritate the eyes. Splashes may cause severe irritation. possible corneal burns and eye damage.

Chronic Exposure:
Prolonged contact with skin may cause mild irritation, drying, cracking, or contact dermatitis may develop.

Aggrevation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired respiratory function mry be more susceptible to the effects of the substance.

B. FIRST AID

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a phpician.

Ingestion:
Give water to drink. Induce vomiting if medical help not is immediately available. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Skin Exposure:
Remove any contaminated clothing. Wash skin with soap or mild detergent and water for at least IS minutes. Get medical attention if irritation develops or persists.

Eye Exposure:
Wash eyes with plenty of water lor at least 15 minuter, lifting lower and upper eyelids occasionally. Get medical attention immediately.

C. TOXICITY DATA (RTECS, 1982)

Oral rat LD50: 5840 mg/kg. Skin rabbit LDSO: 13 gm/kg. Inhalation rat LOO: 16000 ppm/8H. Mutation references cited Aquatic Todcity rating TLm96: 1000-10 ppm.

SECTION 6 Occupational Control Measures

Airborne Exposure Limits:
- OSHA Permissible Exposure Limit (PEL): 400 ppm (TWA).
- ACGIH Threshold Limit Value (TLV): 400 ppm (TWA); 500 ppm (STEL).

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work arm. Please refer to the ACGIH document, 'Industrial Ventilation, A Manual o l Recommended Practices', most recent edition, for details.

Personal Respirators: (NIOSH Approved)
If the TLV is exceeded a full lacepiece chemical cartridge respirator may be worn, in general, up to the maximum use concentration specified by the respirator supplier. Alternatively, a supplied air full lacepiece respirator or airlined hood may be worn.

Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls to prevent skin contact.

Eye Protection:
Use chemical safety goggles and/or a lull face shield where splashing is possible. Contact lenses should not be worn when working with this material. Maintain eye wash fountain and quickdrench facilities in work arm.

SECTION 7 Storage and Special Information

Protect against physical damage. Store in a cool. dry well-ventilated location, away from any area where the fire hazard may be acute. Outside or detached storage is preferred. Separate from oxidizing materials. Containers should be bonded and grounded lor transfers to avoid static sparks. Storage and use areas should be NO Smoking areas. Use non-sparking type tools and equipment.

Material Safety Data

Emergency Phone Number: 314-982-5000

Individuals receiving this information must exercise their independent judgment in determining its appropriateness for a particular purpose.

the information set forth herein or to the product to which the information refers. Accordingly, Mallinckrodt will not be responsible for damages resulting from use of or reliance upon this information.

Mallinckrodt, Inc., Science Products Division, P.O. Box M, Paris, KY 40361.

NITRIC ACID, 70%

3701028

PRODUCT IDENTIFICATION:

Synonyms: Aqua Fortis; Azotic Acid; Nitric Acid 70%

Formula U S No.: 7697-37-2

Molecular Weight: *63.00*

Chemical **Formula:** HNO_3

Hazardous Ingredients: **Not** Applicable

PRECAUTIONARY MEASURES

DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED. INHALATION MAY CAUSE LUNG DAMAGE.

Do not get in eyes, **on** skin, **or on** clothing.
Avoid **breathing** mist.
Use only with adequate ventilation.
Wash thoroughly after handling.
Keep from contact with clothing **and other** combustible materials.
Do not store near combustible materials.
Store in a tightly closed container.
Remove **and** wash contaminated clothing promptly.
This substance **is** classified **as** a POISON under the Federal Caustic Poison Act.

EMERGENCY/FIRST AID

In case of contact, immediately flush skin **or** eyes with plenty of water for at least 15 minutes. If swallowed, **DO NOT** INDUCE **VOMITING!** Give large quantities of water **or** milk if available. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. **In all** cases call a physician.
SEE SECTION 5.

DOT Hazard Class: Oxidizer

SECTION 1 Physical Data

Appearance: Clear, colorless to slightly yellow liquid.

Odor: Suffocating acrid.

Solubility: Infinite in **water.**

Boiling Point: **122°C (252°F)**

Melting **Point: -34°C** (-29°F)

Specific Gravity: 1.41

Vapor Density (Air = 1): 2-3 approximately

Vapor Pressure (mm **Hg):** 62 **@ 20°C (68°F)**

Evaporation Rate: **No** information found.

SECTION 2 Fire and Explosion Information

Fire:
Not combustible, but substance **is** a strong oxidizer and its heat of reaction with reducing **agents or** combustibles may aw ignition. Can react with metals to release flammable **hydrogen gas.**

Explosion:
Reacts explosively with combustible **organic or** readily oxidizable materials such **as:** alcohols, turpentine, charcoal, organic refuse, metal powder, hydrogen sulfide, **etc.**

Fire Extinguishing Media:
If involved in a fire, **use water** spray.

Special Information:
Increases the flammability of combustible, organic and readily oxidizable materials. In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing **apparatus** with **full** facepiece operated in the **pressure** demand or other positive pressure mode.

SECTION 3 Reactivity Data

Stability:
Stable under ordinary conditions of use **and** storage. Containers may burst **when** heated.

Hazardous Decomposition Products:
When heated **to decomposition, emits toxic** nitrogen oxides fumes **and hydrogen** nitrate. Will **react** with water **or** steam to **produce heat** and toxic and corrosive fumes.

Hazardous Polymerization:
Will not occur.

Incompatibilities:
A dangerously powerful **oxidizing agent,** concentrated nitric acid **is** incompatible with **mart substances, especially strong bases,** metallic powders, carbides, hydrogen sulfide, turpentine, and combustible organics.

SECTION 4 Leak/Spill Disposal Information

Isolate **or** enclose the **area** of the leak or spill. **Clean-up** personnel should wear **protective** clothing and respiratory equipment suitable for toxic or **corrosive** fluids or vapors.
Small Spills: Flush **with water** and **neutralize** with alkaline material (**soda ash,** lime, etc.). Sewer **with** excess water.
Larger spills **and** lot **sizes:** Neutralize with alkaline material. pick **up with absorbent** material (sand, earth, vermiculite) and **dispose** in RCRA-approved waste facility or sewer the neutralized slurry **with excess water** if local ordinances allow. Provide forced ventilation to dissipate fumes.

Reportable Quantity **(RQ)(CWA/CERCLA) :1000** lbs.

Ensure compliance with **local, state and federal** regulations.

NFPA Ratings: **Health:** 3 **Flammability:** 0 Reactivity: 0 **Other: Oxidizer**

SECTION 5 Health Hazard Information

A. EXPOSURE / HEALTH EFFECTS

Inhalation:
Corrosive! Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema. which may be fatal. Other symptoms may include coughing, choking. and irritation of the nose, throat, and respiratory tract.

Ingestion:
Corrosive! Swallowing nitric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract.

Skin Contact:
Corrosive! Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color.

Eye Contact:
Corrosive! Vapors are irritating and may cause damage to the eyes. Splashes may cause severe burns and permanent eye damage.

Chronic Exposure:
Long-term exposure to concentrated vapors may cause erosion of teeth. Long term exposures seldom occur due to the corrosive properties of the acid.

Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye disease may be more susceptible to the effects of this substance.

B. FIRST AID

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

Ingestion:
DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to in unconscious person. Get medical attention immediately.

Skin Exposure:
In case of contact. immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Eye Exposure:
Wash eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

C. TOXICITY DATA (RTECS, 1982)

Inhalation (Rat) LC50: 244 ppm
(NO_2)/30M

SECTION 6 Occupational Control Measures

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
2 ppm (TWA)
-ACGIH Threshold Limit Value (TLV):
2 ppm (TWA); 4ppm (STEL)

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, "Industrial Ventilation, A Manual of Recommended Practices", mat recent edition. for details.

Personal Respirators: (NIOSH Approved)
If the TLV is exceeded, wear a supplied air, full-facepiece respirator, airlined hood, or self-contained breathing apparatus. Nitric acid is an oxidizer and should not come in contact with cartridges and cannisters that contain oxidizable materials. such as activated charcoal.

Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls to prevent skin contact.

Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Contact lenses should not be worn d e n working with this material. Maintain eye wash fountain and quick-drench facilities in work area.

SECTION 7 Storage and Special Information

Keep in a tightly closed container. stored in a cool. dry, ventilated area. Protect from physical damage and direct sunlight. Isolate from incompatible substances. Protect from moisture.

Chemical Fact Sheet* Version 3

XYLENES

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Xylene, CAS 1330-20-7; 1,3-Dimethylbenzene, meta-xylene, CAS 108-38-3; 1,2-Dimethylbenzene, ortho-xylene, CAS 95-47-6; 1,4-Dimethylbenzene, para-xylene, CAS 104-42-3.

Trade Names: nixed aromatic hydrocarbons, p-Xylol, o-Xylol, m-Xylol and others.

Uses: Used as an intermediate in the manufacture of dyes; found in solvent mixtures, Certain insecticides and aviation furl; degreasing and cleaning agent; raw material for terephthalic acid. Used in pharmaceutical synthesis and raw material for phthalic anhydrides.

Appearance: Clear, colorless liquid which may form crystals at temperatures below 57°F (14°C).

Odor: Strong; pleasant. **Minimum Detectable by Odor:** 20 ppm.

Behavior in Water: Xylene is not soluble in water, it will float.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure -- 100 ppm.

NIOSH Recommended Limit: Average 10 hour day/40 hour week -- 100 ppm.

ACGIH Recommended Limit: Average 8 hour exposure -- 100 ppm.

Note: the health effects and standards for all the xylenes are similar.

Short Term Exposure:

Inhalation: Exposure to vapor can be irritating to the nose and throat. Inhalation of vapor at concentrations above 200 ppm or 3-5 minutes can lead to xylene intoxication. Symptoms include headache, dizziness and nausea. If exposure should continue, central nervous system depression characterized by shallow breathing and weak pulse can occur. Levels of 230 ppm for 15 minutes may cause lightheadedness without loss of equilibrium. Reversible liver and kidney damage in man has followed exposure to sudden high concentrations of vapor. Such high levels may also give rise to lung congestion. Exposure to extremely high concentrations (10,000 ppm) of xylene vapors can lead to a Strong narcotic effect wrth symptoms of slurred speech, stupor and coma.

Skin: Contact with vapor or liqurd can cause drying and defatting which may lead to irrication.

Eyes: vapor and liquid may be irritating to the eye and eyelids at levels of 100 ppm tor 15 minutes.

Ingestion: Swallowing liquid xylene will bring about an immediate burninq sensation in the mouth and throat. Irritation of the stomach and intestine can give rise to sharp stomach pains. Symptoms arm the same as inhalation, except that lung congestion will not usually develop.

Long Term Exposure:

Inhalation of xylene vapor and skin contact with liquid arc the two most probable rouces of lonq term exposure. Symptoms of inhalation are dizziness, headache and nausea. Long term exposure has been associated with liver and kidney damage, intestinal tract disturbances and central nervous system depression. These effects are revertible ana disappear once the chemical has been removed. Prolonged contact with skin can lead to irritation.

*Prepared by the Bureau of Toxic Substance Assessment. New York State Department of Health. For an explanation of the terms and abbreviations used, see 'Toxic Substances: How Toxic is Toxic' available from the New York State Department of Health.

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EMERGENCY AND FIRST AID INSTRUCTIONS

Inhalation: Move person to fresh air and give artificial respiration if breathing has stopped. Seek medical attention if necessary.

Skin: Wash with soap and water for at least 5 minutes. Seek medical attention if necessary.

Eyes: Wash with water for at least 15 minutes. Seek medical attention.

Ingestion: Do not try to induce vomiting. Seek medical attention immediately.

Note to Physician: May require supportive measures for pulmonary edema.

FIRE AND EXPLOSION INFORMATION

General: Liquid and vapor are both flammable. Vapor can spread to a source of ignition and flash back. Ignites at 84°F (30°C).

Explosive Limits: Upper -- 71, Lower -- 1.11.

Extinguisher: Foam, dry chemical or carbon dioxide.

REACTIVITY

Materials to Avoid: Oxidizing agents such as permanganate and chlorine.

Conditions to Avoid: Any source of ignition.

PROTECTIVE MEASURES

Storage and Handling: Protect containers against physical damage. Store, if possible, outdoors or in a detached building. If indoors, a standard flammable liquid storage room should be used.

Engineering Controls: Proper ventilation of storage area and work area. Sink, showers, eyewash stations should be available.

Protective Clothing (Should not be substituted for proper handling and engineering controls): If contact with xylene is likely, wear rubber gloves, chemical goggles and impervious protective clothing.

Protective Equipment: For levels up to 1,000 ppm use a supplied-air respirator, a self-contained breathing apparatus, a chemical cartridge respirator with organic vapor cartridges or a powered air-purifying respirator with organic vapor cartridges. For levels up to 4500 ppm use a supplied-air respirator operated in continuous flow mode. For levels up to 5000 ppm use a gas mask with an organic vapor canister, a self-contained breathing apparatus with a full facepiece or a supplied-air respirator with a full facepiece. For levels up to 10,000 ppm use a Type C supplied-air respirator with full facepiece operated in a positive pressure mode. For levels above 10,000 ppm or use in areas of unknown concentrations use a self-contained breathing apparatus with full facepiece operated in a positive pressure mode or a Type C supplied-air respirator with an auxiliary self-contained breathing apparatus, both with a full facepiece and operated in a positive pressure mode. For escape from a contaminated area use a gas mask with an organic vapor canisrer or an escape self-contained breathing apparatus.

PROCEDURES FOR SPILLS AND LEAKS

Get all workers out of spill area. After putting on protective clothing and equipment, spread absorbent material on spill area. Sweep and place absorbent into fiber carton container. For final disposal contact your regional office of the New York State Department of Environmental Conservation.

For more information:
Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, 2 University Place, Albany, New York 12203.

Chemical Fact Sheet* Version 2

NAPHTHALENE

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Naphthaline; CAS 91-20-3.

Trade Names: White tar, moth balls, moth flakes and others.

Uses: Moth repellent, insecticide; in the manufacture of phthalic acid, anthranilic acid, dyes, resins, lampblack and others.

PHYSICAL INFORMATION

Appearance: White flakes, cakes or powder.

Odor: Mothball-like. **Minimum Detectable by Odor:** 0.03 ppm.

Behavior in Water: Insoluble.

Evaporation: Moderate rate of change from a solid directly to a gas.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure -- 10 ppm.

NIOSH Recommended Limit: None established.

ACGIH Recommded Limit: Average 8 hour exposure -- 10 ppm.

Short Term Exposure:

Inhalation: Levels above 10 ppm may cause headache, nausea, excessive sweating and vomiting.

Skin: May cause irritation. If hypersensitive to naphthalene, severe irritation may occur.

Eyes: Levels above 15 ppm may cause irritation. Direct contact may cause severe irritation, injury to the cornea and a blurring of vision.

Ingestion: Ingestion of 1/2 gram (1/60 ounce) may cause nausea, vomiting, abdominal pain, irritation of the bladder, and brown or black coloration of the urine. The symptoms usually disappear after a few days. Animal studies indicate that the probable lethal dose for an adult is 5 to 15 grama (1/16 to 1/2 ounce).

Long Term Exposure:

Repeated ingestion of 1f2 gram doses may cause clouding of the eye. Inhalation of levels above 10 ppm may cause headaches, nausea, vomiting and a feeling of general discomfort. Chronic skin problems are rare, except in cases of hypersensitivity.

*Prepared by the Bureau of Toxic Substance Assessment, New York State Department of Health. For an explanation of the terms and abbreviations used, see 'Toxic Substances: How Toxic is Toxic' available from the New York State Department of Health.

EMERGENCY AND FIRST AID INSTRUCTIONS

Inhalation: Move person to fresh air. Give artificial respiration or oxygen as required. Seek medical attention, if necessary,

Skin: Remove chemically soiled clothinq. Wash affected area for at least 5 minutes. Seek medical attention, if necessary.

Eyes: Wash with large amounts of water for at least 15 minutes. See an eye doctor immediately.

Ingestion: Give person plenty of water, including one glass vitb about 1/6 ounce of baxing soda. Seek medical attention immediately. **Note:** Never force an unconscious person to drink.

Note to Physician: *nay* require emesis or gastric lavage, saline cathartic, and protein demulcents. Oils may speed absorption. Occurrence of hemolysis may require transfusio Hemodialysis may be required in case of acute renal failure. Detection of alpha-naphth in urine may be necessary for definitive diagnosis.

FIRE AND EXPLOSION INFORMATION

General: Flammable. Ignites at 880C (1740F).

Explosive Limits: Upper — 68, lower — 0.9%.

Extinguisher: Water, carbon dioxide, dry chemical or foam. Direct vater or spray on burnin naphthalene can Cause violent and excessive foaming.

REACTIVITY

Conditions to Avoid: High temperatures.

Materials to Avoid: Reacts violently with stronq oxidizing aqents (permanganate, dichromate). Reacts explosively with dinitrogen pentoxide.

Storage and Handling: Store in a cool, dry place away from sources of heat and ignition. Protect containers frun damage.

Engineering Controls: Use with local exhaust ventilation. Sinks, showers and eyewash stati should be available.

Protective Clothing (Should not be substituted for proper handling and engineering controls If contact is likely wear chemical goggles, face shield, plastic or rubber footwear, ap and gloves.

Protective Equipment For levels up to 100 ppm use a chemical cartridge respirator with organic vapor cartridges and dunt and mist filters, a supplied-air respirator or a self-contained breathing apparatus. For levels up to 250 ppm use a supplied-arr respirator operated in continuous flow mode or a powered-air purifying respirator with organic vapor cartridges and dust and mist filters. For levels up to 500 ppm use a chemical cartridge respirator vith organic vapor cartridges and high-cfficiency particulate Filters, a supplied-air respirator vich a full facepiece or a self-containe breathing apparatus with a full facepiece. For levels above 500 ppm or use in areas of unknown concentrations use a self-contained breathing apparatus with a full facepiece operated in a positive pressure mode or a combination Type C supplied-air respirator wi an auxiliary self-contained breathing apparatus, both with a full facepiece and operate in a positive pressure mode. par escape from a contaminated area use a gas mask vith a organic vapor canister and high-efficiency particulate filter or an escape self-contain breathing apparatus. For firefighting use a self-contained breathing apparatus with a full facepiece operated in a positive pressure mode.

PROCEDURES FOR SPILLS AND LEAKS

Get all workers out of the spill area. Wearing proper protective clothinq and equipment s into a fiber carton. For final disposal contact your regional office of the New York State Department of Environmental Conservation.

For more information:
Contact the Industrial Hygienist or Safety Officer at your vorksite or the New York Sta Deportment of Health, Bureau of Toxic Substance Assessment, 2 University Place, Albany, New York 12203.

Chemical Pact Sheet* Version 2

VINYL CHLORIDE

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Chloroethylene, chloroethene, ethylene monochloride, monochloroethene, monochloroethylene; CAS 75-01-4.

Trade Names: VC, VCM, Troviduer, and others.

Uses: In the manufacture of plastics, as a refrigerant, and in organic synthesis.

PHYSICAL INFORMATION

Appearance: Colorless gas; may be liquified by refrigeration or pressurization.

Odor: Faint, sweet, ether-like. **Minimum Detectable by Odor:** 4000 ppm.

Behavior in Water: Slightly soluble.' **Evaporation:** Rapid.

HEALTH HAZ

OSHA Standard: Average 8 hour exposure -- 1 ppm.

NIOSH Recommended Limit: Lowest reliably detectable level.

ACGIH Recommended Limit: Averaqe 8 hour exposure -- 5 ppm.

Short Term Effe:

Inhalation: Exposure at 8,000 ppm for 5 minutes can cause a feeling of intoxication, trredncrs, drowsiness, abdominal pain, numbness and tingling in fingers and toes, pains in joints, coughing, sneezing, irritability and loss of appetite and weight.

Skin: Contact with liquid may cause frostbite; contact with vapor may cause irritation and rash. Absorption is possible through the skin.

Eyes: Can cause severe and immediate irritation.

Ingestion: None found.

Long Term Exposure:

May cause club-like swelling and shortening of finger tips. Skin may become thickened and stiff with coarse, whitish patches. Bones and joints of arms and legs may suffer damage. Liver and spleen damage may occur. Not all symptoms disappear after exposure stops.

Vinyl chloride has caused liver cancer in occupationally exposed individuals.

*Prepared by the Bureau of Toxic Substance Assessment, New York State Department of Health. For an explanation of the terms and abbreviations used, see 'Toxic Substances: How Toxic is Toric' available from the New Yotk State Department of Health.

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EMERGENCY AND FIRST AID INSTRUCTIONS

Inhalation: Move person to fresh air. Give artificial respiration or oxygen as required. Seek medical attention.

Skin: Remove soaked clothing. Wash affected area with soap and water for at least 5 minutes. Seek medical attention if necessary.

Eyes: Wash with running water for at least 15 minutes. Seek medical attention.

Ingestion: Seek immediate medical atrention.

FIRE AND EXPLOSION IN

General: Flammable. Fumes may travel long distances and flash back. Ignites ar -108°F (-78°C).

Explosive Limits: Upper -- 33%, Lower -- 3%.

Extinguisher: Stop flow of gas. Use water to keep fire exposed containers cool.

REACTIVITY

Conditions to Avoid: High temperatures may cause breakdown to phosgene ana hydrochloric acrd. avoid sources of ignition.

: Long contact with arr may result in formation of unstable peroxides which are explosive. Corrosive to iron at hrqh temperatures in the presence of water.

PROTECTIVE MEASURES

Storage and Handling: Protect against physical damage. Outside or detached storage preferred. Indoors, store in a cool, dry, well-ventilated area away from sources of iqnition.

Engineering Controls: Provide ventilation or process enclosures. Sinks, shovers and eyewash stations should be readily available.

Protective Clothing (Should not be substituted for proper handling and engineering controls): Goggles, gloves and impervious clothing should be warn if contact with vinyl chloride is possible.

Protective Equipment: For any detectable levels use a self-contained breathing apparatus with a full facepiece operated in a positive pressure mode or a supplied-arr resirator with an auxiliary self-contained breathing apparatus, both with a full facepiece and operated in a positive pressure mode. For escape from a contaminated area use a qas mask providing protection against vinyl chloride or an escape self-contained breathinq apparatus.

PROCEDURES FOR SPILLS AND LEAKS

Get all workers ouf of the spill area. Put on respirator and other protective clothing. Establish ventilation to keep levels below explosive limit. Remove possible sources of iqnition. Move lcakrnq cylinders to safe place in open air. for final disposal contact you: regional office of the New York State Department of Environmental Conservation.

For more information:
Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, 2 University Place, Albany, New York 12203.

Chemical Fact Sheet*

Version 2

BENZENE

The information in this sheet applies to workplace exposure resulting from procesring. manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The beat industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Benzol, phenyl hydride. cyclohexatriene; CAS 71-43-2.

Trade Names: Benzole, Benzolene, Carbon Oil, Carbon Naphtha, Mineral Naphtha, Motor benzol, Nitration benzene, Phene, Pyrobenzol a d ochers.

Uses: In the manufacture of styrene, phenol. detergents, organic chemicals, pesticides, plastics and resins, synthetic rubber, aviation fuel, pharmaceuticals, dyes. explosives. gasoline, flavors and perfumes, paints and coatings. Used in the industrial processing of nylon. certain food products and photographic chemicals.

PHYSICAL INFORMATION

Appearance: Colorless liquid.

Odor: Stronq. pleasant. **Minimum Detectable by Odor:** 5 ppm.

Behavior in Water: Slightly soluble. floats.

Evaporation: Rapid.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure limit -- 10 ppm.

NIOSH Recommended Limit: 1 ppm.

ACGIH Recommended Limit: Average 8 hour exposure limit -- 10 ppm.

Short Term Exposure:

Inhalation: Benzene may produce both nerve and blood effects. Irritation of tbr nose. throat and lungs may occur (3,000 ppm may be tolerated for only 30 to 60 minutes). Lung congestion u y occur. Nerve effects may include an exaggerated feeling of well-being, excitement, headache, dizziness and slurred speech. At high levels. slowed breathing and death may result. Death has occurred at 20.000 ppm for 5 to 10 minutes, or 1.500 ppm for 30 minutes.

Skin: Irritation may occur. with redness and blistering if nor promptly removed. Benzene is poorly absorbed. Whole body exposure for 30 minutes has been reported with no health effects.

Eyes: May cause severe irritation.

Ingestion: Kay cause irritation of mouth, throat and stomach. Symptoms are similar to those listed under inhalation. One tablespoon may cause collapse, bronchitis, pneumonia and death.

Long Term Exposure:

May cause loss of appetite, nausea. weight loss, fatigue, muscle weakness, headache. dizziness, nervousness and irritability. Mild anemia h u ken reported from exposures of 25 ppm for several yearn and 100 ppm for 3 months. At levels between 100 ana 200 ppm for periods of 6 months, or more, severe irreversible blood changes and damage to liver and heart may occur. Temporary partial paralysis has been reported.

Benzene is a known human carcinogen. Exposure has ken linked to increased risk of several forms of leukemia. Periodic blood testa of occupationally exposed individuals should be conducted.

*Prepared by the Bureau of Toxic Substance Assessment, New York State Department of Health. For an explanation of the terms and abbreviations used, see "Toxic Substances: How Toxic is Toxic" available from the New York State Department of Health.

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EMERGENCY AND FIRST AID INSTRUCTIONS

Inhalation: Remove to fresh air. Give artificial respiration or oxygen if necessary. Seek medical attention.

Skin: Remove soiled clothing immediately. Wash thoroughly with soap and water for at least 5 minutes. Seek medical attention, if necessary.

Eyes: Irrigate eyes with water for at least 15 minutes. Seek medical attention.

Ingestion: Do not try to induce vomiting. Seek medical attention immediately.

Note to Physician: Severe exposure may require supportive measures for pulmonary edema.

FIRE AND EXPLOSION INFORMATION

General: Flammable, vapor may spread considerable distance to a source of ignition and flash back. Ignites at -11°C (12°F).

Explosive Limit: Upper -- 7.18, Lower -- 1.3%.

Extinguisher: Carbon dioxide, dry chemical or foam.

REACTIVITY

Materials to Avoid: Contact with strong oxidizers, or iron in the presence of chlorine or bromine.

Conditions to Avoid: Exposure to sources of ignition.

PROTECTIVE MEASURES

Storage and Handling: Protect containers against physical damage. Storage preferred in an outdoor or detached burlding. If storage is indoor, use a standard flammable liquid storage room.

Engineering Controls: Use only with efficient ventilation.

Protective Clothing (Should not be substituted for proper handling and engineering controls): If direct contact is likely, wear protective rubber clothing, gloves and eye goggles.

Protective Equipment: For any detectable levels use a self-contained breathing apparatus with a full facepiece and operated a positive pressure mode or a combination type C supplied-air respirator with an auxiliary self-contained breathing apparatus, both with full facepiece and operated in a positive pressure mode. For escape from a contaminated area use a gas mask with organic vapor canister or an escape self-contained breathing apparatus.

PROCEDURES FOR SPILLS AND LEAKS

Get all workers out of spill area. Put on protective clothing and equipment when entering spill area for clean-up. Spread absorbent material on spill, sweep up and keep contained in fiber carton tightly sealed. For final disposal, contact your regional office of the New York State Department of Environmental Conservation.

For more information:
Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, 2 University Place, Albany, New Yorr 12203.

Chemical Fact Sheet* Version 7

TOLUENE

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Methylbenzene, methylbenzol, phenylmethane, toluol; CAS 108-88-3.

Trade Names: Methacide, Antisal I and others.

Uses: Used in the manufacture of benzoic acid, benzaldehyde, explosives, dyes and adhesives.

PHYSICAL INFORMATION

Appearance: Clear, colorless liquid.

Odor: Strong, pleasant. Minimum Detectable by Odor: 40 ppm.

Behavior in Water: Only a very small amount will mix, the rest will float.

Evaporation: Liquid evaporates very slowly.

OSHA Standard: Average 8 hour exposure limit -- 200 ppm.

NIOSH Recommended Limit: Average 8 hour exposure -- 100 ppm.

ACGIH Recommended Limit: Average 8 hour exposure -- 100 ppm.

Short Term Exposure:

Inhalation: 100 ppm exposure can cause dizziness, drowsiness and hallucinations. 100-200 ppm can cause depression. 200-500 ppm can cause headaches, nausea, loss of appetite, lost of energy, loss of coordination and coma. In addition to the above, death has resulted from exposure to 10,000 ppm for an unknown time.

Skin: Can cause dryness and irritation. Absorption may cause or increase the severity of symptoms listed above.

Eyes: Can cause irritation at 300 ppm.

Ingestion: Can cause a burning sensation in the mouth and stomach, upper abdominal pain, cough, hoarseness, headache, nausea, loss of appetite, loss of energy, loss of coordination and coma.

Long Term Exposure:

Levels below 200 ppm may produce headache, tiredness and nausea. From 200 to 750 ppm symptoms may include insomnia, irritability, dizziness, some loss of memory, loss of appetite, a feeling of drunkeness and disturbed menstruation. Levels up to 1,500 ppm may cause heart palpitations and loss of coordination. Blood effects and anemia have been reported but are probably due to contamination by benzene. Most of these effects art believed to go away when exposure stop..

Prepared by the Bureau of Toric Substance Assessment, New Yotk State Department of Health. For an explanation of the terms and abbreviations used, see "Toxic Substances: How Toxic is Toxic" available from the New York State Department of Health.

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EMERGENCY AND FIRST AID INSTRUCTIONS

Inhalation: Get perron to fresh air Keep warm and quiet. Give artificial respiration, if necessary. Seek medical attention, if necessary.

Skin: Take oft clothing soaked with liquid. Wash contaminated area with soap and water for at least 5 minutes. Seek medical attention, if necessary.

Eyes: Wash with large amounts of water for at least 15 minutes, Seek immediate medical attention.

Ingestion: Do not induce vomiting. Give one or two ounces of mineral oil. Seek immediate medical attention. Note: Never force an unconscious person to dcink.

Note to Physician: Exposure to toluene at levels greater then 200 ppm may result in hippuric acid levels above 5 gm/liter urine. After elevated exposure, toluene may also be detected in blood.

EXPLOSION INFORMATION

General: Flammable liquid. Fumes may spread a considerable distance and flash back. Will ignite at 4.4°C, 40°F.

Explosive Limits: Upper Limit -- 7.0%, Lower Limit -- 1.27%.

Extinguisher: Water spray, carbon dioxide, dry chemical or foam.

REACTIVITY

Materials to Avoid: Reacts violently with chlorine, permanganate and dichromate.

Conditions to Avoid: Sources of ignition.

PROTECTIVE MEASURES

Storage and Handling: Store outdoors or in a detached building, if possible. If indoors, store in a standard flammable liquid storage room or cabinet. Protect containers from physical damage.

Engineering Controls: Use in well-ventilated area. Eyewash stations, sinks and showers should be readily available.

Protective Clothing (Should not be substituted for proper [illegible] rols: If direct contact is likely, wear viton, PVA, NBR or polyethylene clothing.

Protective Equipment: For levels up to 1000 ppm use a chemical cartridge respirator with organic vapor cartridges, a supplied-air respirator, a stlf-contained breathing apparatus or a powered air-purlfyinq respirator with organic vapor cartridges. For levels up to 2,000 ppm use a gas mask with an organic vapor canister, a supplied-air respirator with a full facepiece, a self-contained breathinq apparatus with a full facepiece or a supplied-air respirator operated in continuous flow mode. For levels above 2000 ppm or at unknown concentrations use a self-contained breathing apparatus with a full facepiece operated in a positive pressure mode or a Type C supplied-air respirator with an auxiliary self-contained breathing apparatus, both with a full facepiece and operated in a positive pressure mode. For escape from a contaminated area use a gas mask vith an organic vapor Canister or an escape self-contained breathing apparatus.

PROCEDURES FOR SPILLS OR LEAKS

Get all workers out of the spill area. Put on a respirator and other protcctivt clothing. Spread sand or ocher absorbent material over liquid to absorb it. Shovel into buckets, take to a safe place in the open air. Wash area of spill with soap and water. For final disposal contact your regional office of the N.Y.S. Department of Environmental Conservation.

lor more information:

Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, 2 University Place, Albany, New York 12203.

1,1,2-TRICHLOROETHANE

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large, Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical,

Chemical Names: Ethane trichloride; beta-trichlorocthane; 1,2,2-trichloroethane; vinyl trichloride; NCI-C04579; CAS 79-00-5.

Trade Names: Beta-T.

Uses: As an intermediate in the production of vinylidine chloride; as a solvent for fats, waxes, and natural resins; and as a component of adhesives.

PHYSICAL INFORMATION

Appearance: Colorless liquid.

Odor: Chloroform-like, sweet.

Evaporation: Moderate. Vapors are heavier than air and tend to sink-

Behavior In Water: Only slightly soluble: sinks.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure -- 10 ppm.

NIOSH Recommended Limit: Average 10 hour day/40 hour week -- 10 ppm.

ACGIH Recommended Limit: Average 8 hour exposure -- 10 ppm.

Short Term Exposure:

Inhalation: Inhalation may produce headache, lassitude, dizziness, incoordination, low blood pressure, irregular heart beat, coma and death from respiratory arrest, Exposure to vapor concentrations near 2000 ppm for 5 minutes causes central nervous system depression and anesthetic effects. Symptoms are nasal irritation, drowsiness and equilibrium disturbances, Death may result from 13,600 ppm for 2 hours.

Skin: May cause irritation and chemical burns if allowed to remain on the skin for a prolonged period, nay be absorbed through the skin to cause or increase the severity of symptoms listed above,

Eyes: May cause irritation,

Ingestion: Hay cause effects similar to those listed under inhalation. Liver and kidney damage have occurred in animals. Laboratory studies with animals suggests that the probable lethal dose for humans is about 12 ounces.

Long Term Exposure:

Inhalation may cause liver and kidney damage. Has caused cancer in laboratory animals. Whether it does so in humans is unknown.

*Prepared by the Bureau of Toxic Substance Assessment, New York State Department of Health. For an explanation of the terms And abbreviations used, see "Toxic Substances: How Toxic Is Toxic", available from the New York State Department of Health.

EMERGENCY AND FIRST AID INSTRUCTIONS

Inhalation: Move to fresh air and perform artificial respiration if necessary. Keep warm and at rest. Get medical attention.

Skin: Remove contaminated clothing. Wash skin with soap or mild detergent and plenty of vater for at least 15 minuter. Seek medical attention if necessary.

Eyes: Wash with water for 15 minutes. Seek medical attention.

Ingestion: Do not induce vomiting. Seek medical attention immediately.

FIRE AND EXPLOSION INFORMATION

General: Not flammable under normal conditions.'

Explosive Limits: Upper -- 15.5%, lower -- 6.0%. (High energy ignition source required.)

Extinguisher: Water fog, foam,' carbon dioxide, dry chemical.

REACTIVITY

Materials to Avoid: Fire and explosion may result from reaction vith stronq oxidizers such as peroxides and permanganates; stronq caustics such as potassium hydroxide and sodium hydroxide and chemically active metals such as aluminum, magnesium powders, and potassium. Liquid will attack some forms of plastic, rubber and coatinqs.

Conditions to Avoid: When decomposed by hot metals, ultraviolet radiation, acids or acid fumes, highly toxic hydrogen chloride gas and small amounts of phosqane and carbon monoxide fumes are evolved. Open flames, welding arcs or other hiqh temperature sources which induce thermal decomposition should be avoided.

PROTECTIVE MEASURES

Storage and Handling: Store in a cool, dry and dark place. Do not store in aluminum containers. Contaminated clothinq should be placed in closed containers until it can be discarded or cleaned.

Engineering controls: Provide proper ventilation. Sinks, showers and eyewash stations should be easily available.

Protective Clothing (Should not be substituted for proper handling and engineering controls): Splash-proof goggles, impervious clothinq, gloves (not leather), and face shield. Wash clothing before reuse: it may not be possible to clean contaminared leather.

Protective Equipment: For any detectable levels use a self-contained breathing apparatus with a full facepiece and operated in a positive pressure mode or a combination Type C supplied-air respirator with an auxiliary self-contained breathing apparatus, both vrth a full facepiece and operated in a positive pressure mode. For fire fighting use a self-contained breathing apparatus with a full facapiece operated an a positive pressure mode. For escape use a gas mask providing protection against organic vapors or an escape self-contained bcreathing apparatus.

PROCEDURES FOR SPILLS AND LEAKS

Warn other workers of spill. Put on proper protective clothing and equipment. Ventilate the area. Mop, wipe or rook up immediately an absorbent material such as vermiculite or dry sand and move to safe place out-of-doors. Contain liquid, transfer to closed metal containers. For final disposal, contact your regional office of the Nev York State Department of Environmental Conservation.

For more information:
Contact the Industrial Hygienist or Safety Officer at your vorksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, 2 Untversity Place, Albany, New York 12203.

1,2-DICHLOROETHANE

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Ethylene dichloride; 1,2-ethylene dichloride; 1,2-bichloroethane; alpha, beta-dichloroethane; symdichloroethane; dichloroethylene; CAS 107-06-2.

Trade Names: Freon 150, EDC.

Uses: As a lead scavenger in gasoline; in anti-knock mixtures; fumigant for grain, upholstery and carpets; as a degreaser, as a solvent for fats, oils, waxes, gums, and resins; in the manufacture of acetyl cellulose; present in paint removers, wetting and penetrating agents, soaps and scouring compounds; in tobacco extract; as plastic cement and others.

PHYSICAL INFORMATION

Appearance: Clear, colorless,. oily liquid.

Odor: Sweetish. **Minimum Detectable By Odor:** 6 ppm.

Evaporation: Rapid.

Behavior In Water: Slightly soluble, sinks.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure -- 50 ppm.

NIOSH Recommended Limit: Average 10 hour day/40 hour week — 1 ppm.

ACGIH Recommended Limit: Average 8 hour exposure -- 10 ppm.

Short Term Exposure:

Inhalation: Levels of 10 to 30 ppm may cause dirtiness, nausea, and vomiting. Levels up to 50 ppm may cause weakness, trembling, headaches, abdominal cramps, liver and kidney damage, and fluid build up in lungs, May cause coma and death at high levels.

Skin: Prolonged contact may cause irritation and skin rashes.

Eyes: May cause redness, pain, and blurred vision. Vapor can damage the cornea.

Ingestion: Ingestion of 2 ounces has resulted in nausea, vomiting, faintness, drowsiness, difficulty breathing, pale skin, internal bleeding, kidney damage, and death due to respiratory failure. Other possible symptoms may include abdominal spasms, severe headache, lethargy, lowered blood pressure, diarrhea, shock, physical collapse, and coma.

Long Term Exposure:

May cause eye, nose and throat irritation, nausea, vomiting, loss of appetite, nerve damage, liver and kidney damage. This substance has been determined to cause cancer in laboratory animals. Whether it does so in humans is not known.

*Prepared by the Bureau of Toxic Substance Assessment, New York State Department of Health. For an explanation of the terms and abbreviations used, set "Toxic Substances: How Toxic Is Toxic", available from the New York State Department of Health.

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EMERGENCY AND FIRST AID INSTRUCTIONS

Inhalation: Move to fresh air. Give oxygen or artificial respiration as necessary. Seek medical attention.

Skin: Remove contaminated clothing. Wash affected areas with soap and water. See medical attention.

Eyes: Wash with plenty of water lifting eyelids occasionally. Seek medical attention.

Ingestion: If conscious, give plenty of water and induce vomiting. Seek medical attention,

FIRE AND EXPLOSION INFORMATION

General: Highly flammable. Flashbacks' can occur along vapor trail.

Explosive Limits: Upper -- 15.9%, lower -- 6.23.

Extinguisher: Dry chemical, foam, carbon dioxide. Water can be used to cool fire exposed containers.

Materials to Avoid: Reacts violently with strong caustics such as lye or potassi hydroxide and oxidizers such as potassium permanganate; may react with alumin to form compounds sensitive to mechanical shock,- Explosions have occurred. on contact with dimethylaminopropylamine or with mixtures of liquid ammonia.

Conditions to Avoid: Heat, sources of ignition, May produce highly toxic fumes phosgene when heated.

PROTECTIVE MEASURES

Storage and Handling: Dry, explosion-proof room, separated from oxidizers.

Engineering Controls: Use in closed system, if possible. Provide adequate ventilation. Use spark-proof tools and electrical equipment. Sinks, showers and eyewash stations should be readily available.

Protective Clothing (Should not be substituted for proper handling and engineering controls): Faceshield, Viton gloves and protective clothing.

Protective Equipment: For any detectable levels use self-contained breathing apparatus with a full facepiece operated in a positive pressure mode or a combination *Type* C supplied-air respirator and an auxiliary Self-contained bteathinq apparatus, both with a full facepiece and operated in a positive pressure mode. For escape from a contaminated area use a gas mask with an organic vapor canister or an escape self-contained breathing apparatus.

PROCEDURES FOR SPILLS AND LEAKS

Warn other workers of spill. Put on proper protective clothing and equipment. Eliminate all sources of ignition. Ventilate area, absorb on vermiculite or other suitable material. Collect liquid into sealable containers. Small amounts can be allowed to evaporate out of doors OK in a laboratory hood. For disposal of large amounts, contact your regional office of the New York State Department of Environmental Conservation.

For more information:
Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, 2 University Place, Albany, New York 12203.

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is *not* designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations *of* 3 1 chemicals at levels as low as is practical.

Chemical Names: Dichloromethane, Methylene dichloride; CAS 75-09-2.

Trade Names: Solaestine, Aerothene MM, Narkotel, Somethine, R30 and others.

Uses: The liquid is used as a solvent, degreasing and cleaning fluid, aerosol propellant, anesthetic and refrigerant. Also used in print removers, blowing agents in foams, in the process of decaffeinating *coffee* and extraction of spices.

PHYSICAL INFORMATION

Appearance: Clear, colorless liquid.

Odor: Sweetish (like chloroform or ether). **Minimum Detectable by Odor:** 214 ppm.

Behavior in Water: Slightly soluble (1.32 g/100 g water), remainder will rink.

Evaporation: Liquid evaporates rapidly.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure limit -- 500 ppm.

NIOSH Recommended Limit: Reduce exposure to the lowest feasible level.

ACGIH Recommended Limit: Average 8 hour exposure -- 100 ppm. (Proposed for change in 1988: 50 ppm).

Short Term Exposure:

Note: Methylene chloride' is changed to carbon monoxide in the human *body.* This is a particularly hazardous condition for those who have a history of heart trouble or those who are also exposed to carbon monoxide. See carbon monoxide fact sheet. These persons should taka extra precautions.

Inhalation: Levels *of* 300-700 ppm for 3-5 hours has caused slight loss of muscle contrcl and coordination. Effects of higher concentrations include stupor, dizziness, chest pain, arm and leg pains, loss of feeling, loss of appetite, hot flashes and death.

Skin: May be irritating if confined on the skin by gloves or clothing, nay be absorbed slowly tbrough the skin to cause symptoms listed under inhalation.

Eyes: May cause pain, irritation and burns.

Ingestion: Accidental ingestion of print removers containing methylene chloridc as the ruin ingredient have reportedly caused headache, nausea, vomiting, visual disturbance, presence of blood in the urine, and unconsciousness.

Long Term Exposure:

Same symptoms as above. Prolonqed exposure can cause changes in blood, hallucinations and decreased response to visual and auditory stimulation. Some long term exposures have also resulted in damage to the liver. Most of the effects will disappear after exposure stops. Methylene chloride caused genetic effects in certain bacteria and caused birth defects in chickens. In laboratory studies, methylene chloride has also been shown to cause tumors in mice and rats. Whether methylene chloride cuses birth defects or tumors in humans is not known.

*Prepared by the Bureau of Toxic Substance Assessment, New York State Department of Health. For an explanation of the terms and abbreviations used, see 'Toxic Substances: How Toxic is Toxic' available from the New York State Department of Health.

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EMERGENCY AND FIRST AID INSTRUCTIONS

Inhalation: Remove perron to fresh air. Give artificial respiration or oxygen if breathing has stopped. Seek medical attention immediately.

Skin: Wash with large amounts of soap and water for at least 5 minutes. Seek medical attention if necessary.

Eyes: Wash with water for at least 15 minutes. Seek medical attention.

Ingestion: Do not induce vomiting. Seek medical attention.

Note to Physician: Gastric lavaqa with 3-51 sodium bicarbonate. Prompt hemodialysis if blood methanol level is above 50 mg/dl or if there is evidence of acidosis. Provide routine supportive measures and 1008 oxygen until the carboxyhemoglobin level is satisfactory (less than 10% in an otherwise healthy patient).

FIRE AND EXPLOSION INFORMATION

General: Considered non-flammable, bur will burn in high concentrations such as near spills or in closed spaces. Ignites at 624°C (1224°F).

Explosion Limits: Upper -- 64.6%; lower -- 15.5% in oxygen.

REACTIVITY

Conditions to Avoid: Avoid heat; decomposes to highly poisonous gases (phosgene).

Materials to Avoid: Avoid contact with alkali metals (example: sodium or potassium); such contact may cause an explosion. Methylene chloride will corrode iron, stainless steel ana copper, especially at high temperatures and if the metals are wet. Can is impervious and resistant to methylene chloride. Improper gloves or clothing can prevent evaporation and promote skin contact. Check with manufacturer's specification or your supervisor.

Protective Equipment: For any detectable levels use a self-contained breathing apparatus with a full facepiece operated in a positive pressure mode or a combination Type C supplied-air respirator with an auxiliary self-conrained breathing apparatus, both with a full facepiece and operated in a positive pre is impervious and resistant to methylene chloride. Improper gloves or clothing can prevent evaporation and promote skin contact. Check with manufacturer's specification or your supervisor.

Protective Equipment: For any detectable levels use a self-contained breathing apparatus with a full facepiece operated in a positive pressure mode or a combination Type C supplied-air respirator with an auxiliary self-conrained brearhrnq apparatus, both with a full factpiece and operated in a positive pressure mode. For escape use a gas mask with an organic vapor canister or an escape self-contained breathing apparatus.
Use a self-contained breathing apparatus with a full facepiece operated in a positive pressure mode.

PROCEDURES FOR SPILLS AND LEAKS

Get all workers out of the spill area. Remove all sources of combustion. Ventilate the area. If you must enter the area, wear protective clothing and equipment. Since methylene chloride is extremely volatile, most will evaporate. For final disposal contact your regional office of the New York State Department of Environmental Conservation.

For more information:
Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, 2 University Place, Albany, New York 12203.

B

APPENDIX B

SITE-SPECIFIC QUALITY ASSURANCE PROJECT PLAN

Section 10 -- Title Page

Vork Plan Group: 0
Site No. : 32, 33, and 35
Site Name: IWTP/WWTP Complex

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Contract Number N62467-88-C-0200

Signature Approvals:

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E & E ASC Director: _____
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E & E QA/QC Project Officer: _____
M. Meredith

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Section 3.0 -- Project Summary

Work Plan Group: 0

Site No.: 32,33, and 35

Site Name: IWTP/WWTP Complex

Site Description: A complete site description and history are presented in Section 2.0 of the attached work plan.

Physical Survey (check all that apply):

- X Overall Physical Reconnaissance'
- X OVA Surface Emission Survey
- X Radiation Survey
- X Habitat/Biota Survey
- X Hydrologic Assessment

Geophysical Survey (check all that apply):

- ___ Electromagnetic Conductivity:
  - ___ EM-31 ___ EM-34
- ___ Magnetometry
- ___ Very Low Frequency
- ___ Ground Penetrating Radar
- ___ Seismic Refraction
- ___ Seismic Reflection

Characterization/Extent Delineation (check all that apply):

- X Field Analyses
- ___ Soil Headspace Analyses
- X Soil Gas Analyses
- X Laboratory Analyses:

PLANNED NUMBER OF SAMPLES

Surface Water	4
Sediment	4
Soil	44
Soil Gas	460
Groundwater	23
Duplicates	10
Soil Gas Duplicates	92
Trip Blanks	10
Field Blanks	4
Preservative Blanks	1

Rinsate Blanks 4

CATEGORIES OF ANALYSES

X Purgeable Aromatics
X Purgeable Halocarbons
X Base/Neutral Extractables
X Acid Extractables
Polynuclear Aromatic Hydrocarbons
X Dioxins
X Organophosphorus Pesticides
X Herbicides
X Pesticides
X Polychlorinated Biphenyls
___ Total Recoverable Petroleum Hydrocarbons
X Metals
X Cyanide

Additional analytical categories are identified below:

X Gross Alpha
X Gross Beta
X Gamma Scan
X Total Organic Carbon
X Grain Size
X Alkalinity
X Total Suspended Solids (water only)
X Total Kjeldahl Nitrogen
X Ammonia Nitrogen
X Orthophosphate Phosphorus
X pH
X Percent Moisture
X Hardness (water only)
X BTU Content
X Ash Content
X Total Halogens
X Sulfur
X Ignitability
X Cation Exchange Capacity
X Sulfide

_X_ Dissolved Oxygen (in field)
_X_ 5-day Biological Oxygen Demand
_X_ Chemical Oxygen Demand

Section 4.0 -- Project Organization and Responsibility

The overall organizational structure for this site is discussed in Section 4.0 of the GQAPP. Site-specific designated personnel and their responsibilities are listed below:

Site Hanager:
Team/Task Leader(s): To Be Determined
Field Support Personnel:

Biographies for those personnel listed above which are not included in the GQAPP are included in Appendix A of this document.

Section 5.0 -- QA/QC Objectives for Heasurement Data

Criteria for reporting the accuracy, precision, and completeness of data are presented in Section 5.0 of the GQAPP. Detection limits for screening and quantitative analyses are presented in Section 9.0 of the GQAPP. Procedures used to assess data accuracy, precision, and completeness are presented in Section 14.0 of the GQAPP. All analytes (including field parameters), sample media, and method numbers relevant to the investigation of this site are listed in the following table, which also identifies any modifications to the accuracy (A), precision (P), completeness (C), and detection limit (DL) criteria specified in the above-referenced GQAPP sections.

Analyte	Hedia	Hethod No.	A	P	C	DL
Laboratory Analyses						
Volatile Halogenated Hydrocarbons	S/W	EPA 8010/601	N/M	N/M	N/M	N/M
Volatile Aromatic Hydrocarbons	S/W	EPA 8020/602	N/M	N/M	N/M	N/M
Gross Alpha	S/W	EPA 900	N/M	N/M	N/M	N/M
Gross Beta	S/W	EPA 900	TBD	TBD	TBD	TBD
Gamma Scan	S/W	EPA 901.1	TBD	TBD	TBD	TBD
TCL Purgeables + xylene	S/W	EPA 8240/624	N/M	N/M	N/M	N/M
TCL BNAs	S/W	EPA 8270/625	N/M	N/M	N/M	N/M
TCL Pesticides & PCBs	S/W	EPA 8080/608	N/M	N/M	N/M	N/M
Dioxins	S/W	EPA 8280	TBD	TBD	TBD	TBD
Organophosphorus Pesticides	S/W	EPA 8140	N/M	N/M	N/M	N/M
Herbicides	S/W	EPA 8150 (modified)/509B	N/M	N/M	N/M	N/M
TAL Metals:						
Aluminum	S/W	EPA 6010	N/M	N/M	N/M	N/M
Antimony	S/W	EPA 6010	N/M	N/M	N/M	N/M
Arsenic	S/W	EPA 7060	N/M	N/M	N/M	N/M
Barium	S/W	EPA 6010	N/M	N/M	N/M	N/M
Beryl1ium	S/W	EPA 6010	N/M	N/M	N/M	N/M
Boron	S/W	EPA 6010	N/M	N/M	N/M	N/M
Cadmium	S/W	EPA 6010	N/M	N/M	N/M	N/M
Calcium	S/W	EPA 6010	N/M	N/M	N/M	N/M
Chromium	S/W	EPA 6010	N/M	N/M	N/M	N/M
Cobalt	S/W	EPA 6010	N/M	N/M	N/M	N/M
Copper	S/W	EPA 6010	N/M	N/M	N/M	N/M
Iron	S/W	EPA 6010	N/M	N/M	N/M	N/M
Lead	S/W	EPA 7421	N/M	N/M	N/M	N/M
Magnesium	S/W	EPA 6010	N/M	N/M	N/M	N/M
Manganese	S/W	EPA 6010	N/M	N/M	N/M	N/M
Mercury	S/W	EPA 747117470	N/M	N/M	N/M	N/M
Nickel	S/W	EPA 6010	N/M	N/M	N/M	N/M
Selenium	S/W	EPA 7740	N/M	N/M	N/M	N/M
Silver	S/W	EPA 6010	N/M	N/M	N/M	N/M
Sodium	S/W	EPA 6010	N/M	N/M	N/M	N/M
Thallium	S/W	EPA 7841	N/M	N/M	N/M	N/M
Tin	S/W	EPA 282.2	N/M	N/M	N/M	N/M
Vanadium	S/W	EPA 6010	N/M	N/M	N/M	N/M
Zinc	S/W	EPA 6010	N/M	N/M	N/M	N/M

Analyte	Media	Method No.	A	P	C	DL
Cyanide	S/W	EPA 9010/335.2	N/M	N/M	N/M	N/M
Sulfide	S/W	EPA 376.1	N/M	N/M	N/M	N/M
TOC	S/W	EPA 415.1	N/M	N/M	N/M	N/M
Hardness	W	EPA 130.2	N/M	N/M	N/M	N/M
Alkalinity	W	EPA 310.1	N/M	N/M	N/M	N/M
Total Suspended Solids	W	EPA 160.2	N/M	N/M	N/M	N/M
Total Kjeldahl Nitrogen	S/W	EPA 351.3	N/M	N/M	N/M	N/M
Nitrogen-Ammonia	S/W	EPA 350.2	N/M	N/M	N/M	N/M
Orthophosphate Phosphorus	S/W	EPA 365.2	N/M	N/M	N/M	N/M
5-day Biological Oxygen Demand	W	SM 507	N/M	N/M	N/M	N/M
Chemical Oxygen Demand	W	EPA 410.4	N/M	N/M	N/M	N/M
pH	W	EPA 150.1	N/M	N/M	N/M	N/M
Percent Moisture	S	ASTM D-2216-80	N/M	N/M	N/M	N/M
Grain Size	S	ASTM D-422-63	N/M	N/M	N/M	N/M
BTU Content	S	ASTM D-2015-77	N/M	N/M	N/M	N/M
Ash Content	S	ASTM D-482	N/M	N/M	N/M	N/M
Total Halogens	S	ASTM D-808-81	TBD	TBD	TBD	TBD
		EPA 325.3	TBD	TBD	TBD	TBD
Sulfur	S	ASTM D-129-64	N/M	N/M	N/M	N/M
Ignitability	S/W	EPA 1010	N/M	N/M	N/M	N/M
Cation Exchange Capacity	S	EPA 9081	75-125	35	95%	100mg/kg
Field Parameters						
pH	W	150.1	N/M	N/M	N/M	N/M
Specific Conductance	W	120.1	N/M	N/M	N/M	N/M
Temperature	W	170.1	N/M	N/M	N/M	N/M
Dissolved Oxygen	W	EPA 360.1	N/M	N/M	N/M	N/M

Notes: S = Soil and/or sediment
W = Groundwater and/or surface water
N/M = No modifications from GQAPP
TBD = To be determined.

Section 6.0 -- Fieldwork and Sampling Procedures

Fieldwork and sampling procedures are presented in Section 6.0 of the GQAPP. Modifications to these procedures are described below:

No Modifications

Section 7.0 -- Sample Custody

Sample custody procedures are presented in Section 7.0 of the GQAPP. Modifications to these procedures are described below:

No Modifications

Section 8.0 -- Calibration Procedures and Frequency

Calibration procedures and frequency are presented in Section 8.0 of the GQAPP. Modifications to these procedures are described below:

No Modifications

Section 9.0 -- Analytical Procedures

Screening and quantitative analytical procedures are presented in Section 9.0 of the GQAPP. Site-specific accuracy, precision, completeness, and detection limit criteria are presented in Section 5.0 of this SQAPP. Modifications to any other of the analytical procedures are described below:

No Modifications

Section 10.0 -- Data Reduction, Validation, and Reporting

Data reduction, validation, and reporting procedures are presented in Section 10.0 of the GQAPP. Modifications to these procedures are described below:

No Modifications

Section 11.0 -- Internal Quality Control Checks

Internal quality control check procedures are presented in Section 11.0 of the GQAPP. Modifications to these procedures are described below:

No Modifications

Section 12.0 -- Performance and System Audits

Performance and system audit procedures are presented in Section 12.0 of the GQAPP. Specific audits planned for this site investigation are listed below:

Audit Type	Frequency/Date	Description
	To Be Determined	

Section 13.0 -- Preventive Maintenance

Preventive maintenance procedures are presented in Section 13.0 of the GQAPP. Modifications to these procedures are described below:

No Modifications

Section 14.0 -- Procedures Used to Assess Accuracy, Precision, and Completeness of Data

Procedures used to assess the accuracy,.precision, and completeness of data are presented in Section 14.0 of the GQAPP. Modifications to these procedures are described below:

No Modifications

Section 15.0 -- Corrective Action

Corrective action procedures are presented in Section 15.0 of the GQAPP. Modifications to these procedures are described below:

No Modifications

Section 16.0 -- Quality Assurance Reports to Management

Quality assurance report procedures are presented in Section 16.0 of the GQAPP. Modifications to these procedures are described below:

No Modifications

Appendix A -- Additional Personnel Biographies

Personnel assigned to this site investigation whose biographies do not appear in the GQAPP are listed below; biographies for these site personnel are presented on the following pages.

To Be Determined

C

APPENDIX C

LOCAL CLIMATOLOGICAL DATA

LOCAL CLIMATOLOGICAL DATA

NORMALS, MEANS, AND EXTREMES

PENSACOLA, FLORIDA

LATITUDE: 30°28'N LONGITUDE: 87°12'W ELEVATION: FT GRND 112 BARO TIME ZONE: CENTRAL WBAN: 13899

	a)	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	YEAR
TEMPERATURE °F:														
Normals														
-Daily Maximum		60.5	63.0	69.2	76.7 / 59.3	83.7	89.0	90.1	89.6	86.6	79.3	67.4	63.2	76.8
-Daily Minimum		42.7			68.0	66.3	72.1	74.4	73.3	70.9	59.5	43.9	44.4	59.1
-Monthly		51.7	54.2	60.4	68.0	75.0	80.6	82.3	81.9	78.7	69.4	53.7	53.8	68.0
Extremes														
-Record Highest	26	80	82	85	86	96	101	106	104	98	92	85	91	106
-Year		1975	1972	1974	1987	1964	1983	1980	1986	1989	1973	1979	1978	JUL 1980
-Record Lowest	26	5	19	22	33	48	56	61	63	43	34	25	11	5
-Year		1985	1970	1980	1987	1979	1984	1967	1967	1967	1989	1976	1399	JAN 1385
NORMAL DEGREE DAYS:														
Heating (base 65°F)		445	327	184	29	0	0	0	0	0	35	192	353	1571
Cooling (base 65°F)		33	24	42	119	310	468	536	523	411	171	33	12	2680
% OF POSSIBLE SUNSHINE	5	48	53	61	63	67	67	57	58	60	71	64	49	60
MEAN SKY COVLR (tenths)														
Sunrise - Sunset	23	6.3		6.0	5.4	5.5	5.5	6.2	6.0	5.4	4.4	5.2	6.1	5.7
MEAN NUMBER OF DAYS:														
Sunrise to Sunset														
-Clear	23	7.9		8.7	10.3	3.6	7.3	4.6	5.8	3.9	14.0	11.3	3.1	107.5
-Partly Cloudy	23	7.2		8.2	9.8	11.0	14.7	16.1	14.9	10.6	8.5	7.7	6.3	120.9
-Cloudy	23	15.9		13.9	10.9	10.4	9.9	10.3	10.4	9.7	8.5	11.0	15.7	136.9
Precipitation .01 inches or more	26	9.7		9.2	6.2	7.3	10.0	14.0	12.9	8.3	4.9	7.6	9.6	109.3
Snow, Ice pellets 1.0 inches or more	26	0.1		0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Thunderstorms	20	1.5		4.3	3.7	5.6	10.4	15.4	14.4	6.4	2.0	2.2	1.5	70.0
Heavy fog Visibility 1/4 mile or less	20	5.9		6.3	3.9	1.9	9.5	0.5	0.2	0.7	1.9	3.8	4.8	35.2
Temperature °F														
-Maximum														
90° and above	26	0.0	0.0	0.0	0.1	2.1	13.0	17.5	14.8	8.0	0.3	0.0	0.0	55.8
32° and below	26	0.2	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2
-Minimum														
32° and below	26	7.1	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.4	17.0
0° and below	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVG. STATION PRLSS.(mb)	17	1016.7	015.5	013.0	1012.6	011.1	1011.8	1012.9	1012.5	1011.9	014.4	1015.1	1016.7	1013.7
RELATIVE HUMIDITY (%)														
Hour 00	24	74		81	81	84	83	86	87	83	80	82	01	02
Hour 06 (Local Time)	24	81	81	83	85	86	86	89	90	88	84	84	83	85
Hour 12	24	62	58	59	56	59	60	64	66	62	55	60	64	60
Hour 18	24	71	68	69	66	67	68	71	74	72	69	74	75	70
PRECIPITATION (inches):														
Water Equivalent														
-Normal		4.41	4.90	5.66	4.45	3.87	5.75	7.1	7.04	6.75	3.52	3.4	4.15	61.16
-Maximum Monthly	26	13.41	11.66	12.96	15.52	10.31	17.68	20.3	14.14	15.71	14.84	7.6	9.50	20.36
-Year		1978	1966	1979	1964	1787	1978	171	1787	1988	1985	178	1982	JUL 1979
-Minimum Monthly	26	0.60	1.07	0.87	0.38	0.08	0.86	1.6	7.77	0.39	0.00	0.3	0.51	0.00
-Year		1981	1780	1967	1987	1788	1975	197	1989	1984	1978	198	1980	OCT 1978
-Maximum in 24 hrs	26	5.44	4.70	11.10	7.51	5.01	6.77	5.1	5.32	10.02	5.88	4.2	4.52	11.10
-Year		1978	1982	1979	1964	1981	1970	197	1987	1967	1986	198	1964	MAR 1979
Snow, Ice pellets														
-Maximum Monthly	26	2.1	1.9	T	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.	T	2.5
-Year		197	1973	1980									1909	JAN 1977
-Maximum in 24 hrs	26	1.1	1.3	T	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.	T	1.9
-Year		197	1973	1980									1989	FEB 1973
WIND:														
Mean Speed (mph)	26	9.	9.4	9.7	9.1	8.6	7.0	6.9	6.7	7.1	7.9	8.4	9.0	8.4
Prevailing Direction														
Fastest Obs. 1 Min														
-Direction (!!!)	19	2	16	10	2	2	3	0	05	1	13	21	10	10
-Speed (MPH)	19	3	35	32	3	3	3	3	35	5	35	35	34	53
-Year		198	1904	1983	197	197	197	197	1979	197	1985	1972	1988	SEP 1979
Peak Gust														
-Direction (!!!)														
-Speed (mph)														
-Date														

(!!!) See Reference Notes on Page 68.

Page 3

Source: National Oceanographic and Atmospheric Administration 1989.

D

APPBNDIX D

THREATENED AND ENDANGERED FLORA AND FAUNA ASSOCIATED WITH NAS PENSACOLA

APPENDIX D

THREATENED AND ENDANGERED FLORA AND FAUNA OBSERVED OR LIKELY TO OCCUR WITHIN THE NAS PENSACOLA FACILITY OR NEARBY

Scientific Name	Common Name	Base * Status	Status FGFWFC(or FDA)	Status USFWS	Habitat
FISHES					
Acipenser oxyrhynchus	Atlantic sturgeon	M	SSC	UR 2	Gulf coast, estuarine
Ammocrypta asprella	Crystal darter	U	T	UR 2	Fresh water
Etheostoma histrio	Harelquin darter	U	SSC		Fresh water
Fundulus jenkinsi	Salt marsh topminnow	P	SSC		Salt, fresh, brackish waters
Lepisosteus spatula	Alligator gar	U	SSC		Brackish, fresh, salt water
Moxostoma carinatum	River redhorse	U	SSC		Fresh water
AMPHIBIANS AND REPTILES					
Alligator mississippiensis	American Alligator	R	SSC	T(S/A)	Swamps, marshes, ponds
Caretta carotta carotta	Loggerhead turtle	M ?	T	T	Marine, coastal
Chelonia mydas mydas	Green turtle	M ?	E	E	Marine, coastal
Dermochelys coriacea	Leatherback turtle	M	E	E	Marine, coastal
Drymarchon corais coupori	Eastern indigo snake	P	T	T	Open areas near water
Eretmochelys imbricata	Hawksbill turtle	M ?	E	E	Marine, coastal
Gopherus polyphemus	Gopher tortoise	P	SSC	UR 1	Sandy coastal plains
Graptemys pulchra	Alabama map turtle	U	SSC		Swamps, streams, marshes, ponds
Lepidochelys kempi	Atlantic ridley	M ?	E	E	Marine, coastal
Rana areolata aesopus	Florida gopher frog	P	SSC	UR 2	Sand hill communities
Macroclemys temmincki	Alligator snapping turtle	SR	SSC	UR 2	Swamps, marshes, ponds
MAMMALS					
Mustela vison lutensis	Florida mink	U		UR 2	Terrestrial habitats
Peromyscus polionotus trissyllepsis	Perdido Key beach mouse	N/A	T	E	Beach dunes
Trichechus manatus latirostris	West Indian manatee	M	E	E	Atlantic and Gulf coasts
Ursus americanus floridanus	Florida black bear	N/A	T	UR 2	Titi swamps

Scientific Name	Common Name	Base * Status	Status FGFWFC(or FDA)	USFWS	Habitat
BIRDS					
Charadrius melodus	Piping Plover	P	T	T	Open dry, sandy beaches
Charadrius alexandrinus	Snowy plover	P	T	UR 2	Open dry, randy beaches
Dendroida dominica atoddardi	Stoddard's yellow-throated warbler	P-U		UR 2	Wooded habltats
Dendroica kirtlandiI	Kirtland's warbler	U	E	E	Wooded habitats
Haematopus palliatus	American oystercatcher	U	SSC		Coastal habltats
Egretta rufescens	Reddish egret	P-u	SSC	Ult 2	Freshwater/coastal wetlands
Egretta caerulea	Little blue heron	P-u	SSC		Freshwater/coastal wetlands
Egretta thula	Snowy egret	P-u	SSC		Freshwater/coastal wetlands
Grus canadensis pratensis	Florida sandhill crane	U	T		Freshwater wetlands
Falco peregrinus tundrius	Arctic peregrine falcon	n	E	T	Winters on coasts
Falco sparverius paulus	Southeastern kestrel	R	T	UR 2	Open pine forests, clearings
Haematopus palliatus	American oystercatcher	P-U	SSC		Open coastal beaches
Haliaeetus leucocephalus	Bald eagle	P-u	T	e	Pine forests/coastal habitat
Pandion haliaetus	Osprey	R	SSC		Near water
Pelecanus occidentalis	Brown pelican	R	SSC	AC	Mangrove trees, coasts
Picoides borealis	Red-cockaded woodpecker	P-U	T	E	Cavity nests/old pine stands
Vermivora bachmanii	Bachmann's warbler	U	E	e	Wooded habitats
Campephilus principalis	Ivory-billed woodpecker	U	e	E	Wooded habitats
Sterna antillarum	Least torn	U	T		Coastal habitats
Mycteria americana	Wood stork	U	L	E	Freshwater/coastal wetlands
Rostrhamus sociabilis	Snail kite	U	E	e	Freshwater/coastal wetlands
INVERTEBRATES					
Copris gopheri	Scarab beetle	P		UR 2	Associated w/Gopher Tortoise

3201043

Scientific Name	Common Name	Base * status	status FGFWFC(or FDA)	USFWS	Habitat
PLANTS					
Chrysopsis gossypina cruiseana	Cruise's goldon-astor	P	E	UR 1	Coastal dunes
Drosera intermedia	Spoon-loavod sundew	R	T		Aquatic habitats
Epigaea repens	Trailing arbutus	U	e		Dry, acid, sandy soil
Kalmia latifolia	Mountain laurel	U	T		Rich, moist, shady woods
Lilaeopsis carolinensis	Carolina lilaeopsis	R		UR 2	
Lilium iridollae	Panhandlo lily	U	E	UR 2	Black, mucky soils
Pinguicula planifolia	Chapman's buttorwort	U	RE	UR 2	
Polygonella macrophylla	Largo-loavod jointweed	R	T	UR 1	Sand pino-oak scrub
Rhododondron austrinum	Orange azalea	U	E	UR 5	Moist, woody habitats
Sarracenia leucophylla	White-top pitchorplant	R	E		Opon acid bogs
Sarracenia rubra	Sweet pitchorplant	U	E	UR 2	Acid bogs/slash pine woods
Stewartia malacodnedron	Silky camellia	U	E		Slopes of wooded ravines

E = Endangered
T = Threatened
UR 1 = under review, for Federal listing with substantial evidence in existence indicating at least some degree of biological vulnerability and/or throat.
UR 2 = Under review, insufficient biological data available.
UR 5 = Candidate species, but taxa has proven to bo more widespread than was previously believed and/or those species that are not subject to any identifiable throat.
FDA = Florida Department of Agriculture.
FGFWFC = Florida Game and Freshwater Fish Commission.
USFWS = U.S. Fish and Wildlife Service.

Base * = Status of species on the NAS P■ ○ ℘ <○le ℰ cility

R = Resident.

M = Migrant.

SR = Suspected resident.

P = Possible resident due to availebl■ h bitat; ℘ur ey ℘ squir d

U = Unknown, survey required.

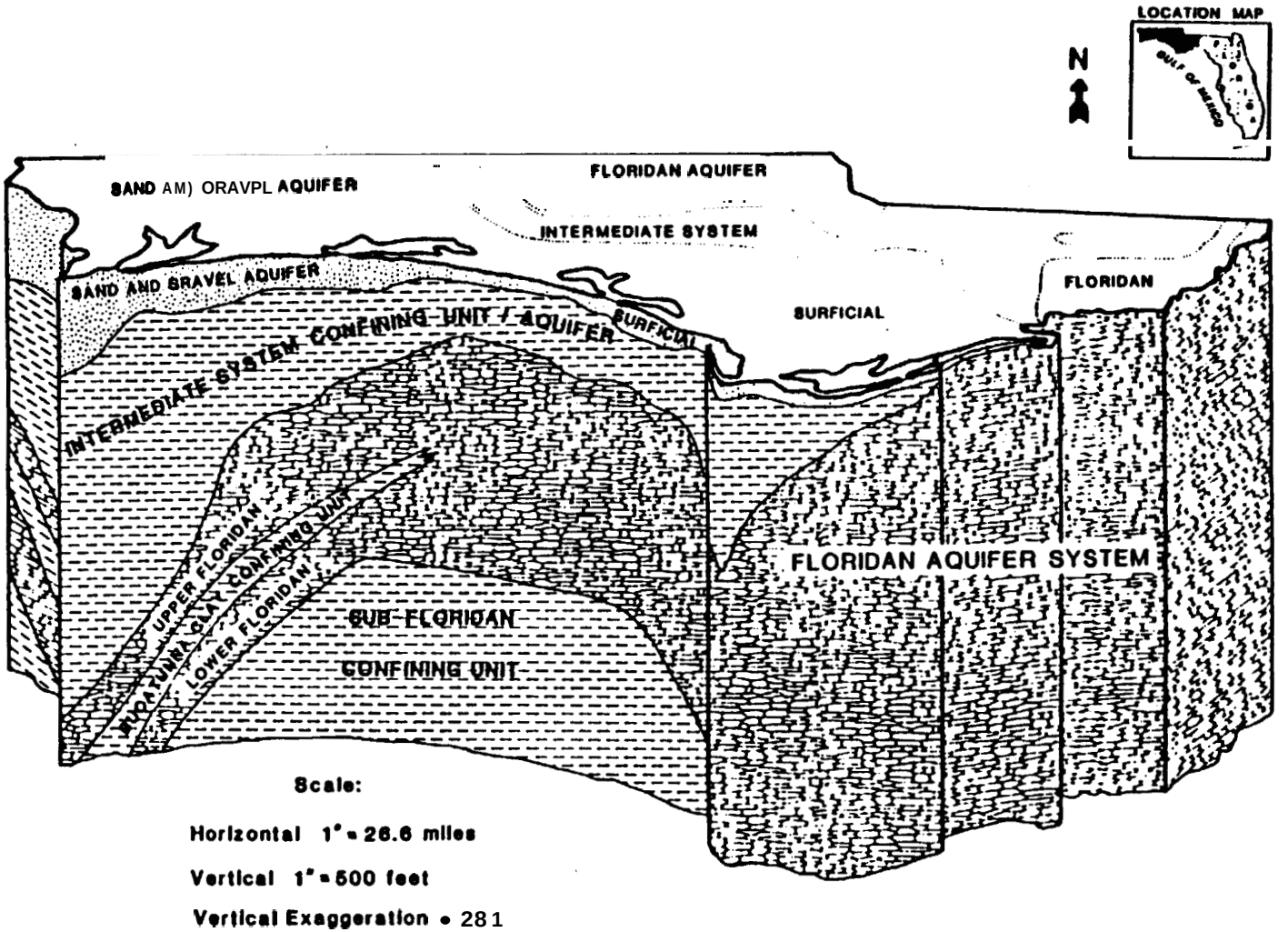
N/A = Not expected to occur on th■ NAS P n℘e ○le f <ility

3201049

E

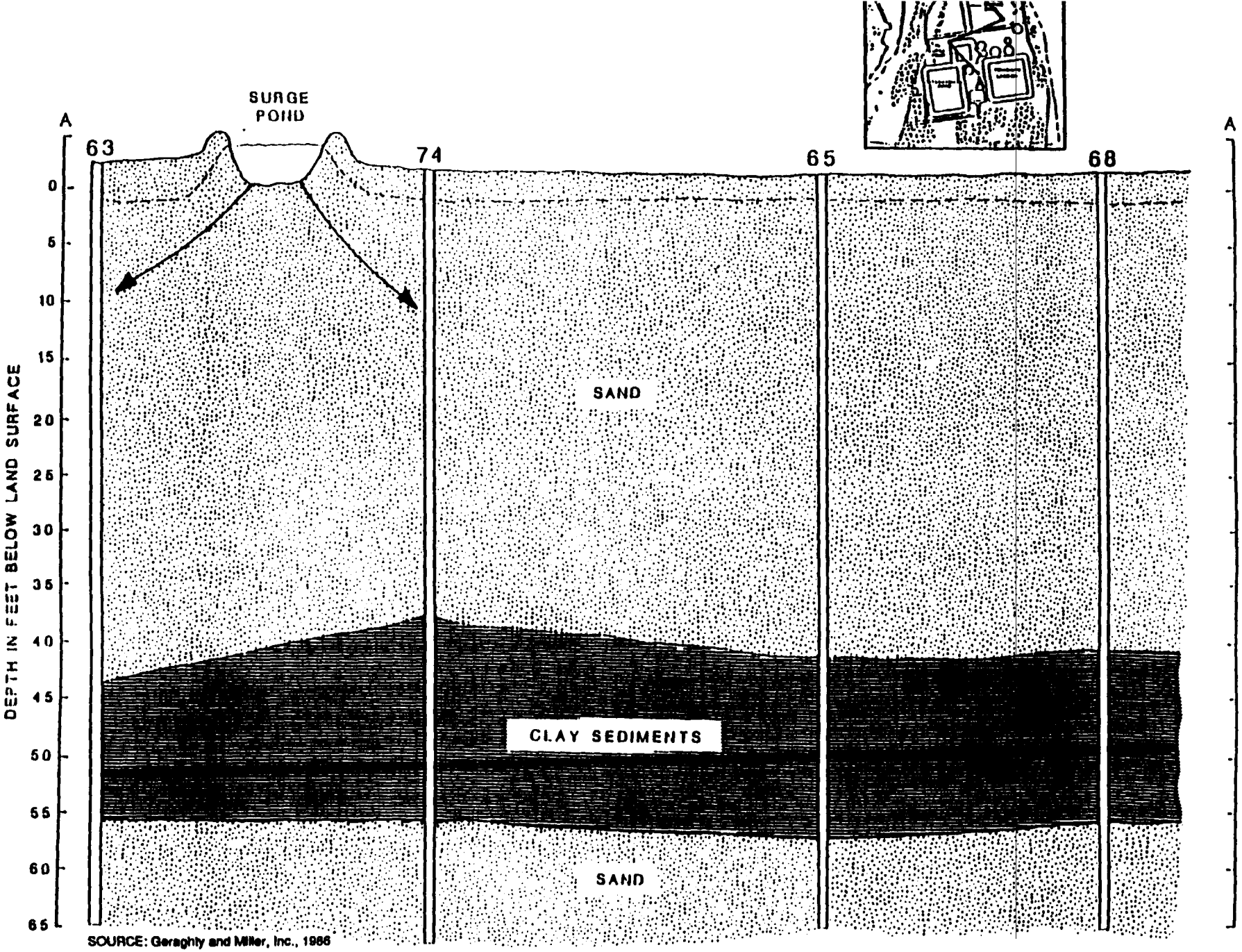
APPENDIX B

ADDITIONAL GEOLOGIC INFORMATION



SOURCE: John D. Barksdale 1988.

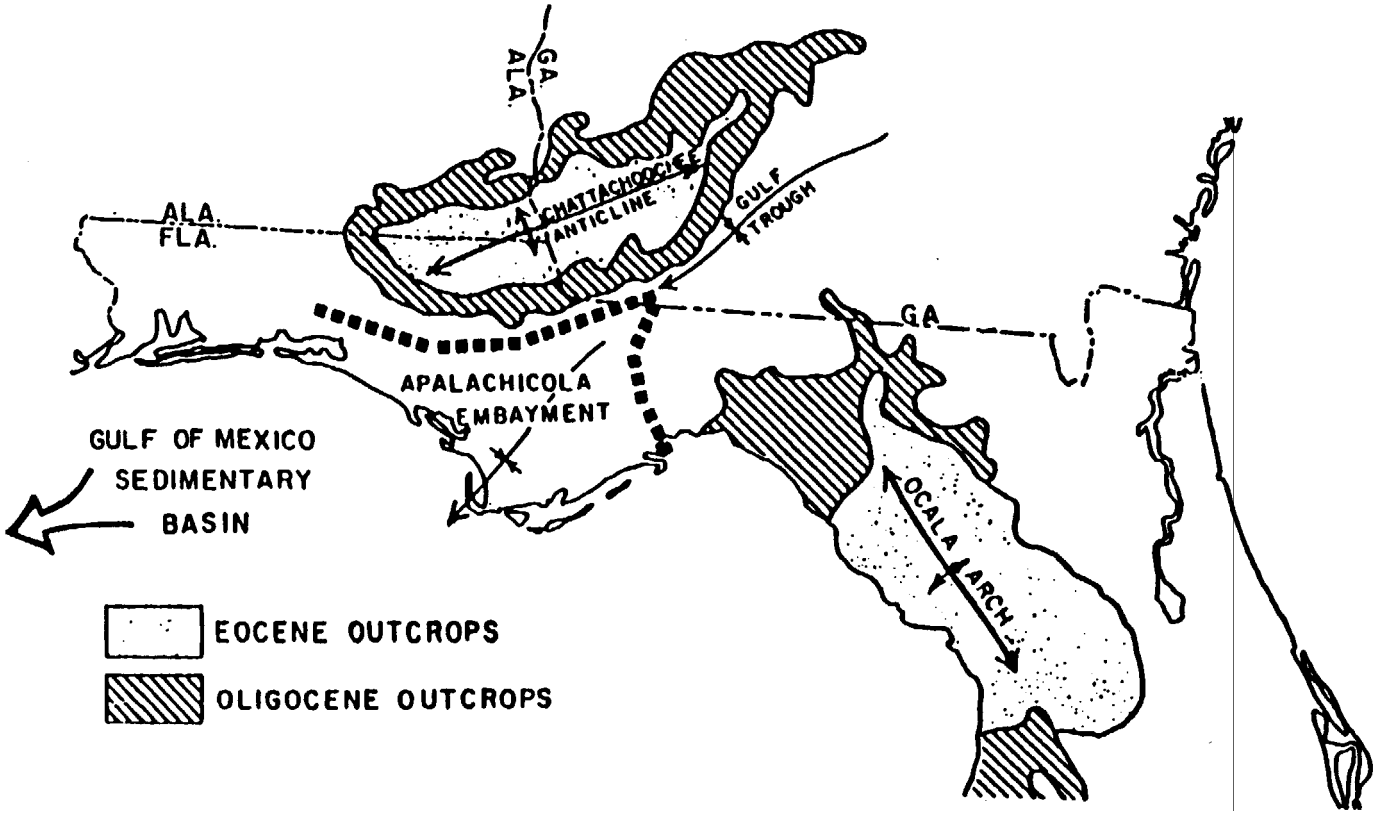
Figure E-1 GEOLOGIC CROSS-SECTION OF HYDROGEOLOGIC UNITS IN NORTHWEST FLORIDA



SOURCE: Geraghty and Miller, Inc., 1986

Figure E-2 GENERALIZED GEOLOGIC CROSS-SECTION OF SURFICIAL ZONE OF SAND-AND-GRAVEL AQUIFER IN THE VICINITY OF NAS PENSACOLA SITES 32, 33, AND 35.

3201051



SOURCE: John D. Barksdale 19 ~~69~~

gure E-3 GEOLOGIC STRUCTURES OF THE NORTHWEST FLORIDA REGION

F

APPENDIX F

MONITORING AND RECOVERY WELL LOCATIONS IN THE VICINITY OF NAS PENSACOLA SITES 32, 33, AND 35

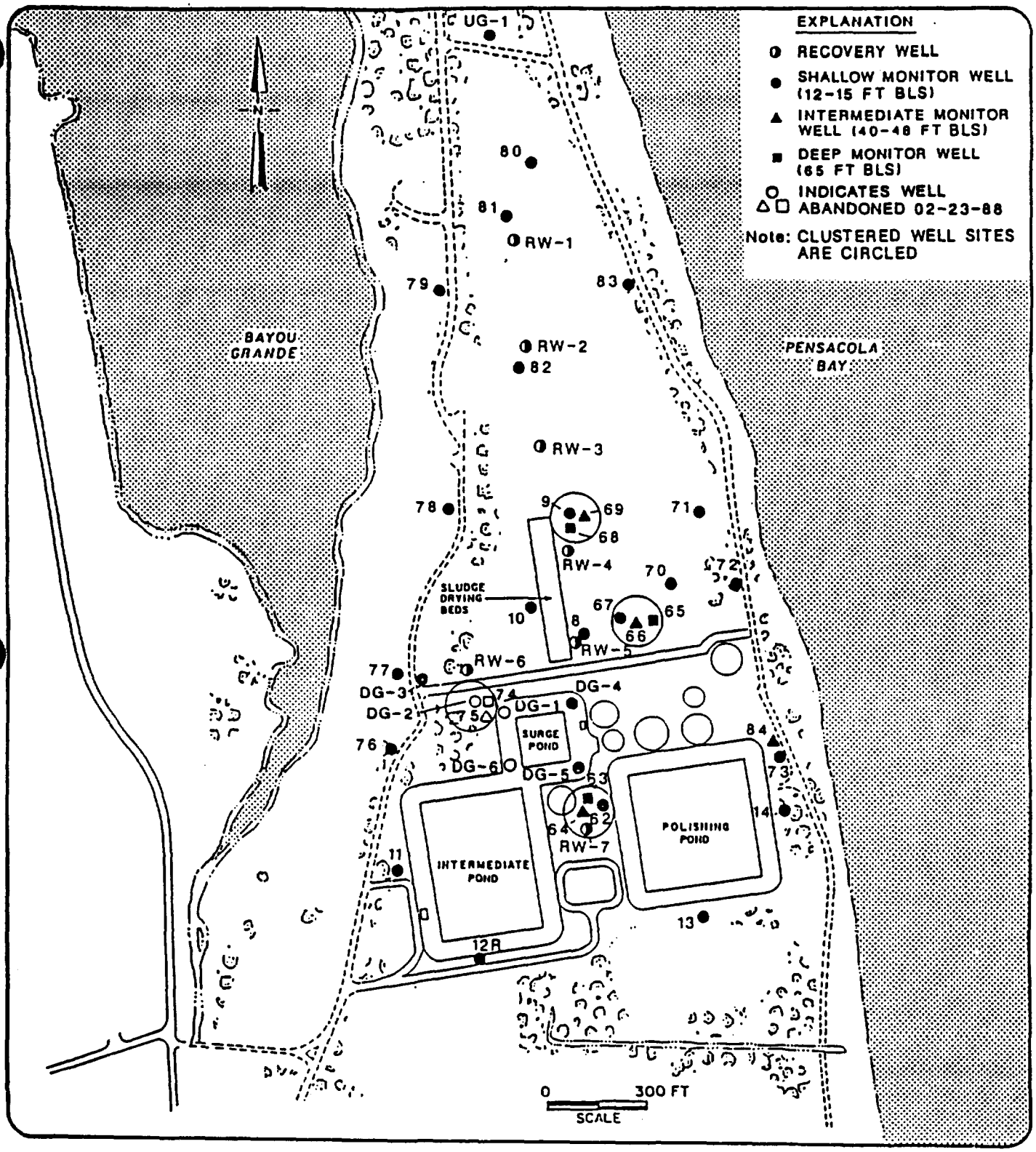


Figure 2.4

Locations of Monitor Wells and Recovery Wells.

CLIENT NAME:

Naval Facilities Engineering Command, Southern Division

G

APPENDIX G

PREVIOUS ANALYTICAL RESULTS
SUMMARY TABLES FOR GROUNDWATER AND SOIL
PRESENTED BY SAMPLING EVENT 1981 TEROUGH 1991
NAS PENSACOLA SITES 32, 33, AND 35

DRAFT

MISSIMER AND ASSOCIATES, INC.

1981 AND 1982

(GROUNDWATER)

HAZARDOUS WASTE SURFACE IMPOUNDMENT

NAVAL AIR STATION

PENSACOLA. FLORIDA

SEMI-ANNUAL GROUND WATER MONITORING PROGRAM

AND

OUTLINE OF A GROUND WATER ASSESSMENT PLAN

JANUARY

1983

PREPARED BY

MISSIMER AND ASSOCIATES. INC.

CONSULTING HYDROLOGISTS. GEOLOGISTS. AND ENVIRONMENTAL SCIENTISTS

CAPE CORAL. FLORIDA

3202056

1981-19
WATER QUALI DATA

HWSI, MONITOR WELL: DG-1

Indicators of Ground Water Contamination					Mean	Variance	Standard Deviation
Date	11/24/81	2/17/82	5/12/82	8/3/82			
pH	7.8	6.90	6.90	6.44			
	7.8	'6.95	6.85	6.40	7.02	.25	.50
	7.8	7.00	6.90	6.45			
	7.8	7.00	6.92	6.40			
Specific Conductance, umhos/cm	1400	490	820	360			
	1400	495	815	364	769.	162,861.	404.
	1420	496	795	362			
	1410	497	830	360			
Total Organic Carbon, ppm	43.0	25.5	38.5	26			
	46.2	22.3	32.8	25			
	42.7	23.2	38.5	25	32.2	68.7	8.3
	40.8	24.4	37.6	24			
Total Organic Halogen, ppb	53.0	8	12	13			
	50.0	11	11	14	21.5	331.	18.2
	58.0	10	10	13			
	50.0	7	13	11			

1981-1982
WATER QUALITY DATA

HWSI, MONITOR WELL: DG-1

Parameters Establishing Ground Water Quality

Date	11/24/81	2/17/82	5/12/82	8/3/82
*Chloride	97.5	34	88	55
Iron	.ll	.32	5.13	1.40
Manganese	.006	.175	.22	.081
Phenols	.05	.124	.026	.003
Sodium	136	55	77	28
Sulfate	< 1	12.7	14.6	66

*ppm unless otherwise shown.

3201057

1-1982

WATER QUALITY DATA

HWSI. MONITOR WELL: DG-1

EPA Interim Primary Drinking Water Standards

Date	11/24/81	2/17/82	5/12/82	8/3/82
Arsenic, ppm	<.001	<,002	<.001	<.001
Barium, ppm	.019	<.01	<.01	<.01
Cadmium, ppm	,004	<.005	<.002	<.002
Chromium, ppm	.023	4.001	.009	.019
Fluoride, ppm	<.01	.35	.12	.5
Lead, ppm	<.003	<.02	<.02	<.02
Mercury, ppm	4.0005	<.0002	<.0005	<.0005
Nitrate, ppm	<.01	.34	.15	.12
Selenium, ppm	4.001	<.001	<.001	<.001
Silver, ppm	.002	<.005	<.001	<.001
Endrin, ppb	<.033	<.042	<.07	<.035
Lindane, ppb	4.004	<.0052	<.009	4.004
Methoxychlor, ppb	<.124	<.012	<.254	<.110
Toxaphene, ppb	<.6	<.157	<2.0	<1.0
2, 4-D, ppb	<.1	<.14	<.5	<.10
2,4, 5-TP Silvex, ppb	<.01	<.014	<.05	<.01
Radium, pCi/L	.4	1.9	.4	1.2
Gross Alpha, pCi/L	4.6	6.3	<2.7	2.2
Gross Beta, pCi/L	18.2	7.8	5.3	7.7
Turbidity, NTU	34	21	4.7	<.1
Coliform Bacteria, cls/100 ml	>1600	>80	<2	25

1981-19.2

WATER QUALITY DATA

3201058

HWSI, MONITOR WELL: DG-2

Indicators of Ground Water Contamingtion					Mean	Variance	Standard Deviation
Date	11/24/01	2/17/02	5/12/82	8/3/82			
pH	7.5 7.5 7.5 7.5	6.62 6.62 6.68 6.70	6.60 6.60 6.65 6.55	6.40 6.40 6.42 6.40	6.79	.18	.42
Specific Conductance, µmhos/cm	970 1000 1000 1000	810 800 800 805	300 320 300 310	965 964 960 964	767.	75,528.	275.
Total Organic Carbon, ppm	40.0 32.6 31.3 32.6	32.5 28.8 27.0 28.0	35.0 35.2 32.6 33.2	28 25 25 26	30.8	16.5	4.1
Total Organic Halogen, ppb	65.0 62.0 70.0 68.0	10 11 12 9	13 14 13 15	12 14 13 14	25.9	546.	23.4

1981-1982
WATER QUALITY DATA

HWSI, MONITOR WELL: DG-2

Parameters Establishing Ground Water Quality

Date	11/24/81	2/17/82	5/12/82	8/3/82
*Chloride	125	119	35	102
Iron	.36	.03	9.13	2.45
Manganese	,015	<.005	.13	.30
Phenols	< ,005	.015	.048	.048
Sodium	101	80	25	99
Sulfate	< 1	< 1	< 1	68

*ppm unless otherwise shown.

1981-1982
WATER QUALITY DATA
HWSI, MONITOR WELL: DG-2
EPA Interim Primary Drinking Water Standards

Date	11/24/81	2/17/82	5/12/82	8/3/82
Arsenic, ppm	<.001	<.002	<.001	<.001
Barium, ppm	.048	<.01	<.01	<.01
Cadmium, ppm	,003	<.005	<.002	4.002
Chromium, ppm	.018	<.001	.013	.012
Fluoride, ppm	<.01	.32	,078	.5
Lead, ppm	,004	<.02	<.02	<.02
Mercury, ppm	<.0005	<.0002	<.0005	<.0005
Nitrate, ppm	<.01	.24	.32	.13
Selenium, ppm	<.001	<.001	<.001	<.001
Silver, ppm	<.001	<.005	<.001	<.005
Endrin, ppb	<.033	<.042	4.07	<.035
Lindane, ppb	<.004	4.0052	<.009	4.004
Methoxychlor, ppb	<.124	<.012	<.254	<.110
Toxaphene, ppb	<.6	<.157	<2.0	< 1.0
2, 4-D, ppb	<.1	<.14	<.5	<.10
2,4, 5-TP Silvex, ppb	<.01	<.014	<.05	<.01
Radium, pCi/L	.4	1.8	.3	.3
Gross Alpha, pCi/L	7.3	5.8	<1.1	1.4
Gross Beta, pCi/L	17.5	10.5	4.1	10.6
Turbidity, NTU	48	34	5.0	<.1
Coliform Bacteria, c 100 ml	< 1600	<80	< 2	15

3201053

1981-1982
WATER QUALITY DATA

HWSI, MONITOR WELL: DG-3

Indicators of Ground Water Contamination					Mean	Variance	Standard Deviation
Date	11/24/81	2/17/82	5/12/82	8/3/82			
pH	7.6	6.75	6.85	6.10			
	7.6	6.85	6.90	6.12	6.86	.20	.52
	7.6	6.88	6.90	6.15			
	7.6	6.90	6.88	6.10			
Specific Conductance, umhos/cm	980	810	800	800			
	980	815	815	800	851.	6432.	80.
	1000	810	800	802			
	1000	800	810	804			
Total Organic Carbon, ppm	37.0	21.0	47.0	58.			
	31.0	21.5	42.3	50.	36.4	140.3	11.8
	31.0	18.0	36.4	49.			
	31.6	20.0	41.6	47.			
Total Organic Halogen, ppb	52.0	10	13	14			
	47.0	11	11	12	20.3	214.0	14.6
	41.0	11	14	11			
	41.0	14	12	11			

1981-1982
WATER QUALITY DATA
HWSI, MONITOR WELL: DG-3
EPA Interim Primary Drinking Water Standards

Date	11/24/81	2/17/82	5/12/82	8/3/82
Arsenic, ppm	<.001	c.002	<.001	<.001
Barium, ppm	.053	<.01	<.01	<.01
Cadmium, ppm	,003	<.005	<.002	4.002
Chromium, ppm	.018	<.001	.011	.034
Fluoride, ppm	<.01	.38	.08	1.3
Lead, ppm	.005	<.02	<.02	<.02
Mercury, ppm	<.0005	.000U	<.0005	<.0005
Nitrate, ppm	<.01	.37	.26	.28
Selenium, ppm	<.001	<.001	<.001	<.001
Silver, ppm	<.001	<.005	<.001	.002
Endrin, ppb	<.033	<.042	<.07	<.035
Lindane, ppb	<.004	<.0052	<.009	<.004
Methoxychlor, ppb	<.124	<.012	<.254	<.110
Toxaphene, ppb	<.6	<.157	<2.0	<1.0
2, 4-D, ppb	<.1	<.14	<.5	<.10
2,4, S-TP Silvex, ppb	<.01	<.014	<.05	<.01
Radium, pCi/L	.1	3.6	.2	.1
Gross Alpha, pCi/L	10.2	7.3	2.1	.2
Gross Beta, pCi/L	9.7	14.7	9.8	9.7
Turbidity, NTU	56	26	9.4	<.1
Coliform Bacteria, /100 ml	<1600	4	<2	<2

3201060

1981-1982
WATER QUALITY DATA

HWSI, MONITOR WELL: DG-3

Parameters Establishing Ground Water Quality

Date	11/24/81	2/17/82	5/12/82	8/3/82
*Chloride	223	161	160	245
Iron	.01	.026	4.3	.65
Manganese	,009	<.005	.061	.029
Phenols	<.005	.006	.006	.006
Sodium	126	94	145	140
Sulfate	< 1	13.6	10.2	20

*ppm unless otherwise shown.

1981-1902

WATER QUALITY DATA

HWSI, **MONITOR WELL:** UG-1

320106

Indicators of Ground Water Contamination

Date	11/24/81	2/17/02	5/12/82	8/3/02	Mean	Variance	Standard Deviation
pH	7.1 7.1 7.1 7.1	6.05 6.12 6.28 6.40	6.30 6.32 6.30 6.35	5.55 5.50 5.50 5.52	6.29	.32	.56
Specific Conductance, µmhos/cm	500 530 530 530	264 266 266 268	320 315 320 310	340 344 345 342	362.	9408.	100.
Total Organic Carbon, ppm	26.0 27.5 29.2 24.0	27.5 24.5 24.0 25.0	30.0 27.6 32.0 31.6	25 20 24 26	27.0	6.56	2.6
Total Organic Halogen, ppb	57.0 70.0 65.0 60.0	14 L0 11 13	13 12 14 10	13 12 14 11	25.	491.	22.1

C.11

1981-1982
WATER QUALITY DATA

HWSI, MONITOR WELL: UG-1

Parameters Establishing Ground Water Quality

Date	11/24/81	2/17/82	5/12/82	8/3/82
*Chloride	114	60	54	60
Iron	.08	,014	14.5	1.66
Manganese	<.002	<.005	.064	.007
Phenols	<.005	,002	.01	<.001
Sodium	68	31	35	29
Sulfate	17.4	15.1	16.0	31

*ppm unless otherwise shown,

1981-1982
WATER QUALITY DATA
HWSI, MONITOR WELL: UG-1
EPA Interim Primary Drinking Water Standards

Date	11/24/81	2/17/82	5/12/82	8/3/82
Arsenic, ppm	<.001	<.002	<.001	<.001
Barium, ppm	<.01	<.01	<.01	<.01
Cadmium, ppm	<.001	<.005	<.002	<.002
Chromium, ppm	.018	<.001	.023	.012
Fluoride, ppm	<.01	.31	.08	.5
Lead, ppm	<.003	<.02	<.02	<.02
Mercury, ppm	<.0005	<.0002	<.0005	<.0005
Nitrate, ppm	<.01	.21	.18	.13
Selenium, ppm	<.001	<.001	<.001	<.001
Silver, ppm	4.001	<.005	<.001	<.001
Endrin, ppb	<.033	<.042	<.07	<.035
Lindane, ppb	<.004	<.0052	<.009	<.004
Methoxychlor, ppb	<.124	<.012	<.254	<.110
Toxaphene, ppb	<.6	<157	t2.0	<1.0
2, 4-D, ppb	<.1	4.14	<.5	<.10
2,4, 5-TP Silvex, ppb	<.01	<.014	<.05	<.01
Radium, pCi/L	.2	.4	.I	.6
Gross Alpha, pCi/L	3.2	2.8	<1.5	1.6
Gross Beta, pCi/L	8.6	5.0	4.2	5.3
Turbidity, NTU	36	32	9.2	<.1
Coliform Bacteria, ls/100 ml	36	22	14	60

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MISSIMER AND ASSOCIATES, INC.

NOVEMBER 1983

(GROUNDWATER)

HAZARDOUS WASTE SURFACE IMPOUNDMENT
SEMI-ANNUAL GROUND WATER MONITORING PROGRAM

NOVEMBER, 1983 SAMPLING

TABLE 1. RESULTS OF LABORATORY ANALYSES: INDICATOR PARAMETERS AND PARAMETERS THAT ESTABLISH GROUND WATER QUALITY (former reported as mean of four replicate measurements)

		Well Numbers				
Parameter	Unit	DG-1	DG-4	DG-5	DG-6	UG-1
Total Organic Carbon	ppm	27.0	66.2	12.8	39.8	4.6
Total Organic Halogen	ppb	16.0	12.5	11.5	23.0	7.5
	--	7.70	7.60	7.50	8.29	6.81
Specific Conductance	umhos/cm	750.	770.	800.	981.	260.
Iron	ppm	1.03	6.13	0.98	0.36	2.03
Manganese	ppm	0.11	0.11	0.07	0.11	0.02
Chloride	ppm	50.	65.	75.	120.	45.
Sodium	ppm	93.	91.	93.	132.	24.
Sulfate	ppm	<1.	<1.	<1.	<1.	1.2
Phenol	ppm	0.60	0.42	0.75	0.84	0.01

3201063

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MISSIMER AND ASSOCIATES, INC.

FEBRUARY 1984

(GROUNDWATER) .

GROUND WATER ASSESSMENT PLAN
HAZARDOUS WASTE SURFACE IMPOUNDMENT
NAVAL AIR STATION, PENSACOLA, FLORIDA

MISSIMER AND ASSOCIATES. INC.

CONSULTING HYDROLOGISTS. GEOLOGISTS.
AND ENVIRONMENTAL SCIENTISTS.

CAPE **CORAL FLORIDA**

3201064

Table TCL

SUMMARY ANALYTICAL RESULTS FOR GROUNDWATER SAMPLES COLLECTED 2/84 AT THE NAS PENSACOLA IWTP
(All results in µg/L, unless noted)

	Well Number	
Para ntor	W-6	UG-1
Total Metals		
Antimony	90	<SO
Arsonic	19	<1
Beryllium	<1	<1
Cadmium	8	2
Chromium	367	162
Copper	50	44
Load	200	60
Mercury	0.2	1.1
Nickel	327	145
Selenium	<1	<1
Silver	3	<1
Thallium	30	40
Zinc	337	302
Phonols	7850	27
Cyanide	<1	<1
Vinyl Chloride	7	<1
Chloroethane	43	<1
1,1-Dichloroethane	670	<1
1,1,1-Trichloroethane	130	<1
Trichloroethylene	58	<1
Benzene	3.5	<1

Table TCL (Cont.)

Parameter	Well Number DG-6	UG-1
1,1-Dichloroethylene	8	<1
Tetrachloroethylene	6	<1
1,2-Trans-Dichloroethylene	32	<1
Toluene	550	2.0
Chlorobenzene	6	<1
Phenol	2170	1.05
2-Chlorophenol	0.7	<5
1,3-Dichlorobenzene	16.5	<5
1,4-Dichlorobenzene	37.6	<5
1,2-Dichlorobenzene	283	<5
Naphthalene	159	<5
Di-N-Butyl-Phthalate	0.26	<5
P-Chloro-M-Cresol	25.2	<5

Source: Missimer and Associates, Inc., 1964. Doc. No. 32:17

3201065

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GERAGHTY AND HILLER, INC.

JULY AND OCTOBER 1984

(GROUNDWATER)

FINAL REPORT

Water-Quality Assessment Program at the Wastewater-Treatment Plant, NAS Pensacola, Florida (Phase I)

Prepared for

DEPARTMENT OF THE NAVY
Southern Division,
Naval Facilities
Engineering Command
Charleston, South Carolina

GERAGHTY & MILLER, INC.
GROUND-WATER CONSULTANTS

CARROLLWOOD VILLAGE EXECUTIVE CENTER
13902 North Dale Mabry Highway, Tamp, Florida 33618 (813) 961-1921

3201066

Tabla 1 Results of Dissolved Metals Analyses From the Monitor Wells, July and October, 1984.

Constituent (mg/l)	Cambridge Analytical (7/19/84)					Pioneer Laboratory (10/31/84)							(EPA Recommended Health Criteria) Flocida Primary and Secondary Drinking Water Standards
	DG-1	DG-1	DG-4	DG-5	DG-6	GM-8	GM-9	GM-10	GM-11	GM-12	GM-13	GM-14	
Antimony (Sb)	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	-	-	-	-	-	N/S
Arsenic (As)	<0.005	<0,005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	0.009	<0.001	<0.001	0.05 mg/l
Barium (Ba)	-	-	-	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1 mg/l
Beryllium (Be)	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	N/S
Cadmium (Cd)	<0.001	(0.001	<0.001	<0.001	<0.001	0.001	0.004	0.004	0.001	0.002	0.001	*0.003*	0.01 mg/l
Chromium (Cr)	<0.025	<0.025	<0.025	<0.025	<0.025	0.006	0.016	0.017	0.001	0.002	0.004	*0.003*	0.05 mg/l
Copper (Cu)	0.034	<0.025	<0.025	<0.025	<0.025	0.005	0.006	0.008	-	-	-	-	1.0 mg/l*
Lead (Pb)	<0.005	<0.005	<0.005	<0.005	<0.005	0.03	0.03	0.04	0.02	*0.03*	0.02	*0.03*	0.05 mg/l
Manganese (Mn)	-	-	-	-	-	0.270	0.339	0.200	-	-	-		0.05 mg/l*
Mercury (Hg)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0010	<0.0012	<0.0002	<0.0002	<0.0002	<0.0002	0.002 mg/l
Nickel (Ni)	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	N/S
Selenium (Se)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01 mg/l
Silver (Ag)	<0.01	<0.01	<0.01	<0.01	<0.01	0.002	0.003	0.004	0.001	0.001	<0.001	0.002	0.05 mg/l
Thallium (Tl)	<0.005	<0.005	<0.005	<0.005	<0.005	-		-	-	-	-	-	N/S
Zinc (Zn)	<0.01	<0.01	<0.01	<0.01	0.076	0.025	0.034	*0.038*	-	-	-	-	5.0 mg/l*
Cyanide**	0.019	0.024	0.022	0.058	0.022 0.020[a]	-	-	-	-	-	-	-	(0.02 mg/l) N/S

[a] = Duplicate analysts performed.

* = Secondary standard (Effective July 1, 1985)

** = All samples contained high levels of sulfide which may cause interferences for these analyses.

N/S = No Florida standard established.

Geraghty & Miller, Inc.

Table 2. Volatile Organic Compounds Detected in the 17-3 and 17-4 FAC Monitor Wells (Method 601)

Organic Compound	Cambridge Analytical Associates (7/19/84)							Pioneer Laboratory (10/31/84)							Florida Primary & Secondary Drinking-Water Standards
	GM-8	GM-9	GM-10	GM-11	GM-12	GM-13	GM-14	GM-8	GM-9	GM-10	GM-11	GM-12	GM-13	GM-14	
Chloroform	-	-	-	-	-	-	-	TR	TR	TR	6	6	TR	-	100 ppb
Chloroethane	-	-	-	-	-	-	-	-	5	46	-	-	-	-	N/S
1,1-Dichloroethane	50	6900	1060	ND	ND	ND	ND	5	660	250	TR	-	-	TR	N/S
Methylene chloride	-	-	-	-	-	-	-	-	TR	TR	TR	11	12	TR	N/S
1,1-Dichloroethene	ND	50	ND	ND	ND	ND	ND	-	TR	TR	-	-	-	-	N/S
1.2 Dichloroethene	-	-	-	-	-	-	-	-	TR	TR	-	-	-	-	N/S
1,2-Dichloroethane	0.6	9600	2	ND	ND	ND	ND	-	TR	TR	-	-	-	-	N/S
1,1,2,2 Tetrachloro-ethane	-	-	-	-	-	-	-	-	6	TR	-	-	TR	TR	N/S
1,1,1-Trichoroethane	ND	11,500	100	ND	ND	ND	ND	-	TR	TR	-	-	-	-	200 ppb
Trichloroethene	ND	60	ND	ND	ND	ND	ND	-	TR	TR	-	-	-	-	3 ppb
Tetrachloroethene	ND	675	ND	ND	ND	ND	ND	-	4	TR	-	-	-	-	3 ppb
Vinyl chloride	-	-	-	-	-	-	-	-	21	7	-	-	-	-	1 ppb
Chlorobenzene	ND	47	ND	ND	ND	ND	ND	TR	10	19	TR	-	-	TR	N/S
Dichlorobenzene	-	-	-	-	-	-	-	TR	1000	65	TR	-	-	-	N/S

ND = none detected
TR = trace
N/S = no standard
All amounts in ppb.

2201067

Table 3. Volatile Organic Compounds Detected in the RCRA Monitor Wells (Method 624)

Compound	Pioneer Lab (2/9/84) DG-6	Cambridge Analytical (7/19/84) ffi-1	DG-4	ffi-5	DC-6	UG-1	Pioneer Laboratory (10/31/84) DG-1	DG-4	DG-5	DG-6	UG-1	Florida Primary Drinking-Water Standards
1,1-Dichloroethane	670	1500	850	37	1500	ID	2750	1025	525	1225	-	N/S
1,1-Dichloroethene	8	ND	ND	ND	ND	ND	800	TR	-	25	-	N/S
1,2-Dichloroethylene	32	ND	ND	ND	ND	ND	-	75	TR	16	-	N/S
Carbon Tetrachloride	-	-	-	-	-	-	425	TR	0	9	TR	N/S
1,1,1-Trichloroethane	130	110	61	26	330	ND	5900	8	-	103	-	N/S
1,1,2,2-Tetrachloroethane	-	-	-	-	-	-	800	16	TR	33	TR	N/S
Trichloroethene	58	ND	ND	ND	TR(20)	ND	20	13	-	32	-	3 ppb
Tetrachloroethene	6	ND	ND	ND	ND	ND	500	11	TR	38	TR	3 ppb
Chlorobenzene	ND	ND	13	ND	ND	ND	160	3	45	7	-	N/S
2-Chloro ethylvinyl ether	-	-	-	-	-	-	-	-	-	-	TR	N/S
Vinyl chloride	ND	10	20	ND	ND	ND	32	16	9	13	-	N/S
Chloroethane	43	180	20	ND	ND	ND	-	-	72	37	-	N/S
Chloroform	-	-	-	-	-	-	250	TR	TR	5	-	100 ppb
Benzene	35	ND	ND	ND	ND	ND	TR	2	2	2	TR	1 ppb
Toluene	550	160	210	TR(6)	170	ND	600	14	18	35	TR	N/S
Ethylbenzene	ND	ND	TR(2)	ND	ND	ND	6	9	4	15	-	N/S
Total xylene	ND	ND	43	ND	ND	ND	-	-	-	-	-	N/S
2-Hexanone	ND	160	110	TR(7)	240	ND	-	-		-	-	N/S
Methyl ethyl ketone	ND	11,000	ND	540	10,200	ND	-	-	-		-	N/S
Acetone	ND	4,700	ND	ND	ND	ND	-	-	-	-	-	N/S
1,2-Dichloro,1,1,2 hi-fluoroethane	ND	ND	75	110	8,000	ND	-	-	-		-	N/S
Methylene chloride	ND	ND	ND	450	ND	ND	TR	TR	TR	TR	TR	N/S

ND = none detected
TR = trace
NS = no standard

Concentrations in ppb

Note: Table includes only compounds which were detected.

Table 4. Base Neutral/Acid Extractable Analysis in the RCRA Monitor Wells (Method 8270 and 625)

Organic Compound	Cambridge Analytical (7/19/84)					Pioneer Laboratory (10/31/84)					EPA Recommended Health Criteria
	DG-1	DG-4	DG-5	DG-6	UG-1	DG-1	DG-4	DG-5	DG-6	UG-1	
Acid Extractables											
Phenol	TR(3)	ND	ND	TR(6)	ND	-	95	-	5	-	3.1 ppm
2-Chlorophenol	24	ND	ND	30	ND	35	42	15	14	ND	0.3 ppb
2-4 Dimethylphenol	480	ND	ND	80	ND	-	-	-	-	-	No Standard
2-4 Dichlorophenol	TR(3)	ND	ND	TR(2)	ND	-	-	-	-	-	371 ppb
2-Methyl phenol	3,300	ND	ND	3,300	ND	-	-	-	-	-	No Standard
Base-Neutral Extractables											
1,3-Dichlorobenzene	110	ND	TR(3)	56	ND	193	38	80	71	-	230 ppb
1,4-Dichlorobenzene	200	ND	TR(6)	120	ND	337	98	170	182	-	230 ppb
1,2-Dichlorobenzene	530	ND	16	500	ND	1163	194	708	933	-	230 ppb
1,2,4-Trichlorobenzene	TR(3)	ND	ND	TR(4)	ND	-	-	-	-	-	13 ppb
Napthalene	260	ND	ND	22	ND	-	383	250	782	-	143 ppb
Acenaphthene	TR(2)	ND	ND	ND	ND	-	-	-	-	-	20 ppb
Nitrobenzene	-	-	-	-	-	638	-	-	-	-	13.9 ppm
2-Methyl napthalene	50	ED	ND	80	ND	-	-	-	-	-	
Di-n-octyl-phthalate	-	-	-	-	-	8	11	TR	26	-	160 ppm
Hexachloroethane	ND	ND	ND	TR(2)	ND	-	-	-	-	-	4.4 ppb
Bis(2 ethylhexyl)phthalate	-	-	-	-	-	-	-	-	-	27.3	10 ppm

ND = none detected
TR = trace

Concentrations in ppb

Note: Table inclues only detected compounds

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GERAGHTY AND MILLER, INC.

SEPTEMBER 1985

(GROUNDWATER)

3201069

Table 2. Results of Organic Compounds Detected in the Shallow Wells
(concentrations In ug/l)

Compound	DG-2	DG-3	GM-8	GM-9	GM-10	GM-62	GM-67	GM-70	GM-71	GM-72	04-76	GM-77	04-78	GM-79	GM-80	01-81	GM-82	GM-83
Acid Extractables																		
2,4-dimethylphenol	760	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenol	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-
2,4-dichlorophenol	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p-chloro-m-cresol	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Base-Neutral Extractables																		
1,2-dichlorobenzene	330	-	14	3200	75	-	160	-	-	-	-	-	-	-	-	-	-	-
1,3-dichlorobenzene	330	-	13	2250	75	-	150	-	-	-	-	-	-	-	-	-	-	-
1,4-dichlorobenzene	170	-	30	4000	120	-	200	-	-	-	-	11	-	-	-	-	14	-
Di-n-butyl-phthalate	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Di-n-octyl-phthalate	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Volatile Organics																		
Chlorobenzene	6	2	-	-	-	-	12	3	10	1	-	15	4	-	-	-	10	-
Chloroethane	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1-dichloroethane	240	-	-	-	-	-	7	-	12	-	11	1	-	-	-	-	-	-
Ethylbenzene	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methylene chloride	88	33	-	-	-	21	-	-	-	-	-	-	-	-	-	260	120	159
1,1,2,2-tetrachloroethane	27	16	-	-	-	23	-	-	-	-	-	-	-	-	-	130	30	38
Tetrachloroethylene	17	10	-	-	-	6	-	-	-	-	-	-	-	-	-	78	19	25
Toluene	81	3	-	-	-	2	-	1	-	-	-	-	-	1	1	2	1	2
Trichloroethylene	6	-	-	-	-	-	50	7	1	-	-	-	-	-	-	-	-	-
Vinyl Chloride	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,2-trans-dichloroethylene	-	-	-	-	-	-	16	-	-	-	-	-	-	-	-	-	-	-
TOTAL ORGANICS	2124	89	57	9520	270	52	595	11	23	1	11	27	4	1	1	476	194	224

- = None Detected
(206/30)

Note: GM-11, GM-12, GM-13, GM-14, and GM-73 were also analyzed 9/85 but had no detectable concentrations of parameters.

Table 3. Results of Organic Compounds Detected in the Intermediate and Deep Wells
'(concentrations in ug/l)

Compound	Intermediate				Deep			
	GM-64	GM-66	GM-69	GM-75	GM-63	GM-65	01-68	GI-74
Acid Extractables								
Phenol	-	-	-	-	-	-	-	10
Base Neutral Extractables								
Di-n-butylphthalate	610	-	-	-	-	-	-	-
1,2-dichlorohenzene	-	-	620	-	-	-	-	-
1,3-dichlorobenzene	-	-	1400	-	-	-	-	-
1,4-dichlorobenzene	-		1350	-	-	-	-	-
Naphthalene	-	-	11	-	-	-	-	-
Volatile Organics								
1,1,2,2-tetrachloroethane	14	8	-	-	8	-	-	-
Tetrachloroethylene	9	5	-	-	6	-	-	-
Chlorobenzene	-	16	-	55	-	-	-	-
1,1-dichloroethane	-	14	47	1	-	-	-	-
1,1-dichloroethylene	-	160	-	-	-	-	-	-
Toluene	-	5	8	-	2	-	-	1
1,2-trans-dichloroethylene	-	882	-	-	-	-	-	-
Trichloroethylene	-	2600	3	-	-	4	10	-
Vinyl chloride	-	27	3	1	-	-	-	-
Benzene	-	-	3	-	-	-	-	-
Bis(chloromethyl)ether	-	-	-	1	-	-	-	-
TOTAL ORGANICS	633	3717	3445	58	16	4	10	11

- = none detected

(206/31)

DRAFT

U.S. ENVIRONMENTAL PROTECTION AGENCY

JANUARY 1987

(GROUNDWATER)

TABLE 1
SAMPLE LOCATION DESCRIPTION
PENSACOLA NAVAL AIR STATION
PENSACOLA, FLORIDA

SAMPLE STATION	TYPE OF SAMPLE	DESCRIPTION
NAS-1	Ground Water	Monitoring Well UG-1, located north of the WWTP.
NAS-2	Ground Water	Monitoring Well GM-80, located north of the WWTP.
NAS-3	Ground Water	Monitoring Well GM-68, located at the north east corner of the sludge drying be&.
NAS-4	Ground Water	Monitoring Well GM-71, located north east of the WWTP.
NAS-5	Ground Water	Monitoring Well DG-4, located at the north east corner of the surge pond.
NAS-6	Ground Water	Monitoring Well DG-6, located at the south vest corner of the surge pond.
NAS-7	Ground Water	Monitoring Well GM-73, located at the north east corner of the polishing lagoon.
NAS-a	Ground Water	Monitoring Well GM-12, located on the north si& of the intermediate pond.
NAS-9	Wastevater (industrial)	Composite sample consisting of two grab samples of industrial influent at 1035 and 1255 hours. Sample collected from channel prior to coaminutor for extractable organic analysis.
NAS-10	Wastewater (industrial)	A grab sample collected at same location as NAS-9, but only for volatile organic analysis.
NAS-11	Wastewater (industrial)	Same as NAS-10, but collected at a different time.
NAS-12	Sludge (industrial)	Filter press sludge from industrial treatment system process. Metals analysis only.

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Table 1
(continued)

NAS-13	Sludge (aerobic digester)	Sludge collected from aerobic digester. Sludge generated via the biological treatment of both industrial and domestic wastewater. Metals analysis only.
NAS-14	Wastewater (clarifier)	Effluent from clarifier located in industrial treatment system. Analyzed for extractable and volatile organic compounds.
NAS-15	Water	Water sample collected from phenol pond and analyzed for extractable and volatile organic compounds.
NAS-16	Sludge	Sludge sample collected from phenol pond and analyzed for metals.
NAS-17	Water	Water sample collected from polishing pond and analyzed for extractable and volatile organic compounds.
NAS-18	Sludge	Sludge sample collected from polishing pond and analyzed for metals.

TABLE 2
ANALYTICAL DATA SUMMARY
WATER SAMPLES
PENSACOLA NAVAL AIR STATION
PENSACOLA, FLORIDA

	NAS-1	NAS-2	NAS-3	NAS-4	NAS-5	NAS-6	NAS-7	NAS-8	NAS-9	NAS-10	NAS-11	NAS-14	NAS-15	NAS-17
	WELL	WELL	WELL	WELL	WELL	WELL	WELL	WELL	100	100	100	CLARIFIER	PRESEL	POLISH
	05-1	08-00	08-68	08-71	06-4	06-6	08-72	08-12	C200	C200	C200	.047	POND	POND
	01/21/87	01/21/87	01/21/87	01/21/87	01/21/87	01/22/87	01/22/87	01/22/87	01/22/87	01/22/87	01/22/87	01/22/87	01/22/87	01/22/87
	0900	1045	1400	1515	1700	0805	0945	1140	1325	1040	1225	1325	1520	1600
INORGANIC ELEMENTS/COMPOUNDS	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
BARIUM	--	--	--	30	22	30	22	--	NA	NA	NA	NA	NA	NA
CHROMIUM	37	--	--	--	19	22	--	--	NA	NA	NA	NA	NA	NA
NICKEL	23	--	--	--	--	--	--	--	NA	NA	NA	NA	NA	NA
STRONTIUM	86	--	420	180	200	260	210	23	NA	NA	NA	NA	NA	NA
TITANIUM	20	22	--	--	83	--	--	--	NA	NA	NA	NA	NA	NA
ZINC	--	--	--	11	--	--	43	--	NA	NA	NA	NA	NA	NA
ALUMINUM	3700	3400	310	230	5700	640	200	260	NA	NA	NA	NA	NA	NA
MANGANESE	--	--	72	120	37	200	--	200	NA	NA	NA	NA	NA	NA
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
CALCIUM	16	--	36	64	57	70	40	10	NA	NA	NA	NA	NA	NA
MAGNESIUM	2.2	1.4	6.1	9.1	4.2	11	30	2.4	NA	NA	NA	NA	NA	NA
IRON	2.1	3.8	1.4	14	3.2	1.1	1.2	2.2	NA	NA	NA	NA	NA	NA
SODIUM	6.4	20	88	18	45	60	110	10	NA	NA	NA	NA	NA	NA
EXTRACTABLE ORGANIC COMPOUNDS	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
1,3-DICHLOROBENZENE	--	--	--	7.1J	17	21	--	--	--	NA	NA	3.2J	--	--
1,4-DICHLOROBENZENE	--	--	--	14	30	40	--	--	--	NA	NA	4.4J	--	--
1,2-DICHLOROBENZENE	--	--	--	22	86	230	--	--	--	NA	NA	6.1J	--	--
1,2,4-TRICHLOROBENZENE	--	--	--	--	--	1.1J	--	--	--	NA	NA	--	--	--
NAPHTHALENE	--	--	--	--	17	250	--	--	86J	NA	NA	71	--	--
FLUORENE	--	--	--	--	--	2.3J	--	--	22J	NA	NA	5.2J	--	--
PHENANTHRENE	--	--	--	--	--	2.7J	--	--	66J	NA	NA	7.4J	--	--
BIS(2-ETHYLHEXYL) PHTHALATE	--	--	--	--	--	--	--	700	--	NA	NA	--	--	--
2-CHLOROPHENOL	--	--	--	--	5.2J	6.6J	--	--	--	NA	NA	43	--	--
PHENOL	--	--	--	--	--	--	--	1.6J	25000	NA	NA	15000	--	2.7J
2,4-DIMETHYLPHENOL	--	--	--	--	4.2J	130	--	--	160J	NA	NA	86	--	--
2,4-DICHLOROPHENOL	--	--	--	--	--	--	--	--	--	NA	NA	7.6J	--	--
2,4,6-TRICHLOROPHENOL	--	--	--	--	--	--	--	--	--	NA	NA	11	--	--
PENTACHLOROPHENOL	--	--	--	--	--	5.5J	--	--	--	NA	NA	--	--	--
TRIS(2-CHLOROETHYL)PHOSPHATE	--	--	--	10J	--	--	--	--	--	--	--	--	--	--
BUTYL BENZYL (DIMETHYLETHYL) METHYLPHENOL	--	--	--	10J	--	--	--	--	--	--	--	--	--	--
CHLOROMETHYLBENZENE	--	--	--	--	5J	--	--	--	--	--	--	--	--	--
DIETHYLBENZENE	--	--	--	--	5J	--	--	--	--	--	--	--	--	--
METHYL (METHYLETHYL) BENZENE (3 ISOMERS)	--	--	--	--	20J	--	--	--	--	--	--	--	--	--
TETRAMETHYLBENZENE (3 ISOMERS)	--	--	--	--	10J	--	--	--	--	--	--	--	--	--
DIMETHYLPHENOL (NOT 2,4-) (5 ISOMERS)	--	--	--	--	200J	--	--	--	--	--	--	--	--	--
TRIMETHYLBICYCLOHEPTANONE	--	--	--	--	5J	--	--	--	--	--	--	--	--	--
ETHYL METHYLPHENOL (3 ISOMERS)	--	--	--	--	20J	--	--	--	--	--	--	--	--	--
DIMETHYLETHYLPHENOL	--	--	--	--	8J	--	--	--	--	--	--	--	--	--
HEXATRIENYNE	--	--	--	--	5J	--	--	--	--	--	--	--	--	--
(TRIBUTOXYETHYL)PHOSPHATE	--	--	--	--	5J	--	--	--	--	--	--	--	--	--
ANILINE	--	--	--	--	--	3.8J	--	--	--	--	--	--	--	--
TRIMETHYLBENZENE (2 ISOMERS)	--	--	--	--	10J	100J	--	--	--	--	--	--	--	--
METHYL (METHYLETHYL) BENZENE (6 ISOMERS)	--	--	--	--	--	400J	--	--	--	--	--	--	--	--
DIMETHYLPHENOL (NOT 2,4-) (3 ISOMERS)	--	--	--	--	--	200J	--	--	--	--	--	--	--	--
DIMYRCENE METHYLIMINE	--	--	--	--	--	100J	--	--	--	--	--	--	--	--
TRIMETHYLCYCLOHEXANEMETHANOL	--	--	--	--	5J	50J	--	--	--	--	--	--	--	--
TETRAMETHYLBUTYLPHENOL	--	--	--	--	10J	60J	--	--	--	--	--	--	--	--
2 UNIDENTIFIED COMPOUNDS	--	--	--	--	100J	200J	--	--	--	--	--	--	--	--
CAPROLACTAM	--	--	--	--	--	--	1J	--	--	--	--	--	--	--
BUTYL (DIMETHYLETHYL) METHYLPHENOL	--	--	--	--	--	--	4J	--	--	--	--	--	--	--
BUTOXYETHANOL	--	--	--	--	--	--	--	--	1000J	--	--	--	--	--
ETHYL METHYLBENZENE (2 ISOMERS)	--	--	--	--	--	--	--	--	100J	--	--	--	--	--
METHYLPROPYLBENZENE	--	--	--	--	--	--	--	--	200J	--	--	--	--	--
METHYL (METHYLETHYL) BENZENE (4 ISOMERS)	--	--	--	--	--	--	--	--	1000J	--	--	--	--	--
DIMETHYL (METHYLETHYL) BENZENE (2 ISOMERS)	--	--	--	--	--	--	--	--	200J	--	--	--	--	--
DIMETHYLNAPHTHALENE (4 ISOMERS)	--	--	--	--	--	--	--	--	800J	--	--	--	--	--
TRIMETHYLNAPHTHALENE (8 ISOMERS)	--	--	--	--	--	--	--	--	1000J	--	--	--	--	--
METHYLPHENANTHRENES (5 ISOMERS)	--	--	--	--	--	--	--	--	500J	--	--	--	--	--
DIMETHYLPHENANTHRENE (4 ISOMERS)	--	--	--	--	--	--	--	--	300J	--	--	--	--	--
TRIMETHYLPHENANTHRENE (2 ISOMERS)	--	--	--	--	--	--	--	--	100J	--	--	--	--	--
BUTOXYETHANOL (2 ISOMERS)	--	--	--	--	--	--	--	--	--	--	--	700J	--	--
ETHYL METHYLBENZENE (3 ISOMERS)	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--	--
ETHYLPENTANOL	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--	--
DIMYRCENEDIENE	--	--	--	--	--	--	--	--	100J	--	--	[illegible]	--	--
METHYL (METHYLETHYL) BENZENE (8 ISOMERS)	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--	--
METHYLPROPENYLBENZENE	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--	--
DIMETHYLPHENOL (NOT 2,4-) (6 ISOMERS)	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--	--
ETHYL METHYLPHENOL (4 ISOMERS)	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--	--
DIMETHYL (METHYLETHYL) BENZENE	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--	--
DIMYRCENYLMETHYLIMINE	--	--	--	--	--	--	--	--	200J	--	--	[illegible]	--	--
1-METHYLNAPHTHALENE	--	--	--	--	5J	30J	--	--	300J	--	--	[illegible]	--	--
(DIMETHYLETHYL) METHYLPHENOL	--	--	--	--	--	--	4J	--	--	--	--	[illegible]	--	--
DIMETHYLNAPHTHALENE (6 ISOMERS)	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--	--
METHYLBIPHENYL	--	--	--	--	--	--	--	--	100J	--	--	[illegible]	--	--
TRIMETHYLNAPHTHALENE (7 ISOMERS)	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--	--
BIS(DIMETHYLETHYL) METHYLPHENOL	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--	--
METHYLFLUORENE (2 ISOMERS)	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--	--
DIBENZOTHIOPHENE	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--	--
METHYLPHENANTHRENE (4 ISOMERS)	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--	--
DIMETHYLPHENANTHRENE	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--	--
DIMETHYLETHYLPHENOL	--	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--
PETROLEUM PRODUCT	--	--	--	--	--	--	--	--	8	--	--	9	9	--
BENZOIC ACID	--	--	--	--	--	--	--	--	--	--	--	23	--	--
2-METHYLPHENOL	--	--	--	--	37	84	--	--	91J	--	--	[illegible]	--	--
4-METHYLPHENOL	--	--	--	--	--	130	--	--	--	--	--	[illegible]	--	--
DIBENZOFURAN	--	--	--	--	--	--	--	--	--	--	--	[illegible]	--	--
2-METHYLNAPHTHALENE	--	--	--	--	--	20	--	--	230	--	--	41	--	--

3201.072

TABLE 2
ANALYTICAL DATA SUMMARY
WATER SAMPLES
PENSACOLA NAVAL AIR STATION
PENSACOLA, FLORIDA

	NAS-1	NAS-2	NAS-3	NAS-4	NAS-5	NAS-6	NAS-7	NAS-8	NAS-9	NAS-10	NAS-11	NAS-14	NAS-15	NAS-17
	WELL	WELL	WELL	WELL	WELL	WELL	WELL	WELL	IND	IND	IND	CLA/FLO	PHENOL	POLISH
	UB-1	GR-80	GR-68	GR-71	36-4	36-6	GR-72	59-12	CONN	CONN	CONN	UNIT	FCNB	POND
	01/21/87	01/21/87	01/21/87	01/21/87	01/21/87	01/22/87	01/22/87	01/22/87	01/22/87	01/22/87	01/22/87	01/22/87	01/22/87	01/22/8
	0900	1045	1400	1215	1700	0815	0945	1140	1035	1040	1235	1255	1520	1600
PURGEABLE ORGANIC COMPOUNDS	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
1,1-DICHLOROETHANE	--	--	--	3.7J	270	510	1.4J	--	NA	--	--	--	--	--
1,1,1-TRICHLOROETHANE	--	--	--	--	--	--	1.2J	--	NA	4300	1400	430	19	1.2J
BENZENE	0.9J	--	--	--	--	--	--	--	NA	--	--	--	--	--
TETRACHLOROETHENE(TETRACHLOROETHYLENE)	--	--	--	--	--	--	--	--	NA	110J	--	--	--	--
TOLUENE	--	--	--	--	--	62J	--	--	NA	--	240	--	--	--
CHLOROBENZENE	1J	--	--	3J	--	--	--	--	NA	--	11J	--	--	--
TOTAL XYLENES	--	--	--	--	--	12J	--	--	NA	--	29J	--	--	--
ACETONITRILE	--	--	--	--	10JN	--	--	--	--	--	--	--	--	--
DICHLORODIFLUOROETHANE	--	--	--	7JN	20JN	40JN	--	--	--	--	--	--	--	--
BUTYL ACETATE	--	--	--	--	--	--	--	--	--	--	700JN	--	--	--
TETRACHLORODIFLUOROETHANE	--	--	--	--	--	--	--	--	--	800JN	230JN	60JN	--	--
TOTAL UNIDENTIFIED ALKYLHYDROCARBONS	--	--	--	--	--	--	--	--	--	--	4000J	--	70JN	--
METHYL ETHYL KETONE	--	--	--	--	--	570J	--	--	--	22000	8100	2400	--	--
METHYLENE CHLORIDE	--	--	--	--	--	--	--	--	NA	12200	18000	1530	43	--
CONVENTIONAL PARAMETERS	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
CHLORIDE	9.2	24	140	23	29	97	119	14A	NA	NA	NA	NA	NA	NA
CYANIDE	NA	NA	NA	NA	NA	0.01J	--	--	NA	NA	NA	NA	NA	NA
FLUORIDE	0.15	--	--	0.21	0.16	0.21A	0.48	--	NA	NA	NA	NA	NA	NA
NITRATE-NITRITE NITROGEN	0.18	0.26	0.23	1.1	0.26	0.16	0.17	0.44	NA	NA	NA	NA	NA	NA
SULFATE	7.4	--	9.2	17	20A	23	200	--	NA	NA	NA	NA	NA	NA
	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
PHENOL (4AAP)	NA	NA	NA	56	110	230A	25	--	NA	NA	NA	NA	NA	NA
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
TOTAL ORGANIC CARBON	7.9	45	1.6	18A	19	17	9.8	7.2	NA	NA	NA	NA	NA	NA

****

QUALIFIERS
A - AVERAGE VALUE
NA - NOT ANALYZED
J - ESTIMATED VALUE
N - PRESUMPTIVE EVIDENCE OF PRESENCE OF MATERIAL

TABLE 3
ANALYTICAL DATA SUMMARY
WASTE WATER TREATMENT SLUDGES
PENSACOLA NAVAL AIR STATION
PENSACOLA, FLORIDA

	NAS-12 FILTER PRESS 01/22/87 1400	NAS-13 DIG'TR NUM. 3 01/22/87 1415	NAS-16 PHENOL POND 01/22/87 1530	NAS-18 POLISH POND 01/22/87 1615
INORGANIC ELEMENT/COMPOUND	MG/KG	MG/KG	MG/KG	MG/KG
SILVER	--	1300	50	26
BARIUM	--	7200	79	88
CADMIUM	210	1400	26	21
CHROMIUM	69000	86000	1100	840
COPPER	470	15000	140	140
NICKEL	2600	6600	190	78
LEAD	680	2800	110	45
STRONTIUM	150	2600	25	30
TITANIUM	130	480	19	43
VANADIUM	100	350	5.4	13
ZINC	410	17000	150	200
MERCURY	2.8	NA	0.3	0.75
ALUMINUM	23000	780000	7800	14000
MANGANESE	250	1700	24	20
CALCIUM	67000	310	4900	2700
MAGNESIUM	35000	160	680	610
IRON	5900	180	7200	3600
SODIUM	--	400	670	650
CONVENTIONAL PARAMETERS	MG/KG	MG/KG	MG/KG	MG/KG
CYANIDE	23	0.096	3.5	--

****

FOOTNOTES
NA - NOT ANALYZED
-- - MATERIAL WAS ANALYZED FOR BUT NOT DETECTED

3201073

DRAFT

GERAGHTY AND MILLER, INC.

MAY 1988

(GROUNDWATER)

32010

GERAGH & MILLER C.

D-12

RESULTS OF ORGANIC COMPOUND ANALYSES
WASTEWATER TREATMENT PLANT
NAS PENSACOLA, FLORIDA

t Voca	= Total Volatile Organic Compounds
Bono	= Benzene
Ctet	= Carbon Tetrachloride
Cbene	= Chlorobenzene
Cane	= Chloroethane
Cform	= Chloroform
Dicbene	= Dichlorobenzenes
11Diane	= 1,1-Dichloroethane
12Diane	= 1,2-Dichloroethane
11Diene	= 1,1-Dichloroethene
12Diene	= trans-1,2-Dichloroethene
Ebene	= Ethyl Benzene
totene	= Tetrachloroethene
Tol	= Toluene
111Triane	= 1,1,1-Trichloroethane
Tce	= Trichloroethene
vc	= Vinyl Chloride
Nd	= None Detected or Below Quantitation Levels
T Bnes	= total Base Neutral Extractables
T Aes	= Total Acid Extractables
(Date)	= Sampled according to operating permit
(S)	= Shallow monitor well, about 13 It deep
(I)	= Intermediate monitor wall, about 40 It deep
(D)	= Deep monitor well, about 65 It deep

NOTE: All blank entries designate that tho compound vas below the detection limit or below quantitation levels.

DATA REVISED: HAY I?, 1988

MONITOR WELL DO-2 (S)

Concentrations in ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	503/a			6	28		/c	240				9	17	81		6	1
(01-Dec-87)	172			5	150		/c	12						5			
(22-Feb-88)	35/b			3	26		/c										
23-Feb-88	well abandoned																

/a = sample also contained 88 ug/l methylene chloride and 27 ug/l 1,1,2,2-tetrachloroethane
/b = sample also contained 6 ug/l total xylenes
/c = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	841/a	330	330	170		
(01-Dec-87)	310	160	36	66	48	
(22-Feb-88)	101	59	14	28		
23-Feb-88	well abandoned					

/a = sample also contained 11 ug/l dl-n-butyl phthalate

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethyphenol	Phenol
12-Sep-85	7110	760	20
(01-Dec-87)	ND		
23-Feb-88	well abandoned		

GERAGHTY & MILLER, INC.

MONITOR WELL OM-9 *(8)*

Concentrations In ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
17-Jul-84	28,907			47			/c	6,900	9,600	125			675		11,500	60	
31-Oct-84	1,735/a			10	5	<5	1,000	660	<3		<5		4		<5	<1	21
03-Feb-87	1,784			80			885	403		11			42		356	7	
15-May-87	1,961/b			8			1,327	27				3	23	2		1	
18-Aug-87	ND																
(01-Dec-87)	ND						/d										
(24-Feb-88)	54/e						/d										

/a = sample also contained <10 ug/l methylene chloride and 6 ug/l 1,1,2,2-tetrachloroethane
/b = sample also contained 243 ug/l dibromochloromethane and 327 ug/l trichlorfluoromethane
/c = not reported
/d = reported in base/neutral extractable analytical results
/e = sample contained 54 ug/l acetone; estimated value; suspected laboratory contamination bared on review of QA/QC data

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	9,450	3,200	2,250	4,000		
03-Feb-87	515	262	109	127	17	
18-Aug-87	ND					
(01-Dec-87)	28	17	11			
(24-Feb-88)	ND					

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	70/a	20	
03-Feb-87	ND		
(01-Dec-87)	ND		

/a = sample also contained 50 ug/l p-chloro-m-cresol

MONITOR WELL OM-62 (S)

Concentrations in ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	52/a						/b						6	2			
(02-Dec-87)	ND						/b										
(23-Feb-88)	9						/b				9						

/a = sample also contained 21 ug/l methylene chloride mnd 23 ug/l 1,1,2,2-tetrachloroethane
/b = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					
(02-Dec-87)	ND					
(23-Feb-88)	ND					

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		
(02-Dec-87)	ND		

MONITOR WELL GM-63 (D)

Concentrations in ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dichene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	16/a						/b						6	2			
(02-Dec-87)	ND						/b										
(23-Feb-88)	ND						/b										

/a = sample also contained 8 ug/l 1,1,2,2-tetrachloroethane
/b = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					
(02-Dec-87)	ND					
(23-Feb-88)	ND					

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		
(02-Dec-87)	ND		

GERAGHTY & MILLER, INC.

3201076

MONITOR WELL GM-64 (I)

Concentrations in ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triane	Tce	Vc
12-Sep-85	23/a						/b						9				
(02-Dec-87)	102			19			/b	83									
(23-Feb-88)	12						/b	12									

/a = sample also contained 14 ug/l 1,1,2,2-tetrachloroethane
/b = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	610/a					
(02-Dec-87)	49	49				
(23-Feb-88)	22/b	10				

/a = sample contained 610 ug/l dl-n-butyl phthalate
/b = sample also contained 12 ug/l bis (2-ethylhexyl) phthalate; 10 ug/l 1,2-dichlorobenzene estimated value bared on reviev of QA/QC data

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phconl
12-Sep-85	ND		
(02-Dec-87)	ND		

MONITOR WELL GM-65 (D)

Concentrations in ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sop-85	4						/a									4	
(01-Doc-81)	50/b						/a									50	
(26-Cob-88)	25/c						/a										

/a = reported in base/neutral extractable analytical results
/b = replicate A (field replicate of CH-65) contained no VOCs
/c = sample contained 25 ug/l acetone; estimated value; suspected laboratory contamination based on review of QA/QC data

Data Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	WD					
(01-Dec-87)	ND					
(26-Cob-88)	ND					

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-sop-85	ND		
(01-Dec-87)	ID		

GERAGHTY & MILLER, INC.

320 1077

MONITOR WELL OM-66 (I)

Concentrations In ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triane	Tce	Vc
12-Sep-85	3,717/a			16			/c	14		160	882		5	5		2,600	27
03-Feb-87	16,574			34				18		446			8	15		15,907	146
15-May-87	24,750															24,750	
18-Aug-87	14,730			140							990					13,600	
(01-Dec-87)	12,331			49			/c	15		390	1,600			7		10,000	270
(24-Feb-88)	6,377			61			/c	18		320/b	1,600/b			8		4,200/b	170

/a = sample also contained 8 ug/l 1,1,2,2-tetrachloroethane
/b = concentration exceeded calibrated ranee of Instrument
/c = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					
03-Feb-87	ND					
18-Aug-87	23/a					
(01-Dec-87)	23	13			10	
(24-Feb-88)	46/b	11			10	

/a = sample contalned 23 ug/l diethylphthalate
/b = sample also contalned 25 ug/l pyrene; 11 ug/l 1,2-dichlorobenzene and 10 ug/l naphthalene estimated values bared on review of QA/QC data

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		
03-Fcb-87	ND		
(01-Dec-87)	30	30	

MONITOR WELL OW-67 (B)

Concentrations In ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	85			12			/a	7			16					50	
03-Feb-87	753			70			507	85			12					78	1
15-May-87	8															8	
18-Aug-87	258	2		79			170	7									
(01-Dec-87)	ND						/a										
(24-Feb-88)	ND						/a										

/a = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	510	160	150	200		
03-Feb-87	328	114	86	128		
18-Aug-87	145	62	38	45		
(01-Dec-87)	ND					
(24-Feb-88)	ND					

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
03-Feb-87	ND		
(01-Dec-87)	ND		

GERAGHTY & MILLER, INC.

3201073

HONITOR WELL OM-68 (D)

Concentrations in ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triane	Tce	Vc
12-Sep-85	10						/a									10	
(01-Dec-87)	ND						/a										
(24-Feb-88)	ND						/a										

/a = reported In bar-/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					
(01-Dec-87)	ND					
(24-Feb-88)	ND					

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		
(01-Dec-87)	ND		

MONITOR WELL GM-69 (I)

Concentrations In ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	64	3					/c	47						8		3	3
03-Feb-87	1,412	9		387	36		710	238				3		4		8	17
15-May-87	792/a	3		112			543	38				2		3		6	
18-Aug-87	6,050			232			5,700	118									
(01-Doc-07)	450	6		240	93		/C	89									22
(24-Cob-08)	686/b	5		510	69		/c	76						5			13

/a = sample also contained 85 ug/l dibromochloromethane
/b = sample also contained 8 ug/l total xylenes
/c = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	3,381	620	1,400	1,350	11	
03-Feb-87	505	148	192	165		
18-Aug-87	1,841	594	774	473		
(01-Dec-87)	2,540	660	1,000	880		
(24-Feb-88)	2,050	540	800	710		

ACID EXTRACTABLES

Date Sampled	T Aor	2,4-Dimethylphenol	Phenol
12-Sop-05	ND		
03-Cab-87	ND		
(01-Doc-81)	ND		

320107W
GERAGHTY MILL ER. INC.

HONITOR WELL GM-74 (D)

Concentrations in ug/l (ppb)

VOLATILE ORCANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triane	Tce	Vc
12-Sep-85	1						/b							1			
(01-Dec-87)	ND						/b										
(22-Feb-88)	22/a						/b										
23-Feb-88	well abandoned																

/a = sample contained 22 ug/l acetone; estimated value; suspected laboratory contamination based on review of QA/QC data
/b = reported In base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					
(01-Dec-87)	ND					
(22-Feb-88)	ND					
23-Feb-88	well abandoned					

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	10		10
(01-Dec-87)	ND		
23-Feb-88	well abandoned		

GERAGHTY & MILLER, INC.

MONITOR WELL GM-75 (I)

Concentrations in ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	58/a			55			/b	1									1
(01-Dec-87)	170			110			/b	44						16			
(22-Feb-88)	160			160			/b										
(22-Feb-88)	170			170			/b										
23-Feb-88	well abandoned																

/a = sample also contained 1 ug/l blr (chloromethyl) ether
/b = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					
(01-Dec-87)	184	100	16	30	38	
(22-Feb-88)	24	24				
(22-Feb-88)	76/a	22				
23-Feb-88	well abandoned					

/a = sample also contained 54 ug/l blr (2-ethylhexyl) phthalate

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sip-05	ND		
(01-Dec-87)	120	120	
(22-Feb-88)	ND		
23-Feb-88	well abandoned		

INORGANICS

Date Sampled	Manganese
(22-Feb-88)	65
23-Feb-88	well abandoned

MONITOR WELL OM-84 (I)

Concentrations in ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cene	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
25-Apr-86	13/a					6	/b										
18-Aug-87	5			5													
(02-Dec-87)	7			7			/b										
(24-Feb-88)	31/c						/b										

/a = sample also contained 7 ug/l methylene chloride
/b = reported in base/neutral extractable analytical results
/c = sample contained 31 ug/l acetone; estimated value; suspected laboratory contamination based on review of QA/QC data

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
25-Apr-86	71/a					
18-Aug-87	ND					
(02-Dec-87)	ND					
(24-Feb-88)	ND					

/a = sample contained 71 ug/l bis(2-ethylhexyl)phthalate

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
25-Apr-86	ND		
(02-Dec-87)	ND		

RESULTS OF ORGANIC COMPOUND ANALYSES
WASTEWATER TREATMENT PLANT
WAS PENSACOLA, FLORIDA

T Vocr	= Total Volatile Organic Corpoundr
Dana	= Benzene
Ctet	= Carbon Tetrachloride
Cbene	= Chlorobenzene
Cane	= Chloroethane
Cform	= Chloroform
Dicbene	= Dichlorobanranar
11Diane	= 1,1-Dichloroethane
12Diane	= 1,2-Dichloroethane
11Diene	= 1,1-Dichloroethene
12Diene	= trans-1,2-Dichloroethene
Ebene	= Ethyl Benzene
Tetene	= Tetrachloroethene
Tol	= Toluene
111Triane	= 1,1,1-Trichloroethane
Tce	= Trichloroethene
VC	= Vinyl Chloride
Nd	= None Detected or Below Quantitation Levels
T Bnes	= Total Base Neutral Extractables
T Aes	= Total Acid Extractables
(Data)	= Sampled according to operating permit
(S)	= Shallow monitor well, about 13 ft deep
(I)	= Intermediate monitor well, about 40 ft damp
(D)	= Deep monitor well, about 65 ft deep

NOTE: All blank entries designate that the compound was below the detection limit or below quantitation levels.

DATA REVISED: MAY 17, 1988

32010

E-3

GERAGHT & MILLER INC

MONITOR WELL UG-1 (8)

Concentrations in ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triane	Tce	Vc
17-Jul-84	ND						/b										
31-Oct-84	28/a	<1	<3				/b						<3	<1			
(22-Feb-88)	ND						/b										

/a = sample also contained <5 ug/l 2-chloroethylvinyl ether, <10 ug/l methylene chloride end <5 ug/l 1,1,2,2-tetrachloroethane
/b = reported In base/neutral extractable analytical results.

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
17-Jul-84	ND					
31-Oct-84	27/a					
(22-Feb-88)	10/b					

/a = sample contained 27 ug/l bis (2-ethylhexyl) phthalate
/b = sample contained 10 ug/l bis (2-ethylhexyl) phthalate

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
17-Jul-84	ND		
31-Oct-84	ND		
(22-Feb-88)	ND		

INORGANICS

Date Sampled	Manganese
(22-Feb-88)	15

GERAGHTY & MILLER, INC.

MONITOR WELL DO-1 (B)

Concentrations In ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Va
17-Jul-84	17,820/a				180		/d	1,500						160	110		10
31-Oct-84	12,324/b	<1	425	160		320	/d	2,750		800		6	500	600	5,900	20	32
(22-Feb-88)	48/c				23		/d	11									
23-Fob-88	well abandoned																

/a = sample also contained 160 ug/l 2-hexanone, 11,000 ug/l methyl ethyl ketone and 4,700 ug/I acetone
/b = sample also contained 800 ug/l 1,1,2,2-tetrachloroethane end <10 ug/l methylene chloride
/c = sample also contalnod 14 ug/l acetone; estimated value based on revlew of QA/QC data
/d = reported In base/neutral extractable analytical results

DASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
17-Jul-84	1.155/a	530	110	200	260	3
31-Oct-84	2,389/b	1,163	193	387		
(22-Fob-88)	88/c	43	10	15		
PI-Fob-88	well abandoned					

/a = sample also contained 2 ug/l acenaphthene and 50 ug/l 2 [illegible]
/b = sample also contained 8 ug/l di-n-octyl-phthalate and 6 ug/l [illegible]
/c = sample aslo contained 20 ug/l bis (2-ethylhexyl) [illegible]

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
17-Jul-84	3.810/a	480	3
31-Oct-84	35/b		
(22-Feb-88)	ND		
23-Feb-88	well abandoned		

/a = sample also contalnod 24 ug/l 2-chlorophenol, 3 ug/l 2.4-dlchlorophenol and 3.300 ug/l 2-methyl phenol
/b = sample contalnod 35 ug/l 2-chlorophenol

IHORGANICS

Date Sampled	Manganese
(22-Feb-88)	119
23-Feb-88	well abandoned

3201082

MONITOR WELL DO-4 (8)

Concentrations in ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triane	Tce	Vc
17-Jul-84	1,412/a			13	28		/e	850				2		210	61		20
31-Oct-84	1,218/b	2	<3	3		<5	/e	1025	<3	<5	75	9	11	14	8	13	16
(03-Dec-87)	634/c			13	130		/e	310				5		34			
(23-Feb-88)	825						/e	140			410/d			25/f			250/d

/a = sample also contalned 43 ug/l total xylenes, 110 ug/l 2-hexanone and 75 ug/l 1,2-dichloro-1,1,2-trifluoroethane
/b = sample also contalned <10 ug/I methylene chloride and 16 ug/l 1,1,2,2-tetrachloroethane
le = sample also contalned 87 ug/l 2-butanon*, 21 ug/l 4-methyl-2-pentanone, 34 ug/l total xylenes, and 130 ug/l acetone (estimated value, suspected laboratory contamination based on review of QA/QC data)
/d = concentrrtlon exceeded calibrated range of instrument
/e = reported in base/neutral extractable analytical results
/f = estimated value; holding time exceeded

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	I,3-Dichlorobenzene	1.4-Dlchlorobcnzene	Naphthalene	1,2,4-Trichlorobenzene
17-Jul-84	ND					
31-Oct-84	716/a	194	38	90	383	
(03-Dec-87)	473/b	270	33	63	97	
(23-Fcb-88)	342/c	180	24	45	17	

/a = sample also contained 11 ug/l di-m-octyl-phthalate
/b = sample also contalned 10 ug/l 2-methylnaphthalene
/c = sample also contalned 16 ug/l 2-methylnaphthalene

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
17-Jul-84	ND		
31-Oct-84	137/a		95
(03-Dec-87)	199/b	85	
(23-Fcb-88)	44/c		

/a = sample also contalned 42 ug/l 2-chlorophenol
/b = sample also contalned 12 ug/l 2-chlorophenol, 37 ug/l 2-methylphenol, and 65 ug/l 4-methylphenol
/c = sample contalned 12 ug/l 2-methylphenol and 32 ug/l 2,4-dimethylphenol

INORGANICS

Date Sampled	Manganese	Aluminum	Barium	Calcium	Copper	Iron	Magnesium	Mercury	Potassium	Sodium
(03-Dec-87)	<167	244	16	91,400	2.9	262	14,300	0.21	6,900	153,000
(23-Feb-88)	190									

GERAGHTY & MILLER, INC.

MONITOR WELL DG-5 (8)

Concentrations in ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
17-Jul-84	1,716/a						/d	37						6	26		
31-Oct-84	706/b	2		45	72	<5	/d	525	<3		<5	4	<3	18			9
(23-Feb-88)	126/c			9			/d	44				6					

/a = sample also contalnod 450 ug/l mathylono chloride, 7 ug/l 2-heranone, 540 ug/l methyl ethyl ketone and 110 ug/l acetone
/b = sample alro contalnod <10 ug/l methylene chloride and <5 ug/l 1,1,2,2-tetrachloroethane
/c = sample also contalnod 60 ug/l acetone (estimated value based on review of QA/QC data) and 7 ug/l total xylenes
/d = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
17-Jul-84	25	16	2	6		
31-Oct-84	1,218/a	708	80	170	250	
(23-Feb-88)	157/b	48	14	24	46	

/a = sample also contalnod <10 ug/l di-n-octyl-phthalate
/b = sample also contained 15 ug/l 2-methylnaphthalene

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
17-Jul-84	ND		
31-Oct-84	15/a		
(23-Feb-88)	ND		

/a = sample contalnod 15 ug/l 2-chlorophenol

INORGANICS

Date Sampled	Manganese
(23-Feb-88)	147

GERAGHTY & MILLER, INC.
3201083

MONITOR WELL DG-6 (B)

Concentrations in ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
17-Jul-84	20,460/a						/c	1,500						170	330	20	
31-Oct-84	1,608/b	2	9	7	37	5	/c	1,225	<3	25	16	15	38	35	103	32	13
(22-Feb-88)	ND						/c										
23-Feb-88	well abandoned																

/a = sample also contained 240 ug/l 2-henanone, 10,200 ug/l methyl ethyl ketone and 8,000 ug/l acetone
/b = sample also contained <10 ug/l methylene chloride and 33 ug/l 1,1,2,2-tetrachloroethane
/c = reported In base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
17-Jul-84	784/a	500	56	120	22	4
31-Oct-84	1,994/b	933	71	182	782	
(22-Feb-88)	ND					
23-Feb-88	well abandoned					

/a = sample also contained 2 ug/l hexachloroethane and 80 ug/l 2-methyl naphthalene
/b = sample also contained 26 ug/l di-n-octyl-phthalate

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
17-Jul-84	3,412/a	80	6
31-Oct-84	569/b	550	5
(22-Feb-88)	ND		
23-Feb-88	well abandoned		

/a = sample also contained 30 ug/l 2-chloroplirnol, 2 ug/l 2.4-dlchlorophenol and 3.300 ug/l 2-methyl phenol
/b = sample also contained 14 ug/l 2-chloroplirnol

INORGANICS

Date Sampled	Manganese
(22-Feb-88)	16
23-Feb-88	well abandoned
23-Feb-88	abandoned

GERAGHTY & MILLER, INC.

HONITOR WELL OM-75 (I)

Concentrations in ug/l (ppb)

VOLATILE ORGANIC COMPOUNDS

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	58/a			55			/b	1									1
(01-Dec-87)	170			110			/b	44						16			
(22-Feb-88)	160			160			/b										
(22-Feb-88)	170			170			/b										
23-Feb-88	well abandoned																

/a = sample also contained 1 ug/l bis (chloromethyl) ether
/b = reported In base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					
(01-Dec-87)	184	100	16	30	38	
(22-Feb-88)	24	24				
(22-Feb-88)	76/a	22				
23-Feb-88	well abandoned					

/a = sample also contained 54 ug/l bis (2-ethylhexyl) phthalate

ACID EXTRACTABLES

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		
(01-Doc-87)	170	170	
(22-Feb-88)	ND		
23-Feb-88	well abandoned		

INORGANICS

Date Sampled	Manganese
(22-Feb-88)	65
23-Feb-88	well abandoned

DRAFT

GERAGHTY AND MILLER, INC.

DECEMBER 1988

(GROUNDWATER)

RESULTS OF ANALYSES
WASTEWATER **TREATMENT PLANT**
NAS **PENSACOLA, FLORIDA**

T Vocr	= Total Volatile Organic Compounds
Bono	= Benzene
Ctet	= Carbon Tetrachloride
Cbene	= Chlorobenzene
Cane	= Chloroethane
Cform	= Chloroform
Dicbene	= Dichlorobenzenes
11Diane	= 1,1-Dichloroethane
12Diane	= 1,2-Dichloroethane
11Diene	= 1,1-Dichloroethene
12Diene	= trans-1,2-Dichloroethene
Ebene	= Ethyl Benzene
Tetene	= Tetrachloroethene
tol	= Toluene
111Triane	= 1,1,1-Trichloroethane
Tce	= Trichloroethene
vo	= Vinyl Chloride
Nd	= None Detected or Below Quantitation Levels
NA	= Not Analyzed
T Bnes	= Total Base Neutral Extractables
T Aes	= Total Acid Extractables
(Date)	= Sampled according to operating permit
(S)	= Shallow monitor well, about 13 ft deep
(I)	= Intermediate monitor well, about 40 ft deep
(D)	= Deep monitor well, about 65 It deep

NOTE: All blank entries designate that tho compound was below tho detection limit or below quantitation levels.

DATA REVISED: DECEMBER 8, 1988

3201085

MONITOR HELL UG-1 (S)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
17-Jul-84	ND						/b										
31-Oct-84	28/a	<1	<3				/b						<3	<1			
(22-Feb-88)	ND						/b										
(02-Jun-88)	ND																
(15-Aug-88)	ND																
(08-Nov-88)	40/c																

/a = sample also contained <5 ug/l 2-chloroethylvinyl ether, <10 ug/l methylene chloride and <5 ug/l 1,1,2,2-tetrachloroethane
/b = reported in base/neutral extractable analytical results.
/c = sample contained 50 ug/l acetone, suspected laboratory contamination bared on review of QA/QC data.

BASE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
17-Jul-84	ND					
31-Oct-85	211.					
(22-feb-88)	10/b					
(02-Juri-88)	ND					
(15-Aug-88)	ND					
(08-Nov-88)	ND					

ACID EXTRACTABLES

Concentrations In ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
17-Jul-84	ND		
31-Oct-84	ND		
(22-Feb-88)	ND		
(02-Jun-88)	ND		
(15-Aug-88)	ND		
(08-Nov-88)	ND		

(Monitor Well UG-1 continued)

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Sodium	Chloride	Manganese
(03-Dec-87)	5.4	5.0	NA
(22-Feb-88)	4.6	9.0	0.015
(02-Jun-88)	8	22	
(15-Aug-88)	5	I2	
(08-Nov-88)	NA	NA	

HOHITOR WELL DG-2 (S)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	503/a			6	28		/c	240				9	17	81		6	1
(01-Dec-87)	172			5	150		/c	12						5			
(22-Feb-88)	35/b			3	26		/c										
23-Feb-88	well abandoned																

/a = sample also contained 88 ug/l methylene chloride and 27 ug/l 1,1,2,2-tetrachloroethane
/b = sample also contained 6 ug/l total xylenes
/c = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	841/a	330	330	170		
(01-Dec-87)	310	160	36	66	48	
(22-Feb-88)	101	59	14	28		
23-Ceb-88	well abandoned					

/a = sample also contained 11 ug/l dl-n-butyl phthalate

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethyphenol	Phenol
12-Sep-85	780	760	20
(01-Dec-87)	ND		
23-Feb-88	well abandoned		

HONITOR WELL GM-9 (S)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
17-Jul-84	28,907			47			/c	6,900	9,600	125			675		11,500	60	
31-Oct-84	1,735/a			10	5	<5	1,000	660	<3		<5		4		<5	<1	21
03-Feb-87	1,784			80			885	403		11			42		356	7	
15-May-87	1,961/b			8			1,327	27				3	23	2		1	
18-Aug-87	ND																
(01-Dec-87)	ND						/d										
(24-Feb-88)	54/e						/d										
(20-Jun-88)	ND																
(17-Aug-88)	ND																

/a = sample also contained <10 ug/l methylene chloride and 6 ug/l 1,1,2,2-tetrachloroethane
/b = sample also contained 241 ug/l dibromochloromethane and 327 ug/l trichlorfluoromethane
/c = net reported
/d = reported in base/neutral extractable analytical results
/e = sample contained 54 ug/l acetone; estimated value; suspected laboratory contamination based on review of QA/QC data

BALE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	9,490	1,200	2,290	4,000		
03-Feb-87	515	262	109	127	17	
18-Aug-87	WD					
(01-Dec-87)	28	17	11			
(24-Feb-88)	ND					
(20-Jun-88)	ND					
(17-Aug-88)	ND					

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	70/a	20	
03-Feb-87	ND		
(01-Dec-87)	ND		

/a = sample also contained 50 ug/l p-chloro-m-cresol

3201087

(Monitor Well GM-9 continued)

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Sodium	Chloride
(01-Dec-87)	2.1	2.9
(24-Feb-88)	1.8	1.8
(20-Jun-88)	3	5
(17-Aug-88)	2	4

MONITOR WELL GM-62 (S)

VOLATILE ORGANIC COMPOUNDS

Concentrations In ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cene	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	52/a						/b						6	2			
(02-Dec-87)	ND						. /b										
(23-Feb-88)	9						/b				9						
(20-Jun-88)	161				31			102							28		
(16-Aug-88)	346							287							59		

/a = sample also contained 21 ug/l methylene chloride and 23 ug/l 1,1,2,2-tetrachloroethane
/b = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Concentratlens in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					
(02-Dec-87)	ND					
(23-Feb-88)	ND					
(20-Jun-88)	ND					
(16-Aug-88)	ND					

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		
(02-Dec-87)	ND		

MONITOR WELL GM-63 (D)

VOLATILE ORGANIC COMPOUNDS

Conecntratlonr in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	16/a						/b						6	2			
(02-Dec-87)	ND						/b										
(23-Feb-88)	ND						/b										
(02-Jun-88)	66			2			64										
(16-Aug-88)	ND																

/a = sample also contained 8 ug/l 1,1,2,2-tetrachloroethane
/b = reported in base/neutral extractable analytical results

BASE NEUTRAL EXIRACIMLES

Conecntratlonr in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					
(02-Dec-87)	ND					
(23-Feb-88)	ND					
(02-Jun-88)	ND					
(16-Aug-88)	ND					

ACID EXTRACTABLES

Conecntratlonr in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		
(02-Dec-87)	ND		

INORGANICS

Conecntratlonr in mg/l (ppm)

Date Sampled	Sodium	Chloride
(02-Dcc-87)	470	030
(23-Feb-88)	420	800
(02-Jun-88)	709	1140
(16-Aug-88)	448	850

MONITOR WELL GM-64 (I)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Diebene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	23/a						/b						9				
(02-Dec-87)	102			19			/b	83									
(23-Feb-88)	12						/b	12									
(02-Jun-88)	226			3	111		9	90	4	9							
(16-Aug-88)	ND																

/a = sample also contained 14 ug/l 1,1,2,2-tetrachloroethane
/b = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	610/a					
(02-Dec-87)	49	49				
(23-Feb-88)	22/b	10				
(02-Jun-88)	ND					
(16-Aug-88)	ND					

/a = sample contained 610 u /l dl-n-butyl phthalate
/b = sample also contained f2 ug/l bis (2-ethylhexyl) phthalate; 10 ug/l 1,2-dichlorobenzene estimated value bared on review of QA/QC data

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		
(02-Dec-87)	ND		

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Sodium	Chloride
(02-Dec-87)	330	470
(23-Feb-88)	200	340
(02-Jun-88)	86	136
(16-Aug-88)	142	235

HONJTOR WELL GM-65 (D)

VOLATILE ORGANIC CONTOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triane	Tce	Vc
12-Sep-85	4						/a									4	
(01-Dec-87)	50/b						/a									50	
(24-Feb-88)	25/c						/a										
(20-Jun-88)	ND																
(15-Aug-88)	ND																

/a = reported in base/neutral extractable analytical results
/b = field replicate of GM-65 contained no VOCs
/c = sample contained 25 ug/l acetone) estimated value; suspected laboratory contamination based on review of QA/QC data

BASE NEUTRAL EXTRACTABLES

Concentrations In ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					
(01-Dec-87)	ND					
(24-Feb-88)	ND					
(20-Jun-88)	ND					
(15-Aug-88)	ND					

ACID EXTRACTABLES

Concentrations In ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		
(01-Dee-87)	ND		

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Sodium	Chloride
(01-Dee-87)	120	180
(24-Feb-88)	110	180
(20-Jun-88)	110	192
(15-Aug-88)	76	156

MONITOR WELL GM-66 (I)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cene	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	3,717/a			16			/c	14		160	882		5	5		2,600	27
03-Feb-87	16,574			34				18		446			8	15		15,907	146
15-May-87	24,750															24,750	
18-Aug-87	14,730			140							990					13,600	
(01-Dec-87)	12,331			49			/c	15		390	1,600		A(J)	7		10,000	270
(24-Feb-88)	6,377			61			/c	18		320/b	1,600/b		A(J)	8		4,200/b	170
(02-Jun-88)	8,400									500	1,300			300		6,300	
(17-Aug-88)	5,600										600					5,000	

/a = sample also contained 8 u /l t lorsst
/b = Lon exceeded t of nstrument
/c = reported in base/neutral extractable cal il

BASE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-sap-89	ND					
03-Feb-87	ND					
18-Aug-87	23/a					
(01-Dec-87)	23	13			10	
(24-Tab-88)	46/b	11			10	
(02-Jun-88)	29	17			12	
(17-Aug-88)	124	40		15	69	

/a = sample contalnod 23 ug/l diethylphthalate
/b = sample also contained 25 ug/l pyrene; 11 ug/l 1,2-dichlorobenzene and 10 ug/l naphthalene estimated values based on review of QA/QC data

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		
03-Feb-87	ND		
(01-Dec-87)	30	30	

3201060

(Honltor Well CH-66 continued)

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Sodium	Chloride
(01-Dec-67)	640	530
(24-Feb-88)	670	620
(02-Jun-88)	527	540
(17-Aug-88)	465	460

MONITOR WELL OH-67 (S)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cene	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	85			12			/a	7			16					50	
03-Feb-87	753			70			507	85			12					78	1
15-May-87	8															8	
18-Aug-87	258	2		79			170	7									
(01-Dec-87)	ND						/a										
(24-Feb-88)	ND						/a										
(02-Jun-88)	4			4													
(17-Aug-88)	ND																

/a = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	510	160	150	200		
03-Feb-87	328	114	86	128		
18-Aug-87	145	62	38	45		
(01-Dec-87)	ND					
(24-Feb-88)	ND					
(02-Jun-88)	ND					
(17-Aug-88)	ND					

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		
03-Feb-87	ND		
(01-Dec-87)	ND		

3201091

(Monitor Well CM-67 continued)

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Sodium	Chloride
(01-Dec-87)	55	68
(24-Feb-00)	130	200
(02-Jun-88)	24	29
(17-Aug-88)	50	84

MONITOR WELL GM-68 (D)

VOLATILE ORGANIC COMPOUNDS

Concentrations In ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	10						/a									10	
(01-Dec-87)	ND						/a										
(24-Feb-88)	ND						/a										
(02-Jun-88)	ND																
(15-Aug-88)	ND																

/a = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Concentrations In ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					
(01-Dec-87)	ND					
(24-Feb-10)	ND					
(02-Jun-88)	ND					
(15-Aug-88)	ND					

ACID EXTRACTABLES

Concentrations In ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		
(01-Dec-87)	ND		

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Sodium	Chloride
(01-Dec-87)	61	120
(24-Feb-88)	67	120
(02-Jun-10)	72	138
(15-Aug-88)	79	146

3201092

MONITOR WELL GH-69 (I)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	64	3					/c	47						8		3	3
03-Feb-87	1,412	9		387	36		710	238				3		4		8	17
15-May-87	792/a	3		112			543	38				2		3		6	
18-Aug-87	6,050			232			5,700	118									
(01-Dec-87)	450	6		240	93		/c	89									22
(24-Feb-88)	686/b	5		310	69		/c	76						5			13
(02-Jun-88)	5,080			220			4,700							160			
(17-Aug-88)	3,135			120			3,015										

/a = sample also contained 85 ug/l dibromochloromethane
/b = sample also contained 8 ug/l total xylenes
/c = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	3,381	620	1,400	1,350	11	
03-Feb-87	505	148	192	165		
18-Aug-87	1,841	594	774	473		
(01-Dec-87)	2,540	660	1,000	880		
(24-Feb-88)	2,050	540	800	710		
(02-Jun-88)	1,771	454	729	588		
(17-Aug-88)	2,560	660	1,100	800		

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		
03-Feb-87	ND		
(01-Dec-87)	ND		

(Monitor Yell CM-69 continued)

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Sodium	Chloride
(01-Dec-87)	510	120
(24-Feb-88)	500	730
(02-Jun-88)	561	720
(17-Aug-88)	598	785

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MONITOR WELL GM-71 (S)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triane	Tce	Vc
12-Sep-85	23			10				12								1	

BASE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Dare Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Sodium	Chloride
(03-Dec-87)	9.8	8.9
(24-Feb-88)	5.7	11.0
(01-Jun-88)	4	5
(16-ha-00)	7	10

MONITOR WELL GM-72 (S)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cene	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	1			1													

BASE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Sodium	Chloride
(03-Dec-81)	79	98
(23-Feb-88)	42	46
(01-Jun-88)	44	49
(16-Aug-88)	73	109

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MONITOR WELL GH-74 (D)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triane	Tce	Vc
12-Sep-85	1						/b							1			
(01-Dec-87)	ND						/b										
(22-Feb-88)	22/a						/b										
23-Feb-88	well abandoned																

/a = sample contained 22 ug/l acetone; estimated value; suspected laboratory contamination bared on review of QA/QC data
/b = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTMCTMLBS

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					
(01-Dec-87)	ND					
(22-Feb-88)	ND					
23-Feb-88	well abandoned					

ACID EXTRACTABLES

Concentrations In ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	10		10
(01-Dec-87)	ND		
23-Feb-88	well abandoned		

INORGANICS

Concentrations In mg/l (ppm)

Date Sampled	Sodium	Chloride
(01-Dec-87)	81	130
(22-Feb-88)	63	120
23-Feb-88	Well abandoned	

MONITOR HELL 61-75 (I)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cforr	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-sap-85	58/a			55			/b	1									1
(01-Dec-87)	170			110			/b	44						16			
(22-Feb-88)	160			160			/b										
(22-lab-88)	170			170			/b										
23-Feb-88	well abandonad																

/a = sample also contained 1 ug/l bis (chloromethyl) ether
/b = reported In base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Concantratlonr in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-sap-85	WD					
(01-Dec-87)	184	100	16	30	38	
(22-Feb-88)	24	24				
(22-Feb-88)	76/a	22				
13-tab-88	well abandoned					

/a = sample also contained 54 ug/l bis (2-ethylhexyl) phthalate

ACID EXTRACTABLES

Concentrations In ug/l (ppb)

Data Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		
(12-tab-88)	ND		
23-tab-88	well abandonad		

INORGANICS

Concantratlonr in mg/l (ppm)

Date Sampled	Manganese
(22-Feb-88)	0.065
23-tab-88	well abandoned

MONITOR WELL GH-76 (S)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triane	Tce	Vc
12-Sep-85	11							11									

BASE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Sodium	Chloride
(03-Dec-87)	210	250
(23-Feb-88)	190	220
(01-Jun-88)	207	305
(16-Aug-88)	501	980

MONITOR HELL GM-77 (S)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	16			1s				1									

BASE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene	
12-Sep-85	11			11			

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		

INORGANICS

Coneentratlonr in mg/l (ppm)

Date Sampled	Sodium	Chloride
(03-Dec-87)	53	50
(23-Feb-88)	43	48
(01-Juri-81))	40	44
(16-Aug-88)	303	680

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HONITOR WELL CH-78 (S)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	4			4													

BASE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Sodium	Chloride
(03-Dec-87)	11	17
(23-Feb-88)	14	22
(01-Jun-88)	10	18
(16-Aug-88)	4	6

MONITOR WELL GM-79 (S)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
12-Sep-85	1													1			

BASE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Data Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Sodium	Chloride
(03-Dec-87)	34	50
(23-Feb-88)	17	18
(01-Jun-88)	14	20
(16-Aug-88)	20	24

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MONITOR WELL GM-83 (S)

VOLATILE ORGANIC COMPOUNDS

Concantrattons Ln ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triane	Tce	Vc
12-Sep-85	224/a												25	2			

/a = sample also contained 159 ug/l methylene chloride and 38 ug/l 1,1,2,2-tetrachloroethane

BASE NEUTRAL EXTRACTABLES

Concantrattons in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
12-Sep-85	ND					

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	ND		

INORCANICS

Concentrations in mg/l (ppm)

Date Sampled	Sodium	Chloride
(03-Dec-87)	24	48
(23-Feb-88)	23	39
(01-Jun-88)	221	39
(16-Aug-88)	20	23

MONITOR WELL GM-84 (I)

VOLATILE ORGANIC COMPOUNDS

Concentrrtlons in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triane	Tce	Vc
25-Apr-86	13/a					6	/b										
18-Aug-87	5			5													
(02-Dec-87)	7			7			/b										
(24-Feb-88)	31/c						/b										
(20-Jun-88)	ND																
(17-Aug-88)	ND																

/a = sample also contained 7 ug/l methylene chloride
/b = reported in base/neutral extractable analytical results
/c = sample contained 31 ug/l acetone; estimated value; suspected laboratory contamination based on review of QA/QC data

BASE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
	71/a					
18-Aug-17	ND					
(02-Dee-67)	ND					
(24-Feb-88)	ND					
(20-Jun-88)	ND					
(17-Aug-88)	ID					

ACID EXTRACTABLES

Concentrations In ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
25-Apr-86	ND		
(02-Doc-87)	ND		

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RESULTS OF ANALYSES
WASTEWATER TREATMENT PLANT
NAS PENSACOLA. FLORIDA

T Vocr	= Total Volatile Organic Compounds
Bene	= Benzene
Ctet	= Carbon Tetrachloride
Cbene	= Chlorobenzene
Cane	= Chloroethane
Cform	= Chloroform
Dicbene	= Dichlorobenzenes
11Diane	= 1,1-Dichloroethane
12Diane	= 1,2-Dichloroethane
11Diene	= 1,1-Dichloroethene
12Diene	= trans-1,2-Dichloroethene
Ebene	= Ethyl Benzene
Tetene	= Tetrachloroethene
Tol	= Toluene
111Triane	= 1,1,1-Trichloroethane
Tce	= Trichloroethene
VC	= Vinyl Chloride
Nd	= None Detected or Below Quantitation Levels
NA	= Not Analyzed
T Bnes	= Total Dare Neutral Extractables
T Aes	= Total Acid Extractables
(Dace)	= Sampled according to operating permit
(S)	= Shallow monltor well. about 13 ft deep
(I)	= Intermediate monitor well, about 40 ft deep
(D)	= Deep monitor well, about 65 ft deep

NOTE: All blank entries designate that tho compound vas below the detection limit or below quantitation levels.

DATA REVISED: DECEMBER 8, 1988

MONITOR WELL UG-1 (S)

VOLATILE ORGANIC COMPOUNDS

Coneentratlonr In ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tel	111Triene	Tce	Vc
17-Jul-84	ND						/b										
31-Oct-84	28/a	<1	<3				/b						<3	<1			
(22-Feb-88)	ND						/b										
(02-Jun-SO)	ND																
(15-Aug-88)	ND																
(08-Nov-88)	40/c																

/a = sample also contalned <5 ug/l 2-chloroethylvinyl ether, 410 ug/l methylene chloride and <5 ug/l 1,1,2,2-tetrachloroethane
/b = reported In base/neutral extractable analytical results.
/c = sample contalned 40 ug/l acetone, suspected laboratory contamination bared on review of QA/QC data.

BASE WEUTML EXTRACTABLES

Concentrations In ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
17-Jul-84	ND					
31-Oct-84	27/a					
(22-Feb-88)	10/b					
(02-Jun-88)	ND					
(15-Aug-88)	ND					
(08-Nov-88)	ND					

/a = sample contalned 27 ug/l bis (2-ethylhenil) phthalate
/b = sample contalned 10 ug/l bis (2-ethylhexyl) phthalate

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
17-Jul-84	ND		
31-Oct-84	ND		
(22-Feb-88)	ND		
(02-Jun-BO)	ND		
(15-Aug-88)	ND		
(08-Nov-88)	ND		

3201095

(Monitor Well UC-1 continued)

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Sodium	Chloride	Manganese
(03-Dec-67)	5.4	5.0	NA
(22-Feb-88)	4.6	9.0	0.015
(02-Jun-88)	6	22	
(15-Aug-88)	5	12	
(08-Nov-88)	WA	NA	

MONITOR WELL DG-1 (S)

VOLATILE ORGANIC COMPOUNDS

Coneantratlons in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cene	Cform	Diebene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Ve
17-Jul-84	17,820/a				180		/d	1,500						160	110		10
31-Oct-84	12,324/b	<1	425	160		320	/d	2,750		800		6	500	600	5,900	20	32
(22-Feb-88)	48/c				23		/d	11									
23-Feb-88	well abandonad																

/b = sample also contained 160 ug/l 2-hexanone, 11,000 ug/l methyl ethyl ketone and 4,700 ug/l acetone
/c = sample also contalnod BOO ug/l 1,1,2,2-tetrachloroethane and <10 ug/l methylene chloride
/d = sample also contained 14 ug/l acetone; estimated value based on review of QA/QC data
= reported In base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Concentrations In ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
17-Jul-84	1,155/a	530	110	200	260	3
31-Oct-84	2,389/b	1,163	193	387		
(22-Feb-88)	88/c	43	10	15		
23-Feb-88	well abandoned					

/a = sample also contained 2 ug/l acenaphthene and SO ug/l 2-methyl naphthalene
/b = sample also contained 8 ug/l di-n-octyl-phthalate and 638 ug/l nitrobenzene
/c = sample aslo contained 20 ug/l bis (2-ethylhexyl) phthalate

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
17-Jul-84	3,810/a	480	3
31-Oct-84	35/b		
(22-Fob-BO)	ND		
23-Fob-BB	well abandoned		

/a = sample also contained 24 ug/l 2-chlorophenol, 3 ug/l 2,4-dichlorophenol and 3,300 ug/l 2-methyl phenol
/b = sample contalnod 35 ug/l 2-chlorophenol

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(Monitor Well Do-1 continued)

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Manganese
(22-Feb-88)	0.119
23-Feb-88	well abandoned

HONITOR WELL DG-4 (S)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cene	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
17-Jul-84	1,412/a			13	28		/e	850				2		210	61		20
31-Oct-84	1,218/b	2	<3	3		<5	/e	1,025	<3	<5	75	9	11	14	8	13	16
(03-Dec-87)	634/c			13	130		/e	310				5		34			
(23-Feb-88)	825						/e	140			410/d			25/f			250/d
(29-Apr-88)	1,810/g						/e	510			90	220		160			
(02-Jun-88)	well dry due to operation of dewatering system																
(17-Aug-88)	ND																
(08-Nov-88)	7	7															

/a = sample also contained 43 ug/l total xylenes, 110 ug/l 2-hexanone and 75 ug/l 1,2-dichloro-1,1,2-trifluoroethane
/b = sample also contalnad <10 ug/l methylene chloride and 16 ug/l 1,1,2,2-tetrachloroethane
/c = sample also contalnad 07 ug/l 2-butanone, 21 ug/l 4-methyl-2-pentanone, 34 ug/l total xylenes, and 130 ug/l acetone (estimated value, suspected laboratory contamination based on review of QA/QC data)
/d = concentration exceeded calibrated range of instrument
/e = reported in base/neutral extractable analytical results
/f = estimated value; holding time exceeded
/g = sample also contalnad 150 ug/l styrene and 680 ug/l total xylenes

BASE NEUTRAL EXTRACTABLES

Concantratlonr in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
17-Jul-84	MD					
31-Oct-84	716/a	194	38	90	383	
(03-Dec-87)	473/b	270	33	6J	97	
(23-Feb-88)	342/c	180	24	45	17	
(29-Apt-00)	628/d	J24	46	88	128	
(02-Jun-88)	well dry due to operation of dewatering system					
(17-Aug-88)	ND					
(08-Nov-88)	ND					

/a =
/b =

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(Monitor Well DG-4 continued)

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
17-Jul-84	ND		
31-Oct-84	137/a		95
(03-Dec-87)	199/b	85	
(23-Feb-88)	44/c		
(29-Apr-88)	26/d	14	
(02-Jun-88)	well dry due to operation of dewatering system		
(17-Aug-88)	ND		
(08-Nov-88)	ND		

/a = sample also contained 42 ug/l 2-chlorophenol
/b = sample also contained 12 ug/l 2-chlorophenol, 37 ug/l 2-methylphenol, and 65 ug/l 4-methylphenol
/c = sample contained 12 ug/l 2-methylphenol mnd 32 ug/l 2,4-dimethylphenol
/d = sample also contained 12 ug/l M-cresol

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Manganese	Aluminum	Barium	Calcium	Chloride	Copper	Iron	Magnesium	Mercury	Potassium	Sodium	Fluoride	Sulfide	Sulfate
(03-Dec-87)	0.167	0.244	0.016	91.4	NA	0.003	0.262	14.3	0.0002	6.9	153	0.0002	0.036	NA
(23-Feb-88)	0.1901	NOT ANALYZED												
(29-Apr-88)	0.25	NA		MA	138		0.29	NA		NA	106	NA		152
(02-Jun-88)	well dry due to operation of dewatering system													
(08-Nov-88)	0.22													

MONITOR WELL DG-5 (S)

VOLATILE ORGANIC COMPOUNDS

Concentrations In ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diene	12Diene	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
17-Jul-84	1,716/a						/d	37						6	26		
31-Oct-84	706/b	2		45	72	<5	/d	525	<3		<5	4	<3	18			9
(23-Feb-88)	126/c			9			/d	44				6					
(02-Jun-88)	24						22							2			
(16-Aug-88)	ND																
(08-Nov-88)	ND																

/a = sample also contained 430 ug/l methylene chloride, 7 ug/l 2-hexanone, 560 ug/l methyl ethyl ketone and 110 ug/l acetone
/b = sample also contained <10 ug/l methylene chlorida and <5 ug/l 1,1,2,2-tetrachloroethane
/c = sample also contained 60 ug/l acetone (estimated value based on review of QA/QC data) and 7 ug/l total xylenes
/d = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
17-Jul-84	25	16	3	6		
31-Oct-84	1,218/a	701	80	170	250	
(23-Feb-88)	157/b	48	14	24	56	
(02-Jun-88)	ND					
(16-Aug-88)	WD					
(08-Nov-88)	ND					

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
17-Jul-84	ND		
31-Oct-84	15/a		
(23-Feb-88)	ND		
(02-Jun-88)	ND		
(16-Aug-88)	ND		
(08-Nov-88)	ND		

/a = sample contained 15 ug/l 2-chlorophenol

3201102

(Monitor Well DG-5 continued)

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Manganese
(23-Feb-88)	0.147
(02-Jun-88)	0.01
(16-Aug-88)	0.02
(08-Nov-88)	0.13

MONITOR WELL DO-6 (S)

VOLATILE ORGANIC COMPOUNDS

Concentrations in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triene	Tce	Vc
16-May-84	916/a	<10			79	<10	/d	520		<10	14	<10	<10	140	79	21	
17-Jul-84	20,460/b						/d	1,500						170	330	20	
31-Oct-84	1,608/c	2	9	7	37	5	/d	1,225	<3	25	16	15	38	35	103	32	13
(22-Feb-88)	ND						/d										
23-Feb-88	well abandoned																

/a = sample alro contalnad 13 ug/l methylene chloride
/b = sample alro contained 240 ug/l 2-horanona, 10,200 ug/l methyl ethyl ketone and 8,000 ug/l acetone
/c = sample also contalnad <10 ug/l methylene chloride and 33 ug/l 1,1,2,2-tetrachloroethane
/d = reported in base/neutral extractable analytical results

BASE NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	1,2,4-Trichlorobenzene
16-May-84	988/a	470	41	77	380	
17-Jul-84	784/b	500	56	120	22	4
31-Oct-84	1,994/c	933	71	182	782	
(22-Fob-88)	ND					
23-Feb-88	well abandoned					

ACID EXTRACTABLES

Concentrations in ug/l (ppb)

Date Sampled	T Aes		Phenol
16-Mar-84	1,783/a	730	1000
17-Jul-84	3,412/b	80	6
31-Oct-84	569/c	550	5
(22-Feb-88)	ND		
23-Feb-88	well abandoned		

/a = sample also contalnod 33 ug/l 2-ehlorophanol, <10 ug/l 2,4-dichlorophenol and <10 ug/l pentachlorophenol
/b = sample also contalnad 30 ug/l 2-ehlorophenol, 2 ug/l 2,4-dichlorophenol and 3,300 ug/l 2-methyl phenol
/c = sample alro contained 14 ug/l 2-ehlorophonol

3201103

(Monitor Well DG-6 continued)

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Manganese
(22-Feb-88)	0.016
23-Feb-88	well abandoned

HONITOR WELL On-76 (I)

VOLATILE ORGANIC COMPOUNDS

Cancontratlonr in ug/l (ppb)

Date Sampled	T Vocs	Bene	Ctet	Cbene	Cane	Cform	Dicbene	11Diane	12Diane	11Diene	12Diene	Ebene	Tetene	Tol	111Triane	Tce	Vc
12-Sep-85	58/a			55			/b	1									1
(01-Dec-87)	170			110			/b	44						16			
(22-Feb-88)	160			160			/b										
(22-Feb-88)	170			170			/b										
23-Feb-88	well abandoned																

/a = sample also contained 1 ug/l bis (chloromethyl) ether
/b = reported In base/neutral extractable analytical results

BASK NEUTRAL EXTRACTABLES

Concentrations in ug/l (ppb)

S m l d	T Bnes	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Naphthalene	
12-Sep-85	ND					
( )	184	100	16	30	3	
(22-Cob-00)	24	24				
22 I b 88	76	22				
23 Feb 88	well abandoned					

ont

ACID EXTRACTABLES

Concentrations In ugll (ppb)

Date Sampled	T Aes	2,4-Dimethylphenol	Phenol
12-Sep-85	HD		
(01-Dec-87)	170	170	
(22-Fob-60)	ND		
23-rob-00	well abandoned		

INORGANICS

Concentrations in mg/l (ppm)

Date Sampled	Manganese
(22-Feb-88)	0.065
2J-Cob-00	well abandoned

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GERAGHTY AND MILLER, INC.

MARCH 1989

(GROUNDWATER)

SUMMARY ANALYTICAL RESULTS FOR GROUNDWATER SAMPLES COLLECTED 3/89
AT THE NAS PENSACOLA IWTP
(All results in µg/L, unless noted)

3201105

Parameter	Well Number								
	OM-0	on-9	GM-10	GM-11	GM-12R	OM-13	GM-14	011-62	011-63
Total Metals									
Antimony	—	—	—	—	80	—	—	—	—
Arsonic	4	—	—	—	—	—	—	—	—
Barium	00	—	90		60	—	30	—	—
Cadmium	3	0.2	—	—	S	0.1	0.2	—	—
Chromium	30	10	—	—	—	—	—	—	—
Icon	21,000	3,700	150	100	30	330	50	—	—
Manganese	100	90	120	20	140	30	100	—	—
Silver	—	0.1	—	—	0.6	—	—	—	—
Sodium (mg/L)	6.3	6.3	60	23	12	20	200	—	515
Zinc	60	20	20	40	—	—	40	—	—
Chloride (mg/L)	32	13	S6	25	11	26	244	—	803
Sulfate (mg/L)	S0	170	136	12	39	38	151	—	—
Cyanide	—	—	—	—	9.0	—	—	—	—
Vinyl Chloride	1	—	—	—	—	—	—	—	—
Chloroethane	17	—	—	—	—	—	—	16	—
Acetone	—	—	71	—	51	—	—	—	—
1,1-Dichloroethene	125	—	—	—	—	—	—	—	—
1,1-Dichloroethane	1,200	—	—	—	—	—	—	32	—
Trans 1,2-Dichloroethene	—	—	—	—	—	—	—	—	—
1,1,1-Trichloroethane	1,200	—	—	—	—	—	—	8	—
Trichloroethene	56	—	—	—	—	—	—	—	—
Benzene	—	—	—	—	—	—	—	—	—
Tetrachloroethene	130	—	—	—	—	—	—	—	—
Toluene	21	2	—	—	—	—	—	—	—
Chlorobenzene	3	—	—	—	—	—	—	—	—
Total Xylenes	33	—	—	—	—	—	—	—	—
1,3-Dichlorobenzene	437	5	8	—	—	—	—	—	—
1,4-Dichlorobenzene	424	7	13	—	—	—	—	—	—
1,2-Dichlorobenzene	452	—	11	—	—	—	—	—	—
Naphthalene	22	—	—	—	—	—	—	—	—
Methyl Ethyl Ketone	21	—	—	—	—	—	—	—	—

See key at end of table.

Table 3/89 (Continued)

Parameter	Well Number							
	On-64	GM-65	Ox-66	GM-67	GM-68	GM-69	GM-71	Ox-72
Total Metals								
Antimony	—	—	—	—	—	—	—	—
Arsenic	—	—	—	—	—	—	—	—
Barium	—	—	—	—	—	—	—	—
Cadmium	—	—	—	—	—	—	—	—
Chromium	—	—	—	—	—	—	—	—
Iron	—	—	—	—	—	—	—	—
Manganese	—	—	—	—	—	—	—	—
Silver	—	—	—	—	—		—	—
Sodium (mg/L)	515	100	662	20	57	669	3,201	2,793
Zinc	—	—	—	—	—	—	—	—
Chloride (mg/L)	407	151	507	71	111	807	5,775	5,387
Sulfate (mg/L)	—	—	—	—	—	—	—	—
Cyanide	—	—	—	—	—		—	—
Vinyl Chloride	4	—	380	—	—	14	—	—
Chloroethane	6	—	—	—	—	25	—	—
Acetone	—	—	—	—	—	—	—	—
1,1-Dichloroethene	—	—	310	—	—	—	—	—
1,1-Dichloroethane	9	—	—	—	—	79	—	—
Trans 1,2-Dichloroethene	—	—	1,290	—	—	—	—	—
1,1,1-Trichloroethane	—	—	—	—	—	—	—	—
Trichloroethene	—	—	8,900	—	—		—	—
Benzene	—	—	—	—	—	3	—	—
Tetrachloroethene	—	—	—	—	—	4	—	—
Toluene	—	—	10	—	—	3	—	—
Chlorobenzene	12	—	70	—	—	—	—	—
Total Xylenes	—	—	—	—	—	—	—	—
1,3-Dichlorobenzene	10	—	—	—	—	980	—	—
1,4-Dichlorobenzene	14	—	18	11	—	1,510	—	—
1,2-Dichlorobenzene	32	—	46	—	—	1,360	—	—
Naphthalene	—	—	80	—	—		—	—
Methyl Ethyl Ketone	—	—	—	—	—	—	—	—

See key at end of table.

Table 3/89 (Continued)

Parameter	Well Number							
	an-74	011-76	on-77	GM-78	on-79	GM-83	GM-84	UG-1
Total Metals								
Antimony	—	—	—	—	—	—	—	—
Arsenic	—	—	—	—	—	—	—	—
Barium	—	—	—	—	—	—	—	—
Cadmium	—	—	—	—	—	—	—	—
Chromium	—	—	—	—	—	—	—	—
Iron	—	—	—	—	—	—	—	670
Manganese	—	—	—	—	—	—	—	—
Silver	—	—	—	—	—	—	—	—
Sodium (mg/L)	—	22	117	2.2	5.9	24	4,450	9.6
Zinc	—	—	—	—	—	—	—	—
Chloride (mg/L)	—	32	208	5	6	44	6,927	12
Sulfate (mg/L)	—	—	—	—	—	—	—	8.4
Cyanide	—	—	—	—	—	—	—	—
Vinyl Chloride	—	—	—	—	—	—	—	—
Chloroethane	—	—	—	—	—	—	—	—
Acetone	—	—	—	—	—	—	—	—
1,1-Dichloroethene	—	—	—	—	—	—	—	—
1,1-Dichloroethane	—	—	—	—	—	—	—	—
Trans 1,2-Dichloroethene	—	—	—	—	—	—	—	—
1,1,1-Trichloroethane	—	—	—	—	—	—	—	—
Trichloroethene	—	—	—	—	—	—	—	—
Benzene	—	—	—	—	—	—	—	—
Tetrachloroethene	—	—	—	—	—	—	—	—
Toluene	—	—	—	—	—	—	—	—
Chlorobenzene	—	—	—	—	—	—	—	—
Total Xylenes	—	—	—	—	—	—	—	—
1,3-Dichlorobenzene	—	—	—	—	—	—	—	—
1,4-Dichlorobenzene	—	—	—	—	—	—	—	—
1,2-Dichlorobenzene	—	—	—	—	—	—	—	—
Naphthalene	—	—	—	—	—	—	—	—
Methyl Ethyl Ketone	—	—	—	—	—	—	—	—

Key:
Dash (—) indicates compound not detected.

Source: Geraghty and Miller, 1919

Doc. lo. 32:02

3201106

DRAFT

GENERAL ENGINEERING LABORATORIES

JULY 1989

(SOIL)

GENERA, ENGINEERING LABORATORIES

Environmental Engineering and Analytical Services

Molly F. Greene
President

George C Greene, P.E. Ph.D.
Vice President
SC Registration No. 9103

Laboratory Certifications:

FL	E87156/87294
NC	233
SC	10120
VA	00151
NACIP	Approved

CERTIFICATE OF ANALYSIS

Client: Tricil Environmental Response
PO Box 19529
Houston, TX 77224

Date: 07/20/89

Contact: Mr. Chuck Orwig

Released By: Edith M. Kent

CC/FC: TRCL/TRCL1

Page No.: 1

Sample ID.:	S-A composite 06/13/89	S-B Composite 06/13/89		
Lab I.D.:	89060902	89060903		
Sample Type:	15	15		
Date Received:	06/14/89	06/14/89		
Collected by	GEL	GEL		
Parameter			Detection Limit	Method
Cyanide, total	1.2 ppm	4.10 ppm	<0.1 ppm	335.2
pH - lab	7.89 @ 23C	8.16 @ 23C	N/A	150.1
Cadmium	<0.50 ppm	<0.50 ppm	<0.50 ppm	6010
Chromium - Hexavalent	<0.20 ppm	4.20 ppm	4.20 ppm	7195
Nickel	<1.00 ppm	<1.00 ppm	<1.00 ppm	6010
EP Tox Extraction - Solid	Yes	Yes	N/A	1310
1,2-Dichlorobenzene	<10 ppb		<10 ppb	8240
1,3-Dichlorobenzene	67 ppb	<1 ppb	<10 ppb	8240
1,4-Dichlorobenzene	10 ppb	<10 ppb	<10 ppb	8240
Chlorobenzene	<10 ppb	<10 ppb	<10 ppb	8240
Chloroform	<10 ppb	<10 ppb	<10 ppb	8240
Toluene	<10 ppb	<10 ppb	<10 ppb	8240
Dichloroethane (1,1)	<10 ppb	<10 ppb	<10 ppb	8240
Vinyl Chloride	<10 ppb	<10 ppb	<10 ppb	8240
Dichloroethylene (1,1)	<10 ppb	<10 ppb	<10 ppb	8240
Trichloroethane (1,1,1)	<10 ppb	<10 ppb	<10 ppb	8240
Trichloroethylene	<10 ppb	<10 ppb	<10 ppb	8240
Methylene Chloride	<10 ppb	<10 ppb	<10 ppb	8240
Benzene	<10 ppb	<10 ppb	<10 ppb	8240
Xylene, Total	<10 ppb	<10 ppb	<10 ppb	8240
Cresol	<1.0 ppm	<1.0 ppm	<1.0 ppm	8270
Trichlorofluoromethane	<10 ppb	<10 ppb	<10 ppb	8240
Dichlorodifluoromethane	<10 ppb	<10 ppb	<10 ppb	8240
2,4-Dimethylphenol	<16500 ppb	430 ppb	430 ppb	8270
Phenol by GC/MS	<16500 ppb	430 ppb	430 ppb	8270
Sample Prep-Acid Compounds	Yes	Yes	N/A	3550
Naphthalene	<16500 ppb	430 ppb	430 ppb	8270
Sample Prep-B/N Compounds	Yes	Yes	N/A	3550
Moisture Content (loss @ 105C)	7 wt%	14 wt%	N/A	8240,8270
Sample Prep - Compositing	Yes	Yes	N/A	N/A

3201107

P. O. Box 30712 • Charleston, SC 29417
Phone (803) 556-8171 • FAX (803) 766-1178

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ECOLOGY AND ENVIRONMENT, INC.

MAY 1989

(GROUNDWATER)

3201108

Table C-2
SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS
(All results in ug/L unless noted)

Compound	Sample No. (Location)								
	P32W062* (GM-62)	P32063 (GM-63)	P32064 (GM-64)	P32065 (GM-65)	P32066 (GM-66)	P32067 (GM-67)	P32W068 (GM-68)	P32W069 (GM-69)	P32084 (GM-84)
Sodium (mg/L)	--	604	3.8	1.78	6.83	1.22	69	879	10,200
Chloride (mg/L)	--	850	520	190	560	110	120	790	7,100
Chloroethane	--	--	--	--	--	--	--	14	--
Acetone	--	--	6(J)	57	--	--	--	--	--
1,1-Dichloroethane	--	--	5	--	--	--	--	98	--
1,1-Dichloroethene	--	--	--	--	1,100	--	--	--	--
1,2-Dichloroethene (total)	--	--	--	--	--	--	--	1(J)	--
Chlorobenzene	--	--	11	--	--	3(J)	--	110	--
Trichloroethene	--	--	--	--	6,500	--	--	--	--
Tetrachloroethene	--	--	--	--	--	--	--	6	--
Toluene	--	--	--	--	--	--	--	3(J)	--
Total Xylenes	--	--	--	--	--	--	--	5	--
1,3-Dichlorobenzene	--	--	11	--	15	5(J)	--	480	--
1,4-Dichlorobenzene	--	--	18	--	28	8(J)	--	410	--
1,2-Dichlorobenzene	--	--	30	--	47	3(J)	--	510	--
2-Methylphenol	--	--	--	--	7(J)	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	61	--	--	--	--
Naphthalene	--	--	--	--	46	--	--	3(J)	--
2-Methylnaphthalene	--	--	--	--	4(J)	--	--	--	--
Dibenzofuran	--	--	--	--	1(J)	--	--	--	--
Fluorene	--	--	--	--	1(J)	--	--	--	--
bis(2-Ethylhexyl) phthalate	--	--	3(J)	2(J)	5(J,B)	2(J)	8(J,B)	12(J,B)	24(B)

J-Estimated value, compound present bolou detection limit
B-Compound also present in method blank at similar concentration
Analysed for VOCs and BNAs only

Table C-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS
(All results in mg/L)

Compound	Sample No. (Location)							
	P32W071 (GM-71)	P32W072 (Cur-71)	P32W076 (Cur-76)	P32W077 (Cur-77)	P32W078 (Cur-78)	P32W079 (GM-79)	P32W083 (GM-83)	P32WR1-6 (RW1-6)
Sodium	258	288	39.1	1.48	0.58	0.71	0.86	1.89
Chloride	4,400	4,600	41	120	5.3	6.6	47	200

Note: These samples analyzed for sodium and chloride only

3201103

Table D-2
SUMMARY ANALYTICAL RESULTS FOR
POINT-OF-COMPLIANCE MONITORING WELLS
(All results in ug/L)

Compound	Sample No. (Location)							
	P32W001 (UG-1)	P32W008 (GM-8)	P32W009 (GM-9)	P32W010 (GM-10)	P32W011 (GM-11)	P32W012R (GM-12R)	P32W013 (GM-13)	P32W014 (GM-14)
Barium	--	93.4	45.4	76.2	--	46	16	22
Cbromium	--	26.1	--	--	--	--	--	--
Iron	689	32,400	3,190	252	77	883	551	450
Manganese	--	115	13.7	174	17	532	31	98
Nickel	--	--	--	--	--	--	38	--
Sodium	7,380	15,500	9,210	25,300	21,600	15,200	18,000	184,000
Zinc	18.8	54.3	12.3	--	--	--	--	14.6
Chloride	9,700	16,000	8,800	31,000	35,000	14,000	29,000	240,000
Sulfate	20,000	150,000	170,000	140,000	23,000	28,000	56,000	200,000
Acetone	38	--	--	--	--	14	8(J)	--
1,1 Dichloroethane	--	170	--	--	--	--	--	--
1,2 Dichloroethene (total)	--	35	--	--	--	--	--	--
1,1,1-Trichloroethane	--	6	--	--	--	--	--	--
Trichloroethene	--	1(J)	--	--	--	--	--	--
Tetrachloroethene	--	22	--	--	--	--	--	--
Chlorobenzene	--	--	6	5	2(J)	--	--	3(J)
1,3-Dichlorobenzene	--	110	3(J)	8(J)	--	--	--	--
1,4-Dichlorobenzene	--	130	4(J)	11	--	--	--	--
1,2-Dichlorobenzene	--	140	4(J)	13	--	--	--	--
2,4-Dimethylphenol	--	4(J)	--	--	--	--	--	--
2,4-Dichlorophenol	--	6(J)	--	--	--	--	--	--
1,2,4-Trichlorobenzene	--	2(J)	--	--	--	--	--	--
Naphthalene	--	8(J)	--	--	--	--	--	--
bis(2-Ethylhexyl) phthalate	--	17(B)	12(B)	13(B)	--	3(J,B)	--	--
Di-n-octyl phthalate	--	--	--	--	1(J)	--	--	--
totramotbylbutyl phenol	--	--	--	21(J)	--	--	--	1(J)
Dimethyl ethyl phenol	--	--	--	--	--	--	--	1(J)
Dichlorobenzene isomer	--	--	--	--	--	--	--	2(J)

J-Estimated value, compound present below detection limit
a-Compound also present in method blank at similar concentration

Table E-2
SUMMARY ANALYTICAL RESULTS
FOR FIELD QA/QC SAMPLES
(All results in ug/L)

Compound	Sample no. (Location)							
	P32W008 (GM-8)	P32W008D[a] (GM-8)	P32ASCWTB01[b]	P32WTB02[b]	P32WRB01	P32WRB02	P32WFB01	P32WPB01[c]
Barium	93.4	93.0	--	--	--	--	--	--
Copper	--	--	--	--	--	--	25.0	--
Chromium	26.1	25.6	--	--	--	--	--	--
Icon	32,400	32,000	--	--	--	--	--	46
Manganese	115	115	--	--	--	--	--	--
Sodium	15,550	15,500	--	--	226	61.8	--	399
Zinc	54.3	61.9	--	--	10.1	--	31.2	27
Chloride	**16,000**	**17,000**	--	--	--	--	--	--
Sulfate	**150,000**	**140,000**	--	--	--	--	--	--
1,1 Dichloroethane	170	170	--	--	--	--	--	--
1,2 Dichloroethene (total)	35	37	--	--	--	--	--	--
1,1,1-Trichloroethane	6	6	--	--	--	--	--	--
Chloroethane	--	9(J)	--	--	--	--	--	--
Trichloroethene	1(J)	1(J)	--	--	--	--	--	--
Total Xylenes	--	1(J)	--	--	--	--	--	--
Tetrachloroethene	22	21	--	--	--	--	--	--
Trichlorofluoromethane	--	--	--	--	1.13	--	--	--
Trimethyl benzene	8(J)	8(J)	--	--	--	--	--	--
"alkylated" benzene	6(J)	6(J)	--	--	--	--	--	--
1,3-Dichlorobenzene	110	130	--	--	--	--	--	--
1,4-Dichlorobenzene	130	140	--	--	--	--	--	--
1,2-Dichlorobenzene	140	170	--	--	--	--	--	--
2.4-Dimothylphonol	4(J)	4(J)	--	--	--	--	--	--
2,4-Dichlorophenol	6(J)	7(J)	--	--	--	--	--	--
1,2,4-Trichlorobenzene	2(J)	2(J)	--	--	--	--	--	--
Naphthalene	8(J)	9(J)	--	--	--	--	--	--
bis(2-Ethylhexyl) phthalate	17(B)	13(B)	--	--	--	20(B)	--	--
Di-n-octyl phthalate	--	--	--	--	31	19	--	--

[a] **Duplicate** sample of P32W008
[b] **Analyzed** for VOCs only
[c] Analyzed for metals and cyanide only

J-Estimated value, compound present below detection limit
8-Coapound **also** present **in** method blank at **similar** concontration

DRAFT

ECOLOGY AND ENVIRONMENT, INC.

AUGUST *1989*

(GROUNDWATER)

Table C-2
SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS
(All results in ug/L unless noted)

Compound	Sample No. (Location)								
	P32W062* (GM-62)	P32W063 (GM-63)	P32W064 (GM-64)	P32W065 (GM-65)	P32W066 (GM-66)	P32W067 (GM-67)	P32W068 (GM-68)	P32W069 (GM-69)	P32W084 (GM-84)
Sodium (mg/L)	--	449	105	1,070	160	74	600	618	4,470
Chloride (mg/L)	--	993	501	173	602	144	132	835	7,910
Vinyl Chloride	--	--	--	--	--	--	--	9(J)	--
Chloroethane	--	--	--	--	--	--	--	12	--
Methylene Chloride	--	--	1(J,B)	--	180(J)	1(J,B)	1(J,B)	2(J,B)	1(J)
Acetone	12(B)	14(B)	15(B)	10(B)	3,700	37(B)	5(J,B)	13(B)	17(B)
Carbon Disulfide	--	--	--	9(J)	--	2(J)	3(J)	4(J)	--
1.1-Dichloroothano	--	--	1(J)	--	--	--	--	100	--
1,1-Dichloroethene	--	--	--	--	320(J)	--	--	--	--
Vinyl Acetate	--	--	--	--	--	--	--	3(J)	--
1,2-Dichlorothene (total)	2(J)	--	--	--	--	--	--	--	--
2-Butanone	--	--	--	--	--	7(J)	--	--	--
Chlorobenzene	--	--	15	--	120(J)	1(J)	--	110	--
Benzene	--	--	--	--	--	--	--	3(J)	--
Trichloroethene	--	--	--	--	11,000	--	--	--	--
Tetrachloroethene	--	--	--	--	--	--	--	7	--
Toluene	--	--	--	--	--	13	--	3(J)	--
Total Xylenes	--	--	--	--	--	--	--	2(J)	--
Phenol	--	--	--	--	--	3(J)	--	--	--
2-Chlorophenol	--	--	--	--	2(J)	--	--	--	--
1,3-Dichlorobenzene	--	--	9(J)	--	11	2(J)	--	650	--
1,4-Dichlorobenzene	--	--	14	--	22	4(J)	--	560	--

J-Estimated value, compound present below detection limit
B-Compound also present in method blank at similar concentration
*Analyzed Cor VOCs and BNAs only

Table C-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS
(All results in ug/L unless noted)

Compound	Sample No. (Location)								
	P32W062* (GM-62)	P32W063 (GM-63)	P32W064 (GM-64)	P32W065 (GM-65)	P32W066 (GM-66)	P32W067 (GM-67)	P32W068 (GM-68)	P32W069 (GM-69)	P32W084 (GM-84)
1,2-Dichlorobenzene	--	--	17	--	42	1(J)	--	770	--
2-Methylphenol	--	--	--	--	--	1(J)	--	--	--
4-Methylphenol	--	--	--	--	2(J)	3(J)	--	--	--
2,4-Dimethylphenol	--	--	--	--	79	--	--	--	--
Napthalene	--	--	--	--	94	--	--	--	--
2-Methylnaphthalene	--	--	--	--	4(J)	--	--	--	--
Acenaphthene	--	--	--	--	3(J)	--	--	--	--
Dibenzofurane	--	--	--	--	1(J)	--	--	--	--
Fluorene	--	--	--	--	2(J)	--	--	--	--
Butylbenzylphthalate	--	--	3(J)	--	--	--	--	--	--
bis (2-Ethylhexyl) phthalate	2(J,B)	--	4(J,B)	--	2(J,B)	2(J,B)	--	14(J,B)	4(J,B)

J-Estimated value, compound present below detection limit.
B-Compound also present in method blank at similar concontration.
*Analyzed for VOCs and BNAs only.

Table D-2

SUMMARY ANALYTICAL RESULTS FOR

POINT-OF-COMPLIANCE MONITORING WELLS

(All results in ug/L)

Compound	Sample No. (Location)							
	P32W001 (UG-1)	P32W008 (GM-8)	P32W009 (GM-9)	P32W010 (GM-10)	P32W011 (GM-11)	P32W012R (GM-12R)	P32W013 (GM-13)	P32W014 (GM-14)
Barium	--	81	31	58	--	58	15	24
Cadmium	--	5.4	--	--	--	--	--	--
Chromium	--	13	--	11	--	--	--	--
Iron	750	14,000	2,540	630	50	270	590	100
Lead	--	--	5.1	--	--	--	--	--
Manganese	--	100	46	160	15	230	48	20
Mercury	0.22	--	--	--	0.22	--	0.22	--
Sodium	6,800	6,800	2,970	400	34,900	12,000	6,000	180,000
Zinc	--	37	17	--	--	--	13	--
Chloride	7,900	7,000	4,400	13,000	48,000	13,000	9,700	230,000
Sulfate	14,000	200,000	25,000	48,000	36,000	25,000	48,000	140,000
Cyanide	--	80	--	140	200	20	40	240
Methylene Chloride	1(J)	3(J,B)	5(B)	5(B)	3(J)	2(J)	3(J)	1(J)
Acetone	24(B)	45(B)	23(B)	14(B)	32(B)	23(B)	12(B)	19(B)
Carbon Disulfide	--	--	--	--	--	--	--	4(J)
Tetrachloroethene	--	9	--	--	--	--	--	--
Chlorobenzene	--	5	--	12(J)	--	--	--	1(J)
Tetramethyl Benzene	--	0.44(J)	--	--	--	--	--	--
2-Chlorophenol	--	--	--	--	--	1(J)	--	--
1,3-Dichlorobenzene	--	47	--	6(J)	--	--	--	--
1,4-Dichlorobenzene	--	66	--	10	--	--	--	--
1,2-Dichlorobenzene	--	79	--	12	--	--	--	--
Naphthalene	--	2(J)	--	--	--	1(J)	--	--
2-Methylnapthalene	--	--	--	--	--	2(J)	--	--
Diethylpthalate	--	--	--	--	--	2(J)	--	--
Butylbenzylphthalate	--	--	--	--	--	2(J)	--	--
bis(2-Ethylhexyl) phthalate	1(J,B)	2(J,B)	--	2(J,B)	2(J,B)	4(J,B)	2(J,B)	(J,B)
Di-n-butlphthalate	--	--	--	--	--	1(J)	--	--
Pyrene	--	--	--	--	--	1(J)	--	--
Tetramethylbutyl phenol	--	--	--	31(J)	--	3(J)	--	3(J)

J-Estimated value, compound present below detection limit

B-Compound also present in method blank at similar concentration

32011112

Table E-2
SUMMARY ANALYTICAL RESULTS FOR FIELD QA/QC SAMPLES
(All results in ug/L)

Compound	Sample No. (Location)					
	P32W008 (GM-8)	P32W008D[a] (GM-8)	P32W069 (GM-69)	P32W069D[b] (GM-69)	P32WTB01[c]	P32WTB02[c]
Barium	81	83	--	--	--	--
cam ium	5.4	5.5	--	--	--	--
Chromium	13	12	--	--	--	--
Iron	14,000	14,700	--	--	--	--
Manganese	100	100	--	--	--	--
Mercury	--	0.22	--	--	--	--
Sodium	6,800	5,900	618	644	--	--
Zinc	37	40	--	--	--	--
Chloride	7,000	7,000	835	598	--	--
Sulfate	200,000	180,000	--	--	--	--
Cyanide	80	--	--	--	--	--
Vinyl Chloride	--	--	9(J)	8(J)	--	--
Methylene Chloride	3(J,B)	5(B)	2(J,B)	1(J,B)	2(J)	--
Acetone	45(B)	33(B)	13(B)	15(B)	12(B)	3(J,B)
Carbon Disulfide	--	6	4(J)	3(J)	--	--
1,1 Dichloroethane	--	--	100	99	--	--
Chloroform	--	--	--	--	1(J)	1(J)
Vinyl Acetate	--	--	3(J)	3(J)	--	--
Chloroethane	--	--	12	11	--	--
Trichloroethene	--	--	7	--	--	--
total Xylenes	--	--	2(J)	2(J)	--	--
Benzene	--	--	3(J)	3(J)	--	--
Tetrachloroethene	9	7	7	6	--	--
Chlorobenzene	5	5	110	100	--	--
Tetramethylbenzene	0.44(J)	0.52(J)	--	--	--	--
Toluene	--	--	3(J)	3(J)	--	--
Phenol	--	--	--	--	--	--
2-Chlorophenol	--	--	--	--	--	--
1,3-Dichlorobenzene	47	47	650	760	--	--
1,4-Dichlorobenzene	66	68	560	660	--	--
1,2-Dichlorobenzene	79	80	770	870	--	--
Naphthalene	2(J)	2(J)	--	--	--	--
bis (2-Ethylhexyl) phthalate	2(B)	2(J,B)	14(J,B)	14(J,B)	--	--

[a] Duplicate sample of P32W008
[b] Duplicate of sample P32W069, analyzed for sodium, chlorides, VOCs and BNAs only
[c] Analyzed for VOCs only
[d] Analyzed tor metals, cyanide, and VOCs only

J-Estimated value, compound present below detection limit
8-Compound also present in method blank at similar concantration

Table B-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR FIELD QA/QC SAMPLES
(All results in ug/L)

Compound	Sample No. (Location)				
	P32WRB01	P32WRB02	P32WRB03	P32WFB01	P32WFB01[d]
Barium	--	--	--	--	--
Cadmium	--	--	--	--	--
Chromium	--	--	--	--	--
Iron	--	--	40	--	--
Manganese	--	--	--	--	--
Mercury	0.29	--	--	--	0.26
Sodium	450	930	--	1200	100
Zinc	--	--	--	--	--
Chloride	--	--	--	--	--
Sulfate	--	--	--	--	--
Cyanide	--	--	--	--	--
Vinyl Chloride	--	--	--	--	--
Methylene Chloride	8	37,000(B)	2(J,B)	2(J,B)	22(B)
Acetone	35(B)	4,400(J,B)	12(B)	--	12(B)
Carbon Disulfide	--	--	1(J)	--	--
1,1 Dichloroethane	--	--	--	--	--
Chloroform	--	--	--	--	--
Vinyl Acetate	--	--	--	--	--
Chloroethane	--	--	--	--	--
Trichloroethene	--	--	--	--	--
Total Xylenes	--	--	--	--	--
Benzene	--	--	--	--	--
Tetrachloroethene	--	--	--	--	--
Chlorobenzene	--	--	--	--	--
Tetramethylbenzene	--	--	--	--	--
Toluene	--	--	--	--	--
Phenol	--	--	--	2(J)	--
2-Chlorophenol	--	--	--	1(J)	--
1,3-Dichlorobenzene	--	--	--	--	--
1,4-Dichlorobenzene	--	--	--	--	--
1,2-Dichlorobenzene	--	--	--	--	--
Naphthalene	--	--	--	--	--
bis (2-Ethylhexyl) phthalate	1(J,B)	1(J,B)	--	1(J,B)	--

[a] Duplicate sample of P32W008
[b] Duplicate of sample P32W069, analysed for sodium, chlorides, VOCs and BNAs only
[c] Analysed for VOCs only
[d] Analysed for metals rad cyanide only

J-Estimated value, compound present below detection limit
B-Compound also present in method blank at similar concentration

3201113

DRAFT

ECOLOGY AND ENVIRONMENT, INC.

NOVEMBER 1989

(GROUNDWATER)

Table C-2

SUMMARY ANALYTICAL RESULTS FOR CORRECTIVE-ACTION MONITORING WELLS

(All results in ug/L unless noted)

Compound	Sample No. (Location)								
	P32W062* (GM-62)	P32W063 (GM-63)	P32W064 (GM-64)	**P32W065** (GM-65)	P32W066 (631-66).	P32W067 (GM-67)	P32W068 (631-68)	P32W069 (GM-69)	P32W084 (GM-84)
Sodium (mg/L)	---	479	241	88.9	842	50.6	693	693	5,540
Chloride (mg/L)	---	840	310	180	570	35	130	760	7,800
Vinyl Chloride	---	---	---	---	180(J)	---	---	11	---
Chloroethane	---	---	---	---	---	---	---	14	---
Methylene Chloride	6(B)	5(B)	6(B)	5(B)	340(B)	5(B)	7(B)	7(B)	9(B)
Acetone	---	---	---	19(B)	460(B)	---	---	30(B)	49(B)
Carbon Disulfide	15	---	46	---	240	64	86	---	---
1.1-Dichloroethane	---	---	---	---	---	---	---	110	---
1.1-Dichloroethene	---	---	---	---	320	---	---	---	---
Chlorobenzene	---	17	15(B)	---	59(J)	92(B)	---	120	---
Trichloroethene	2(J,B)	---	2(J,B)	---	8,400(E)	2(J,B)	4(J,B)	1(J)	---
Tetrachloroethene	---	---	---	---	---	---	---	7	---
Toluene	---	---	---	---	---	3(J)	---	4(J)	---
Total Xylene8	---	---	---	---	---	---	---	5(B)	---
1.3-Dichlorobenzene	---	---	5(J)	---	8(J)	---	---	310	---
1.4-Dichlorobenzene	---	---	8(J)	---	16	8(J)	---	250	---
1,2-Dichlorobenzene	---	---	8(J)	---	34	---	---	350	---
2-Methy1pheno1	---	---	---	---	6(J)	---	---	---	---
4-Methylphenol	---	---	---	---	2(J)	---	---	---	---
2,4-Dimethylphenol	---	---	---	---	64	---	---	---	---
Naphthalene	---	---	---	---	78	2(J)	---	2(J)	---
bis(2-Ethylhexyl)phthalate	3(J,B)	18(B)	2(J,B)	---	3(J,B)	---	2(J,B)	---	8(J,B)
Di-n-butylphthalate	15(B)	5(J,B)	4(J,B)	5(J,B)	10(B)	5(J,B)	4(J,B)	2(J)	4(J)
2.4-Dichlorophenol	---	---	---	---	---	---	---	5(J)	---
2.4-Dinethylphenol	---	---	---	---	63	---	---	---	---
2-Methylnaphthalene	---	---	---	---	4(J)	---	---	---	---
Acenapthene	---	---	---	---	3(J)	---	---	---	---
Dibenzofuran	---	---	---	---	1(J)	---	---	---	---
Fluorene	---	---	---	---	2(J)	---	---	---	---
Di-n-octylphthalate	---	---	---	---	1(J)	---	---	---	---

*Analyzed for VOCs and BNAs only

J-Estimated value, compound present below detection limit

B-Compound also present in method blank at similar concentration

E-Detected concentration exceeded calibration range of analyzinq instrument

A dash (---) indicates compound not detected

3201114

Table C-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS

(All results in mg/L)

Compound	Sample No. (Location)							
	P32W071 (GM-71)	P32W072 (GM-72)	P32W076 (GM-76)	P32W077 (GM-77)	P32W078 (GM-78)	P32W079 (GM-79)	P32W083 (GM-83)	P32WR1-6 (RW1-6)
Sodium	110	27.4	136	46.5	4.24	3.13	24.7	138
Chloride	240	57	180	52	10	5.60	53	200

Bote: These samples analyzed for sodium and chloride only.

Table D-2

SUMMARY ANALYTICAL RESULTS FOR
POINT-OF-COMPLIANCE MONITORING WELLS

(All results in ug/L)

Compound	Sample No. (Location)							
	P32W001 (DG-1)	P32W008 (GM-8)	P32W009 (GM-9)	P32W010 (GM-10)	P32W011 (GM-11)	P32W012R (GM-12R)	P32W013 (GM-13)	P32W014 (GM-14)
Barium	---	70	38	47	---	44	11	23
Iron	368	4,550	3,860	724	48	611	430	314
Lead	---	---	---	---	---	---	---	---
Manganese	---	94	72	123	21	325	44	179
Mercury	---	---	---	---	4.4	---	---	---
Sodium	9,420	6,840	2,470	5,970	27,300	8 460	3,830	164,000
Zinc	---	12	15	---	---	---	12	---
Chloride	13,000	8.300	2,600	12,000	41,000	8 700	7,000	190,000
Sulfate	18,000	40,000	13,000	37,000	38,000	31 000	30,000	18,000
Cyanide	30	80	20	100	990	20	40	220
Methylene chloride	7(B)	44(B)	8(B)	32(B)	30(B)	5(B)	6(B)	6(B)
Acetone	27(B)	45(B)	25(B)	23(B)	32(B)	---	13(B)	20(B)
Carbon disulfide	45	---	5	---	---	42	31	70
Tetrachloroethene	---	1(J)	---	---	---	---	---	---
Chlorobenzene	---	35(B)	---	2(J,B)	1(J,B)	---	---	1(J,B)
1,3-Dichlorobenzene	---	25	---	3(J)	---	---	---	---
1.4-Dichlorobenzono	---	25	---	5(J)	---	---	---	---
1.2-Dichlorobrnroae	---	36	---	6(J)	---	---	---	---
bis(2-Ethylhexyl)phthalate	7(J,B)	5(J,B)	4(J,B)	3(J,B)	3(J,B)	3(J,B)	2(J,B)	14(B)
Di-n-butylphthalate	6(J)	---	---	---	---	1(J)	---	1(J)
Tetramethylbutyl phenol	---	---	---	37(J)	---	---	---	---
Carbon tetrachloride	1(J)	---	---	---	---	---	---	---
Trichloroethene	6(B)	1(J)	4(J,B)	---	---	6 B)	3(J,B)	2(J,B)
Toluene	---	3(J,B)	---	2(J,B)	---	---	---	---
Total Xylenes	---	1(J,B)	---	2(J,B)	---	---	---	---

J-Estimated value, compound present below detection limit
B-Compound also present in method blank at similar concentration
A dash (---) indicator compound not detected

3201115

Table E-2

SUMMARY ANALYTICAL RESULTS FOR FIELD QA/QC SAMPLES
(All results in ug/L)

Compound	Sample No. (Location)					
	P32W008 (GM-8)	P32W008D[a] (GM-8)	P32W010 (GM-10)	P32W010D[b] (GM-10)	P32WTB01[c]	P32WTB02[c]
Barium	81	70	47	42	---	---
Iron	4,550	4,610	724	620	---	---
Manganese	94	93	123	122	---	---
nercucy	---	---	---	---	---	---
Sodium	6,840	6,760	5,970	5,860	---	---
Zinc	12	---	---	---	---	---
Chloride	8,300	8,500	12,000	12,000	---	---
Sulfate	40,000	43,000	37,000	36,000	---	---
Cyanide	80	70	100	---	---	---
Vinyl Chloride	---	---	---	---	---	---
Methylene Chloride	44(B)	42(B)	32(B)	34(B)	6(B)	8(B)
Acetone	45(B)	18(B)	23(B)	41(B)	---	16(B)
Carbon Disulfide	---	6	---	---	---	---
Chloroform	---	---	---	---	---	---
Trichloroethene	1(J)	---	---	---	---	1(J)
Total Xylenes	1(J,B)	2(J,B)	2(J,B)	1(J,B)	---	---
Tetrachloroethene	1(J)	1(J)	---	---	---	---
Chlorobenzene	35(B)	34(B)	2(J,B)	2(J,B)	---	---
Toluene	3(J,B)	2(J,B)	2(J,B)	1(J,B)	---	---
1,3-Dichlorobenzene	25	21	3(J)	3(J)	---	---
1,4-Dichlorobenzene	25	22	5(J)	5(J)	---	---
1.2-Dichlorobenzene	36	30	6(J)	6(J)	---	---
bis (2-Ethylhexyl)phthalate	5(J,B)	4(J,B)	3(J,B)	5(J,B)	---	---
Tetramothylbutylphenol	---	---	37(J)	---	---	39(J)

a Duplicate sample of P32W008
b Duplicate of sample P32W010, analyzed for sodium, chlorides, VOCs and BNAs only
c Analyzed for VOCs only
d Analyzed for metals, cyanide, 8nd VOCs only
J-Estimated value,'qompound present below detection limit
8-Compound also present in method blank at similar concentration

Table E-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR FIELD QA/QC SAMPLES
(All results in ug/L)

Compound	Sample No. (Location)				
	P32WRB01	P32WRB02	P32WRB03	P32WPB01	P32WPB01[d]
Barium	---	---	---	---	---
Cadmium	---	---	---	---	---
Chromium	---	---	---	---	---
Iron	---	---	---	---	---
Manganese	---	---	---	---	---
Mercury	---	0.89	---	---	---
Sodium	---	356	231	228	842
Zinc	---	---	---	---	---
Chloride	---	---	---	---	---
Sulfate	---	---	---	---	---
Cyanido	---	---	---	---	---
Vinyl chloride	---	---(E,B)	---	---	---
Methylene chloride	8(B)	9,900(J,B)	52(B)	130(B)	36,000(E,B)
Acetone	24(B)	490(B)	59(B)	21(B)	1,500(B)
Carbon disulfide	170	230	3(J)	---	---
Chloroform	1(J,B)	51(J)	---	---	160(J,B)
Trichloroethene	5(B)	---	---	---	---
Total xylenes	---	---	---	---	---
Tetrachloroethene	---	---	---	---	---
Chlorobenzene	---	---	1(J)	1(J,B)	150(J,B)
Toluene	---	---	1(J)	2(J,B)	---
1,3-Dichlorobenzene	---	---	---	---	---
1,4-Dichlorobenzene	---	---	---	---	---
1,2-Dichlorobenzene	---	---	---	---	---
bis(2-ethylhexyl)phthalate	2(J,B)	---	2(J,B)	3(J,B)	---
Di-n-butylphthalate	---	---	---	1(J)	---

[a] Duplicate sample of P32W008
[b] Duplicate of sample P32W069, analyzed for sodium, chlorides. VOCs and BNAs only
[c] Analyzed for VOCs only
[d] Analyzed for metals and cyanide only
J-Estimated value, compound present below detection limit
B-Compound also present in method blank at similar concentration
E-Detected concentration exceeded calibration range of analyzing instrument

DRAFT

ECOLOGY AND ENVIRONMENT, INC.

MARCH 1990

(GROUNDWATER)

Table C-2

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS

(All results in ug/L unless noted)

Compound	Sample No. (Location)							
	F32N062[a] (GM-62)	F32N063 (GM-63)	F32N064 (GM-64)	F32N065 (GM-65)	F32N067 (GM-67)	F32N068 (GM-68)	F32N069 (GM-69)	F32N084 (GM-84)
Sodium (mg/L)	N/A	560	320	120	58	n	690	4,300
Chloride (mg/L)	N/A	860	400	190	38	130	740	7,600
Chloromethane	13	—	—	—	—	—	—	—
Vinyl Chloride	—	—	—	—	—	—	12	—
Chloroethane	—	—	—	—	—	—	17	—
Methylene Chloride	6(B)	6(B)	6(B)	6(B)	5(B)	7(B)	6(B)	15(B)
Acetone	26(B)	19(B)	13(B)	19(B)	20(B)	170(B,X)	41(B)	19(B)
Carbon Disulfide	—	—	—	—	(L)	29	—	—
1,1-Dichloroethane	—	—	—	—	—	—	110	—
Chlorobenzene	—	—	25	—	—	—	150	—
Tetrachloroethene	—	—	—	—	—	—	(L)	—
Toluene	—	—	—	—	—	—	(L)	—
Total Xylenes	—	—	—	—	—	—	5	—
1,3-Dichlorobenzene	—	—	(L)	—	—	—	160	—
1,4-Dichlorobenzene	—	—	(L)	—	(L)	—	140	—
1,2-Dichlorobenzene	—	—	(L)	—	—	—	180	—
2-Clorophenol	—	—	—	—	—	—	(L)	—
Naphthalene	—	—	—	—	—	—	(L)	—
bis(2-Ethylhexyl)phthalate	31(B)	27(B)	24(B)	21(B)	35(B)	(L,B)	33(B)	41(B)
Di-n-butylphthalate	22(B)	19(B)	18(B)	15(B)	(L,B)	(L,B)	23(B)	11(B)
Di-n-octylphthalate	—	—	(L)	—	—	—	—	—

[a]Analyzed for VOCs and BNAs only

B-Compound also present in method blank
X-Detected concentration exceeded calibration range of analyzing instrument
L-Compound present below detection limit
N/A-Analysis not performed
A dash (—) indicates compound not detected

3201117

Table C-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS
(All results in mg/L)

Compound	Sample No. (Location)							
	P32W071 (GM-71)	P32W072 (GM-72)	P32W076 (GM-76)	P32W077 (GM-77)	P32W078 (GM-78)	P32W079 (GM-79)	P32W083 (GM-83)	P32WR1-6 (RW1-6)
Sodium	6.7	17	100	44	8.6	4.5	14	130
Chloride	9.6	12	110	52	12	5.2	21	52

Note: These samples analyzed tor sodium and chloride only.

Table D-2

SUMMARY ANALYTICAL RESULTS FOR
POINT-OF-COMPLIANCE MONITORING WELLS
(All results in ug/L)

Compound	Sample No (Location/Type)							
	F32N008 (GM-8)	F32N009[a] (GM-9)	(F32N002[a]) (Rinsate)	F32N010 (GM-10)	F32N011 (GM-11)	F32N012R (GM-12R)	F32N013 (GM-13)	F32N014 (GM-14)
Barium	69	—	(30)	n	—	54	—	26
Iron	9,100	—	(2,000)	870	160	160	220	120
Lead	12	—	(—)	12	14	—	15	11
Manganese	130	—	(20)	180	44	250	46	190
Copper	—	—	(—)	—	—	12	—	—
Sodium	21,000	—	(6,500)	13,000	15,000	4,000	2,400	140,000
Selenium	10	—	(—)	—	—	—	—	—
Chloride	25,600	—	(7,400)	21,000	17,000	15,000	6,100	200,000
Sulfate	95,000	—	(32,000)	78,000	22,000	29,000	15,000	160,000
Cyanide	60	—	(20)	60	70	—	—	30
		—	(1,400[B])	7.0(B)	(L,B)	18(B)	8.0(B)	9.0(B)
		10(B)	(32,000[B])	29(B)	19(B)	25(B)	180(B)	24(B)
		7.0	(—)	46	39	—	10	—
		—	(—)	—	—	—	—	—
		—	(—)	(L)	—	—	—	(L)
		—	(—)	(L)	—	—	—	—
		—	(—)	(L)	—	—	—	—
		—	(—)	(L)	—	—	—	—
		—	(—)	—	—	—	—	—
		44(B)	(11[B])	19(B)	(L,B)	(L,B)	(L,B)	(L,B)
		(L,B)	(L,B)	12(B)	(L,B)	(L,B)	(L,B)	(L,B)
		—	(—)	49	—	—	—	(L)
		—	(—)	—	—	—	—	—
		—	(—)	—	—	—	—	—
		—	(—)	—	—	—	—	—
		—	(—)	—	—	—	—	—
		—	(—)	—	—	—	—	—

[a] Sample containers believed to have been switched in the field; see QA/QC Validation Summary for explanation.

B-Compound also present in method blank
L-Compound present below detection limit
A dash (—) indicates compound not detected

Table E-2

SUMMARY ANALYTICAL RESULTS FOR FIELD QA/QC SAMPLES
(All results in ug/L)

Compound	Sample No.					
	P32W008 (GM-8)	P32W008D[a] (GM-8)	P32W010 (GM-10)	P32W010D[b] (GM-10)	P32WTB01[c]	P32WTB02[c]
Barium	69	67	71	76	N/A	N/A
Iron	9,100	9,000	870	1,100	N/A	N/A
Lead	1.2	1.2	1.2	1.9	N/A	N/A
Manganese	130	130	180	200	N/A	N/A
Copper	—	—	—		N/A	N/A
Sodium	21,000	21,000	13,000	12,000	N/A	N/A
Selenium	1.0	—	—	—	N/A	N/A
Chromium Total	—	23	—	23	N/A	N/A
Chloride	25,000	25,000	21,000	21,000	N/A	N/A
Sulfate	95,000	130,000	78,000	13,000	N/A	N/A
Cyanide	60	30	60	80	N/A	N/A
Vinyl Chloride	180	180	—	—	—	—
Methylene Chloride	110(B)	(L,B)	70(B)	9.0(B)	6(B)	6.0(B)
Acetone	350(B)	130	29(B)	33(B)	(L)	26(B)
Carbon Disulfide	(L)	(L)	46	(L)	9.0	—
Benzene	(L)	(L)	—	—	—	—
Naphthalene	(L)	(L)	—	—	N/A	N/A
Di-N-Butylphthalate	—	(L,B)	12(B)	(L,B)	N/A	N/A
2,4-Dichlorophenol	(L)	(L)	—	—	N/A	N/A
trans-1,2-Dichloroethene	430	390	—	—	—	—
Chlorobenzene	1,300	1,200	(L)	(L)	—	—
Toluene	66	50	—	—	—	—
1,3-Dichlorobenzene	1,400	1,500	(L)	(L)	N/A	N/A
1,4-Dichlorobenzene	2,800	2,900	(L)	(L)	N/A	N/A
1,2-Dichlorobenzene	2,300	2,300	(L)	(L)	N/A	N/A
bis (2-Ethylhexyl)phthalate	(L,B)	—	19(B)	(L,B)	N/A	N/A
Tetramethylbutylphenol	—	—	49	40	N/A	N/A
1,1-Dichloroethane	80	(L)	—	—	—	—

[a] Duplicate sample of P32W008
[b] Duplicate of sample P32W010
[c] Analysed for VOCs plus TICs only

B-Compound also present in method blank
L-Compound present detection limit
N/A-Analysis not performed
A dash (—) indicates compound not detected

Table B-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR FIELD QA/QC SAMPLES
(All results in ug/L)

Compound	Sample No.					
	FS2RB001	FS2RB002[d]	(FS2R009[d])	FS2RB003	FS2RF001	FS2RF001[e]
Barium	—	30	(—)	—	—	—
Iron	—	2,000	(—)	—	—	—
Lead	—	—	(—)	—	—	—
Manganese	—	20	(—)	—	—	—
Copper	18	—	(—)	—	14	—
Sodium	370	6,500	(—)	380	—	—
Selenium	—	—	(—)	—	—	—
Chromium Total	—	—	(—)	—	—	—
Chloride	—	7,400	(—)	—	1,700	N/A
Sulfate	—	32,000	(—)	N/A	—	N/A
Cyanide	—	20	(—)	—	—	—
Vinyl chloride	—	—	(—)	—	—	—
Methylene chloride	3,000(B)	1,400(B)	(—)	6.0(B)	13(B)	6.0(B)
Acetone	380(B)	32,000(B)	(10[B])	170(B)	(L,B)	11(B)
Carbon disulfide	150	—	(7.0)	—	12	12
Benzene	—	—	(—)	—	—	—
Naphthalene	—	—	(—)	—	—	N/A
Di-N-Butylphthalate	(L,B)	(L,B)	([L,B])	—	13(B)	N/A
2,4-Dichlorophenol	—	—	(—)	—	—	N/A
trans-1,2-Dichloroethene	—	—	(—)	—	—	—
Chlorobenzene	—	—	(—)	—	—	—
Toluene	—	—	(—)	—	—	—
1,3-Dichlorobenzene	—	—	(—)	—	—	N/A
1,4-Dichlorobenzene	—	—	(—)	—	—	N/A
1,2-Dichlorobenzene	—	—	(—)	—	—	N/A
bis(2-Ethylhexyl)phthalate	29(B)	11(B)	(44[B])	—	55(B)	N/A
Tetramethylbutylphenol	—	—	(—)	—	—	N/A
1,1-Dichloroethane	—	—	(—)	—	—	—

[d] Sample containers believed to have been switched in the field; see QA/QC Validation Summary for explanation

[e] Analyzed for metals, cyanide, and VOCs only

B-Compound also present in method blank

L-Compound present below detection limit

N/A-Analysis not performed

A dash (—) indicates compound not detected

Table C-2

SUMMARY ANALYTICAL RESULTS FOR
MONITORING WELLS GM-66 AND UG-1 AND FIELD QA/QC SAMPLES
(All results in ug/L unless noted)

Compound	Sample No. (Location)		FIELD QA/QC Samples	
	F32N066 (GM-66)	F32N001 (UG-1)	F32NFB02	F32NFB03
Barium	29	27	—	N/A
Beryllium	96	—	—	N/A
Cadmium	43	—	—	N/A
Chromium (Total)	210	15	—	N/A
Iron	380,000	1,400	41	N/A
Manganese	1,600	18	11	N/A
Sodium	820,000	3,700	300	N/A
Nickel	87		—	N/A
Lead	2.6	4.7	—	N/A
Vanadium	280	—	—	N/A
Zinc	270	19	—	N/A
Chloride (mg/L)	780	15	—	N/A
Sulfide (mg/L)	2.0	—	—	N/A
Acetone	1(J,B)	—	—	4(J,B)
Benzene	2(J)	—	—	—
2-Butanone	—	—	—	23(B)
Carbon disulfide	4(J)	—	—	—
Carbon tetrachloride	2(J,B)	2(J,B)	3(J,B)	2(J,B)
Chlorobenzene	99	—	—	—
1,1-Dichloroethane	21	—	—	—
1,1-Dichloroethene	350(E)	—	—	—
Trans-1,2-dichloroethene	7	—	—	—
Ethyl benzene	2(J)	—	—	—
Methylene chloride	—	—	—	2(J,B)
4-Methyl-2-pentanone	4(J)	—	—	—
Tetrachloroethene	4(J)	—	—	—
Toluene	9	—	—	—
Trichloroethene	8,200(D)	—	—	—
Vinyl chloride	240(D)	—	—	—
Xylenes (Total)	7	—	—	—
Cis-1,2-dichloroethene[a]	1,300(D)		—	—

[a] Cis-1,2-dichloroethene io not an Appendix IX parameter
B-Compound also present in method blank
J-Estimated value less than the detection limit
E-Compound exceeded calibration range of analyzing instrument
D-Compound analyzed at e secondary dilution tutor
N/A-Analysis Mt performed
Dash(——)indicates compound not detected

Table C-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR
MONITORING WELLS GM-66 AND US-1 AND FIELD QA/QC SAMPLES
(All results in ug/L unless noted)

Compound	Sample No. (Location)		Field QA/QC Samples	
	FS2M66 (GM-66)	FS2M01 (US-1)	FS2MFB02	FS2MTB03
1,3-Dichlorobenzene	8(J)	—	—	N/A
1,4-Dichlorobenzene	18	—	—	N/A
1,2-Dichlorobenzene	33	—	—	N/A
2-Methylphenol	5(J)	—	—	N/A
2,4-Dimethylphenol	46	—	—	N/A
Naphthalene	68	—	—	N/A
2-Methylnaphthalene	4(J)	—	—	N/A
Acenaphthene	2(J)	—	—	N/A
N-Nitrosodiphenylamine[b]	9(J,B)	10(J,B)	13(B)	N/A
Diphenylamine	5(J,B)	6(J)	8(J,B)	N/A
Pentachlorophenol	—	—	2(J)	N/A
Di-n-butylphthalate	—	—	5(J)	N/A

[b] Detected as diphenylamine
B-Compound also present in method blank
J-Estimated value less than the detection limit
E-Compound exceeded calibration range of analyzing instrument
D-Compound analyzed at a secondary dilution factor
N/A-Analysis not performed
Dash(—)indicates compound not detected

DRAFT

ECOLOGY AND ENVIRONMENT, INC.

MAY 1990

(GROUNDWATER)

Table C-2

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS
(All results in ug/L unless noted)

Compound	Sample No. (Location)								
	FS2N062[a] (GM-62)	FS2N063 (GM-63)	FS2N064 (GM-64)	FS2N065 (GM-65)	FS2N066 (GM-66)	FS2N067 (GM-67)	FS2N068 (GM-68)	FS2N069 (GM-69)	FS2N084 (GM-84)
Sodium	N/A	510,000	210,000	180,000	670,000	57,000	81,000	600,000	4,400,000
Chloride (mg/L)	N/A	840	380	200	520	24	140	810	*7,600*
Chloroethane	(L)	—	—	—	—	—	—	(L)	—
Methylene Chloride	10(B)	12(B)	12(B)	12(B)	1,300(B)	12(B)	11(B)	55(B)	11(B)
1,1-Dichloroethene	—	—	—	—	(L)	—	—	—	—
1,1-Dichloroethane	—	—	—	—	—	—	—	97	—
Tetrachloroethene	—	—	—	—	—	—	—	(L)	—
Chlorobenzene	—	—	29	—	—	—	—	120	—
Acetone	22(B)	15(B)	12(B)	13(B)	1,400(B)	22(B)	12(B)	55(B)	11(B)
2-Butanone	10(B)	—	(L,B)	—	1,600(B)	(L,B)	14(B)	—	—
Carbon Disulfide	—	—	(L)	—	—	—	—	240	—
Total Xylenes	—	—	—	—	—	—	—	5	—
1,3-Dichlorobenzene	—	—	(L)	—	13	—	—	*600*	—
1,4-Dichlorobenzene	—	—	(L)	—	28	(L)	—	550	—
1,2-Dichlorobenzene	—	—	(L)	—	48	—	—	670	—
Naphthalene	—	—	—	—	67	—	—	(L)	—
Acenaphthylene	—	—	—	—	(L)	—	—	—	—
Fluorene	—	—	—	—	(L)	—	—	—	—
Di-N-Butyl-Phthalate	—	—	—	—	10(B)	—	—	—	—
Bis(2-Ethylhexyl)Phthalate	17(B)	19(B)	27(B)	20(B)	46(B)	24(B)	13(B)	(L,B)	26(B)
Di-N-Octyl-Phthalate	—	—	(L)	—	—	—	—	—	—
Chloroaniline	—	—	(L)	—	—	—	—	—	—
2-Methylnaphthalene	—	—	—	—	(L)	—	—	—	—
Dibenzofuran	—	—	—	—	(L)	—	—	—	—
2,4-Dimethylphenol	—	—	—	—	40	—	—	—	—
2,4 Dichlorophenol	—	—	—	—	—	—	—	(L)	—
2-Methylphenol	—	—	—	—	(L)	—	—	—	—

[a]Analyzed for VOCs and BNAs only

B-Compound also present in method blank
L-Compound present below detection limit
N/A-Analysis not performed
A dash (—) indicates compound not detected

3201121

Table C-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS

(All results in ug/L unless noted)

Compound	Sample No. (Location)							
	P32W071 (GM-71)	P32W072 (GM-72)	P32W076 (GM-76)	P32W077 (GM-77)	P32W078 (GM-78)	P32W079 (GM-79)	P32W083 (GM-83)	P32WR1-6 (RW1-6)
Sodium	12,000	13,000	64,000	28,000	9,200	3,700	10,000	130,000
Chloride (mg/L)	10	10	61	29	11	52	1s	140

Note: These samples analyzed for sodium and chloride *only.*

Table D-2

SUMMARY ANALYTICAL RESULTS FOR
POINT-OF-COMPLIANCE MONITORING WELLS
(All results in ug/L unless noted)

Compound	Sample No (Location/Type)							
	FS2N001 (MW-1)	FS2N008 (GM-8)	FS2N009 (GM-9)	FS2N010 (GM-10)	FS2N011 (GM-11)	FS2N012R (GM-12R)	FS2N013 (GM-13)	FS2N014 (GM-14)
Arsenic	51	—	—	—	—	—	—	—
Barium	—	69	29	55	—	43	—	—
Chromium Total	—	—	12	22	—	—	—	—
Iron	910	14,000	3,000	980	92	190	380	110
Manganese	—	140	12	180	25	270	69	150
Sodium	4,800	16,000	14,000	10,000	30,000	5,200	2,700	120,000
Chloride (mg/L)	61	21	13	13	28	2.6	3.5	130
Sulfate (mg/L)	11	85	2	41	13	24	5.7	100
Cyanide (mg/L)	—	0.48	0.04	0.07	0.44	—	0.02	0.23
Vinyl Chloride	—	(L)	—	—	—	—	—	—
Methylene Chloride	10(B)	130(B)	11(B)	10(B)	48(B)	10(B)	10(B)	10(B)
1,1-Dichloroethane	—	(L)	—	—	—	—	—	—
Chlorobenzene	—	1,400	(L)	—	—	—	—	—
Acetone	15(B)	120(B)	24(B)	21(B)	21(B)	21(B)	24(B)	—
Carbon Disulfide	—	—	—	—	(L)	—	—	—
2-Butanone	10(B)	—	14(B)	13(B)	(L,B)	12(B)	(L,B)	10(B)
Trimethyl Benzene	—	24	—	—	—	—	—	—
1,3-Dichlorobenzene	—	1,700	—	(L)	—	—	—	—
1,4-Dichlorobenzene	—	2,600	—	(L)	—	—	—	—
1,2-Dichlorobenzene	—	2,200	—	(L)	—	—	—	—
Naphthalene	—	(L)	—	—	—	—	—	—
Bis(2-Ethylhexyl)Phthalate	16(B)	—	18(B)	25(B)	17(B)	16(B)	11(B)	16(B)
2,4-Dichlorophenol	—	(L)	—	—	—	—	—	—
Tetramethylbutyl Phenol	—	—	(L)	44	—	—	—	(L)

B-Compound also present in method blank
L-Compound present below detection limit
A dash (—) indicates compound not detected

3201122

Table D-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR
POINT-OF-COMPLIANCE MONITORING WELLS
(All results in ug/L unless noted)

Compound	Sample No (Location/Type) P32MS1 (PCS-1)	P32WI1 (PCI-1)	P32MD1 (PCD-1)
Arsenic	—	11	—
Barium	39	—	17
Copper	29	—	—
Iron	1,800	450	2,000
Manganese	920	71	89
Sodium	19,000	120,000	130,000
Zinc	37	29	48
Chloride (mg/L)	5.2	220	190
Sulfate (mg/L)	28	65	9.8
Cyanide (mg/L)	0.14	0.92	0.13
Methylene Chloride	10(B)	9(B)	9(B)
Acetone	—	—	25(B)
2-Butanone	34	—	(L)
Chlorobenzene	—	17(B)	—
1,3-Dichlorobenzene	(L)	(L)	—
1,4-Dichlorobenzene	(L)	(L)	—
1,2-Dichlorobenzene	12	12	(L)
Acenaphthene	(L)	—	—
Fluorene	(L)	—	—
Di-N-Butyl-Phthalate	—	(L)	—
Bis(2-Ethylhexyl)Phthalate	26(B)	20(B)	27(B)
Tetramethyl Benzene	2(J)	—	—
Tetramethylbutyl Phenol	25	4(J)	—

J-Estimated value, compound present below detection limit
B-Compound also present in method blank
A dash (—) indicates compound not detected

Table B-2

SUMMARY ANALYTICAL RESULTS FOR FIELD QA/QC SAMPLES
(All results in ug/L unless noted)

Compound	Sample No.					
	P32W008 (GM-8)	P32W008D[a] (GM-8)	P32W010 (GM-10)	P32W010D[b] (GM-10)	P32WTB01[c]	P32WTB02[c]
Barium	69	69	55	55	N/A	N/A
Chromium Total	—	—	22	21	N/A	N/A
Iron	14,000	14,000	980	1,000	N/A	N/A
Manganese	140	140	180	180	N/A	N/A
Sodium	16,000	16,000	10,000	10,000	N/A	N/A
Zinc	—	12	—	—	N/A	N/A
Chloride (mg/L)	21	22	13	13	N/A	N/A
Sulfate (mg/L)	85	34	U	46	N/A	N/A
Cyanide (mg/L)	0.48	0.44	0.07	—	N/A	N/A
Vinyl Chloride	(L)	(L)	—	—	—	—
Methylene Chloride	130(B)	100(B)	10(B)	10(B)	12(B)	10(B)
1,1-Dichloroethane	(L)	(L)	—	—	—	—
Chlorobenzene	1,400	1,200	—	—	—	—
Acetone	120(B)	130(B)	21(B)	16(B)	11(B)	—
Carbon Disulfide	—	(L)	—	—	—	—
2-Butanone	—	140(B)	13(B)	10(B)	—	—
Trimethyl Benzene	24	23	—	—	—	—
Tetramethyl Benzene	—	(L)	—	—	—	—
Trans-1,2-Dichloroethene	—	390	—	—	—	—
1,3-Dichlorobenzene	1,700	3,400	(L)	(L)	N/A	N/A
1,4-Dichlorobenzene	2,600	5,200	(L)	(L)	N/A	N/A
1,2-Dichlorobenzene	2,200	4,400	(L)	(L)	N/A	N/A
Naphthalene	(L)	170	—	—	N/A	N/A
Di-N-Butylphthalate	—	—	—	—	N/A	N/A
Bis (2-Ethylhexyl)phthalate	—	—	25(B)	18(B)	N/A	N/A
2,4-Dichlorophenol	(L)	(L)	—	—	N/A	N/A
Tetramethylbutyl Phenol	—	—	44	42	N/A	N/A

[a] Duplicate sample of P32W008
[b] Duplicate of sample P32W010
[c] Analyzed for VOCs plus TICs only

B-Compound also present in method blank
L-Compound present detection limit
N/A-Analysis not performed
A dash (—) indicates compound not detected

3201123

Table B-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR FIELD QA/QC SAMPLES

(All results in ug/L unless noted)

Compound	Sample No.				
	F32MRB01	F32MRB02[d]	F32MRB03	F32MFB01	F32MFB01[e]
Barium	—		—	—	—
Chromium Total	—	—	—	—	—
Iron	41	26	64	49	46
Manganese	—	—	—	—	—
Sodium	510	—	1,100	1,700	670
Chloride (mg/L)	—	—	—	—	N/A
Sulfate (mg/L)	—	—	—	—	N/A
Cyanide (mg/L)	—	—	—		
Vinyl Chloride	—	—	—	—	—
Methylene Chloride	10(B)	11(B)	14(B)	13(B)	11(B)
1,1-Dichloroethane	—	—	—	—	—
Chlorobenzene	—	—	—	—	—
Acetone	—	—	—	—	12(B)
Carbon Disulfide	—	—	—	—	(L)
2-Butanone	(L,B)	(L,B)	—	—	11(B)
Trans-1,2-Dichloroethene	—	—	—	—	—
1,3-Dichlorobenzene	—		—	—	N/A
1,4-Dichlorobenzene	—	—	—	—	N/A
1,2-Dichlorobenzene	—	—	—	—	N/A
Naphathalene	—	—	—	—	N/A
Di-N-Butylphthalate	—	—	—	—	N/A
Bis(2-Ethylhexyl)phthalate	13(B)	14(B)	16(B)	16(B)	N/A
2,4-Dichlorophenol	—	—	—	—	N/A
Tetramethylbutylphenol	—	—	—	—	N/A

[e] Analyzed for metals, cyanide, and VOCs only

B-Compound also present in method blank
L-Compound present below detection limit
N/A-Analysis not performed
A dash (—) indicates compound not detected

DRAFT

ECOLOGY AND ENVIRONMENT, INC.

AUGUST *1990*

(GROUNDWATER)

Table C-2

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS

(All results in ug/L unless noted)

Compound	Sample No. (Location)							
	FS2N062 (GM-62)	FS2N063 (GM-63)	FS2N064 (GM-64)	FS2N065 (GM-65)	FS2N066 (GM-66)	032N067 (GM-67)	FS2N068 (GM-68)	FS2N069 (GM-69)
Arsenic	5.1	—	—	4	12	—	—	—
Barium	79	23	15	61	28	15	19	25
Cadmium	—	—	—	—	31	—	—	—
Chromium Total	—	—	—	—	240	—	—	—
Iron	33,000	1,100	36	720	400,000	420	1,500	450
Manganese	940	64	190	160	1,400	31	83	89
Sodium	7,600	550,000	310,000	180,000	580,000	83,000	90,000	620,000
Nickel	—	—	—	—	100	—	—	—
Zinc	34	—	—	—	350	20	—	—
Chloride (mg/L)	150	1,000	390	290	410	54	150	740
Sulfate (mg/L)	18	23	180	45	7,400	3.8	8.8	220
Vinyl Chloride	—	—	—	—	180	—	—	(L)
Chloroethane	—	—	—	—	—	—	—	20
Methylene Chloride	(L,B)	(L,B)	5(B)	(L,B)	(L,B)	(L,B)	7(B)	8(B)
1,1-Dichloroethene	—	—	—	—	260	—	—	98
Total-1,2-Dichlorethene	—	—	—	—	1,400	—	—	—
Trichlorethene	—	—	—	—	7,300(X)	—	—	—
Benzene	—	—	—	—	—	—	—	(L)
Acetone	—	—	—	—	—	120	—	30(B)
Toluene	—	—	—	—	—	—	—	(L)
Chlorobenzene	—	—	27(B)	—	150	(L)	—	150(B)
Carbon Disulfide	—	—	—	—	—	—	—	(L)
Total Xylenes	—	—	—	—	—	—	—	(L)
2-Methylnaphthalene	—	—	—	—	(L)	—	—	—
1,3-Dichlorobenzene	—	—	(L)	—	(L)	—	—	430(X)
1,4-Dichlorobenzene	—	—	(L)	—	11	(L)	—	330(X)
1,2-Dichlorobenzene	—	—	(L)	—	17	—	—	360(X)
Naphthalene	—	—	—	—	29	—	—	—
Acenaphthene	—	—	—	—	(L)	—	—	—
Fluorene	—	—	—	—	(L)	—	—	—
Di-N-Butyl-Phthalate	(L,B)	83(B)	(L,B)	13(B)	31(B)	19(B)	(L,B)	11(B)
Bis(2-Ethylhexyl)Phthalate	24(B)	30(B)	18(B)	10(B)	34(B)	18(B)	11(B)	14(B)
Dibenzofuran	—	—	—	—	(L)	—	—	—
2,4-Dimethylphenol	—	—	—	—	44	—	—	—
2-Methylphenol	—	—	—	—	(L)	—	—	—

L-Compound present below detection limit
B-Compound also present in method blank
A dash (—) indicates compound not detected
X-Exceeds calibration limit

Table D-2

SUMMARY ANALYTICAL RESULTS FOR
POINT-OF-COMPLIANCE MONITORING WELLS

(All results in ug/L unless noted)

Compound	Sample No (Location)						
	P32N001 (UG-1)	P32N008 (GM-8)	P32N009 (GM-9)	P32N010 (GM-10)	P32NE1 (PCS-1)	P32NI1 (PCI-1)	P32ND1 (PCD-1)
Arsenic	—	—	—	—	1.8	23	—
Barium	—	85	36	63	39	15	18
Chromium Total	—	—	—	13	—	—	—
Iron	810	16,000	2,800	830	2,300	220	1,100
Manganese	23	130	18	190	510	110	82
Sodium	4,900	23,000	14,000	9,100	7,400	310,000	160,000
Nickel	11	—	—	13	—	—	—
Zinc	8.8	12	—	—	8.4	27	20
Chloride (mg/L)	10	140	18	16	22	520	260
Sulfate (mg/L)	86	72	10	36	21	110	17
Vinyl Chloride	—	74	—	—	—	—	—
Methylene Chloride	(L,B)	(L,B)	(L,B)	(L,B)	8(B)	7(B)	9(B)
1,1-Dichloroethane	—	45	—	—	—	—	—
Trans-1,2-Dichlorethene	—	130	—	—	—	—	—
Benzene	—	(L)	—	—	—	—	—
Toluene	—	(L)	—	—	—	—	—
Chlorobenzene	—	790	—	—	(L)	110	—
Acetone	47(B)	180(B)	380(B)	—	280(X,B)	1,600(X,B)	1,200(X,B)
1,3-Dichlorobenzene	—	640	—	(L)	—	(L)	—
1,4-Dichlorobenzene	—	860	—	(L)	—	(L)	—
1,2-Dichlorobenzene	—	770	—	(L)	—	17	—
Naphthalene	—	(L)	—	—	—	—	—
Di-N-Butyl-Phthalate	23(B)	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)	13(B)
Bis(2-Ethylhexyl)Phthalate	13(B)	(L,B)	(L,B)	18(B)	(L,B)	12(B)	15(B)
Benzyl Alcohol	—	—	—	—	—	(L)	—

B-Compound also present in method blank
L-Compound present below detection limit
A dash (—) indicates compound not detected
X-Exceeds calibration limit

	Sample No.					
	P32W008 (GM-8)	P32W008D[a] (GM-8)	P32W010 (GM-10)	P32W010D[b] (GM-10)	P32WTB01[c]	P32WTB02[c]
Barium	85	86	63	63	N/A	N/A
Chromium Total	—	14	13	—	N/A	N/A
Copper	—	16	—	—	N/A	N/A
Iron	16,000	16,000	830	790	N/A	N/A
Manganese	130	130	190	180	N/A	N/A
Sodium	23,000	24,000	9,100	9,000	N/A	N/A
Nickel	—	—	13	—	N/A	N/A
Zinc	12	27	—	18	N/A	N/A
Chloride (mg/L)	140	87	16	18	N/A	N/A
Sulfate (mg/L)	72	84	36	36	N/A	N/A
Vinyl Chloride	74	60	—	—	—	—
Methylene Chloride	(L,B)	(L,B)	(L,B)	6(B)	(L,B)	8(B)
1,1-Dichloroethane	45	40	—	—	—	—
Trans-1,2-Dichloroethene	130	120	—	—	—	—
Chloroform	—	—	—	—	(L)	(L)
Benzene	(L)	(L)	—	—	—	—
Toluene	(L)	(L)	—	—	—	—
Chlorobenzene	790	750	—	—	—	—
Acetone	180(B)	—	—	(L,B)	12(B)	86(B)
Carbon Disulfide	—	—	—	(L)	—	(L)
1,3-Dichlorobenzene	640	690	(L)	(L)	N/A	N/A
1,4-Dichlorobenzene	860	910	(L)	(L)	N/A	N/A
1,2-Dichlorobenzene	770	830	(L)	(L)	N/A	N/A
Naphthalene	(L)	(L)	—	—	N/A	N/A
Di-N-Butylphthalate	(L,B)	(L,B)	(L,B)	19(B)	N/A	N/A
Bis (2-Ethylhexyl)phthalate	(L,B)	(L,B)	18(B)	19(B)	N/A	N/A

[a] Duplicate sample of P32W008
[b] Duplicate of sample P32W010
[c] Analyzed for VOCs only

B-Compound also present in method blank
L-Compound present detection limit
N/A-Analysis not performed
A dash (—) indicates compound not detected

3201126

Table E-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR FIELD QA/QC SAMPLES

(All results in ug/L unless noted)

Compound	Sample No.			
	P32MEB01	P32MEB02	P32MFB01	P32MFB01[d]
Barium	—	—	—	—
Chromium Total	—	—	—	—
Iron	—	25	15	15
Manganese	—	—	—	—
Sodium	—	—	—	—
Zinc	—	—	—	16
Chloride (mg/L)	3.4	10	2.5	N/A
Sulfate (mg/L)	—	—	—	N/A
Vinyl Chloride	—	—	—	—
Methylene Chloride	(L,B)	63(B)	5(B)	6(B)
1,1-Dichloroethane	—	—	—	—
Trans-1,2-Dichloroethene	—	—	—	—
Chloroform	(L)	(L)	(L)	(L)
Chlorobenzene	—	—	—	—
Acetone	—	2,100(X,B)	—	38(B)
Carbon Disulfide	—	—	—	—
1,3-Dichlorobenzene	—	—	—	N/A
1,4-Dichlorobenzene	—	—	—	N/A
1,2-Dichlorobenzene	—	—	—	N/A
Naphthalene	—	—	—	N/A
Di-N-Butylphthalate	11(B)	(L,B)	12(B)	N/A
Bis(2-Ethylhexyl)phthalate	13(B)	10(B)	19(B)	N/A
2,4-Dichlorophenol	—	—	—	N/A
Tetramethylbutylphenol	—	—	—	N/A

[d] Analyzed for metals and VOCs only

B-Compound also present in method blank
L-Compound present below detection limit
N/A-Analysis not performed
A dash (—) indicates compound not detected

DRAFT

ECOLOGY AND ENVIRONMENT, INC.

NOVEMBER 1990

(GROUNDWATER)

Table C-2

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS

(All results in ug/L unless noted)

Compound	Sample No. (Location)								
	P32N062[a] (GM-62)	P32N063 (GM-63)	P32N064 (GM-64)	P32N065 (GM-65)	P32N066 (GM-66)	P32N067 (GM-67)	P32N068 (GM-68)	P32N069 (GM-69)	P32N084 (GM-84)
Sodium (mg/L)	N/A	560	290	92	730	63	84	670	4,700
Chloride (mg/L)	N/A	910	380	150	530	28	140	820	8,800
Vinyl Chloride	—	—	—	—	—	—	—	(L)	
Chloroethane	—	—	—	—	—	—	—	31	—
Methylene Chloride	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)
1,1-Dichloroethene	—	—	—	—	(L)	—	—	—	—
1,1-Dichloroethane	—	—	—	—	—	—	—	45	—
Trichloroethene	—	—	—	—	140	—	—	—	—
Toulene	—	—	—	—	—	—	—	(L)	—
Chlorobenzene	—	—	26	—	(L)	5.0	—	140	—
Acetone	—	15(B)	19(B)	18(B)	14(B)	—	12(B)	28(B)	34(B)
Carbon Disulfide	—	—	5.0	—	—	—	—	(L)	—
Total Xylenes	—	—	—	—	—	—	—	(L)	—
1,3-Dichlorobenzene	—	—	(L)	—	—	—	—	230	—
1,4-Dichlorobenzene	—	—	(L)	—	—	(L)	—	200	—
1,2-Dichlorobenzene	—	—	(L)	—	(L)	—	—	210	—
Naphthalene	—	—	—	—	(L)	—	—	—	—
Di-N-Butyl-Phthalate	—	—	(L)	(L)	—	(L)	(L)	(L)	(L)
Bis(2-Ethylhexyl)Phthalate	(L)	(L)	(L)	(L)	—	(L)	(L)	(L)	—
4-Chloroaniline	—	—	(L)	—	—	—	—	—	—
2,4-Dimethylphenol	—	—	—	—	(L)	—	—	—	—
2,4-Dichlorophenol	—	—	—	—	—	—	—	(L)	—

[a]Analyzed for VOCs and BNAs only

L-Compound present below detection limit
B-Compound also present in method blank
A dash (—) indicates compound not detected

Doc. Num. 21

3201128

Table C-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS

(All results in ug/L unless noted)

Compound	Sample No. (Location)						
	P32N071 (GM-71)	P32N072 (GM-72)	P32N076 (GM-76)	P32N077 (GM-77)	P32N078 (GM-78)	P32N079 (GM-79)	P32N083 (GM-83)
Sodium (mg/L)	150	60	110	1,100	9	4	23
Chloride (mg/L)	180	75	140	2,000	15	5.1	30

Note: These samples analyzed for sodium and chloride only.

Doc. Num. 21

Table D-2

SUMMARY ANALYTICAL RESULTS FOR
POINT-OF-COMPLIANCE MONITORING WELLS
(All results in ug/L unless noted)

Compound	Sample No. (Location)							
	P32N001 (GM-1)	P32N008 (GM-8)	P32N009 (GM-9)	P32N010 (GM-10)	P32N011 (GM-11)	P32N012R (GM-12R)	P32N013 (GM-13)	P32N014 (GM-14)
	2.6	2.0	—	—	—	3.7	—	1.6
	—	66	34	60	—	46	10	26
	—	11	—	—	—	—	—	
	680	6,500	1,900	600	65	1,000	310	98
	4.4	66	19	140	22	330	120	180
	3.0	4.4	8.4	7.3	32	4.6	2.5	130
	6.6	24	—	5.0	16	6.7	—	—
Chloride (mg/L)	7.2	7.2	12	13	41	5.1	4.1	180
Sulfate (mg/L)	16	5.5	16	22	7.2	16	7.8	140
Cyanide (mg/L)	0.012	—	0.013	—	0.14	—	0.074	0.78
Methylene Chloride	8(B)	6(B)	(L,B)	(L,B)	6(B)	6(B)	6(B)	12(B)
1,1-Dichloroethane	—	(L)	—	—	—	—	—	—
Benzene	—	—	—	—	—	—	—	—
Chlorobenzene	—	41	—	(L)	—	—	—	(L)
Acetone	—	(L,B)	(L,B)	(L,B)	—	(L,B)	(L,B)	(L,B)
Carbon Disulfide	—	—	—	—	—	—	—	(L)
Trichloroflouromethane	—	—	(L)	(L)	—	—	—	—
1,3-Dichlorobenzene	—	140	—	(L)	—	—	—	—
1,4-Dichlorobenzene	—	190	(L)	(L)	—	—	—	—
1,2-Dichlorobenzene	—	160	—	(L)	—	—	—	—
Acenaphthene	—	—	—	—	—	—	—	—
Di-N-Butyl-Phthalate	(L)	—	(L)	(L)	—	11	—	(L)
Bis(2-Ethylhexyl)Phthalate	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)
2,4 Dichlorophenol	—	(L)	—	—	—	—	—	—
Di-Methyl Ethyl Phenol	—	—	—	—	—	—	—	—
Tetramethyl Butyl Phenol	—	—	(L)	50	—	—	—	(L)
Tetramethyl Benzene	—	—	—	—	—	—	—	—

B-Compound also present in method blank
L-Compound present below detection limit
A dash (—) indicates compound not detected

Doc. Num. 24

3201120

Table D-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR
POINT-OF-COMPLIANCE MONITORING WELLS
(All results in ug/L unless noted)

Compound	Sample No. (Location) P32MB01 (PCB-1)	P32MI01 (PCI-1)	P32MD01 (PCD-1)
Arsenic	2.6	1.8	42
Barium	30	15	32
Chromium Total	—	—	—
Iron	1,700	480	1,700
Manganese	370	70	210
Sodium (mg/L)	5.2	370	190
Zinc	9.5	6.6	6.5
Chloride (mg/L)	5.1	5.6	330
Sulfate (mg/L)	12	86	23
Cyanide (mg/L)	0.54	0.049	0.027
Methylene Chloride	13(B)	12(B)	(L,B)
1,1-Dichloroethane	—	—	—
Benzene	—	(L)	
Chlorobenzene	(L)	130	—
Acetone	(L,B)	10(B)	25(B)
Carbon Disulfide	—	—	—
Trichloroflouromethane	—	—	24
1,3-Dichlorobenzene	(L)	(L)	—
1,4-Dichlorobenzene	(L)	15	—
1,2-Dichlorobenzene	12	42	—
Acenaphthene	(L)	—	—
Di-N-Butyl-Phthalate	—	12	(L)
Bis(2-Ethylhexyl)Phthalate	(L,B)	(L,B)	(L)
2,4 Dichlorophenol	—	(L)	—
Di-Methyl Ethyl Phenol	—	59	—
Tetramethyl Butyl Phenol	(L)	(L)	—
Tetramethyl Benzene	(L)	—	—

B-Compound also present in method blank
L-Compound present below detection limit
A dash (—) indicates compound not detected

Doc. Num. 24

Table E-2

SUMMARY ANALYTICAL RESULTS FOR FIELD QA/QC SAMPLES
(All results in ug/L unless noted)

Compound	Sample No.						
	F32N000 (GM-6)	F32N000D[a] (GM-6)	F32N010 (GM-10)	F32N010D[b] (GM-10)	F32NTB01[c]	F32NTB02[c]	F32NTB03[c]
	2.0	—	—	—	N/A	N/A	N/A
	66	64	60	60	N/A	N/A	N/A
	11	—	—	—	N/A	N/A	N/A
	6,500	6,400	600	590	N/A	N/A	N/A
	66	68	140	180	N/A	N/A	N/A
	4.4	4.5	7.3	8.2	N/A	N/A	N/A
	24	16	5.0	4.2	N/A	N/A	N/A
Chloride (mg/L)	7.2	7.2	13	14	N/A	N/A	N/A
Sulfate (mg/L)	5.5	5.5	22	21	N/A	N/A	N/A
Cyanide (mg/L)	—	0.035	—	0.032	N/A	N/A	N/A
Methylene Chloride	6(B)	6(B)	(L,B)	(L,B)	9(B)	8(B)	8(B)
1,1-Dichloroethane	(L)	(L)	—	—	—	—	—
Chlorobenzene	41	35	(L)	—	—	—	—
Acetone	(L,B)	(L,B)	(L,B)	14(B)	18(B)	19(B)	12[illegible]
Carbon Disulfide	—	—	—	—	6.0	11	—
Trichlorofluoromethane	—	—	(L)	(L)	—	—	—
1,3-Dichlorobenzene	140	140	(L)	(L)	N/A	N/A	N/A
1,4-Dichlorobenzene	190	180	(L)	(L)	N/A	N/A	N/A
1,2-Dichlorobenzene	160	170	(L)	(L)	N/A	N/A	N/A
1,2,4-Trichlorobenzene	—	(L)	—	—	N/A	N/A	N/A
Di-N-Butyl-Phthalate	—	(L)	(L)	(L)	N/A	N/A	N/A
Bis (2-Ethylhexyl)Phthalate	(L,B)	(L,B)	(L,B)	(L,B)	N/A	N/A	N/A
2,4-Dichlorophenol	(L)	(L)	—	—	N/A	N/A	N/A
Tetramethyl Benzene	—	—	50	51	—	—	—

[a] Duplicate sample of F32N000
[b] Duplicate of sample F32N010
[c] Analyzed for VOCs only

B-Compound also present in method blank
L-Compound present detection limit
N/A-Analysis not performed
A dash (—) indicates compound not detected

Doc. Num. 22

2201133

Table E-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR FIELD QA/QC SAMPLES

(All results in ug/L unless noted)

Compound	Sample No.				
	F32MEB01	F32MEB02	F32MEB03	F32MFB01	F32MFB01[d]
Arsenic	—	—	—	—	—
Barium	—	—	—	—	—
Chromium Total	—	—	—	—	—
Iron	—	—	—	47	39
Manganese	—	—	—	—	—
Sodium	—	—	—	—	—
Zinc	4.9	—	—	4.2	
Chloride (mg/L)	1.0	3.1	31	1.0	N/A
Sulfate (mg/L)	—	—	—	—	N/A
Cyanide (mg/L)	—	—	—	—	—
Methylene Chloride	16(B)	8(B)	7(B)	13(B)	9(B)
1,1-Dichloroethane	—	—	—	—	—
Chlorobenzene	—	—	—	(L)	—
Acetone	35(B)	—	19(B)	15(B)	22(B)
Carbon Disulfide	5.0	—	—	—	5.0
Trichloroflouromethane	—	—	(L)	—	N/A
1,3-Dichlorobenzene	—	—	—	—	N/A
1,4-Dichlorobenzene	—	—	—	—	N/A
1,2-Dichlorobenzene	—	—	—	—	N/A
1,2,4-Trichlorobenzene	—	—	—	—	N/A
Di-N-Butylphthalate	(L)	(L)	(L)	21	N/A
Bis(2-Ethylhexyl)phthalate	(L,B)	(L,B)	(L,B)	(L,B)	N/A
2,4-Dichlorophenol	—	—	—	—	N/A
Tetramethyl Benesene	—	—	—	—	

[d] Analyzed for metals, cyanide, and VOCs only

B-Compound also present in method blank
L-Compound present below detection limit
N/A-Analysis not performed
A dash (—) indicates compound not detected

DRAFT

ECOLOGY *AND* ENVIRONMENT, INC.

MARCH 1991

(GROUNDWATER)

Table C-2

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS

(All results in ug/L unless noted)

Parameter	Sample No. (Location)							
	P32N062[a] (GM-62)	P32N063 (GM-63)	P32N064 (GM-64)	P32N065 (GM-65)	P32N067 (GM-67)	P32N068 (GM-68)	P32N069 (GM-69)	P32N084 (GM-84)
Sodium (mg/L)	4.4	480	320	93	18	81	580	14,000
Chloride (mg/L)	5.1	860	480	150	13	140	750	8,500
Vinyl Chloride	—	—	—	—	—	—	(L)	—
Chloroethane	—	—	—	—	—	—	19	—
Methylene Chloride	5.8(B)	6.2(B)	7.2(B)	(L,B)	26(B)	19(B)	5.1(B)	(L,B)
1,1-Dichloroethane	—	—	—	—	—	—	79	—
Total 1,2-Dichloroethane	—	—	—	—	(L)	—	—	—
Toluene	—	—	—	—	—	—	(L)	—
Chlorobenzene	—	—	24	—	31	—	160	—
Ethylbenzene	—	—	—	—	—	—	(L)	—
Acetone	13(B)	—	(L,B)	14(B)	23(B,C)	—	(L,B,C)	(L,B)
Carbon Disulfide	—	—	(L)	—	—	—	—	—
Total Xylenes	—	—	(L)	—	—	—	(L)	—
1,3-Dichlorobenzene	—	—	(L)	—	(L)	—	470(X)	—
1,4-Dichlorobenzene	—	—	12	—	(L)	—	390	—
1,2-Dichlorobenzene	—	—	11	—	(L)	—	420(X)	—
Naphthalene	(L)	—	—	—	—	—	—	—
Fluorene	17	—	—	—	—	—	—	—
Acenaphthene	24	—	—	—	—	—	—	—
Diethyl Phthalate	—	(L)	—	—	—	—	—	(L)
Phenanthrene	n	—	—	—	—	—	—	—
Anthracene	22	—	—	—	—	—	—	—
Fluoranthene	55	—	—	—	—	—	—	—

[a]Analyzed for VOCs and BNAs only

B-Compound also present in method blank
L-Compound present below detection limit
X-Detected concentration exceeded calibration range of analysing instrument
C-Comment (See Sample Comment Report following this table)
A dash (—) indicates compound not detected

Doc. Num. 462

3201132

Table C-2 (Continued)

Parameter	Sample No. (Location)							
	P32W062[a] (GM-62)	P32W063 (GM-63)	P32W064 (GM-64)	P32W065 (GM-65)	P32W067 (GM-67)	P32W068 (GM-68)	P32W069 (GM-69)	P32W084 (GM-84)
Pyrene	40	—	—	—	—	—	—	—
Benzo(A)Anthracene	18	—	—	—	—	—	—	—
Bis(2-Ethylhexyl)Phthalate	(L,B)	28(B)	(L,B)	(L,B)	11(B)	26(B)	(L,B)	(L,B)
Chrysene	17	—	—	—	—	—	—	—
Benzo(B)Fluoranthene	15	—	—	—	—	—	—	—
Benzo(K)Fluoranthene	(L)	—	—	—	—	—	—	—
Benzo(A)Pyrene	14	—	—	—	—	—	—	—
Indeno(1,2,3-cd)Pyrene	(L)	—	—	—	—	—	—	—
Dibenzo(H,H)Anthracene	(L)	—	—	—	—	—	—	—
Benzo(G,H,I)Perlyene	(L)	—	—	—	—	—	—	—
4-Chloroaniline	—	—	(L)	—	—	—	—	—
2-Methylnaphthalene	17	—	—	—	—	—	—	—
Dibenzofuran	14	—	—	—	—	—	—	—
3,4-Benzofluoranthene Isomers (1)	15	—	—	—	—	—	—	—
Dimethly Ethyl Phenol	—	—	—	—	—	—	20	—

[a]Analyzed for VOCs and BNAs *only*

L-Compound present below detection limit
B-Compound also present in method blank
A dash (—) indicates compound not detected

Table C-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS

(All results in ug/L unless noted)

Parameter	Sample No. (Location)						
	P32N071 (GM-71)	P32N072 (GM-72)	P32N076 (GM-76)	P32N077 (GM-77)	P32N078 (GM-78)	P32N079 (GM-79)	P32N083 (GM-83)
Sodium (mg/L)	6.2	83	110	200	7.2	5.2	7.3
Chloride (mg/L)	2.6	78	140	170	8.8	7.0	28

Note: These samples analyzed for sodium and chloride only.

3201133

Table D-2

SUMMARY ANALYTICAL RESULTS FOR
POINT-OF-COMPLIANCE MONITORING WELLS
(All results in ug/L unless noted)

Parameter	Sample No. (Location)						
	P32W008 (GM-8)	P32W009 (GM-9)	P32W010 (GM-10)	P32W011 (GM-11)	P32W012R (GM-12R)	P32W013 (GM-13)	P32W014 (GM-14)
Arsenic	—	5.0	—	—	—	—	—
Barium	48	—	47	—	42	—	—
Cadmium	—	—	—	—	8.6	—	—
Chromium Total	16	—	—	—	—	—	—
Iron	6,200	900	620	120	1,600	390	170
Manganese	37	12	86	34	800	96	180
podium (mg/L)	4.5	1.9	5.2	22	3.5	2.6	56
Lead	—	—	13	—	20	—	—
Zinc	60	13	24	14	19	25	16
Chloride (mg/L)	6.8	1.7	12	44	20	27	59
Sulfate (mg/L)	19	6.6	13	5.0	27	4.2	76
Cyanide (mg/L)	0.12	—	0.027	—	—	0.048	—
Methylene Chloride	(L,B)	(L,B)	(L,B)	5.6(B)	(L,B)	(L,B)	(L,B)
Tetrachloroethene	(L)	—	—	—	—	—	—
Chlorobenzene	3,100	160	—	—	—	—	—
Acetone	—	140(B,C)	—	(L,B)	—	—	—
Carbon Disulfide	—	—	L	10	—	—	—
1,3-Dichlorobenzene	2,500(X)	—	—	—	—	—	—
1,4-Dichlorobenzene	3,800(X)	(L)	(L)	—	—	—	—
1,2-Dichlorobenzene	1,400	—	(L)	—	—	—	—
Naphthalene	(L)	—	—	—	—	—	—
Fluorene	—	—	(L)	—	—	—	—
Acenaphthene	—	—	12	—	—	—	—
Phenanthrene	—	—	44	—	—	—	—
Anthracene	—	—	11	—	—	—	—
Fluoranthene	—	—	35	—	—	—	—
Pyrene	—	—	28	—	—	—	—

B-Compound also present in method blank
L-Compound present below detection limit
X-Detected concentration exceeded calibration range of analyzing instrument
C-Comment (See Sample Comment Report following this table)
A dash (—) indicates compound not detected

Doc. Num. 458

Table D-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR
POINT-OF-COMPLIANCE MONITORING WELLS
(All results in ug/L unless noted)

Parameter	Sample No. (Location)		
	P32MW001 (PCS-1)	P32MW001 (PCI-1)	P32MW001 (PCD-1)
Arsenic	—	—	—
Barium	28	—	22
Chromium Total	—	—	—
Iron	3,200	100	980
Manganese	220	36	96
Sodium (mg/L)	220	360	180
Zinc	72	58	58
Chloride (mg/L)	1.7	460	230
Sulfate (mg/L)	20	120	25
Cyanide (mg/L)	—	3.0	—
Methylene Chloride	(L,B)	(L,B)	(L,B)
Chlorobenzene	(L)	140	—
Acetone	98(B,C)	26(B,C)	(L,B,C)
Carbon Disulfide	—	(L)	(L)
1,3-Dichlorobenzene	(L)	(L)	—
1,4-Dichlorobenzene	(L)	17	—
1,2-Dichlorobenzene	(L)	50	—
Fluorene	(L)	—	—
Diethly Phthalate	(L)	—	(L)
Butyl Benzyl Phthalate	(L)	(L)	16
Bis(2-Ethylhexyl)Phthalate	(L,B)	12(B)	12(B)
Benzyl Alcohol	—	—	(L)
Dimethyl Ethyl Phenol	—	39	—
Tetramethylbutyl Phenol	25	—	—

B-Compound also present in method blank
L-Compound present below detection limit
C-Comment (See Sample Comment Report following this table)
A dash (—) indicates compound not detected

Doc. Num. 458

3201134

Table D-2 (Continued)

Parameter	Sample No.(Location)						
	P32W008 (GM-8)	P32W009 (GM-9)	P32W010 (GM-10)	P32W011 (GM-11)	P32W012R (GM-12R)	P32W013 (GM-13)	P32W014 (GM-14)
Benzo (A) Anthracene	—	—	12	—	—	—	—
Bis(2-Ethylhexyl)Phthalate	—	(L,B)	(L,B)	15(B)	15(B)	16(B)	15(B)
Chrysene	—	—	12	—	—	—	—
Di-N-Octyl Phthalate	—	—	—	—	(L)	—	—
Benzo(B)Fluoranthene	—	—	(L)	—	—	—	—
Benzo(K)Fluoranthene	—	—	(L)	—	—	—	—
Benzo(A)Pyrene	—	—	(L)	—	—	—	—
Indeno(1,2,3-cd)Pyrene	—	—	(L)	—	—	—	—
Benzo(G,H,I)Perlyene	—	—	(L)	—	—	—	—
2-Methylnaphthalene	—	—	(L)	—	—	—	—
Dibenzofuran	—	—	(L)	—	—	—	—
Tetramethylbutyl Phenol	—	—	21	—	—	—	—

B-Compound also present in method blank

L-Compound present below detection limit

A dash (—) indicates compound not detected

Doc. Num. 458

Table B-2

SUMMARY ANALYTICAL RESULTS FOR FIELD QA/QC SAMPLES
(All results in ug/L unless noted)

Parameter	Sample No. (Location)						
	P32W008 (GM-8)	P32W008D[a] (GM-8)	P32W010 (GM-10)	P32W010D[b] (GM-10)	P32WTB01[c]	P32WTB02[c]	P32WTB03[c]
Barium	48	44	47	45	NA	NA	NA
Chromium Total	16	14	—	—	NA	la	NA
Copper	—	—	—	—	NA	NA	NA
Iron	6,200	3,800	620	420	NA	NA	NA
Manganese	37	34	86	97	NA	la	NA
Sodium(mg/L)	4.5	4.2	5.2	4.9	NA	NA	NA
Nickel	—	—	—	—	NA	la	NA
Lead	—	—	13	5.4	NA	la	NA
Zinc	60	11	24	14	NA	la	NA
Chloride (mg/L)	6.8	5.1	12	10	NA	la	NA
Sulfate (mg/L)	19	18	13	13	NA	la	NA
Cyanide (mg/L)	—	—	—	0.017	NA	NA	NA
Methylene Chloride	(L,B)	(L,B)	(L,B)	5.0(B)	5.2(B)	(L,B)	(L,B)
Chlorobenzene	8,100	3,200	—	—	—	—	—
Acetone	—	(L)	—	(L,B)	(L,B)	(L,B)	13(B)
Carbon Disulfide	—	—	(L)	—	—	—	—
Tetrachloroethene	(L)	—	—	—	—	—	—
Trimethyl Benzene	—	—	—	—	(L)	—	—
1,3-Dichlorobenzene	2,500(X)	1,400	—	—	NA	NA	NA
1,4-Dichlorobenzene	3,800(X)	2,100(X)	(L)	—	NA	NA	NA
1,2-Dichlorobenzene	1,400(X)	740	(L)	(L)	NA	la	NA
Naphthalene	(L)	(L)	—	—	NA	NA	NA
Tetramethyl Benzene	—	—	—	—	NA	NA	NA
Fluorene	—	—	(L)	—	NA	NA	NA
Acenaphthene	—	—	12	—	NA	la	NA
Phenanthrene	—	—	44	—	NA	la	NA
Anthracene	—	—	11	—	NA	NA	NA
Fluoranthene	—	—	35	—	NA	NA	M
Benzo(A)Anthracene	—	—	12	—	NA	NA	NA
Bis(2-Ethylhexyl)Phthalate	—	—	(L,B)	(L)	NA	la	NA
Chrysene	—	—	12	—	NA	la	NA

[a] Duplicate sample of P32W008
[b] Duplicate of sample P32W010
[c] Analyzed for VOCs only

B-Compound also present in method blank
L-Compound present detection limit
X-Detected concentration exceeds calibration range of analyzing instrument
NA-Analysis not performed
A dash (—) indicates compound not detected

3201135

Table E-2 (Continued)

Parameter	Sample No. (Location)						
	P32W008 (GM-8)	P32W008D[a] (GM-8)	P32W010 (GM-10)	P32W010D[b] (GM-10)	P32WTB01[c]	P32WTB02[c]	P32WTB03[c]
Pyrene	—	—	28	—	NA	NA	NA
Benzo(B)Fluoranthene	—	—	(L)	—	NA	NA	NA
Benzo(K)Fluoranthene	—	—	(L)	—	NA	NA	NA
Benzo(A)Pyrene	—	—	(L)	—	NA	NA	NA
Indeno(1,2,3-cd)Pyrene	—	—	(L)	—	NA	NA	NA
Benzo(G,H,I)Perlyene	—	—	(L)	—	NA	NA	NA
2-Methylnaphthalene	—	—	(L)	—	NA	NA	NA
Dibenzofuran	—	—	(L)	—	NA	VV	NA
Tetramethylbutyl Phenol	—	—	—	20	NA	NA	NA

[a] Duplicate sample of P32W008
[b] Duplicate of sample P32W010
[c] Analyzed for VOCs only

B-Compound also present in method blank
L-Compound present detection limit
NA-Analysis not performed
A dash (—) indicates compound not detected

Table E-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR FIELD QA/QC SAMPLES

(All results in ug/L unless noted)

Parameter	Sample No. (Location)				
	F32WW01	F32WW02	F32WW03	F32WF01	F32WF01[d]
Barium	—	—	—	—	—
Chromium Total	—	—	—	—	130
Copper	—	—	42	—	—
Iron	—	—	—	—	600
Manganese	—	—	—	—	—
Sodium	—	—	—	—	—
Nickel	—	—	—	—	66
Lead	—	—	5.8	—	—
Zinc	19	—	16	—	16
Chloride (mg/L)	3.5	—	—	3.5	—
Sulfate(mg/L)	—	—	—	—	—
Cyanide (mg/L)	—	—	—	—	—
Methylene Chloride	(L,B)	(L,B)	6.7(B)	(L,B)	6.1(B)
Chlorobenzene	—	—	—	—	—
Acetone	140(C)	—	20(B,C)	—	(L,B)
Carbon Disulfide	—	—	—	12(C)	—
Tetrachloroethene	—	—	—	—	—
Trimethyl Benzene	—	—	—	—	—
1,3-Dichlorobenzene	—	—	—	—	—
1,4-Dichlorobenzene	—	—	—	—	—
1,2-Dichlorobenzene	—	—	—	—	—
Naphthalene	—	—	—	—	—
Tetramethyl Benzene	—	—	—	—	—
Fluorene	—	—	—	—	—
Acenaphthene	—	—	—	—	—
Phenanthrene	—	—	—	—	—
Anthracene	—	—	—	—	—
Fluoranthene	—	—	—	—	—
Benzo(A)Anthracene	—	—	—	—	—
Bis(2-Ethylhexyl)phthalate	18(B)	14(B)	11(B)	16(B)	NA
Chrysene	—	—	—	—	—

[d] Analyzed for metals, cyanide, and VOCs only

B-Compound also present in method blank
L-Compound present below detection limit
NA-Analysis not performed
C-Comment (See Sample Comment Report following table)
A dash (—) indicates compound not detected

Doc. Num. 460

3201136

Table E-2 (Continued)

Parameter	Sample No.				
	P32MWB01	P32MWB02	P32MWB03	P32MFB01	P32MFB01[d]
Pyrene	—	—	—	—	NA
Benzo(A)Fluoranthene	—	—	—	—	NA
Benzo(K)Fluoranthene	—	—	—	—	NA
Benzo(A)Pyrene	—	—	—	—	NA
Indeno(1,2,3-cd)Pyrene	—	—	—	—	NA
Benzo(G,H,I)Perlyene	—	—	—	—	NA
2-Methylnaphthelane	—	—	—	—	NA
Dibenzofuran	—	—	—	—	NA
Tetramethylbutyl phenol	—	—	—	—	NA

[d] Analyzed for metals, cyanide, and VOCs only

B-Compound also present in method blank
L-Compound present below detection limit
NA-Analysis not performed
A dash (—) indicates compound not detected

Doc No 460

Table C-2

SUMMARY ANALYTICAL RESULTS FOR
MONITORING WELLS GM-66 AND US-1 AND FIELD QA/QC SAMPLES
(All results in ug/L unless noted)

Compound	Sample No. (Location)		Field QA/QC Samples	
	F32M066 (GM-66)	F32M001 (US-1)	F32MFB02	F32MFB03
	38	—	—	N/A
	79	—	—	N/A
	57	—	5.4	N/A
	360	—	—	N/A
	420,000	2,100	78	N/A
	1,700	—	—	N/A
	670	8	—	N/A
	140	—	—	N/A
	400	8.5	—	N/A
	410	—	—	N/A
	460	15	12	N/A
	—	8.8	—	N/A
	N/A	19	N/A	N/A
	4.9	—	—	N/A
Methylene chloride	—	(L,B)	(L,B)	(L,B)
Acetone	890(B)	(L,B)	12(B)	19(B)
1,1-Dichloroethene	(L)	—	—	—
1,2-Dichloroethene (Total)	1,000	—	—	—
Trichloroethene	8,200	—	—	—
Chlorobenzene	(L)	—	—	—
Xylene (m+p)	(L)	—	—	—
1,3-Dichlorobenzene	16	—	—	N/A
1,4-Dichlorobenzene	34	—	—	N/A
1,2-Dichlorobenzene	49	—	—	N/A
2,4-Dimethylphenol	91	—	—	N/A
Naphthalene	56	—	—	N/A

[a] Sulfate is not an Appendix IX parameter, but is normally analyzed for this well during quarterly sampling events.

B-Compound also present in method blank

L-Present below stated detection limit

N/A-Analysis not performed

Dash(—)indicates compound not detected

Doc. Num. 475

3201137

DRAFT

ECOLOGY AND ENVIRONMENT, INC.

JULY 1991

(GROUNDWATER)

Table C-2

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS

(All results in ug/L unless noted)

Parameter	Sample No. (Location)							
	F32N062 (GM-62)	F32N063 (GM-63)	F32N064 (GM-64)	F32N065 (GM-65)	F32N066 (GM-66)	F32N067 (GM-67)	F32N068 (GM-68)	F32N069 (GM-69)
Sodium (mg/L)	6.1	500	320	96	600	21	89	610
Chloride (mg/L)	10	730	440	130	560	20	130	640
Sulfate (mg/L)	—	—	—	—	2.0	—	—	—
Chloroethane	—	—	—	—	—	—	—	33
Methylene Chloride	11(B)	9.0(B)	8.0(B)	7.0(B)	2,500(B)	7.0(B)	8.0(B)	11(B)
1,1-Dichloroethane	—	—	(L)	—	—	(L)	—	95
Trichloroethene	—	—	—	—	12,000	—	—	—
Toluene	—	—	—	—	—	—	—	(L)
Chlorobenzene	—	—	32	—	—	65	—	150
Acetone	21(B)	—	(L,B)	—	—	—	(L,B)	11(B)
Carbon Disulfide	—	—	—	—	(L)	—	—	28
Total Xylenes	—	—	—	—	—	—	—	(L)
1,3-Dichlorobenzene	—	—	(L)	—	17	(L)	—	800
1,4-Dichlorobenzene	—	—	11	—	40	12	—	390
1,2-Dichlorobenzene	—	—	11	—	55	10	—	630
Naphthalene	—	—	—	—	39	—	—	—
Fluorene	—	—	—	—	(L)	—	—	—
Acenaphthene	—	—	—	—	(L)	—	—	—
2,6-Dinitrotoluene	—	—	—	—	—	—	16	—
Bis(2-Ethylhexyl)Phthalate	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)
2-Methylnaphthalene	—	—	—	—	(L)	—	—	—
Dibenzofuran	—	—	—	—	(L)	—	—	—
2-Clorophenol	—	—	—	—	(L)	—	—	—
2,4-Dimethylphenol	—	—	—	—	74	—	—	—
2,4-Dichlorophenol	—	—	—	—	—	—	—	(L)
2-Methylphenol	—	—	—	—	11	—	—	—
4-Methylphenol	—	—	—	—	(L)	—	—	—

B-Compound also present in method blank
L-Compound present below detection limit

A dash (—) indicates compound not detected

Doc. Num. 7:28

3201138

Table C-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS

(All results in ug/L unless noted)

Parameter	Sample No. (Location)						
	P32W071 (GM-71)	P32W072 (GM-72)	P32W076 (GM-76)	P32W077 (GM-77)	P32W078 (GM-78)	P32W079 (GM-79)	P32W083 (GM-83)
Sodium (mg/L)	3.2	19	110	150	7.9	5.6	6.5
Chloride (mg/L)	5.a	22	120	60	15	12	14

Note: These samples analyzed for sodium and chloride only.

Doc No. 7:28

Table D-2

SUMMARY ANALYTICAL RESULTS FOR
POINT-OF-COMPLIANCE MONITORING WELLS

(All results in ug/L unless noted)

Parameter	Sample No. (Location)							
	P32W001 (UG-1)	P32W008 (GM-8)	P32W009 (GM-9)	P32W010 (GM-10)	P32W011 (GM-11)	P32W012R (GM-12R)	P32W013 (GM-13)	P32W014 (GM-14)
Barium	—	47	24	54	—	38	—	30
Chromium Total	—	11	—	—	—	—	—	—
Iron	830	2,200	850	310	56	300	2,800	6,900
Manganese	—	56	—	55	17	350	54	160
Sodium (mg/L)	6.0	5.2	4.2	3.6	16	2.8	3.2	25
Zinc	—	—	17	—	—	—	—	22
Chloride (mg/L)	9.3	46	7.1	7.2	28	3.6	4.0	33
Sulfate (mg/L)	34	12	16	15	3.7	23	37	100
Cyanide (mg/L)	—	0.14	—	—	0.022	—	—	—
Methylene Chloride	(L,B)	1,500(B)	57(B)	11(B)	(L,B)	(L,B)	(L,B)	(L,B)
Benzene	—	750	—	—	—	—	—	—
Chlorobenzene	—	2,800	1,900	(L)	—	—	—	—
Acetone	—	(L,B)	—	17	—	13	—	—
1,3-Dichlorobenzene	—	700	(L)	—	—	—	—	—
1,4-Dichlorobenzene	—	820	(L)	(L)	—	—	—	—
1,2-Dichlorobenzene	—	480	(L)	(L)	—	—	—	—
Naphthalene	—	(L)	—	—	—	—	—	—
2-Methylnaphthalene	—	(L)	—	—	—	—	—	—
Tetramethyl Benzene	—	(L)	—	—	—	—	—	—
Bis(2-Ethylhexyl)Phthalate	(L,B)	—	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)
Tetramethylbutyl Phenol	—	—	(L)	16	—	—	—	(L)
Phenol	—	—	(L)	—	—	—	—	—

B-Compound also present in method blank
L-Compound present below detection limit
A dash (—) indicates compound not detected

Doc. Num. 7:31

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Table D-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR
POINT-OF-COMPLIANCE MONITORING WELLS
(All results in ug/L unless noted)

Parameter	Sample No. (Location)		
	P32WS001 (PCS-1)	P32WI001 (PCI-1)	P32WD001 (PCD-1)
Barium	29	—	22
Iron	2,600	260	2,100
Manganese	130	38	110
Sodium (mg/L)	6.7	270	180
Zinc	20	150	140
Chloride (mg/L)	5.8	290	230
Sulfate (mg/L)	15	130	23
Cyanide (mg/L)	—	0.090	—
Methylene Chloride	13(B)	22(B)	25(B)
Trichloroethene	(L)	—	—
Chlorobenzene	(L)	60	—
Acetone	14	35(B)	40(B)
1,3-Dichlorobenzene	(L)	(L)	—
1,4-Dichlorobenzene	(L)	14	—
1.2-Dishlorobontono	(L)	46	—
Fluorene	(L)	—	—
Butyl Benzyl Phthalate	—	22	(L)
Bis(2-Ethylhexyl)Phthalate	(L,B)	(L,B)	(L,B)
Benzyl Ncohol	—	(L)	(L)
Tetramethylbutyl Phenol	31	(L)	—

B-Compound also present in method blank
L-Compound present below detection limit
A dash (—) indicates compound not detected

Doc. Num. 7:31

APPENDIX G

ECOLOGY AND ENVIRONMENT, INC.
OCTOBER 1991
(GROUNDWATER)

Table C-2

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS

(All results in ug/L unless noted)

Parameter	Sample No. (Location)							
	P32W062 (GM-62)	P32W063 (GM-63)	P32W064 (GM-64)	P32W065 (GM-65)	P32W066 (GM-66)	P32W067 (GM-67)	P32W068 (GM-68)	P32W069 (GM-69)
Sodium (mg/L)	9.4	480	380	92	640	23	84	570
Chloride (mg/L)	11	870	600	160	590	21	150	ND
Vinyl Chloride	—	—	—	—	—	—	—	(L)
Chloroethane	—	—	—	—	—	—	—	29
Methylene Chloride	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)	(L,B)
1,1-Dichloroethane	—	—	—	—	—	6.0	—	19
1,1-Dichloroethene	—	—	—	—	(L)	—	—	—
Total-1,2-Dichloroethene	—	—	—	—	730	(L)	—	—
Trichloroethene	—	—	—	—	4,500	—	—	—
Toluene	—	—	—	—	—	—	—	(L)
Chlorobenzene	7.0	—	27	—	(L)	38	—	130
Acetone	13(B)	—	(L,B)	(L,B)	(L)	(L,B)	(L,B)	(L,B)
Carbon Disulfide	—	—	(L)	—	—	—	9.0	64
Total Xylenes	—	—	—	—	—	—	—	(L)
1,3-Dichlorobenzene	—	—	(L)	—	26	(L)	—	350(X)
1,4-Dichlorobenzene	—	—	12	—	52	10	—	300(X)
1,2-Dichlorobenzene	—	—	11	—	66	(L)	—	330(X)
Naphthalene	—	—	—	—	49	—	—	—
Fluorene	—	—	—	—	(L)	—	—	—
Acenaphthene	—	—	—	—	(L)	—	—	—
4-Chloroaniline	—	—	(L)	—	—	—	—	—
2-Methylnaphthalene	—	—	—	—	(L)	—	—	—
Dibenzofuran	—	—	—	—	(L)	—	—	—
2,4-Dimethylphenol	—	—	—	—	65	—	—	—
2,4-Dichlorophenol	—	—	—	—	—	—	—	(L)
2-Methylphenol	—	—	—	—	(L)	—	—	—
4-Methylphenol	—	—	—	—	(L)	—	—	—

B-Compound also present in method blank
L-Compound present below detection limit
X-Exceeds calibration limit

A dash (—) indicates compound not detected

Doe. Num. 7:28

3201141

Table C-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR
CORRECTIVE-ACTION MONITORING WELLS

(All results in ug/L unless noted)

Parameter	Sample No. (Location)						
	P32W071 (GM-71)	P32W072 (GM-72)	P32W076 (GM-76)	P32W077 (GM-77)	P32W078 (GM-78)	P32W079 (GM-79)	P32W083 (GM-83)
Sodium (mg/L)	4.6	7.2	110	12	7.4	6.7	10
Chloride (mg/L)	4.8	5.9	140	67	10	11	9.3

Note: Those samples analyzed for sodium and chloride only.

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Table D-2

SUMMARY ANALYTICAL RESULTS FOR
POINT-OF-COMPLIANCE MONITORING WELLS
(All results in ug/L unless noted)

Parameter	Sample No. (Location)						
	P32W001 (UG-1)	P32W008 (GM-8)	P32W009 (GM-9)	P32W010 (GM-10)	P32W011 (GM-11)	P32W012R (GM-12R)	P32W014 (GM-14)
Barium	—	60	21	68	—	33	31
Chromium Total	24	—	—	—	—	—	—
Iron	1,300	1,900	990	450	140	390	16,000
Manganese	—	67	10	69	23	180	170
Sodium (mg/L)	5.8	5.7	3.4	3.4	27	2.9	23
Lead	6.3	—	—	—	—	—	—
Zinc	—	15	12	—	—	—	—
Chloride (mg/L)	7.2	10	3.6	5.3	27	1.8	21
Sulfate (mg/L)	28	9.4	5.4	9.3	6.0	16	150
Cyanide (mg/L)	0.024	0.34	0.031	0.069	1.1	—	0.32
Methylene Chloride	5.0(B)	(L,B)	(L,B)	(L,B)	(L,B)	5.0(B)	5.0(B)
Benzene	—	350	10	—	—	—	—
Toluene	—	—	(L)	—	—	—	—
Chlorobenzene	—	4,800	640	—	—	—	—
Acetone	11(B)	(L,B)	(L,B)	10(B)	18(B)	(L,B)	(L,B)
Carbon Disulfide	—	(L)	(L)	(L)	(L)	—	—
1,3-Dichlorobenzene	—	100	(L)	—	—	—	—
1,4-Dichlorobenzene	—	250	(L)	—	—	—	—
1,2-Dichlorobenzene	—	01	(L)	—	—	—	—
Naphthalene	—	(L)	—	—	—	—	—

B—Compound also present in method blank
L—Compound present below detection limit
A dash (—) indicates compound not detected

Doc. Num. 7:31

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Table D-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR
POINT-OF-COMPLIANCE MONITORING WELLS
(All results in ug/L unless noted)

Parameter	Sample No. (Location)		
	P32WS001 (PCS-1)	P32WI001 (PCI-1)	P32WD001 (PCD-1)
Barium	24	—	21
Iron	2,300	95	1,300
Manganese	64	27	86
Sodium (mg/L)	15	260	180
Zinc	15	27	230
Chloride (mg/L)	8.6	370	300
Sulfate (mg/L)	11	120	21
Cyanide (mg/L)	0.068	3.1	0.014
Methylene Chloride	(L,B)	(L,B)	(L,B)
Chlorobenzene	(L)	25	—
Acetone	—	(L,B)	11(B)
1.3-Dichloroboncenо	(L)	—	—
1,4-Dichlorobenzene	(L)	—	—
1,2-Dichlorobenzene	15	(L)	—
Butyl Benzyl Phthalate	(L)	(L)	(L)
Benzyl Alcohol	15	(L)	26

B-Compound also present in rthod blank
L-Compound present below detection limit
A &ah (—) indicates compound not detected

Doc. Num. 7:31

Table E-2

SUMMARY ANALYTICAL RESULTS FOR FIELD QA/QC SAMPLES
(All results in ug/L unless noted)

Parameter	Sample No. (Location)						
	P32W008 (GM-8)	P32W008D[a] (GM-8)	P32W010 (GM-10)	P32W010D[b] (GM-10)	P32WTB01[c]	P32WTB02[c]	P32WTB03[c]
Barium	60	59	6D	65	NA	NA	NA
Iron	1,900	1,800	450	430	NA	NA	NA
Manganese	67	65	69	75	NA	NA	NA
Sodium(mg/L)	5.7	5.7	3.4	3.5	NA	NA	NA
Zinc	15	10	—	—	NA	NA	NA
Chloride (mg/L)	10	10	5.3	6.5	NA	NA	NA
Sulfate (mg/L)	9.1	9.4	9.3	11	NA	NA	NA
Cyanide (mg/L)	0.34	—	0.069	0.032	NA	NA	NA
Methylene Chloride	(L,B)	(L,B)	(L,B)	(L,B)	5.0(B)	(L,B)	(L,B)
Benzene	350	340	—	—	—	—	—
Chlorobenzene	4,800	4,600	—	—	—	—	—
Acetone	(L,B)	—	10(B)	(L,B)	(L,B)	12(B)	16(B)
Carbon Disulfide	(L)	(L)	(L)	—	—	(L)	—
1,3-Dichlorobenzene	180	ZOO	—	—	NA	NA	NA
1,4-Dichlorobenzene	250	260	—	—	NA	NA	NA
1,2-Dichlorobenzene	81	84	—	—	NA	NA	NA
Naphthalene	(L)	(L)	—	—	NA	NA	NA
2-Chlorophenol	—	(L)	—	—	NA	NA	NA

[a] Duplicate sample of P32W008
[b] Duplicate of sample P32W010
[c] Analyzed for VOCs only

B-Compound also present in method blank
L-Compound present below detection limit
NA-Analysis not performed
A dash (—) indicates compound not detected

Doc. Num. 7:33

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Table E-2 (Continued)

SUMMARY ANALYTICAL RESULTS FOR FIELD QA/QC SAMPLES

(All results in ug/L unless noted)

Parameter	Sample No. (Location)				
	P32WRB01	P32WRB02	P32WRB03	P32WFB01	P32WFB01[d]
Iron	—	—	110	—	—
Methylene Chloride	6.0(B)	(L,B)	(L,B)	5.0(B)	5.0(B)
Chlorobenzene	—	(L)	—	—	—
Acetone	11(B)	—	26(B)	14(B)	10(B)
Carbon Disulfide	—	(L)	—	—	—
Bis(2-Ethylhexyl)phthalate	—	—	—	—	NA

[d] Analyzed for metals, cyanide, and VOCs only

B-Compound also present in method blank
L-Compound present below detection limit
NA-Analysis not performed
A dash (—) indicates compound not detected

Doc. Num. 07:33

H

APPENDIX H

JUSTIFICATION FOR THE USE OF POLYVINYL CHLORIDE AS MONITORING WELL CONSTRUCTION MATERIALS AT NAS PENSACOLA

JUSTIFICATION FOR THE USE OF POLYVINYL CHLORIDE AS HONITORING WELL CONSTRUCTION MATERIALS AT NAS PENSACOLA

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) Region IV has expressed concern regarding the use of polyvinyl chloride (PVC) well construction materials for permanent monitoring well construction at Naval Air Station (NAS) Pensacola. This justification report, prepared by the U.S. Navy, Southern Division, Naval Facilities Engineering Command, addresses the eight EPA information requirements to justify the use of PVC as an alternative well construction material for groundwater monitoring wells. A copy of the EPA information requirements is presented in Attachment A. The ideal monitoring well construction material should be regarded as that which consistently delivers the most representative groundwater samples for the site or sites of concern. The Navy believes that, based on the types and concentrations of the constituents detected thus far at NAS Pensacola, site hydrogeology and geochemistry, and proven well construction practices, PVC is the best overall material for monitoring well construction at NAS Pensacola.

2.0 . EPA INFORMATION REQUIREMENTS

EPA Region IV requires that a justification be submitted when PVC is recommended as the well construction material. The following is a discussion of each of the information requirements for the justification of PVC as the well construction material. Each subsection addresses one of the eight requirements identified by EPA. The discussion that follows each information requirement includes site-specific conditions and project objectives that relate to the use of PVC well materials.

2.1 The Data Quality Objectives (DQOs) for the Samples To Be Collected from Wells with PVC Casing per EPA/540/G-87/003, Data Quality Objectives for Remedial Response Activities.

The DQOs will provide a quantifiable degree of certainty regarding data that will be utilized during development and implementation of all

Remedial Investigation, Feasibility Study, and Remedial Design/Remedial Action activities. Level IV analytical and quality assurance/quality control procedures are designated in the NAS Pensacola Generic Quality Assurance Project Plan (GOAPP), prepared by Ecology and Environment, Inc. The use of PVC well construction materials will not adversely affect the quality of the analytical or hydrogeologic data collected during the investigation.

2.2 The Anticipated Compounds and Their Concentration Ranges

The analytical screening and Target Analyte List/Target Compound List results collected to date have shown that trace to moderate concentrations of metals, total recoverable petroleum hydrocarbons, volatile organic compounds, polynuclear aromatic hydrocarbons, phenols, and pesticides are present in the groundvater at various sites at NAS Pensacola. Attachment B provides a summary of the highest concentrations of constituents detected that exceed the Florida Primary Drinking Water Standards (FPDWSs) or the Florida Secondary Drinking Water Standards (FSDWSs) at one or more sites. As will be discussed below, none of these constituents would be expected to have an adverse effect on PVC well materials, and, in comparison to other well construction materials, PVC well materials are not expected to adversely impact the analytical data collected during the investigation.

2.3 The Anticipated Residence Time of the Sample in the Well

Section 6.8.2 of the NAS Pensacola GQAPP specifies that a minimum of three well volumes of standing water will be purged prior to groundwater sample collection. Furthermore, purging will continue until the groundwater field parameters of temperature, pH, and specific conductance have stabilized for three consecutive measurements. The collection of the groundwater sample then occurs immediately after purging; therefore, the maximum residence time of the sample in the well should be approximately 15 minutes or less.

2.4 The Aquifer's Productivity

Aquifer tests performed on the Sand-and-Gravel Aquifer at NAS Pensacola indicate that permeabilities range from moderate to low.

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Hydraulic conductivities range from 0.20 to 44.36 feet per day and average 17.78 feet per day.

2.5 The Reasons for Not Using Hybrid Vells of PVC Casings and Stainless Steel Screens.

The use of hybrid wells having stainless steel screens and PVC casings offers no significant advantage at NAS Pensacola over wells constructed entirely of one material. In a shallow well where the screen is installed to bracket the water table, because of the prevailing shallow depth to water at NAS Pensacola, averaging about 5 to 10 feet below land surface, only a relatively small length of well casing would be constructed of PVC. Furthermore, because the deeper monitoring wells are expected to have a considerable amount of standing water in the well casings, the water would still be in contact with PVC. Thus, hybrid wells yield no advantage whatsoever.

As a result, the use of hybrid wells is not perceived by the Navy as an acceptable or appropriate well construction practice at NAS Pensacola.

2.6 Brief Discussion of Adsorption/Desorption Characteristics of the Compounds and Elements of Interest for the Type of PVC To Be Used.

The recommended rigid PVC well materials would be Schedule 40 and would conform to ASTM D-1785. A review of published literature on well casing materials has revealed that purging and sampling equipment selection and variations in purging and sampling procedures have a greater influence on sample integrity than do well construction materials. The following is a summary of four of these studies which are representative of the overall findings of this type of research. It should be noted that these papers were not selectively chosen to support the use of PVC well materials. This literature represents the most current research on chemical interference of well materials currently being conducted by the U.S. Army Corp of Engineers, EPA, and state water surveys. Complete copies of these papers are included in Attachment C.

Parker et al. (1990) reported that with increased residence time (1 to 1,000 hours) all common well materials exhibit some form of sample

alteration depending on the chemical constituents in the groundwater. It was concluded that, in a sampling program which will analyze for trace metals and organic compounds, PVC is the best choice for well materials.

Barcelona and Helfrich (1986) reported that proper purging of the well has a greater effect on sample quality than do well casing construction materials. In wells that were properly purged, PVC consistently detected higher, more representative levels of organic compounds than did stainless steel or Teflon.

Jones and Hiller (1988) studied the effects of organic compound adsorption and leaching on PVC (thermoplastic), stainless steel, and Teflon (fluoropolymer) well casing materials. It was concluded that, for organic compounds, no clear advantage exists regarding the use of one particular well casing material over the others. Based on these results, Jones and Hiller determined that well purging procedures, sampling device selection and composition, and sample storage devices are probably of greater influence on sample integrity and representativeness.

Hewitt (1989) evaluated the release of metal analytes from two common, stainless steel alloy types (304, 316), PVC, and Teflon well casings. Teflon was the least reactive material tested and did not leach any metals. PVC was the next least reactive material. Concentrations of leached metals from PVC decreased with time of exposure. Stainless steel, both 304 and 316, exhibited by far the highest concentrations of metals able to be leached. Based on this, Teflon would be the optimum material for use in monitoring only trace concentrations of metal analytes in groundwater. PVC is an acceptable alternative because its influence appears to be predictable and small. The two varieties of stainless steel should be avoided for monitoring systems designed to detect low levels of metals.

These four papers illustrate that all materials have the capacity to affect the representativeness of the groundwater sample in some way. However, given the concentrations and variety of contaminants anticipated at NAS Pensacola and the designated sampling procedures, PVC would clearly be the optimum choice for well construction materials.

2.7 Whether an Anticipated Increase in Thickness of the Monitoring Well Wall Would Require a Larger Annular Space.

No increase in the diameter of the borehole would be required because the outside diameter of the PVC and stainless steel well casings are the same for both the 2-inch and 4-inch inside diameter well casings.

2.8 The Type of PVC To Be Used and, If Available, the Manufacturer's Specifications. Additionally, Assurance that the PVC To Be Used Does Not Leach, Mask, React, or Otherwise Interfere with the Contaminants Being Monitored Within the Limits of the DQOs.

The PVC used for well construction will be rigid Schedule 40 PVC in conformance with ASTM D-1785 standards. The casing will have flush-joint, threaded ends that conform to ASTM F-480-81. The specific manufacturer has yet to be determined.

The Navy cannot assure that the PVC will not leach, mask, react, or otherwise interfere with the contaminants being monitored. However, based on the information presented in Section 2.6 and the available analytical results, the Navy believes that the use of PVC well materials will provide data quality equal or superior to that obtained using stainless steel materials.

3.0 CONCLUSIONS

This justification was prepared by U. S. Navy, Southern Division, Naval Facilities Engineering Command in response to EPA Region IV concerns regarding the selection of well construction materials for NAS Pensacola. The eight EPA information requirements to justify the use of PVC well materials have been presented and discussed relative to actual site conditions. The evaluation of well materials considered the DQOs, expected contaminants and concentrations, sampling procedures, hydrogeology and geochemistry, and common and accepted well construction practices. Consideration of all these factors strongly supports the use of PVC well construction materials for the installation of permanent monitoring wells at NAS Pensacola.

4.0 REFERENCES

Barcelona, M.J. and J.A. Helfrich, 1986, Well Construction and Purging Effects on Ground-Vater Samples, Environmental Science and Technology, V. 20, pp. 1179-1184.

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ATTACHMENT A

EPA INFORMATION REQUIREMENTS

3201149

Information Requirements for Justification of Alternative Well Casing Materials for Groundwater Monitoring Well Construction

I. EPA Region IV requires that groundwater monitoring wells be constructed of stainless steel (304 or 316 - first choice) or rigid PVC meeting NSF Standard 14 ("NSF WC" - second choice). Which of these well casing materials to be used depends upon which would obtain the most representative groundwater sample. A justification must be submitted when monitoring wells constructed of PVC materials are proposed for use in collecting samples for organic analysis. Following are EPA's information requirements for justifying the use of PVC as the well casing material for groundwater monitoring wells.

1. The Data Quality Objectives (DQO) for the samples to be collected from wells with PVC casing per EPA/540/G-87/003, Data Quality Objectives for Remedial Response Activities.

2. The anticipated compounds and their concentration ranges.

3. The anticipated residence time of the sample in the well.

4. The aquifer's productivity.

5. The reasons for not using hybrid wells of PVC casings and stainless steel screens.

6. Brief discussion of adsorption/desorption characteristics of the compounds and elements of interest for the type of PVC to be used.

7. Whether an anticipated increase in thickness of the monitor well wall would require a larger annular space.

8. The type of PVC to be used and, if available, the manufacturer's specifications. Additionally, assurance that the PVC to be used does not leach, mask, react or otherwise interfere with the contaminants being monitored within the limits of the DQOs.

II. EPA acceptance of PVC well casing materials does not constitute approval of that casing material; therefore, if PVC is accepted for use, the following conditions shall apply:

1. The FACILITY accepts the risks that the use of alternate materials for groundwater monitoring may cause interferences or inaccuracies in the chemical analysis of samples from such wells. All compounds found in samples collected from the well will be considered to originate in the aquifer being monitored.

Alternative Well Casing Materials (Cont.)

2. Any such acceptance applies to the implementation of the specified RFI Work Plan only, and any other use of alternate materials for groundwater monitoring must be granted by EPA separately.

3. Any major amendments or revisions to the referenced RFI Work Plan or the intended DQOs of the work plan may require reassessment of the acceptance for use of alternate materials by EPA.

4. EPA reserves the right to refuse groundwater monitoring data from groundwater wells constructed of alternate materials from those specified in the Region IV SOP whenever such construction materials could cause the ground water monitoring data to fail to meet the necessary DQOs.

III. The information to justify the use of PVC well casing could be incorporated into the work plan and be inclusive for all sites where PVC casing will be used.

IV. All field work and laboratory procedures must follow EPA Region IV Standard Operating Procedure Quality Assurance Manuals (SOPQAM). The SOPQAM for field procedures is dated February 1991, and the SOPQAM for laboratory procedures is dated September 1990. Any deviation from EPA Region IV SOPQAM must be justified in writing and be approved by EPA.

August 2, 1991

ATTACHMENT B

SUMMARY OF CONSTITUENTS DETECTED ABOVE TEE FPDWS/FSDWS AT NAS PENSACOLA SITES

SUMMARY OF CONSTITUENTS DETECTED ABOVE THE FPDWS/FSDWS AT NAS PENSACOLA SITES

Parameter	Maximum Concentration Detected (µg/L)	Standard (µg/L)
Arsenic	8,000	50 PPDWS
Cadmium	800	10 PPDWS
Chromium	8,300	50 PPDWS
Copper	6,700	1,000 PSDWS
Lead	22,000	50 PPDUS
Iron	30,300	300 PSDWS
Manganese	341	50 PSDWS
Mercury	3.4	2 PPWS
Silver	180	50 PPDWS
Sodium	1,270,000	160,000 PPDWS
Benzene	810	1.0 PPDWS
Tetrachloroethene	500	3.0 PPDVS
1,1,1-Trichloroethene	2,500	200 FPDWS
1,1-Dichloroethene	1,300	7.0 FPDVS
Vinyl Chloride	310	1.0 PPDWS
Radium-226 (pCi/L)	16.1	5.0 FPDUS

Key :

FPDWS = Florida Primary Drinking Water Standard.
PSDUS = Florida Secondary Drinking Water Standard.

ATTACHMENT C

REPRESENTATIVE STUDIES OF CHEMICAL INTERFERENCE OF WELL CONSTRUCTION MATERIALS

Influence of *Casing* Materials on Trace-Level Chemicals m Well Water

by Louise V. Parker, Alan D. Hewitt, and Thomas E Jenkins

Abstract

Four well casing materials — polyvinyl chloride (PVC), polytetrafluoroethylene (PTFE), and stainless steel 304 (SS 304) and 316 (SS 316) — were examined to determine their suitability for monitoring inorganic and organic constituents in well water.

The inorganic study used a factorial design to test the effect of concentration of mixed metals (arsenic [As], chromium [Cr], lead [Pb], and cadmium [Cd]), pH, and organic carbon. Sample times were 0.5, 4, 8, 24, and 72 hours. Except for slow loss of Pb, PTFE well casings had no significant effect on the concentration of metals in solution. For the other casings, changes in analyte concentration often exceeded 10 percent in eight hours or less and, thus, could bias analyses of samples taken from wells constructed with these materials. Specifically, PVC casings sorbed Pb and leached Cd; SS 316 casings sorbed As and Pb and leached Cd; and SS 304 casings sorbed As, Cr, and Pb and leached Cd. Both stainless steel casing materials showed markedly poorer performance than the PVC casings.

The well casings were also tested for sorption/desorption of 10 organic substances from the following classes: chlorinated alkenes, chlorinated aromatics, nitroaromatics and nitramines. Sample times were 0, 1, 8, 24, and 72 hours, seven days, and six weeks. There were no detectable losses of analytes in any of the sample solutions containing stainless steel well casings. Significant loss of some analytes was observed in sample solutions containing plastic casings, although losses were always more rapid with the PTFE casings than with PVC. Chlorinated organic substances were lost most rapidly. For samples containing PTFE casings, losses of some of these compounds were rapid enough (>10 percent in eight hours) to be of concern for ground water monitoring. Losses of hydrophobic organic constituents in samples containing PTFE casings were correlated with the compound's octanol/water partition coefficient.

Introduction

The U.S. Environmental Protection Agency's (EPA's) RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD) (*US.* EPA 1986a) states that only fluorocarbon resins *or* stainless steel (SS) casings should be used for monitoring volatile organics in the saturated zone. The original draft of this document (US. EPA 1985) suggested that Teflon® or stainless steel 304 be used for all ground water monitoring at RCRA sites. The EPA was concerned that many *of* the casing materials used for ground water monitoring could either affect the quality *of* the ground water *or* did not have the long-term structural characteristics required of RCRA monitoring wells. With respect to the EPA's first concern, a review of the literature published prior to 1986 did not reveal substantial evidence to support the position taken by the EPA in either edition *of* this document (Parker et al. 1989).

Few studies have specifically addressed the possible interactions between well casing materials and metal species. There is considerable evidence, however, that sorption of metals by plastic and glass containers an be significant (Eicholz et al. 1965, Robertson 1968, Batley and Gardner 1977, and Masse et al. 1981). In one study of PVC well casings, there was negligible loss of chromium but large losses of lead from a deionized water solution (Miller 1982). Other studies with Pyrex glass and polyethylene also found that lead was the most rapidly lost analyte (Shendrikar et al. 1976). Barcelona and Helfrich (1986) compared the concentrations of several metal species in samples taken from adjacent PVC, PTFE, and SS wells. They found increased levels of iron in water samples from the non-purged SS well to be the only statistically significant difference. In a previous in situ study by Houghton and Berger (1984), a steel-cased well appeared to leach a number of metal species, including iron, cadmium, chromium, copper, manganese, molybdenum, selenium, and zinc, when compared with a PVC well and one constructed of acrylonitrile-butadiene-styrene (ABS).

Sorption of organic solutes by well casing materials has been reported in several publications. Miller (1982) tested PVC well casing for sorption of trace levels (2-14 ppb) of six halogenated organic compounds (bromo-

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form, trichlorofluoromethane, trichloroethylene. 1,1,1-trichloroethane, 1,1,2-trichloroethane. and tetrachloroethylene) in aqueous solution and found slow losses of tetrachloroethylene (25-50 percent in six weeks).

Reynolds and Gilham (1986) tested both PVC and PTFE materials for sorption of trace levels (ppb) of five halogenated organics. They found rapid sorption of tetrachloroethylene by PTFE, slow sorption of 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane and hexachloroethane. and no sorption of bromoform. They also found slow sorption of all the analytes except trichloroethane by WC While 50 percent of the tetrachloroethylene was sorbed by the PVC in five weeks, the same amount was sorbed by PTFE in only eight hours. They attributed loss of these organics to absorption and developed a model where uptake of the compound proceeds by sorption/dissolution into the polymer surface. followed by diffusion into the polymer matrix. However. Reynolds and Gilham (1986) could not predict which organic chemicals were most susceptible to absorption.

Syks et al. (1986) compared sorption of several organics by PVC, SS, and PTFE well casings. The casing materials were equilibrated for seven days (5 C) in analyte solution. placed in fresh analyte solution, and then tested for losses due to sorption after one and 24 hours. After 24 hours they did not find any significant losses for any of the casing materials.

While these studies indicate that sorption of some organics may be a significant problem for plastic casings over the long term, only the study by Miller (1982) examined desorption during the first two weeks. In that study, he observed some desorption (25 percent) of the tetrachloroethylene that had been previously sorbed by the PVC casings.

Casing materials may also leach a variety of organic substances. In two studies (Miller 1982, Parker and Jenkins 1986), analytical interferences in leachates from PVC well casings were sought but none were found. Curran and Tomson (1983) also examined the leachates from five plastics, including W C and PTFE. They found that PTFE leached the fewest contaminants and that non-glued PVC was a close second While it k possible tbat organic substances such as lubricants used during manufacture or inks from printing could leach from stainless or plastic casings, no information currently available in the literature confirms this.

It is interesting to note that despite the literature that is available regarding sorption of organics by PTFE, articles have recently been published that claim it is superior for sampling organic substances (e.g., Bryden and Smith 1989).

The purpo[redacted]he studies conducted by the authors was to determine the suitability of four well casing materials (PVC, SS304, and SS316) for monitoring inorganic and organic solutes in ground water. To do this, two separate studies were conducted, one for inorganics and one for organics.

General Comments on the Inorganic and Organic Studies

Two-inch (inner) diameter well casings manufactured specifically for ground water monitoring were used in all studies. These casings were purchased specifically for the studies and were stored in a cool, dry room prior to use. Precautions were taken while the casings were being cut to prevent contamination from grease, dirt, oil. solvents. and excessive handling. The ground water used in the studies was obtained from a domestic well (249 feet [76m] deep) in Weathersfield, Vermont. No attempt was made to maintain the native dissolved oxygen level. As a general guideline for evaluating our results, we considered any change in concentration (relative to the control samples) of 10 percent in an eight-hour period to be the maximum change tolerable.

Inorganic Study

Experimental

Mixed metal solutions were prepared by spiking ground water with arsenic (As), cadmium (Cd), chromium (Cr) and lead (Pb) at two concentrations: 50 and 100 µg/L (ppb) for As. Cr, and Pb. and 10 and 2 µg/L for Cd. The higher concentrations are the current maximum concentration limits set by the EPA for drinking water (U.S. EPA 1986b). Prior to treatment. the ground water used in this study was analyzed and found to contain no detectable amounts of any of these metals at the sensitivity levels used for analysis. To simulate a wider range of ground water conditions. the tests were run at the natural pH (7.8) of the well water plus a lower pH (5.8) and at two levels of organic carbon. HCl (reagent grade) was added to lower the pH and 5 mg/L (ppm) of humic acid was added to raise the organic carbon content. A complete (2^3) factorial experiment was used to test the effect of these treatments (concentration of metals. pH and organic carbon content) (Table 1).

Because the wail thicknesses vaned between the plastic and the two stainless steel casings. the casings

TABLE 1
Matrix Design for Inorganic Study

Test Condition	Metal Concentrations[1]	pH	Organic Carbon Added[2]
1	high	7.8	no
2	high	7.8	yes
3	high	5.8	no
4	high	5.8	yes
5	low	7.8	no
6	low	7.8	yes
7	low	5.8	no
8	low	5.8	yes

[1] High metal concentrations were 50 µg/L As, Cr, Pb, and 10 µg/L Cd. Low metal concentrations were 10 µg/L As, Cr, Pb, and 2 µg/L Cd.
[2] 5 mg/L humic acid was added as a source of organic carbon.

were cut 10 different lengths so that the surface area of each was constant (80 cm^2). Cut sections were rinsed with deionized water and air-dried before use. Individual well casings wen then placed in 125mL polypropylene jars containing 100mL of test solution; the ratio of casing surface area to aqueous volume was 0.82 cm^2/mL. Similar jars that contained the test solutions without any casings were used for control samples. The sample vessels were covered, stored at 24C and kept from natural light. Duplicates were run for adb combination of variables and each casing material.

Sample aliquots (2.5mL) were taken from each container after 0.5, 4, 8, 24, and 72 hours. The aliquots were placed in clean 7.5mL polyethylene vials and acidified to a pH of less than 1 with nitric add to prevent sorption by the containers. Metal concentrations were obtained by graphite furnace atomic absorption spectroscopy (Perkin-Elmer, model 703 atomic absorption spectrophotometer coupled with a PE model 2200 bated graphite atomizer). The concentrations of metals given in this study were measured as total.

The metal concentrations were normalized by dividing tbe values obtained for sample solutions that contained well casings by the values found for equivalent controls. This allowed tbe results for both concentrations 10 be analyzed by a single analysis of variance (ANOVA). Thus, it was possible to simultaneously test for the effect of solute concentration, pH and organic carbon at each sample time for each casing material. If a casing exerted no influence on analyte concentration, the expected value would be 1.00. *An* increase in the ratio *indicates* that the well casing released metal into *the* solution, while a decrease in the ratio indicates that metal was sorbed by the casing.

Results and Discussions

Approximately half of the stainless steel casings showed signs of surface rust. In some cases (SS 316 at a low pH), sufficient oxidation occurred to form a hydrous iron oxide precipitate. This precipitate was never observed in the control samples or those with PVC or PTFE *casings*. While the authors realize that rusting of the stainless casings is very condition-specific, the *test* conditions should be generally representative of shallow wells. Also, it was noticed that the *casings* had rusted some during storage prior to any testing.

Table 2 gives tbe normalized mean values and *standard* deviations for each analyte, well casing and time.

TABLE 2
Normalized Mean Metal Values[1] for Samples as a Function of Time

Time (hr)	Pipe	Arsenic Mean Value	Arsenic Standard Deviation	Cadmium Mean Value	Cadmium Standard Deviation	Chromium Mean Value	Chromium Standard Deviation	Lead Mean Value	Lead Standard Deviation
0.5	PVC	0.991 ±	0.038	1.01 ±	0.025	1.01 ±	0.018	0.999 ±	0.009
	PTFE	0.999 ±	0.050	1.01 ±	0.011	1.01 ±	0.007	1.00 ±	0.026
	SS304	0.997 ±	0.057	1.06 ±	0.036	1.01 ±	0.016	1.02 ±	0.008
	SS316	0.994 ±	0.040	1.04 ±	0.021	1.02 ±	0.015	1.01 ±	0.025
4.0	PVC	1.02 ±	0.045	1.13 ±	a037	0.999 ±	0.013	0.889 ±	0.030
	PTFE	0.993 ±	0.052	1.03 ±	0.054	1.01 ±	0.011	0.974 ±	0.019
	SS304	0.978 ±	0.063	1.17 ±	0.15	0.957 ±	0.037	0.784 ±	0.035
	SS316	0.945 ±	0.060	1.24 ±	a49	0.921 ±	0.052	0.803 ±	0.077
8.0	PVC	1.00 ±	0.045	1.15 ±	0.037	1.00 ±	0.014	0.893 ±	0.035
	PTFE	1.01 ±	0.098	1.03 ±	0.016	0.989 ±	0.019	0.985 ±	0.032
	SS304	0.962 ±	0.057	1.16 ±	0.14	0.972 ±	0.16	0.699 ±	0.031
	SS316	0.945 ±	0.068	1.30 ±	a47	0.872 ±	0.10	0.804 ±	0.10
24.0	PVC	0.994 ±	0.064	1.16 ±	0.056	1.00 ±	0.016	0.808 ±	0.051
	PTFE	0.992 ±	0.054	1.03 ±	0.017	1.01 ±	0.024	0.951 ±	0.040
	SS304	0.894 ±	0.051	1.12 ±	a12	1.03 ±	0.37	0.538 ±	0.042
	SS316	0.853 ±	0.080	1.36 ±	0.68	0.855 ±	0.11	0.793 ±	0.19
72.0	PVC	1.03 ±	0.046	1.14 ±	0.049	1.01 ±	0.018	0.743 ±	0.064
	PTFE	1.02 ±	0.045	1.02 ±	0.022	1.00 ±	0.013	0.899 ±	0.034
	SS304	0.891 ±	0.084	1.03 ±	0.14	1.03 ±	0.42	0.452 ±	0.061
	SS316	0.874 ±	0.083	1.25 ±	0.66	0.836 ±	0.099	0.720 ±	0.17

[1] $\frac{\text{(Concentration for samples with casing)}}{\text{(Concentration for control samples)}}$ = Normalized mean value

These normalized values are the mean of all the treatments (i.e., for both pHs, organic carbon content, and concentration).

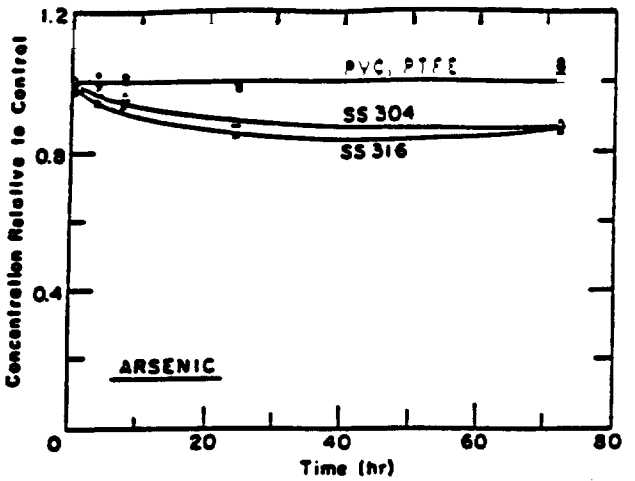


Figure 1. Trends in mean arsenic concentration for four well casing materials.

In general, there was no change in arsenic concentration for the sample solutions containing either the PVC or PTFE casings during the 72-hour test period (Figure 1), and no consistent pattern of effects was evident from the ANOVA. The reason As did not interact with these casings may be because As exists in natural waters in the anionic form (Fowler et al. 1979). Masse et al. (1981) found that anions do not strongly associate with plastic (polyethylene and PTFE) surfaces. which a n known for their cation exchange capacity. The samples containing the stainlets steel casings, on the other hand. showed a 10 percent decrease in aqueous arsenic concentration relative to the controls *after* 24 hours (Figure 1). It appears that there was no further loss of this analyte *after* 24 hours Although these results cannot be used to predict exactly what losses might occur under field conditions. it is doubtful that this loss was rapid enough to impact water quality measuremenu (losses were less than 10 percent after eight hours).

The results for Cd a n quite different. After only four hours, Cd concentrations in the samples containing PVC and stainless steel casings had increased by more than 10 percent (Figure 2), with the most leaching occurring in the samples containing the SS 316 casings. Cadmium may have been added to the PVC as a W stabilizer (Wilson et cl 1982), and may have been added to the stainless steel to enhance resistance to chloride cracking (Sedricks 1979). The concentration of Cd in the samples containing *W C* casings leveled off after eight hours. ANOVA revealed that pH had a significant effect (at tbe 95 percent confidence level) for this casing. Although the same amount of Cd leached in all the samples (approximately 05 mg/L), concentration was also significant (at the 95 percent confidence level), but only because relatively more was leached in the low-concentration samples. Concentrations in samples containing SS 304 casings decreased after eight hours and after 72 hours had returned to the same levels that were found in the control samples. Again. more Cd leached in the low pH samples. Cd was leached most rapidly in samples containing SS 316 casings. There was a large discrepancy between duplicate treatments for the samples that contained stainless steel casings. With the exception of the first set of samples (t = 0.5 hr), the relative standard deviations ranged from 12 to 15 percent for samples containing SS 304 and from 47 to 68 percent for those containing SS 316. In contrast, the standard deviations for samples containing PVC and PTFE casings were consistently below 6 percent. Because the variance in the samples containing SS 316 was so large, there was no consistent detectable effect of pH for these casings. However, surface oxidation appeared to be the major source of this variance. With respect to the leaching of metal stabilizers from *W C* pipes, the literature indicates that loss *can* be a *surface* phenomenon that can be reduced or eliminated by either washing (with detergent) or soaking in dilute mineral add before *use* (Packham 1971). It may be that the lots of Cd from *W C casings can* also be reduced by a similar treatment, although we did not test this possibility.

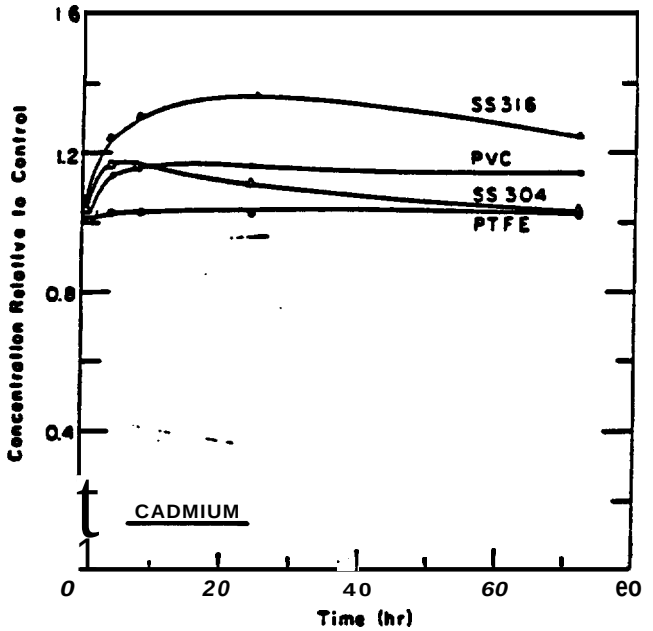


Figure 2 Trends in mean cadmium concentration lor four well casing materials.

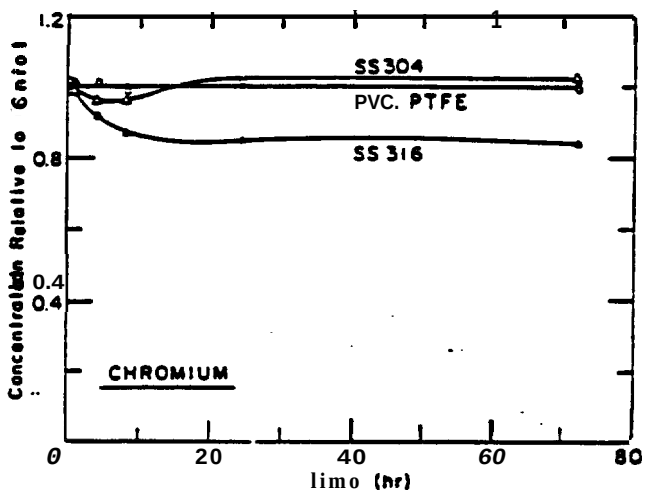


Figure 3 Trends in mean chromium concentration for four well casing materials.

There was no measurable sorption of chromium by the PTFE, PVC, and SS 304 casings (Figure 3). Absence

of interaction with the plastic casings may be due to chromium speciation. In solution. chromium exists predominantly as dichromate and chromate ($Cr_2O_7^{2-}$, CrO_4^{2-}) and, as mentioned previously. anions are not as likely to exchange with plastic surfaces. However. loss of chromium was rapid enough (13 percent after eight hours) for SS 316 casing material to be of concern for ground water monitoring. Loses were greater at the higher pH; Cr speciation is known *to* be affected by pH and may be responsible for some of these differences. Surface oxidation was greater at the lower pH, which likely contributed *to* the larger variability. Also, for those samples where a hydrous iron oxide precipitate was formed, co-precipitation may have contributed to the losses from solution. Again, the standard deviations were considerably greater for the samples containing the stainless steel *casings*. Humic acids apparently increased the stability of aqueous G. perhaps by acting as a complexing agent (Stumm and Morgan 1970s).

Lead was by far the most actively sorbed metal species. While all sample solutions containing casing materials showed some loss of Pb with time (Figure 4), PTFE was the least active surface and SS 304 was the most active. The loses for samples containing PTFE casings do not appear to be of concern with respect *to* ground water monitoring: losses were only 5 percent after 24 hours. However. losses for samples containing PVC and stainless casings are of concern: losses were 10 percent after only four hours in the samples containing PVC casings and 20 percent in those containing stainless casings. Although loss was initially rapid in samples containing SS 316 casings. it leveled off after eight hours. The standard deviation was higher for the samples containing SS 316 casings than for the other casings. For both stainless steel casings. there was less sorption of Pb at the lower pH where hydrogen ions may have competed for sorption sites. Added humic material apparently acted as a complexing agent in solution. making lead less prone to sorption. Concentration had no consistent effect.

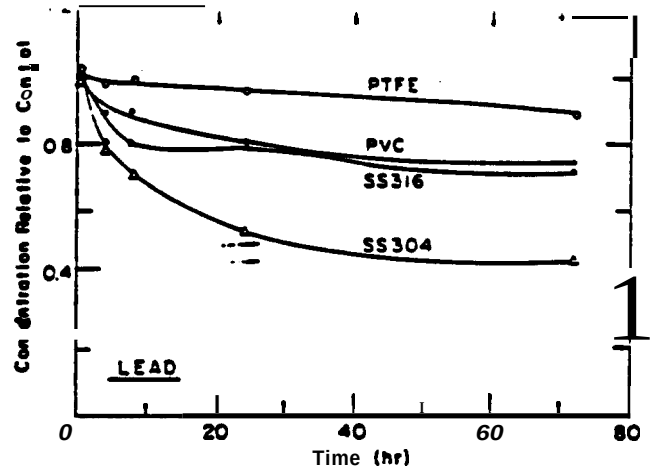
Undoubtedly, there were shifts in the chemical equilibria of the well water solutions from the time the well water was collected until the end of the experiment. Ground water that is removed from an anoxic environment and exposed to oxygen-rich air may undergo redox and precipitation reactions (Stumm and Morgan 1970b). Also, lowering the pH shifts the carbonate equilibrium in solution from predominantly bicarbonate species toward carbon dioxide (Manahan 1972) and causes *shifts* in G speciation. Clearly, such changes would alter the trace metal species distribution. These possible changes were not monitored in this experiment.

For further details on this portion of the study, refer to Hewitt (1989).

Organic Study

Experimental

The four well casing materials were also tested for sorption/desorption of low levels of 10 organic sub. stances. The substances tested were hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), 1,3,5-trinitrobenzene (TNB), *cis*- and trans-1,2-dichloroethylene (CDCE and TDCE), m-nitrotoluene (MNT), trichloroethylene (TCE). chlorobenzene (CLB), and o-, p- and m-dichlorobenzene (ODCB PDCB, MDCB). The criteria used for selecting these analytes included being an EPA priority pollutant, molecular structure, solubility in water. K_{ow} value, and retention time (using reversed-phase high performance liquid chromatography (HPLC) analysis). HPLC analysis of the ground water used in these studies revealed no detectable levels of any of these substances.



4. Trends in mean lead concentration for four well casing materials.

For these experiments, casings were *cut* into 11- to 14mm-long sections, which were then cut into quarters. Again. the length was varied so that the surface area could be maintained constant. The casings were washed in solutions of detergent and deionized water, rinsed many times with deionized water. drained and left to *air dry*. Two pieces of each *type* of casing were placed in 40mL glass vials that were filled with the aqueous test solution so there was no head space. and capped with Teflon-lined plastic caps. Vials with test solution but no well casing material served as controls. These controls allowed us to eliminate any effects such as *those* that might be due to the vials or caps. The ratio of casing surface area to solution volume was 0.79 cm^2/mL. The ratio of solution volume to volume of casing material was approximately 10:1.

In the first experiment, the test solution was prepared by adding known amounts of each of the organic solutes directly to 2.2 L of well *water* in a glass-stoppered bottle, which was stirred overnight. The final concentration was approximately 2 mg/L for *each* organic constituent. The solution also contained 40 mg/L of $HgCl_2$, which was added to prevent biodegradation of the organics. Separate vials were prepared for each sample time so that the test solution could be discarded after sampling; there were three replicate samples for *each* material and time. Contact times were 0 hours, one hour. eight hours, 24 hours, 72 hours (three days), 168 hours (seven days), and approximately 1000 hours (*six* weeks).

After an aliquot was removed for analysis from each

TABLE 3

Normalized[1] Average Concentrations of Organic Analytes for the Four Well Casings with T i e

Analyte	Treatment	1 Hour	a Hours	24 Hours	72 Hours	168 Hours	1000 Hours
RDX	PTFE	1.03	1.00	1.00	1.02	0.91	0.99
	PVC	1.01	1.00	0.98	1.00	1.02	1.00
	SS304	0.99	0.99	1.01	1.02	1.10	0.98
	SS316	1.01	0.99	1.01	1.02	1.11	1.00
TNB	PTFE	1.01	1.00	1.00	0.98	0.95	1.01
	PVC	1.01	1.00	0.98	1.02	1.01	1.02
	SS304	0.99	1.00	1.00	1.05	1.07	1.00
	SS316	1.02	0.99	1.01	1.07	1.06	1.02
C12DCE	PTFE	1.01	0.96	0.96*	0.94	0.91*	0.79*
	PVC	1.00	0.99	0.95*	0.96	0.95	0.90
	SS304	0.97	1.00	1.00	0.96	1.04	0.98
	SS316	0.95	0.99	1.00	1.01	0.98	0.99
T12DCE	PTFE	1.00	0.92	0.88*	0.83	0.66	0.56*
	PVC	1.00	0.98	0.93	1.06	0.83	0.83
	SS304	0.95*	1.00	1.00	0.96	1.11	1.00
	SS316	1.00	0.99	1.00	1.12	1.03	1.00
MNT	PTFE	1.03	1.00	0.99	0.99	0.90	0.90*
	PVC	1.02	1.00	0.98	1.05	0.99	0.94
	SS304	1.00	1.00	1.01	1.00	1.08	1.07
	SS316	1.02	1.00	1.02	1.08	1.10	0.99
TCE	PTFE	1.00	0.90*	0.85	0.78*	0.64*	0.40*
	PVE	1.01	0.98	0.94*	0.99	0.94*	0.88*
	SS304	0.96	1.00	1.01	0.96	1.04	0.99
	SS316	1.00	0.99	1.00	1.04	0.98	1.00
CLB	PTFE	1.01	0.93	0.90*	0.85*	0.74	0.51*
	PVC	1.01	0.98	0.95*	0.98	0.94*	0.86
	SS304	0.98	1.00	1.00	0.97	1.05	0.99
	SS316	0.99	0.99	1.01	1.04	0.98	0.99
ODCB	PTFE	1.01	0.91*	0.88*	0.81*	0.68*	0.43
	PVC	1.02	0.97*	0.94*	0.98	0.93	0.86*
	SS304	0.98	0.99	1.00	0.99	1.04	1.00
	SS316	1.01	0.98*	1.01	1.03	0.98	1.00
PDCB	PTFE	0.92*	0.84*	0.77*	0.64	0.47*	0.26*
	PVC	0.95	0.95*	0.92*	0.97	0.88*	0.80*
	SS304	0.91*	0.98	1.00	0.98	1.02	1.02
	SS316	0.94	0.97*	1.00	1.04	0.97	1.02
MDCB	PTFE	1.00	0.84*	0.78*	0.66	0.48*	0.26*
	PVC	1.02	0.95*	0.92*	0.97	0.88*	0.80*
	SS304	0.99	0.96*	1.00	0.99	1.02	1.02
	SS316	1.03	0.96*	1.00	1.04	0.96	1.01

[1] Values are determined by dividing the mean concentration of a given analyte at a given time and for a particular well casing by the mean concentration (for the same analyte) of the control samples taken at the same time.

* Values significantly different from control values ($\alpha = 0.05$)

of the 1000-hour samples, the vials were emptied and the pieces of casing were rinsed with approximately 40mL of fresh well water to remove any residual solution adhering to the surfaces. The casing pieces were then placed in new vials, and fresh unspiked well water was added. The vials were capped with new caps and allowed to equilibrate for three days. Aliquots were then taken from these samples and analyzed to determine if desorption had occurred.

In the second experiment 20 g/L of NaCl was also added to the test solution to determine the effect of increased ionic strength on the rates of sorption. Sampling times were the same except that the last samples were taken after approximately 1200 hours (seven weeks).

All analytical determinations were made by reversed-phase high performance liquid chromatography. A modular system was employed that consisted of a Spectra Physics SP 8810 isocratic pump, a Dynatech LC-241 autosampler with a 100-µL loop injector, a Spectra-Physics SP8490 variable wavelength UV detector set at 210 nm, a Hewlett-Packard 3393A digital integrator, and a Linear model 555 strip chart recorder. Separations were obtained on a 25cm x 4.6mm (5 µm) LC-18 column (Supelco) eluted with 1.5 mL/min of 62/38 (v/v) methanol-water. Baseline separation was achieved for all 10 analytes. Detector response was obtained from the digital integrator operating in the peak height mode. Analytical precision ranged from 0.4 to 3.98 percent, as determined by the pooled standard deviation of triplicate initial measurements.

For each analyte and sample time, a one-way analysis of variance (ANOVA) was performed to determine if the well casing material had a significant effect on analyte concentration. Where significant differences were found, Duncan's multiple range test was performed to determine which samples were significantly different from the controls.

Before the two experiments described previously were performed, a preliminary leaching study was conducted to determine if any substances that could interfere with the analytical determinations leached from the casing materials. For this study, two pieces of each type of well casing were placed in each of two vials. The vials were filled with fresh well water so that there was no headspace, capped and allowed to sit for one week. An aliquot was taken from each vial and analyzed. No detectable peaks were observed in any of the samples.

Results and Discussion

The data for the first experiment are summarized in Table 3, where the normalized concentrations for solutions containing well casings are given as a function of time. Neither type of stainless steel casing affected the concentrations of any of the analytes in solution. However, significant lots of solute did occur in the solutions that contained plastic casings. While the rate of loss differed dramatically from analyte to analyte, losses were always greater for PTFE than PVC.

For RDX and TNB there was no lost of analyte from solutions containing either plastic casing, even after 1000 hours. There was some loss of MNT in the sample solutions that contained PTFE casings but the loss only became significant after 1000 hours (10 percent loss); there was no loss with the PVC casings. TDCE was lost much more readily in samples containing PTFE casings than was its isomer pair, CDCE (Figure 5). (The solid lines shown in this figure and Figures 6,9 were fitted manually.) Figure 6 shows the losses of TCE for the four well casings. Figure 7 shows the rate of loss of the three DCB isomers and CLB in the samples that contained PTFE casings. The order of loss was PDCB and MDCB > ODCB > CLB. While the rate of loss did not exceed 10 percent in eight hours for any of the previous solutes, it is noted that losses of PDCB and MDCB were 16 percent in eight hours and thus were rapid enough to be of concern with respect to ground

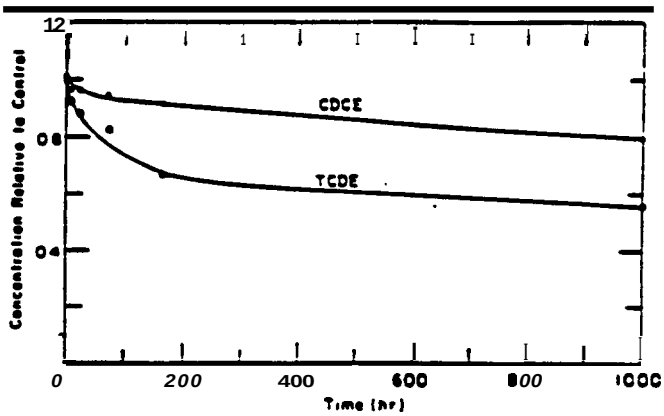


Figure 5. Sorption of CDCE and TDCE by PTFE well casings.

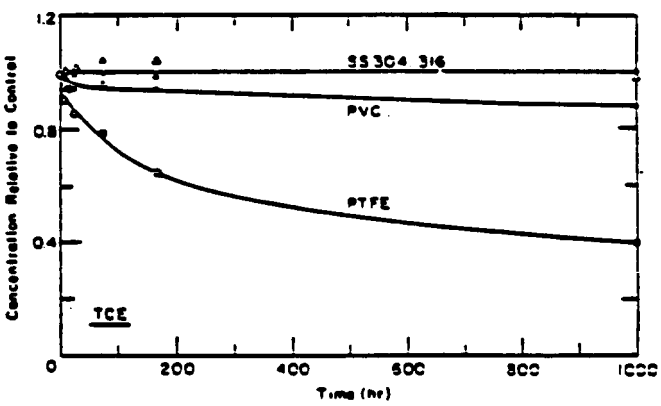


Figure 6. Sorption of TCE by the four well casing materials.

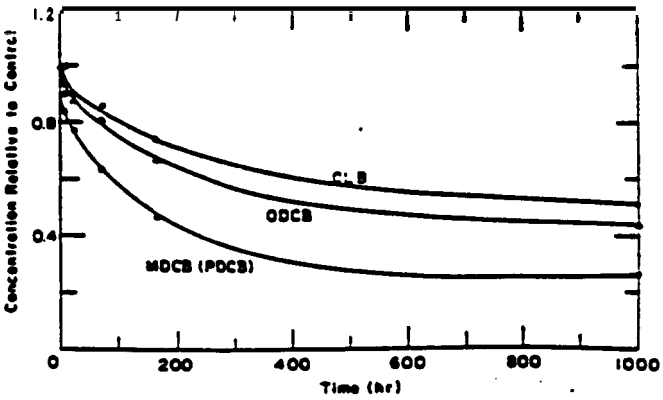


Figure 7. Sorption of CLB, ODCB, MDCB and PDCB by PTFE well casings.

TABLE 4
Results of Desorption Study

Casing Material	Concentration in mg/L after three days equilibration									
	RDX	TNB	CDCE	TDCE	MNT	TCE	CLB	ODCB	PDCB	MDCB
Teflon	ND	ND	0.20	0.43	0.075	0.47	0.28	0.38	0.30	035
	ND	ND	0.21	0.45	0.076	0.48	0.28	0.35	0.34	0.36
	ND	ND	*	*	0.074	o	*	*	*	o
PVC	ND	ND	0.079	0.15	0.046	0.14	'0.10	0.15	0.17	0.18
	ND	ND	0.080	0.14	0.046	0.14	0.10	0.15	0.16	0.21
	ND	ND	0.080	0.15	0.043	0.13	0.11	0.16	0.16	0.20

* Results not presented because of additional loss of volatiles, probably resulting from a loose cap on this vial.
ND = Not detected.

water monitoring. For PVC, losses never reached 10 percent in eight hours for any of the organics tested, and thus the authors believe that PVC is dearly superior to PTFE for wells where water samples will be analyzed for organic constituents.

To determine if the loss of organic solutes was reversible, the pieces of casing that had been exposed to test solution for 1000 hours were rinsed and then exposed to fresh well water for three days. Measurable quantities of all the organics were recovered where significant losses had been observed (Table 4). Thus, loss was due to sorption and was at least partially reversible. Although this experiment did not give us information on the kinetics of desorption, the amount of analyte desorbed after three days generally paralleled the amount sorbed. However, PDCB and MDCB were sorbed to the greatest extent while TCE and TDCE were desorbed to the greatest extent. Therefore. it may be that diffusion out of the polymer is more rapid for smaller molecules.

In the second experiment NaCl was added to raise the chloride concentration above 1000 mg/L. High chloride concentrations are known to corrode 304 stainless steel. Specifically, tests were performed to determine if rusting would alter the sorptivity of the stainless steel surfaces. it is also possible that sorption on plastic materials would change with increasing ionic strength of the test solution.

While addition of NaCl caused rapid rusting of both stainless steel casings (<24 hr), it did not cause sorption of any of the organic solutes by them. In addition, the increased ionic strength had no detectable effect on the rate of sorption by either plastic casing (for example, Figures 8 and 9). These two figures also demonstrate the excellent reproducibility of the results from these two experiments.

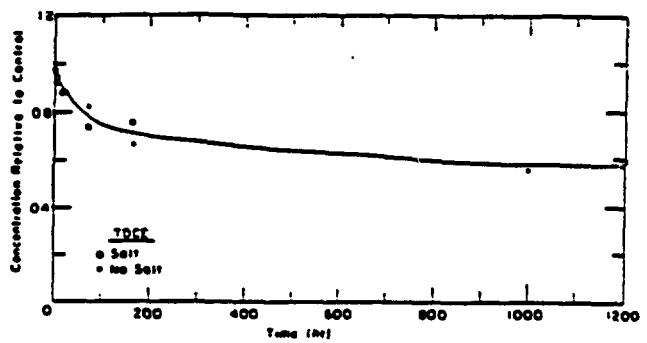


Figure 8. Sorption of TDCE by PTFE well casings in the presence and absence of salt.

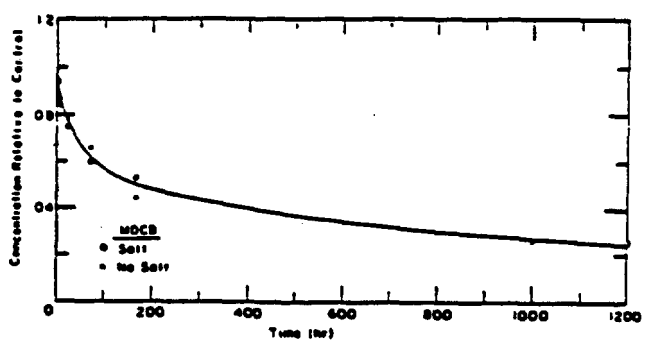


Figure 9. Sorption of MDCB by PTFE well casings in the presence and absence of salt.

Modeling the Sorption Process

These organic studies dearly demonstrated that the loss of organic chemicals from solutions exposed to plastic casing materials is via some reversible sorption process. However. it was uncertain whether this loss was due to sorption on the surface or whether that was penetration into the polymer matrix. The rate of sorption was found to be slow, with no established equilibrium after hundreds of hours. One explanation for this slow rate was that penetration into the polymer was occurring, with the rate controlled by slow diffusion within the bulk polymer and/or the rate of penetration into the small pores on the polymer surface. If it is assumed that this is the case, the process can be kinetically modeled by treating the plastic casing as an immiscible liquid phase in contact with water and relating the degree of partitioning for individual analytes to their octanol/water panition coefficients (K_{ow}). While there are immiscible liquids other than octanol that are better structural models for PTFE or PVC, the most extensive collection of partition coefficients is available for octanol.

If it is assumed that sorption is a reversible process,

$$A_w \underset{k_2}{\overset{k_1}{\rightleftharpoons}} A_s \, , \qquad (1)$$

and is first order in both directions, then the rate equation can be written as (Gould 1959):

$$\frac{d[A_w]}{dt} = -k_1 [A_w] + k_2 [A_s] \qquad (2)$$

where $[A_w]$ is the concentration of solute A in aqueous solution, $[A_s]$ is the concentration of solute A in the plastic casing material, and k_1 and k_2 are the first-order rate constants for sorption and desorption, respectively.

Integration of the rate equation results in a non-linear relationship for A_w as a function of time t and two constants a and b (Equation 3), where a and b are defined in Equations 4 and 5:

$$\frac{\ln (a[A_w] + b)}{a} = t \qquad (3)$$

$$a = k_1 + k_2 \qquad (4)$$

$$b = 10k_2 [A_o] \qquad (5)$$

where A_o is the initial concentration of solute A in aqueous solution.

Optimal values for a and b were obtained for each solute exposed to PTFE by application of the Gauss-Newton method of non-linear curve fitting using the measured concentrations at 1, 8, 24, 72, 128, and 1000 hours (Parker et al. 1989). Using determined values for a and b, the authors simultaneously solved Equations 4 and 5 for each solute to obtain estimates of k_1 and k_2. Because the process described is assumed to be reversible and first order, the ratio of the rate constants, k_1/k_2, is the equilibrium constant, K_{eq}.

When the eight values of K_{eq} were plotted vs. Log K_{ow}, six of the eight points appeared to fall on a straight line, while the points for MNT and ODCB did not (Figure 10). The poor fit for MNT and the lack of significant sorption for TNB and RDX can be explained by the tendency of nitro-containing organic molecules to form strong hydrogen bonds, which keeps them in solution. Water can be a donor in hydrogen bonding, PTFE cannot. Thus, if the authors predict partitioning into PTFE for these molecules based on their octanol/water coefficients, the amount of sorption for these types of compounds will be overestimated.

The poor prediction for ODCB can be explained by the well-documented "ortho effect," which is a complex combination of electronic and steric interactions that often results in ortho di-substituted aromatic molecules behaving much differently than the meta- and para-isomers.

A similar model predicting the loss of analyte for PVC was not created because the percent sorbed was small when compared with the experimental error and this would produce an unacceptable degree of uncertainty in the calculated rate constants.

Therefore, it is concluded that for hydrophobic

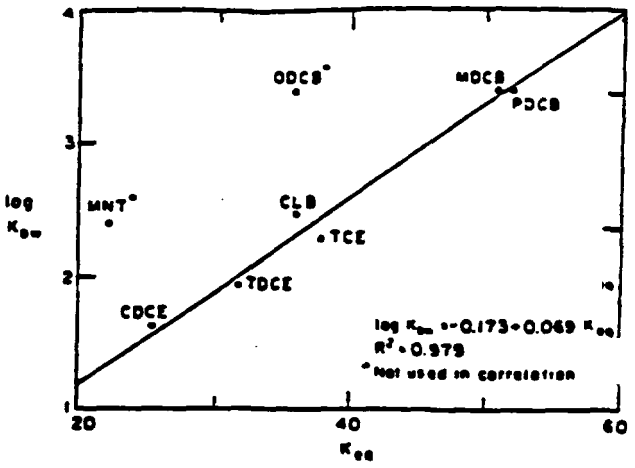


Figure 10. Correlation between log K_{ow} and K_{eq} for solutes exposed to PTFE casings.

organic molecules that are not subject to hydrogen bonding, the relationship presented in Figure 10 can be used to estimate the equilibrium partitioning of an analyte between the aqueous phase and PTFE. It is expected that losses in new wells would occur for some time until equilibrium with the water is achieved.

When K_{eq} will determine the equilibrium concentrations of each analyte in the water and plastic phases, it is the magnitude of k_1 that will determine how quickly various analytes are depleted. For small, planar molecules like TCE, the k_1 values are quite high compared to the other analytes. This may explain the rapid loss of tetrachloroethylene from solutions containing PTFE casings observed by Miller (1982) and Reynolds and Gillham (1986).

Because the rate of sorption appears to be first order, the relative concentration (concentration at a given time relative to its initial concentration) is independent of initial concentration (Castellan 1964). Thus, the percent loss at a given exposure time is expected to be independent of concentration, as was also predicted by the model of Reynolds and Gillham (1986). We did not confirm this, however, by conducting the test at several concentrations.

For further details on the organic portion of this study, refer to Parker et al. (1989).

Summary and Conclusions

In summary, the inorganic study indicated that three of the metals (As, Cr and Pb) were sorbed by one or more of the casing materials. Specifically, Cr was sorbed by SS 316 casings, As was sorbed by both 304 and 316 stainless steel casings, and Pb was sorbed by all four casings. On the other hand, Cd leached from the stainless steel and PVC casings, although subsequent sorption lowered concentrations in the samples containing stainless steel casings. While sorption of As was slow enough that it is probably not of concern for ground water monitoring, the changes in the Cr, Cd and Pb concentrations are of concern. Both SS 304 and 316 casings were subject to surface oxidation, presumably by galvanic action, which apparently provided active sites for sorption and release of major and minor constitu-

ents. Sorption and leaching of metal species was affected in some cases by the ground water composition (pH and organic carbon content). Specifically, there was more leaching of Cd and less sorption of Pb at the lower pH. Our results indicate that humic material may have acted as a complexing agent, making lead and chromium less prone to sorption. If chemical interactions are used as the only criterion, PTFE is dearly the best candidate for monitoring metal species in ground water. PVC would be a good second choice because its performance was considerably better than either SS 304 or SS 316 cas-

In contrast, the organic studies clearly indicated that PTFE was the poorest choice of the four well caring materials tested. PTFE casings sorbed all the chlorinated compounds and one nitroaromatic compound, and losses of PDCB and MDCB were rapid enough to be of concern for ground water monitoring. PVC casings also sorbed some of the same compounds, but always at rates that were considerably slower than those observed for PTFE casings. The rates of these losses on PVC were slow enough that they did not appear to be of concern for ground water monitoring. There was no loss of any of the organic solutes in the presence of either type of SS *casing.*

The desorption study showed that the loss of organics from aqueous solution is due to a sorption process that was reversible. or at least partially so. Desorption from contaminated casing could potentially result in falsely high concentrations of analytes if the concentrations of the analytes in the ground water were to drop.

The loss of hydrophobic organic constituents in the samples containing PTFE casings could be correlated with the substance's K_{ow} values. However. this correlation overestimates losses for hydrophilic organic substances.

There arc several effects that make extrapolating these ten data to a real monitoring situation difficult:

- Casings were tested and not well screens. The rate of sorption could be substantially greater in the screened portions of the well because the surface area of the screened portion would be greater.
- This experiment was conducted under static conditions The effect of sorption under real conditions would be mitigated to some degree. depending on the rate of exchange of water between the aquifer and well casing.

Clearly, choosing one casing material for samples that will be analyzed for both trace metals and organics involves compromise. However. based on the results of the tests that the authors have performed to date, PVC appears to be the best compromise choice of the four casing materials tested.

Future studies will examine leaching of inorganic and organic solutes, the effect of low dissolved oxygen on interactions between the metals and well casings, and the suitability of other materials for ground water monitoring.

Acknowledgments

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lowest rankings are for some benzoic acid, aniline, and phenol derivatives: of course, if some other criteria were used, the ranking might have been somehow different, but probably not too much. For example, the ranking obtained by using Freitag and co-worker's chlorobenzene data and the ranking using Ribo and Kaiser's data are very similar. When a new chemical is developed and its properties are known, it can be easily ranked and compared with other known chemicals or any arbitrary standards. The availability of the program in microcomputer form make the routine applicability easy.

A final comment: the development of a suitable index for environmental risk has bean widely discussed in the literature (3, 4, 12). An index is a suitable scalar function the vector distance components with the best chemicals having the lowest index. Since an index is a scalar quantity, problems concerned with the noncomparability of chemicals cannot arise since the chemicals can always be ranked and represented as a chain in a Hasse diagram. Unfortunately, the choice of a particular index affects the results (7).

A simple esample can clarify the previous arguments: Let C' and C'' he the vector distance components of a chemical C and let $F = C' + 2C''$ be the chosen index. The chemical C2 previously considered has the components $C'_2 = 2$ and $C''_2 = 3$; thus, $F_2 = 2 + 2 \times 3 = 8$. Analogously, for the chemical C3, $C'_3 = 3$, $C''_3 = 2$, and $F_3 = 3 + 2 \times 2 = 7$. As $F_3 < F_2$, the chemical C3 would he considered safer than C2. Conversely, if the inder were $G = 2C' + C''$, then $G_2 < G_3$ and C2 would have to be considered safer than C_3. The conclusions are opposite to each other. They depend only on the index chosen. As a consequence. every time the definition of an index cannot he firmly grounded on a theoretical basis, the results can be completely biased, and the index becomes biased toward a subjective meaning.

Registry No. 1, 108-88-3; 2, 108-86-1; 3, 1817-47-6; 4, 611-06-3; 5, 82-68-8; 6, 65-85-0; 7, 586-76-5; 8, 50-30-6; 9, 62-53-3; 10, 106-47-8; 11, 25265-76-3; 12, 92-87-5; 13, 634-93-5; 14, 91-94-1; 15, 108-95-2; 16, 108-39-4; 17, 123-31-9; 18, 100-02-7; 19, 87-86-5; 20, 128-39-2; 21, 120-83-2; 22, [illegible]-2; 23, 92-52-4; 24, 1[illegible]29-08-8; 25, 34883-43-7; 26, 16606-02-3; [illegible]62796-65-0; 28, 39485-83-1; 29, 71-43-2; 30, 108-90-7; 31, 10[illegible]6-7; 32, 120-82-1; 33, 608-93-5; 34, 118-74-1; 1,2-dichlorobenzene, 95-50-1; 1,3-dichlorobenzene, 541-73-1; 1,2,3-trichlorobenzene, 87-61-6; 1,3,5-trichlorobenzene, 108-70-3; 1,2,3,4-tetrachlorobenzene, 634-66-2; 1,2,3,5-tetrachlorobenzene, 634-90-2; 1,2,4,5-tetrachlorobenzene, 95-94-3.

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Well Construction and Purging Effects on Ground-Water Samples

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■ Multiple well installations of selected casing materials (i.e., poly(tetrafluoroethylene) (PTFE), 304 stainless steel (SS), and poly(vinyl chloride) (PVC)) were constructed and sampled to determine if well purging and construction procedures would significantly bias chemical constituent determinations in ground water. Water quality results from six monthly sampling dates indicate that proper purging of stagnant water from monitoring wells and isolation of cement seals are essential for the collection of representative chemical data. Significant differences in purged samples taken from PTFE, SS, or PVC wells were observed for total organic carbon and volatile halocarbons, which may be linked to the materials' interaction with ground water. The well casing interferences were not predictably high or low for any of the materials.

Introduction

The effects of well construction procedures and sampling Protocols on the reliability of ground-water chemistry investigations have been the subject of a number of research efforts in ihe past 10 years. The published literature has dealt mainly with the potential error introduced by water sampling or analysis (1–3) and by the selection of materials that are appropriate for specific monitoring applications (4, 5). A recent publication details procedures by which ground-water sampling protocols inuy be developed to control systematic sources of sample collection (6). These errors include artifacts of well siting or construction, well purging, and sample retrieval from the well. In general, sample collection errors cannot bo accounted for by traditional laboratory quality control measures. Also, large sampling errors coupled with analytical errors of similar severity can result in the collection of grossly biased data.

Recent work has shown that potential sampling bias due to both sampling mechanisms and flexible tubing materials is of the same order of magnitude (i.e., ±5–20%) as analytical errors for volatile organic compounds (7, 8). These results support the need for very careful consideration of volatilization, sorption, and desorption effects in the selection of sampling pumps or tubing for ground-water investigations.

The effects of drilling fluids, grouts, or well casing interactions with the geologic formation or ground water are

more difficult to evaluate for a number of reasons. Foremost among these reasons is that natural variability in ground-water quality has not been studied in detail. Also, there have been no systematic field studies reported on the effects of well purging or casing materials on organic compound levels in ground water where inert materials have been used as controls. Houghton and Berger (9) have reported significant differences in ground-water dissolved organic carbon and trace metal levels in samples from stainless steel and thermoplastic well casing materials. The observed differences were of the order of analytical bias (i.e., ±10–60%). Laboratory investigations may help in evaluating sources of sampling imprecision or bias; however, systematic field studies are needed to evaluate the actual severity of such errors. The unique details of well construction, completion, development, and the in situ geochemical conditions for an actual ground-water monitoring installation may enhance or limit the potential effects of materials or mechanisms that have been observed in controlled laboratory testing (10).

This study was undertaken to compare the effects of well purging and well construction materials on the reliability of determinations of inorganic and organic chemical constituents in ground water at two sanitary landfill sites in east-central Illinois. Due to the fact that the materials' related errors have been documented for ferrous metal well casing materials other than stainless steel, these materials were not considered in the study (5). Similarly, no solvent cements, nonthreaded joints, or uncommon materials were employed in well construction.

Procedures

Site Descriptions and Well Construction. The two 85–100-acre sites had been operated as municipal landfills/dumps for at least 15 years. Household trash, some light industrial wastes, and other refuse made up the 5–10 million tons of waste emplaced at each site prior to closure. Sampling installations were constructed in May 1983 with hollow-stem auger (10-in o.d., 6-in. i.d.) drilling techniques. All drilling equipment, well casings or screens, split-spoon samplers and steel tapes, etc. were steam-cleaned before they were used to minimize the introduction of foreign materials into the subsurface. Geologic conditions at both sites were characterized as till deposits (i.e., clayey silt with traces of fine to coarse sand) from below the surface topsoil to depths of 6–8 m (20–25 ft). Sand or sand and gravel lenses were observed in split-spoon samples of the till deposits at depths between 8 and 14 m (25–45 ft). All wells were 2 in. in o.d. and were completed at the depth where substantial (>0.5 ft) sand or sand/gravel lenses were observed (see Table I). Wells were placed within 2 m of each other at each location to minimize the potential effects of horizontal inhomogeneities in the formations at the completion depths. At site 1, upgradient and downgradient wells of poly(tetrafluoroethylene) (PTFE, Teflon), stainless steel (SS), and poly(vinyl chloride) (PVC) were constructed. At site 2, stainless steel and PVC wells were completed at upgradient and downgradient locations, and a Teflon/Al oxide, gas-drive dedicated sampler (Marcad) was installed in place of a PTFE (Teflon) well. [illegible] wells were completed with 2-ft screens and packed with Ottawa silica sand from the bottom of the screened inter[illegible] to at least 1 ft above the top of the screen at site 1. [illegible]rtar slurry seals of 2–5 ft were placed in the bore hole [illegible]ove the sand pack of the site 1 wells. The slurry mix c[illegible]sted of 1.5:1.0 mixtures by weight of the silica sa[illegible] with Chem-Comp II shrinkage-compensating cement. T[illegible] wells were finished by backfilling the bore holes to 4–6 [illegible] from the surface with silica sand, and a cement surface [illegible] was

Table I. Field Installations Data

location	material*	depth of screened interval (below land surface), ft
site 1 (upgradient)	PVC	36.5–38.5
	stainless steel (304)	34.5–36.5
	PTFE	35.5–37.5
site 1 (downgradient)	PVC	25.5–27.5
	stainless steel (304)	26.0–28.0
	PTFE	26.0–28.0
site 2 (upgradient)	PVC	32.5–34.5
	stainless steel (304)	32.0–34.0
	gas-drive sampler (Teflon/Al oxide)	30.75–32
site 2 (downgradient)	PVC	40.5–42.5
	stainless steel (304)	40.5–42.5
	gas-drive sample (Teflon/Al oxide)	41.25–42.5

* Materials used in the study were as follows: PVC, rigid poly(vinyl chloride) schedule 40 NSF approved for potable water uses; SS, 304 stainless steel; PTFE, poly(tetrafluoroethylene) (PTFE) (Teflon, Du Pont).

then placed to seal the bore hole from surface water influx. At site 2, the native sand or sand/gravel heaved up above the screened interval from 6 to 15 ft. These installations were completed by placing a cement seal from the top of the heaving material to the land surface.

The wells at both locations were developed within a week of the construction date by use of filtered, compressed air (170 cfm) and procedures described previously (3). The wells at site 2 did not require further development work. Although the wells at site 1 were redeveloped at interval for a period of 12–15 months, turbid water samples were encountered on all sampling dates due to the presence of cement fines.

Well Purging and Sampling. Hydraulic conductivity testing was done on all of the wells at each location to establish their hydraulic performance. The well purging requirements necessary to isolate stagnant water in the well bore were determined by a previously published method (6). Positive-displacement bladder pumps constructed of stainless steel and PTFE with PTFE delivery tubing were utilized for well purging and sampling operations (QED Well Wizard). The pumps were driven by a single controller through a gas manifold, which permitted a simultaneous supply of drive gas (air or N_2) to each pump. Pump intakes were set at the top of the screened interval for both purging and sampling operations.

The experimental design included the measurement of the well purging parameters (pH, Eh, temperature, and conductivity (Ω^{-1})) by use of an in-line flow-through electrode cell prior to well purging. Stagnant water was then collected for NO_3^-, S^{2-}, Fe^{2+}, total organic carbon (TOC), alkalinity, and selected volatile organic compounds. After collection of these samples, the outputs of the pumps were reconnected to the manifold of a flow-through electrode cell to monitor the progress of purging the wells simultaneously. Pumping rates during well purging were controlled between 500 and 1000 mL·min^{-1}, and the purging was continued until the levels of the well purging parameter stabilized to within approximately ±10% over a minimum of 4–5 L pumped (~25% of 1 well volume). All adjacent wells were purged of an equal volume of stagnant water before sampling. The volume depended on site hydrologic conditions and measured hydraulic conductivities. Once well purging was completed, pumping rates were reduced to 100–500 mL·min^{-1}, and samples were taken for the following parameters in order: alkalinity,

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Table II. Well-Purging Effects on Ground-Water Quality

	stagnant	purged	difference (+, −)	change (factor of)
Dissolved Ferrous Irnn. mg·L⁻¹, Site 2 (8/6/85)				
upgradient				
PVC	0.03	0.18	0.15	+5
SS	0.02[a]	0.25	0.23	+12
downgradient				
PVC	0.04	4.57	3.53	+113
SS	1.23	4.37	3.14	+2.6
Dissolved Sulfide. mg·L⁻¹, Site 1 (7/9/85)				
upgradient				
PVC	0.048	0.242	0.194	+4
SS	0.010[b]	0.012	0.002	+1.2
PTFE	0.031	0.172	0.141	+4.5
downgradient				
PVC	0.308	0.047	0.261	−0.85
SS	0.024	0.384	0.360	+IS
PTFE	0.166	0.230	0.064	+0.39

[a] Method detection limit = 0.02 mg·L⁻¹ (accuracy 90% (−10% bias), precision ±15% rsd). [b] Method detection limit = 0.010 my-L. (accuracy 80% (−20% bias). precision ±20% rsd).

TOC, volatile organic compounds. dissolved inorganic constituents, and acid and base/neutral organic compounds. *Pressure filtration of samples* for dissolved constituent determinations was performed in the field. TOC and volatile organic compound samples were collected in 40-mL glass vials, sealed without head apace by PTFE-lined aeptum caps.

Analytical Methodologies and Quality Control. Organic and inorganic chemic91constituents were determined by USEPA-recommended methods (*11, 12*). Total organic carbon (TOC) determinations were performed by a methodology described previously (*13*). Field determinations of alkalinity were performed by potentiometric titration, and the results were analyzed by Gran end-point analysis procedures. On each sompling dare. a series of field standards and blanks were used to account for transport and storage errors, which supplemented the daily analytical procedure control standards for both laboratory and field methods. Replicate samples were analyzed at intervals during analytical sessions to establish the precision and accuracy of the water chemistry data.

Results and Discussion

Well Parging. Stagnant water samples analyzed for pH, alkalinity, reduced inorganic constituents (S^{2-}, Fe(II)), and organic constituents showed higher temporal (i.e., month to month) variability than did the samples obrained after proper well purging. In most cases, well purging resulted in the stabilization of the gross solution chemistry parameters (i.e., pH, E_h, Ω^{-1}, alkalinity) although the concentrations shifted in varying degrees. For example, at site 2, alkalinity levels in stagnant water samples were generally ~25% lower than those measured in water samples after purging. The average magnitude of the alkalinity differences between samples from SS or PVC wells was not significantly different over the course of the study.

In general. the levels of reduced chemical constituents [i.e., Fe(II), S^{2-}] shown in Table II would be expected to be lower in the stagnant water in monitoring wells than in ground water obtained from the formation after purging. The actual concentration differences observed between stagnant and purged samples retlected this trend. However. the magnitude of the differences was quite varinhle and may have been influenced by well casing materials and small-scale heterogeneities in water quality. even in wells that were finished in the same formation less than 5-ft apart. In downgradient wells at both sites, the *stagnant water* from the SS well frequently (i.e., four of six sampling dates) showed higher levels of ferrous iron and lower levels of dissolved sulfide than those from the adjacent PVC or PTFE wells. This would be consistent with leaching of iron from the stainless steel and precipitation of sulfide by the excess iron during stagnant periods. Obviously, PVC and PTFE would not be expected to leach iron in this fashion. Example results for ferrous iron given in Table II show stagnant water values from PVC and SS wells that were significantly differenl at least at the reducing downgradient location. Upon purging, however. ferrous iron values in samples from both upgradient and downgradient locations increased substantially, arid the formation water values from both sets of PVC and SS wells were qual within experimental error. It would seem from these observations that either PVC or SS well awing would be appropriate for ferrous iron determinations if purging is complete. Typical results for dissolved sulfide, an example of which is shown in the lower portion of Table II, reflect somewhat random changes on purging. These changes do not consistently correspond Lo potential well casing effects or the introduction of more reducing formation water. Rather, it seems that variability well above the detection limit and analytical precision can result from natural heterogeneities in water chemistry for some chemical constituents. These average chemical differences in reduced species between stagnant water samples and those obtained after purging were frequently a factor of 5 greater than the errors involved in either the sampling or analytical procedures. Also, purging-related variations in TOC were observed to increase or decrease by ±50% in all wells over the range of 1.20–30.0 my of C·L⁻¹. No consisrent trends in TOC as a function of purging could be associated with the different casing materials. Purging a particular well at either site frequently resulted in greater differences in wnier quality than was observed between upgradient and downgradient ground locations. Improper well purging can obviously cause gross bias in ground-water monitoring results that far exceeds that due to materials's effects or sampling mechanisms.

Cement Grout Contamination. Despite rhe fact that all ttie drilling and well completion operations were held constant. the wells at site 1 exhibited significant water quality differences in both stagnant and formation water samples that could not be attributed to well purging or casing materials. For example. upgradient and downgradient wells at site 1 with the exception of the downgradient PVC well. exhibited pH values in excess of 12 pH units, and the alkalinity was primarily associated with hydroxyl ion. The downgradient PVC well yielded formation samples with pH values between 7 and 8 pH units (mostly bicarbonate alkalinity), and the stagnant water values ranged from 8 to 12 pH units.

Anecdotal references to monitoring well contamination by cement grouts have been reported (*14*). The usual symptom that has been observed is very high solution pH (i.e., 10–12 pH units), even after exhaustive well development. In this study a total of 12 sampling installations was constructed, and the bore holes were sealed above the screen and gravel puck. as well as at the surface with a sand/shrinkage-compensating cement mixture. The grout seals were introduced us thick slurries into standing water in the bore hole utter the well had been constructed.

At site 1, either native geochemical conditions or differential settling of the cement mixture prevented the grout seals from setting Up properly. The wells at this site

Table III. Comparison of Ground-Water Quality and Grout/Water Mixture Analytical Results

	contaminated ground water (field site 1, upgradient)[a]	grout-contaminated water (laboratory)[a]
major species		
pH, pH units	12.7	>13
alkalinity (OH^-), milliequiv·L^{-1}	31.6	167
sulfate	35.9	1076
calcium	190	1069
potassium	8.21	578
sodium	28.6	62
silicate	5.84	a7
conductivity, µS	1975	11500
other species		
magnesium	0.06	0.02
aluminum	<0.10	0.17
chloride	11.0	1.04
iron (total)	0.09	0.10
manganese (total)	0.02	<0.02

[a] Unless otherwise specified, units are mg·L^{-1}.

consistently showed high pH, alkalinity (>90% hydroxyl or caustic), Ω^{-1}, and Ca^{2+} with the exception of the downgradient PVC well, which showed only slightly elevated levels of caustic alkalinity. The apparent cement contamination problem persisted more than 18 months after construction, despite at least 10 redevelopment attempts. The installations at site 2 did not show any evidence of cement contamination, although several early pH measurements of formation water exceeded the long-term mean of ~7.4 pH units.

The cause of this persistent contamination was investigated by careful analysis of a number of cement/sand/water mixtures prepared in the laboratory from the same materials used in well construction. The data in Table III show the comparison of average solution chemistry results from an upgradient well and the aqueous phase of grout/water mixtures prepared in the laboratory. Clearly, the major ionic species identified in the grout-contaminated ground water are represented in the laboratory grout/water mixture aqueous phase. The alkalinity, conductance, and the calcium values in the ground-water samples were all approximately one-fifth their respective levels in the laboratory sample. Attempts to calculate an ion balance on the basis of OH^- as the major anion resulted in ion balances that seldom agreed to better than 40%. There was always an apparent excess negative charge in solution. The possibility of a polymeric or gel phase (e.g., polysilicates) that might interfere with the analytical data or confute the dissolved ion charge balance was examined by $NaHCO_3$ digestion of the aqueous samples prior to analysis (*15*). It was verified that no unusual forms of silica or common alkali or alkaline earth cations were present that might cause gross errors in the alkalinity titrations or wet-chemical analytical methods. Therefore, the grout-contamination problem remains an enigma, although it should be obvious that grouting materials can drastically effect the reliability of ground-water chemistry data for long periods after well construction.

The cement grouts should have been placed either after water had been removed from the well bore or by tremie pipe. Also, the sand pack could have been isolated from the cement grout by a bentonite seal.

Well Casing Material Effects. Apart from the differences noted above (Tables II and III) in the stagnant water samples, no consistent effects on the inorganic chemical constituent data from the two sites were obs[illegible]d

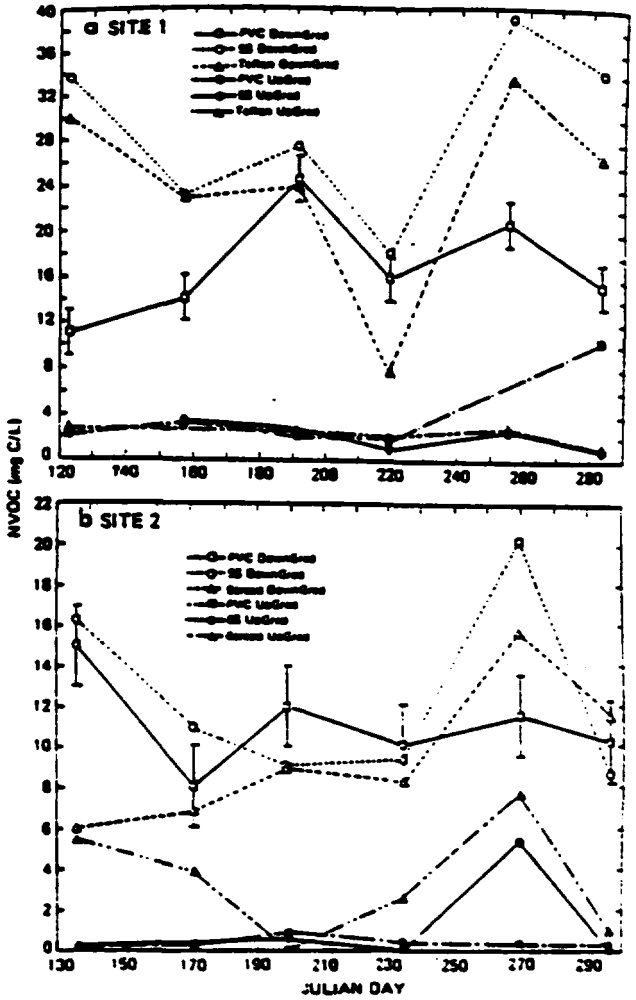

Figure 1. Total organic carbon (mg of C·L^{-1}) in ground water at site 1 and 2. The error bars indicate two standard deviations from the mean of triplicate determinations.

that might be attributed to well casing material exposure alone. Total Fe and Mn concentrations were not significantly different in samples from the SS wells as compared to those from the PVC or PTFE wells. These observations contrast with the elevated metal levels reported by Houghton and Berger on results from a single sampling event (*9*). The divergent results from this study reflect the influence of actual site conditions, temporal variability, and well purging practices on the type and relative severity of sampling and well construction related errors.

At the downgradient locations, all of the installations showed the effects of apparent landfill leachate contamination (i.e., elevated Cl^-, Na^+, K^+, specific conductance, and TOC). The observed levels of TOC or specific organic compounds, however, did not provide evidence of major organic (i.e., volatiles, base–neutrals, and phenols) contamination of these locations.

The observed levels of the nonvolatile fraction of TOC (i.e., NVOC) in ground water from the upgradient and downgradient wells at site 1 after purging are plotted in Figure 1a as a function of time during the summer and fall of 1984. The upgradient samples from each type of well showed negligible differences from the mean TOC of ~3 mg of C·L^{-1}. The downgradient location, however, generally showed higher levels of TOC in samples from the stainless steel and Teflon wells than did samples from the PVC well. On four of the six sampling dates, the positive differences were significant at the 0.05 confidence level.

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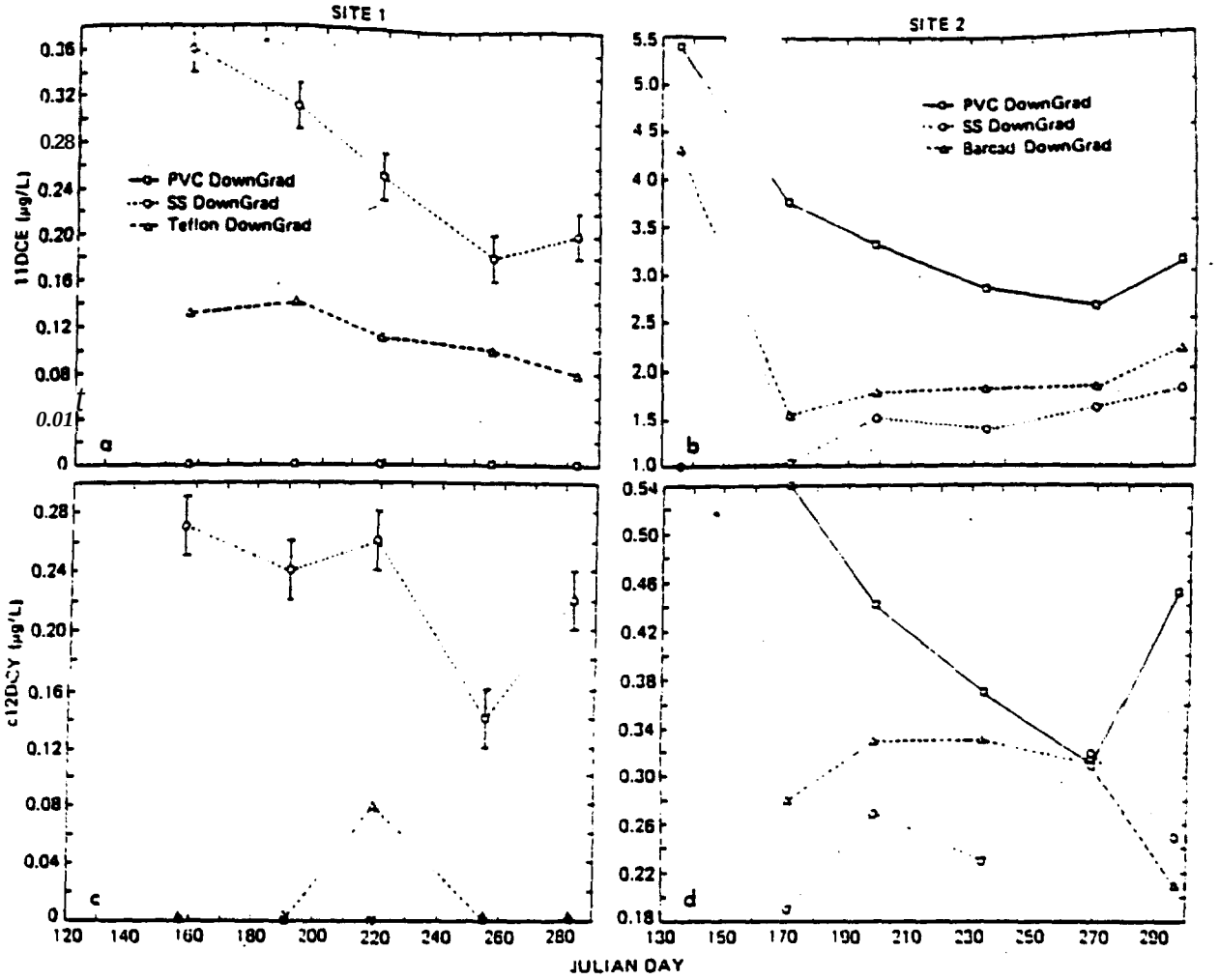

Figure 2. Levels of 1,1-dichloroethane (11DCE) and *cis*-1,2-dichloroethylene (C12DCY) ($\mu g \cdot L^{-1}$) in ground water at sites 1 and 2. The error bars indicate two standard deviations from the mean of triplicate determinations. Detection limit = 0.08 and 0.10 $\mu g \cdot L^{-1}$, respectively.

The TOC results at site 2 showed a similar pattern; however, the differences in samples from the individual well casing materials were not statistically significant when compared to rhe analytical and sampling errors.

At site 1, levels of 1,1-dichloroethane (11DCE) and *cis*-1,2-dichloroethylene (c12DCY) after purging also were higher generally in the samples from the downgradient Teflon and stainless steel wells than in those from the PVC well (Figure 2a,c). The error bars on the figure represent two standard deviations from the mean determined by analysis at replicate samples and standards. In these cases, the "stainless steel" results were significantly higher (at the 0.05 level) than either the Teflon or the PVC data. These concentration levels are all quite low hut in the range of quantitation of the purge and trap analytical methodology. Therefore, systematic differences in observed trace organic compound distributions may arise from the sorptive effects of polymeric well casings as compared to stainless steel. The samples from the differently cased wells at site 1 showed more net difference in purgeable organic compounds than any single well showed over the study period.

Overall, the levels of 1,1-dichloroethane at site 2 (Figure 2b,d) were 10 times above the levels measured at site 1. In contrast wiih the other results, levels of purgeable organics in samples from the PVC well were consistently higher than those in samples from either the stainless steel well or the gas-drive sampler. It is unlikely that the paired wells actually intercepted ground water of different microconstituent quality, as they were finished only 1 m (4 ft) apart. Yet, the PVC and stainless steel results for 11DCE differ by a factor of 2. This is more than 10 times greater than the precision established for analytical determinations of these compounds. This order of materials-related el'fect could result in svstemaiic under- or overestimates of the extent of ground-water contamination, under some conditions. This type of error cannot be accounted for in statistical comparisons of data from upgradient and downgradient locations unless an "inert" artifact-free well casing material can he identified.

The observations noted for site 2 above are also supported by the levels of total volatile halocarbons in ihe PVC and stainless steel wells before and after purging. With the exception of the September 25 sampling date, the stagnant levels of volatile halocarbons from the PVC well are nearly a factor of 2 or more greater than those from the stainless steel installation (see Table IV). On the average, the PVC well yielded samples with higher total levels of volatile halocarbons than did the stainless steel well. It may he that under these conditions the sorptive and leaching properties of PVC tend to maintain a higher background level of organic compounds in ground water exposed to this material relative to stainless steel.

Conclusions

The purging of stagnant water from monitoring wells is essential to the collection of reliable ground-water quality data. In this study, the variations in water chemistry on

Table IV. Total Volatile Halocarbon[a] Levels in Site 2 Wells, $\mu g \cdot L^{-1}$

	PVC		SS	
date	stagnant	purged	stagnant	purged
5/15	7.4	6.2	3.7	1.1
6/19	8.7	7.8	1.1	7.5
7/17	8.8	8.3	3.0	4.8
8/21	7.0	6.8	1.9	4.2
9/25	12.9	6.1	12.2	4.6
10/23	11.2	6.5	6.2	3.9
average	9.3	7.0	4.7	4.4

[a] Included total methylene chloride, dichloromethylene, dichloroethane, trichloroethane, trichloroethylene, tetrachloroethane, and tetrachloroethylene after individual separation and quantitation by gas chromatography with HECD detection.

well purging were generally greater than errors associated with either sampling mechanism, tubing, or apparent well casing material effects.

Cement grout seals, which for one reason or another do not properly set up in the bore hole, can cause severe, persistent contamination of both stagnant and formation water from monitoring wells. Determinations of dissolved inorganic chemical constituents are affected by cement contamination, which significantly changes the background solution composition.

Well casing materials exerted significant, though unpredictable, effects on the results of total organic carbon and specific volatile organic compound determinations. Systematic differences ranging from a factor of 2 to 5 in concentration were observed between samples taken after purging from wells cased with different materials. Though the differences were not consistently higher or lower from site to site, materials' performance may limit the conclusions that may be drawn from ground-water quality results in the low ppb ($\mu g \cdot L^{-1}$) range.

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Registry No. PTFE, 9002-84-0; PVC, 9002-86-2; SS, 12597-68-1; H_2O, 7732-18-5; Fe, 7439-89-6; S^{2-}, 18496-25-8; C, 7440-44-0; 11DCE, 75-34-3; C12DCY, 156-59-2.

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TABLE 9—*Acid compounds and compounds involved in manufacture (μg L⁻¹) sought for in the three leachates from the fiberglass epoxy well casing and powder.*

Substance	Powder Leaching Period 72 h 50 g	Powder Leaching Period 3 Weeks 150 g	Fiberglass Reinforced Epoxy Well Casing 3 Weeks
2-chlorophenol	ND(10)[a]	ND(1.3)	(—)[b]
2,4-dichlorophenol	ND(10)	ND(2.2)	(—)
2,4-dimethylphenol	ND(10)	ND(0.7)	(—)
4,6-dinitro-o-cresol	ND(25)	ND(4.1)	(—)
2,4-dinitrophenol	ND(25)	ND(6)	(—)
2-nitrophenol	ND(10)	ND(2.4)	(—)
4-nitrophenol	ND(10)	ND(2.1)	(—)
p-chloro-m-cresol	ND(10)	(—)	(—)
Pentachlorophenol	ND(10)	ND(2.5)	(—)
Phenol	ND(10)	31	ND(1)
2,4,6-trichlorophenol	ND(10)	ND(1.9)	(—)
Cyclohexene oxide	(—)	4	ND(1)
Bisphenol A	(—)	480	ND(1)
Epichlorohydrin	(—)	ND(680)	(—)
Methyltetrahydrophthalic anhydride	(—)	ND(10)	(—)

[a]ND = not determined at level noted in parentheses.
[b](—) = not determined.

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Adsorption of Selected Organic Contaminants onto Possible Well Casing

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ABSTRACT: In order to assess and monitor the impact of man's activities on ground-water quality, the nature, concentration, and behavior of pollutants in the subsurface must be determined. To do this, it is necessary to collect representative samples of water from the subsurface environment. Ideally, the material chosen as a well casing for monitoring wells should not add or remove constituents from the ground-water sample collected.

The objective of this study was to determine if specific trace organics adsorb and subsequently leach from various well casing materials upon exposure to those specific pollutants for specified periods of time. The types of well casings studied included thermoplastics, stainless steel and fluoroplastics. Of the pollutants studied, only 4-nitrophenol and 2,4,6-trichlorophenol showed appreciable adsorption for all well casing materials. Subsequent leaching of pollutants was not observed in any measurable quantities.

KEY WORDS: adsorption, well casing, ground water, monitoring wells, contamination, leaching

Variables which may cause biased interpretations in ground-water quality monitoring programs can be classified into two main groups, contaminant distribution and sample integrity [1].

Contaminant distribution is concerned with the distribution and extent of the sampling network. Each monitoring well represents a measurement of ground-water quality at a specific location. Therefore, the proper evaluation of ground-water chemistry data for an area is dependent upon the collective interpretation of single well data over the entire area of concern.

In maintaining sample integrity during ground-water sampling it is essential that water samples be collected in a manner that will clearly indicate the actual subsurface contaminant concentrations. This may seem to be a relatively simple task, but in fact it is very complicated. Some of the more familiar processes which may cause a loss in sample integrity are:

1. Contamination of the geologic material near the intake zone of the monitoring well as a result of well drilling and construction.
2. Contamination by materials used in installation of the monitoring well.
3. Contamination by sampling materials.
4. Sample degassing and volatilization.

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5. Contamination from the atmosphere.
6. Contamination by human factors.

Ground-water monitoring wells must be drilled and installed employing techniques that mitigate potential contamination of the aquifer and thus increase the probability of obtaining truly representative ground-water samples. In general, monitoring well casings should be made of materials resistant to suspected contaminants. It is the objectives of this research to investigate the uptake and release of pollutants, with a broad range of solubilities, in contact with potential well casing materials that are most likely to be used for monitoring ground-water contamination.

Adsorption Mechanisms

Adsorption is the adherence of a substance (adsorbate) onto the surface of another substance, called the adsorbent. Absorption, on the other hand, is the penetration of one substance (absorbate) into the inner structure of another substance, called the absorbent [2]. Since both of these processes frequently occur simultaneously, the term sorption is often used to encompass both adsorption and absorption. Throughout this report adsorption and sorption are used synonymously since the predominant mechanism of pollutant removal is considered to be surface removal or adsorption [3].

The degree of solubility is the most significant factor in determining the intensity of the lyophobic nature of the solute for the solvent. The more a substance likes the solvent system (hydrophylic), the less likely it is to be adsorbed. Conversely, a hydrophobic (water disliking) substance will more likely be adsorbed from aqueous solution. Therefore, one would expect an inverse relationship between solubility and adsorption. Solubility and adsorbability relationships will, however, vary between different classes of compounds. It has been shown that adsorption increases with increasing octanol-water partition coefficients (log of adsorption constant) and that the octanol-water partition coefficient may be a more significant quantity than solubility due to a broader application [4]. The significant point is that properties of chemicals such as pK, solubility, or partition coefficients are particularly significant in determining the extent and rate of adsorption [5].

A second primary driving force for adsorption results from an affinity of the solute for the solid. This affinity of solutes for the solid may be considered in three types of adsorption phenomena:

1. Electrical attraction of the solute to the adsorbent (exchange).
2. van der Waals' force (physical).
3. Adsorption of a chemical nature (chemisorption).

Adsorption due to electrical attraction of the solute to the adsorbent is often called exchange adsorption and falls within the realm of ion exchange. Exchange adsorption is the process by which ions of a substance concentrate at specific charged sites on the surface of the adsorbent.

Adsorption due to van der Waals' forces is termed physical adsorption, which represents cases where the adsorbed molecule is not fixed to a specific surface site but is free to move about on the adsorption interface.

Chemical adsorption occurs when the adsorbate and adsorbent chemically interact. Molecules which are chemically adsorbed are not free to move about the adsorption interface.

Physical adsorption is normally predominant at low temperatures and is characterized by low energies of adsorption. Conversely, chemical adsorption predominates at higher temperatures due to chemical reactions proceeding more rapidly at high temperatures.

Most adsorption processes are a result of a combination of all three forms of adsorption and normally it is not easy to distinguish between chemical and physical adsorption [6].

Many factors influence adsorption. These factors are discussed in relation to the following general categories:

1. Surface area.
2. Nature of the adsorbate.
3. pH.
4. Temperature.
5. Mixed solutes.
6. Nature of the adsorbent.

Because adsorption is a surface phenomenon, the extent of adsorption is a function of the available adsorptive surface area. Therefore, the more finely divided and the more porous the solid, the greater normally the amount of adsorption.

As previously stated, the solubility of the solute is, to a large extent, a controlling factor for adsorption processes. The effects noted relative to solubility-adsorption relationships can be seen by conceptualizing that some form of solute-solvent attraction must be overcome before adsorption can occur. The stronger the solute-solvent attraction, the greater the solubility; therefore, a smaller amount of adsorption occurs.

In general, the solubility of any series of organic compounds in water decreases with increasing chain length. The longer chain compounds decrease in solubility because, as more carbon atoms are added, the compounds become more hydrocarbon-like. This principle is stated in Traube's rule, which says that "adsorption from an aqueous solution increases as a homologous series is ascended" [6].

Polarity of adsorbate is another factor influencing adsorption. A general rule for predicting the effects of solute polarity on adsorption is that a polar solute will prefer the phase which is more polar. Simply stated, in adsorption "like" adsorbs "like," or polar surfaces prefer polar adsorbates and nonpolar surfaces prefer nonpolar adsorbates [7]. Since water is a polar molecule, polar solutes tend to be more soluble in water than nonpolar solutes.

The pH of a solution may significantly influence the extent of adsorption of organic pollutants from an aqueous solution. In general, adsorption of typical organic pollutants from water is increased with decreasing pH [8].

Temperature is another factor which can influence adsorption. Adsorption reactions are normally exothermic; therefore, the extent of adsorption generally increases as the temperature decreases [6].

Mixed solutes in a solution can also significantly affect the extent of adsorption of pollutants onto a surface. The pollutants may mutually enhance adsorption, may act relatively independently, or may interfere with one another. Similarly, since the adsorption of one substance tends to reduce the number of adsorption sites, the concentration of pollutants becomes important because it is the pollutant concentrations which provide the driving force to produce adsorption of the various substances. The presence of other solutes in an aqueous mixture can adversely affect the adsorption of the first compound [9].

The physicochemical nature of the adsorbent can have profound effects on both the rate and extent of adsorption. Every solid is a potential adsorbent but will react differently depending upon physical structure, chemical surface characteristics, and environmental conditions.

Organic Adsorption and Leaching

The adsorption and leaching of organic compounds with various container and potential well casing materials have been studied to a much lesser extent than have inorganics (that is, trace metals). Organics are adsorbed by organic matter in porous media [10] and to a smaller degree on mineral surfaces [11]. Organics can also be adsorbed by a range of man-made surfaces o include well casing material. For example, the adsorption of dichlorodiphenyltrichloroethane (DDT) onto most surfaces, including stainless steel, has been documented 1/11. Another example

is the investigation of he interaction of *m*-cresol with two types of plastic tubing [13]. Industrial grade polyvinylchloride (PVC) tubing and Bev-a-line very high temperature (VHT) tubing were exposed to an *m*-cresol solution for varying lengths of time up to two hours. The *m*-cresol was progressively lostd the PVC tubing in amounts proportional to the increasing contact time. while no measurable loss of *m*-cresol to the VHT tubing occurred.

Researchers have determined that organic contamination ranging from I to 5000 ppb by weight was detected in "organic free" water whkh had flowed through tuks of polyethylene, polypropylene, black latex, six formulations of PVC, and a plastic garden hose [14]. Among the contaminant8 found from PVC were o-cresol. naphthalene. butyloctylfumarate and butyl-chloroacetate. The amount of plasticizers in PVC tubing is approximately 40% by weight and represents an essentially inexhaustible supply of contamination. Should this supply of plasticizers eventually be depleted, he contamination will decrease but the tubing will have lost its flexibility and will therefore need to be replaced. However. in the case of relatively rigid polyethylene and polypropylene tubes, it was found that the tubes may eventually become noncontaminating. It should be noted that rigid PVC well casing contains a much smaller content of plasticizers and is thus much less likely to leach contaminants into contacting water.

In one recent laboratory experiment, "organic free" water w u passed through five types of plastic tubing, including polypropylene. polyethylene, polytetrafluoroethylene (TFE), vinyl chloride and vinyl acetate copolymer, PVC (with glue), and PVC (non-glued) [15]. The results indicate low levels of leachates from all the tubing tested except TFE. which disclosed no leachates. Between one and five contuninants were found leached into the water from nonglued PVC, polyethylene. and polypropylene at less than 0.5 ppb. Numerous contaminants were found leached from glued PVC and Tygon. Two organic chemical spikes, naphthalene and para-dichlorobenzene, were not retained (sorbed) significantly by any of the tubing except Tygon.

A recent field and laboratory study included assessment of the potential for contamination of ground-water samples by six PVC *primers* and one PVC adhesive [16]. Tetrahydrofuran (THF), methylethylketone (MEK), methylisobutylketone (MIBK), and cycloheranone were found to be leached into the water surrounding bonded joints. Even though a well was developed after installation and bailed prior to sampling. detectable levels of these compounds were found in well water several months after installation. After immersion of freshly cemented PVC pipe for five drys, up to 110 ppm of MEK was found. After five washings and a 24-h equilibrium, the concentration of MEK was reduced to about 0.54 ppm. Similar trends were noted for the other three pollutants studied although the presence of each constituent and their relative concentrations varied significantly between solvent brands and manufacturers. All four compounds could be introduced into monitoring wells by one or more of the brands of adhesive, Concentrations of contaminant8 declined significantly with successive washes with deionized water. from a mean total concentration of 77800 ppb after five days of soaking to a mean total of S91 ppb after king washed four more limes with deionized water and soaked for an additional 24 h.

Field sampling with a PVC bailer constructed several weeks before sampling resulted in samples with low levels of THF and MEK. With a PVC bailer constructed 30 min prior to sampling, 16000 ppb cyclohexanone, 3800 ppb MEK and 1400 ppb THF were found in a ground water sample. Contaminants in PVC solvents can mask the presence of other volatile priority pollutants that elute from the chromatograph at similar retention times. For example, MEK and 2,3-dichloroethane, cyclohexanone and bromoform, and THF and 1,1-dichloroethane all co-elute with the Environmental Protection Agency (EPA) analytical protocol. All these problems can most simply be circumvented by using well casings and bailers constructed with threaded joints [16].

While PVC is the most common type of synthetic well casing material in use. other synthetic materials have been used or could be used. including acrylonitrile butadiene styrene (ABS), styrene-rubber (SR), polyethylene. polypropylene. TFE, and polyvinylidene fluoride (PVDF). When sampling for organic contaminants, the generally recommended order of choice of well

casing and sampling materials is glass, TFE, stainless steel, polypropylene, polyethylene, and other plastics. metals, and rubber 1/21. However, the same researchers indicated that detailed experimental data on materials selection are simply not available.

The leaching of residual vinyl chloride monomer (RVCM) has been an area of concern and intense investigation since the discovery of a link between vinyl chloride monomer and a rue furm of liver cancer (hemangiosarcoma) in humans. Through a massive research effort a limit of 10-ppm HVCM was established based on the conclusion that vinyl chloride migration from the wall of nominal 25.4-mm-diameter (I in.) Schedule 40 PVC pipe (containing 10-ppm RVCM) into stagnant water retained in the pipe will be undetectable at a 2.0-ppb sensitivity in analysis. Today at least 98% of the PVC manufactured in North America contains less than 10-ppm RVCM and most contains less than 1 ppm RVCM 1/71.

The water leachability of components of PVC and CPVC piper has been investigated in another recent study 1/81. The extract water was analyzed for I number of volatile and extractable compounds and data indicate that the following organics were consistently found in significant concentrations:

CEMENT SOLVENTS	VOLATILE ORGANICS
MEK	Dichloromethane
THF	Carbon tetrachloride
Cyclohexanone	Tetrachloroethene
DMF	Trichloroethene
	Toluene

The cement solvents were found in the ppm range but concentrations decreased rapidly with rinsing. The volatile organics were typically found in the I to 10 ppb range except for toluene. which typically was detected under I ppb. These levels will not necessarily be found when cement solvents are avoided.

Investigations of water leached from PVC and CPVC pipes with and without cemented joints were performed in another study 1/91. This testing was to determine whether leaching of chloroform and carbon tetrachloride was caused by the solvent cementing of pints. Chloroform was not found in the leachate from either PVC or CPVC. However, carbon tetrachloride was found at very low concentrations in the leachate from the CPVC pipe.

Schedule 40 PVC, polyethylene. and polypropylene well casing materials were examined by king exposed under batch conditions to two metal pollutants and sir volatile organic pollutants [20]. Under the conditions of the experiment *h* was generally found that Schedule 40 PVC caused fewer monitoring interferences with volatile organics than did polyethylene or polypropylene. Also. no extractable pollutants were leached from the well casing materials under the conditions of the study.

Well casing materials can bias ground-water sampling efforts by adsorption of constituents. which results in lesser concentrations in the sample than in the ground water. by leaching of adsorbed constituents. leaching of casing constituents, and by permeation of constituents through the well casing from outside. The latter three mechanisms can 111 result in higher concentrations of chemicals in the sample than in the ground water. There are virtually no published field data comparing the adsorption of leaching that occurs with different well casing materials and there are only limited laboratory data. Most of the research is with tubing or piping that may have more plasticizers than well caring materials. Some research used laboratory water and high-purity chemical contaminants that ut not indicative of field conditions, and no researchers have found a way to simulate field sampling conditions in the laboratory for comparative study of well casing influence. Generally recommended lists of well casing materials have been published with the acknowledgment that they are not based on detailed experimental data.

Classes of Well Casing Materials

Well casings could be fabricated from almost any material. Under improper conditions, many of these materials could contribute to biased ground-water sampling either through adsorption or leaching of contaminants. The well casing materials selected for this study are representative of the general classes of materials that have a history of use in ground-water monitoring or are likely candidates for use nationwide in sampling ground water for organic contamination.

Plastics

Plastics fall into two major categories, called thermosets and thermoplastics. Thermosets are those plastics which, once shaped, cannot be reshaped even if reheated. Thermoplastics can be softened and rehardened by heating and cooling. This allows thermoplastics to be easily molded or extruded into pipes and fittings [21].

The plastics most commonly used in ground-water monitoring fall into the thermoplastics category and include [1].

acrylonitrile butadiene styrene (ABS)
polyvinyl chloride (PVC)
styrene-rubber (SR)
polyethylene (PE)
polypropylene (PP)
polytetrafluoroethylene (Teflon—TFE)

Thermoplastics are resistant to electrical and electrochemical effects and are generally resistant to attack by naturally occurring chemical compounds. For this reason, thermoplastics have been extensively used in monitoring inorganic ground-water constituents [1]. Because thermoplastics are very susceptible to attack by organic compounds, however, extreme care must be exercised in monitoring situations where organic pollutants are present.

Metals

The most commonly used metals in ground-water monitoring are iron, stainless steel, brass, aluminum, and copper [1]. Metal well casings (predominantly iron and stainless steel) are very strong and rigid; however, they can contaminate ground-water samples in a number of ways. Metal contaminants can be leached from metal well casings into the water supply. Metallic materials will also release in water the by-products of deterioration processes such as oxidation and corrosion. As previously discussed, metal well casing can also serve as an adsorbing surface for a wide variety of organic and inorganic ground water constituents.

Glass

When considering inertness, glass has been shown to be the material of choice for use in sampling water for organic compounds [12]. In spite of its nature, glass can serve a useful purpose at several points in the sampling equipment. Glass is considerably less expensive than other materials of similar inertness such as TFE and is therefore most useful as sample container material. Due to its fragility, however, glass is not used to make well casings.

Procedure

Well Casing Materials

The particular well casing materials used in this study were chosen because of their availability and repe[illegible] in ground water quality monitoring programs. They were:

1. PVC-40 (polyvinyl chloride—Schedule 40)
PVC-80 (polyvinyl chloride—Schedule 80)
3. ABS (acrylonitrile butadiene styrene)
4. Teflon (3 types)
   a. TFE—tetrafluoroethylene
   b. PFA—perfluoroalkoxy
   c. FEP—fluorinated ethylene propylene
5. Stainless steel (304)
6. Kynar (PVDF = polyvinylidene fluoride)

Polyvinyl chloride (PVC)—Polyvinyl chloride is produced by end-to-end polymerization of vinyl chloride ($CH_2{=}CHCl$). The resulting structure is $—CH_2—CHCl—CH_2—CHCl—$ [22]. The suspension aids for PVC are normally cellulose ethers or polyvinyl alcohol, and the polymerization catalysts are typically organic peroxides. Both types of material may occur in small residual quantities in the finished polymer. The peroxides will degrade to other compounds [23].

The production process involves the combination of PVC resin with various types of stabilizers, lubricants, pigments, fillers, processing aids, and plasticizers (such as titanium dioxide, calcium carbonate, fatty acid-metal salt, oxidized polyethylene wax), all of which are potential sources of leached pollutants [23].

Acrylonitrile Butadiene Styrene (ABS)—ABS is the name given to a unique family of engineering polymers. The acronym is derived from the names of the three monomers used to produce the polymers: acrylonitrile ($CH_2{=}C—N$), butadiene ($CH_2—CH—CH{=}CH_2$), and styrene (vinylbenzene). The three-monomer system can be tailored to end-product needs by varying the ratios in which they are combined. Acrylonitrile contributes heat stability, chemical resistance, and aging resistance; butadiene imparts low-temperature property retention, toughness, and impact strength; and styrene adds luster (gloss), rigidity, and processing ease [24]. The additives for ABS are similar to those for other polymers: antioxidants, lubricants, pigments, and fillers. Typically, ABS uses carbon black as a pigment.

Stainless Steel (304)—Stainless steel is often chosen as a well casing material due to its strength and resistance to rusting and corrosion. Stainless steel has the potential, however, to leach heavy metals into the aqueous environment. These include chromium, nickel, molybdenum, iron, titanium, cobalt, and tungsten. There is also the possibility of an iron oxide coating developing over the surface of the steel. This coating can have unpredictable and changeable effects upon the adsorption capacity [25].

Fluoroplastics—Fluoroplastics are plastics based on polymers made from monomers containing one or more atoms of fluorine. All fluoroplastics are made by free radical initiated polymerization or copolymerization of the monomers. Fluorocarbon plastics are those made from perfluoro monomers. The fluorocarbon plastics chosen for this study were tetrafluoroethylene (TFE), fluorinated ethylene propylene copolymer (FEP), and perfluoroalkoxy resin (PFA). Another important fluoroplastic chosen to study was polyvinylidene fluoride (PVDF—not a fluorocarbon). The fluoroplastics were readily available and TFE and FEP have a history of use in ground-water monitoring programs [26].

Fluoroplastics, and especially fluorocarbon plastics, have unique properties which include high resistance to harsh chemical environments and high temperatures, useful electrical properties, good mechanical properties, low wettability, and low coefficients of friction.

Tetrafluoroethylene (TFE) is made in larger quantities than all other fluoroplastics combined. TFE has an exceptionally low coefficient of friction that produces the antistick properties of its surface. In fact it has the lowest coefficient of friction of any solid [28]. TFE and FEP have been

used as well cuing and screen materials for ground-water monitoring wells and are considered by some to be ideal materials fa monitoring well construction [26].

Fluorinated ethylene propylene (FEP), in general, has properties similar to those of TFE. FEP is not as tough as TFE radiis strength properties decrease more rapidly with increasing temperature. FEP retains most of the electrical properties of TFE, is insoluble in essentially all organic solvents, cll is resistant to corrosive organic reagents.

Perfluoroalkoxy resin (PFA), has mechanical properties at elevated temperatures similar to TFE and much better than FEP. PFA is about equal to TFE in strength, hardness, and wear resistance. Its resistance to chemicals is similar to that of FEP.

Polyvinylidene fluoride (PVDF) is slightly less dense and has a lower melting point than TFE. Ia strength and resistance to wear, however, PVDF is generally similar to TFE [27].

Pollutants Evaluated

Pollutants used for this study were chosen from compounds that, according to the literature, have been and are most likely to be found in ground water. These compounds are all priority pollutants and are less volatile and more polar than those examined in previous studies [20,29]. Another consideration in choosing the pollutants is their wide range of solubilities in water. Table 1 lists the pollutants evaluated and their solubilities in water.

Exposure Solutions

Solutions used for exposing the well casings to the pollutants were made from laboratory water. and nonpolluted and polluted ground water. All three of these types of water were inoculated with the pollutants and the well casings were placed in the appropriate vials for the appropriate experimentation.

Laboratory water free of interferences (organic free) was prepared with a Barnstead Nanopure II Cartridge System followed by a Barnstead Organicpure Water Purification System.

The nonpolluted ground water was taken from Byrd's Mill Spring in Fittstown, Oklahoma. Byrd's Mill Spring is the source of drinking water for the town of Ada, Oklahoma. Byrd's Mill water has been extensively analyzed by personnel of the Robert S. Kerr Environmental Research Laboratory, U.S. Environmental Protection Agency, in Ada. Oklahoma. Table 2 gives data gathered on Byrd's Mill Spring water [30].

The polluted ground water was taken from the northeastern part of Oklahoma in the Tar Creek watershed area. Since November 1979 the Tar Creek watershed has received highly mineralized wid mine discharges from flooded underground lead-zinc mines of the Picher Field in Ottawa

TABLE 1—*Pollutants evaluated.*

Pollutant	Solubility in Water, mg/L	
2,4,6-trichlorophenol	800	(25°C)
4-nitrophenol	16000	(25°C)
Diethyl phthalate	896	(25°C)
Acenaphthene	3.42	(25°C)
Naphthalene	31	(25°C)
1,3-dichlorobenzene	123	(25°C)
1,2,4-trichlorobenzene	30	(25°C)
Hexachlorobenzene	0.020	(25°C)

TABLE 2—*Data for Byrd's Mill Spring—nonpolluted ground water (background levels).*

Constituent	Concentration
pH	1.2 SU
Sodium	5 mg/L
Potassium	2 mg/L
Calcium	77 mg/L
Magnesium	47 mg/L
Alkalinity	325 mg/L
Hardness	340 mg/L
Conductivity	600 μmhos/cm
Total dissolved solids	345 mg/L
Ammonia	<0.01 mg/L
Nitrate	1.1 mg/L
Ortho-phosphate	0.010 mg/L
Total phosphorus	0.015 mg/L
Sulfate	1 mg/L
Chloride	4 mg/L
Chlorobenzene	0.5 μg/L
bis-(2-chloroethyl)ether	1.3 μg/L
Phenol	0.6 μg/L
2-chlorophenol	0.1 μg/L
1,2-dichlorobenzene	0.7 μg/L
Nitrobenzene	0.7 μg/L
2,4-dichlorophenol	1.3 μg/L
1,2,4-trichlorobenzene	0.9 μg/L
2,4,6-trichlorophenol	1.3 μg/L
Diethyl phthalate	0.7 μg/L

County, Oklahoma. The pH of the specific samples used for the study was 2.95. Table 3 gives average data on a number of polluted ground-water samples taken for this study [31].

The exposure solutions were made by first weighing the compounds (0.0200 to 0.0300 g) into a conical-bottom reaction vial. The solid compounds dissolved in the liquid compounds at room temperature. To make the working exposure solution. 3.5 μL (3.5 μg) of the stock solution was injected into a 2-litre borosilicate flask filled with either "organic free." Byrd's Mill, or Tar Creek wafer (final concentration is approximately 250 ppb). A pound-glass stopper was then inserted into the flask, eliminating headspace, to prevent loss of more volatile compounds. The solution was then stirred for 48 h in the absence of light and then used in the respective experimental tasks.

Analytical Methodologies

Atomic Absorption and Emission *Spectroscopy*—The metals analyses for the Tar Creek samples were performed on a Spectraspan IIIB D.C. Argon Plasma Emission Spectrometer with Dynamic Background Compensator. The low-level (<0.100 ppm) metals analyses were completed on a Perkin-Elmer 5000 Atomic Absorption Spectrophotometer equipped with a Model 500 Heated Graphite Atomizer.

High-Performance (Pressure) Liquid Chromatography (HPLC)—The HPLC analyses were completed on a modular unit made by Beckman. The pumps were Beckman Model 110, a d a Hitachi Model 100-40 variable-wavelength ultraviolet (UV) spectrophotometer was used as the detection system. The HPLC column was a Beckman Ultrasphere O.D.S. reverse-phase column

TABLE 3—*Data[a] for Tar Creek—polluted ground water (background levels)*

Constituent	Number of Samples	Mean	Standard Deviation	Minimum	Maximum
Specific conductance (μmhos/cm)	11	3659	441	3150	4530
pH (SU)	11	2 5	0 4	1.9	3 3
Dissolved oxygen (mg/L)	9	1 5	2 4	1.4	8 9
Iron (mg/L)	4	110	17 3	92	133
Zinc (mg/L)	4	88 8	30 6	56	110
Cadmium (mg/L)	4	0 362	0 074	0 260	0 430
Lead (mg/L)	3	0 199	0 081	0 121	0 282
Chromium (mg/L)	1	0014		0 014	0 014
Fluoride (mg/L)	8	6 60	0 50	6 00	7 19

[a] Mine discharge from a large subsidence pit filled with mine water located in the southwest part of Commerce, OK.

with 5-μm particle size. The column dimensions were 4 6 mm inside diameter hy 25 cm in length The chromatography was performed using an isocratic 60% acetonitrile solution with a flow rate of 2.0 mL/min, and at a wavelength of 226 nm.

Extraction and Elution Procedures—An adaptation of a minicolumn procedure for concentration of organics from aqueous solution as reported in the literature war used to simplify the concentration procedure [32,33]. The baric procedure involves extracting the organics from a 30-mm sample hy passing the sample through a minicolumn (TFE, 1.2 to 1 8 mm Iy 25 mm) containing a 50:50 mixture of XAD2:XAD8 resins. Ihc sorbed organics are then eluted into 2 nil. of a 15%:85% acetone:hexane solution for analysis.

Experimental Work

Adsorption (Uptake) Experiment

The objective of the adsorption experiment was o determine what percentage of the pollutants in the neutral pH ground water (unpolluted from Byrd's Mill Spring), exposed to the well casings, would be adsorbed onto the surface of the well casings.

Segments measuring 7.62 cm (3 in.) of each well casing wcic exposed to the pollutants in 40 mL borosilicate glass exposure chambers with TFE-lined caps. Batches of exposures were sampled initially. after one, three, and six weeks for a total of three batches of 36 vials plus eight initial samples. Duplicate exposure chambers were prepared for each well casing and the chambers were sacrificed upon sampling to eliminate head space as a variable.

The adsorption experiment results are given in Tahk 4. The results are indicative of adsorption after six weeks of exposure; however. the observed percentages of adsorption occurred within the first week of exposure. There were no appreciable changes in adsorption percentages from the first week to the sixth week except for 2,4,6-trichlorophenol (TCP). TCP adsorbed partially after one week and totally adsorbed after three weeks as indicated

This experiment Indicates that for the experimental conditions and compounds used the TFE well casings might be less likely to adsorb pollutants. At these concentration levels, however, the TFEs and PVC-40 and 80 exhibited very little difference in the amounts of adsorption

TABLE 4—*Percentage of pollutant adsorbed per well casing after six weeks of exposure*

Casing Material	4-Nitrophenol	2,4,6-Trichloro-phenol[a]	Diethyl Phthalate	Naphthalene	Acenaphthene
PVC-40	100	0	0	48	59
PVC-80	100	9	0	49	68
ABS	0	44	5	0	48
Stainless steel	100	31	0	19	58
Teflon-PFA	100	0	0	53	71
Teflon-FEP	100	18	9	79	83
Teflon-TFE	68	53	0	51	66
Kynar-PVDF	100	56	0	61	55

[a] Percentages adsorbed after 1 week—100% adsorption occurred after six weeks of exposure

Leaching (Release) Experiment

The objective of the leaching (release) experiment was o determine what portion, if my. of the adsorbed pollutants, after a six-week exposure period, would kach or be released hack into noncontaminated ground water.

Experimental design and analytical methods were the same lis for the adsorption experiment, the only difference king that after the well casings were exposed and allowed o adsorb pollutants fur sir weeks the contaminated ground water was replaced with nonpolluted ground water The water from the exposure chambers was then sampled initially, after 1 h. 4 h. 24 h. 4 days, and 14 days. These samples were analyzed to allow an assessment of the rate of release of pollutants back into the noncontaminated ground water.

As can be seen from Table 5, very little leaching of adsorbed pollutants actually occurred over the 14-day period. PVC-80 and PFA-TFE were the only well casings exhibiting any leaching and both leached naphthalene. For all practical purposes, only zero to trace amounts of the sorbed pollutants were released into noncontaminated ground water.

Adsorption Sirr Experiment

The objective of the adsorption site experiment was lo determine if a proportionally greater amount of adsorption occurred at the rougher, cut ends of PVC-80 well caring than at the smooth,

TABLE 5—*Percentages of pollutants leached of percentages adsorbed*[a]

Casing Material	4-Nitrophenol	2,4,6-Trichloro-phenol[b]	Phthalate	Naphthalene	Acenaphthene
PVC 40	0	0	0[b]	0	0
PVC-80	0	0	0[b]	60	0
ABS	0[b]	0	0	0[b]	0
Stainless steel	0	0	0[b]	0	0
Teflon PFA	0	0[b]	0[b]	100	0
Teflon FEP	0	0	0	0	0
Teflon TFE	0	0	0	0	0
Kynar PVDF	0	0	0	0	0

[a] Two-week leaching period after six-week adsorption.
[b] None adsorbed

TABLE 6—*Percent adsorption of pollutants in low-pH (3.0) polluted ground water.*[a]

Casing Material	4-Nitrophenol	2,4,6-Trichloro-phenol[a]	Diethyl Phthalate	Naphthalene	Acenaphthene
PVC-40	15	0	0	100	46
PVC-80	100	0	0	23	0
ABS	60	0	76	72	40
Stainless steel	13	28	48	0	18
Teflon-PFA	0	0	29	90	0
Teflon-FEP	0	17	47	17	0
Teflon-TFE	17	14	35	0	64
Kynar-PVDF	31	28	38	0	21

[a] Six-week exposure.

finished surface of the well casing material. To make this determination. segments of PVC-80 were threaded at each end, filled with exposure solution (laboratory water), and capped.

The samples analyzed were exposed for one week in the threaded exposure chambers. After computing the surface areas available for both the adsorption and the adsorption site experiment it was found that the percentage adsorbed per squire centimetre was independent (within 5 to 10%)of the surface area of the rough ends of the well casing material exposed in the first adsorption experiment.

Ihc rough edges were only a small percentage (3 lo 5%) of the total surface areas available for adsorption. Since the extent of rdsorption is a function of the available adsorptive surface area, the observed adsorption percentages are not surprising [6]. It was necessary, however, lo make this determination so that consistent adsorption. no matter what rate and extent, could bc shown throughout the entire length of the well casing segments.

Low-pH Adsorption/Leaching Experiment

The objective of the low-pH adsorption/leaching experiment was lo determine the differences in rate and extent of adsorption using a low-pH (3.0) polluted ground water. This ground water, as stated previously. was taken from rcid mine drainage in the Tar Creek area of northeastern Oklahoma.

Data from the low-pH experiment are given in Tables 6 and 7. The data indicate that, with the exception of ABS. all the other well casings showed less adsorption in the low-pH contaminated ground water thrn in the neutral-pH noncontaminated ground water (see Tables 4 and 6). A possible explanation could be stronger binding and more preferential complexing of the experimental pollutants with other pollutants in the contaminated ground water.

Another more probable explanation is the consideration of the pK values of the pollutants in

TABLE 7—*Percentage of pollutants leached of percentage adsorbed in low-pH (3.0) polluted ground water.*

Cuing Material	4-Nitrophenol	2,4,6-Trichloro-	Diethyl Phthalate	Naphthalene	Acenaphthene
PVC-40	0	0	0	100	0
Stainless steel	0	0	0	0	0
Teflon-TFE	0	0	0	0	0

[a] Two-week leaching period after six-week adsorption

relation to the pH of the total solution. A definite relationship between the extent of adsorption, pH, pK has been shown. with a maximum adsorption occurring when Ihc pH is approximately equal to the pK [5]. If the pH is decreased further, the hydrogen ion concentration increases and adsorption tends to decrease, suggesting a replacement of the adsorbed compound by the more preferentially adsorbed hydrogen ions.

Conclusions

General conclusions from this experimentation and a review of the literature of previous studies ore:

1. In the neutral- and low-pH ground waters. only 2,4,6-tri-chlorophenol and 4-nitrophenol showed appreciable rdsorplion in all well casings.
2. Leaching of adsorbed pollutants did not occur lo a measurable extent in any of the well casing/pollutant systems.
3. The rate and extent of adsorption were not measurably different on the rough cut ends of the well casings than on the smooth finished surfaces.
4. Lcrs adsorption of pollutants was exhibited for low-pH contaminated ground water than for the neutral-pH noncontaminated ground water.
5. There is no clear advantage to the use of one particular well casing material over the others for organics monitored in this study.
6. Probably of greater influence to sample integrity and representativeness than well casing material selection are the well purging procedures. sampling device selection and composition, and sample storage devices.
7. Solvents should be avoided for joining sections of casing materials in monitoring wells.
8. The amount of adsorption generally correlates with the solubility of the chemical independent of the well casing material.
9. Other influencing factors which have not been assessed may also bias sampling efforts. The most important of these may be biological growth on the casing surface, which can then uptake. transform, and release contaminants.

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Leaching of Metal Pollutants From Four Well Casings Used for Ground-water Monitoring

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INTRODUCTION

Ground-water monitoring requires the installation of conduits to transfer water to the surface for collection. Four commonly used well casings are made from 2-in. (5-cm) diameter polyvinylchloride (PVC), stainless steel 304 (SS 304), stainless steel 316 (SS 316) and polytetrafluoroethylene (PTFE) pipes. Representative sampling of ground water requires that materials employed in the saturated zone do not influence the concentration of analytes of interest.

Only a few studies have reported the influence of well-casing materials on the concentrations of inorganic substances in ground water during water quality analyses. Several studies have demonstrated that these materials (stainless steel, PVC and PTFE) sorb appreciable quantities of certain ionic species (Eichholz et al. 1965, Miller 1982, Hewitt 1989). Evidence also exists showing that metals are released into ground water from stainless steel and PVC pipes (Houghton and Berger 1984, Barcelona and Helfrich 1986, Hewitt 1989). The release of metal analytes by stainless steel has been associated with its corrosion, which in same instances has been observed to produce a hydrous iron precipitate (Barcelona and Helfrich 1986, Hewitt 1989).

Recently, a laboratory experiment was conducted testing the effects of ground-water composition on the well casings cited above (Hewitt 1989). In this experiment two concentrations of metals (As, Cd, G and Pb), pH and total organic carbon were introduced as ground-water solution variables. Results of this experiment indicated that PTFE was inert to the variables, whereas both PVC and stainless steel well casings were affected. These two materials leached and sorbed some of the metals introduced into the ground water. In addition, several stainless steel casing sections developed surface oxidation, which introduced a random source of variation by providing release mechanisms and active sites for sorption. PVC was a low-level source for Cd and provided sorption sites for Pb. Stainless steel 316 was a low-level source for Cd and provided sorption sites for As, G and Pb. Stainless steel 304 was also a low-level source for Cd and provided sorption sites for As and Pb. The extent of the sorption or release of metals was often influenced by the solution variables. This study concluded that the stainless steel casings were the least suitable for monitoring the metals studied (As, Cd, G and Pb) in the ground water solutions.

A concurrent study done at CRREL (Parker et al. 1989) looked at ground-water solutions spiked with organic compounds exposed to the same four well casings. In contrast to the results for metals, eight (cis and trans-1,2-dichloroethylene, m-nitrotoluene, trichloroethylene, chlorobenzene, o-,p- and m-dichlorobenzene) of the ten organic compounds studied sorbed more quickly and to a greater extent onto PTFE than WC and did not sorb onto the stainless steels. The same results were obtained when the ground water was treated with 2.0 g NaCl/L to test for effects of ionic strength. These findings support the earlier work of Reynolds and Gillham (1985) who observed rapid sorption of tetrachloroethylene by PTFE well cluing. They suggested that PTFE is the least desirable material for a well casing when organic compounds are monitored in ground water.

The results of these two recent CRREL studies (Hewitt 1989, Parker et 3 1989) and supporting evidence in the literature led to the suggestion that PVC may be the best compromise among these four well casings for monitoring ground water for both inorganic and organic analytes (Parker e t 3 1988).

The objective of this study is to examine metal leaching characteristics of these four well-casing materials in ground water. Leaching studies that

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compare these four well casings have not been reported in the literature. The results of this experiment will determine which casings are the most or the least susceptible to leaching the metals. The analytes analyzed included all of the metals on the Environmental Protection Agency's priority pollutant list, along with copper.

MATERIALS AND METHODS

Materials

The PVC and stainless steel well casings were obtained from Johnson Well Screen, and the PTFE was obtained from MIP, Inc. All well casings were specifically manufactured for ground-water monitoring. The casings all had approximately a 5-cm inner-wall diameter and were cut in lengths of approximately 2 cm. The exact length of the rings depended on the wall thickness and diameter of the pipe because we wanted to maintain a constant surface area of 80 cm^2. Cut surfaces composed 17% of the area for the PTFE and PVC well casings and 9% for the stainless steels.

Precautions were taken during pipe milling to prevent exposure to grease, dirt, oil and solvents, and to avoid excessive handling. After milling, the individual well-casing rings were rinsed with deionized water (Millipore, Type 1) and air dried before being placed into the ground-water-filled sample containers. During rinsing we made no attempt to remove surface discoloration or ink on the pipes; we used them as we had received them from the manufacturer. This limited cleaning was consistent with commonly employed field protocols.* The well-casing sections were handled with plastic gloves and nylon forceps after milling. Two sections of the SS 316 pipe were not used because excessive surface rust had formed. In general the stainless steel well casings appeared to have developed more rust during the 9-month storage period than they had when first obtained. All experimental work was performed in class 100 clean rooms.

Polypropylene jars (69 mm od × 62 mm height, 125 mL, Model 6185-E37, Thomas Scientific) served as the sample containers. The jars were soaked in a 10% v/v concentrated, redistilled HNO_3 (G. Frederick Smith (GFS)) deionized water solution, then rinsed with and soaked for several days in deionized water prior to use. Other materials, such as the 7.5-mL sample aliquot bottles (polyethylene, Nagle), pipette tips (Eppendorf), and the 2-L glass bottles (reagent grade HNO_3 bottles, Baker), were cleaned similarly.

Test design

Tests for the release of metals from PVC, PTFE, SS 304 and SS 316 well-casings were done in triplicate by exposing sections of each to ground water for periods of 1, 5, 20 and 40 days. Three sample containers with no well casings served as controls for each of the exposure periods. The containers with and without well casings were filled with 98 mL of ground water collected from a 76-m-deep domestic well system in Weatherfield, Vermont; 60 containers, 12 with a single section of each of the four well-casing candidates (12 × 4) and 12 controls, made up the experimental sample setup. The well-casing rings were submerged in the ground-water-filled sample containers creating a pipe-surface-area-to-aqueous-volume ratio of 0.82 cm^2/cm^3. This experimental design provides a surface-area-to-solution ratio similar to that of well casings in ground-water monitoring wells below the saturated zone; however, the ratio is much lower than that which exists for well screens.

Samples were prepared by transferring weighed amounts of ground water into each jar from a single 2-L glass bottle. The jars were selected randomly for the experiment because the ground water was transported in three separate 2-L glass bottles. The pH and conductivity of the ground water from all of the bottles was 7.8 and 2.40×10^{-2} mho/cm, respectively. Ground water collected from this source previously showed similar pH and conductivity levels (Hewitt 1989). While the well casings were exposed to the ground water, the jars were sealed with a cap and stored in the dark at 24°C. After the well-casing sections had been removed from the jars at the end of each time interval, 2 mL of concentrated HNO_3 (GFS) was added to the ground water to bring the pH below 1.0. Studies have shown that acidification below pH 1.5 is effective in preventing the loss of trace metals from natural waters (Subramanian et al. 1978). The acidified, ground-water-filled jars were recapped, hand-swirled for 10 seconds, then left at rest for at least 72 hours before we transferred a 5-mL aliquot to a 7.5-mL sample vial (polyethylene, Nagle) for the subsequent determination of Ag, As, Ba, Cd, Cu, Cr, Pb and Se.

The entire experimental setup was duplicated for the analysis of Hg, except that we determined Hg immediately after the ground-water-filled jar was acidified.

In a preliminary experiment, ground water stored in the polypropylene jars was spiked with

*Personal communication with Louise V. Parker, CRREL, 1989.

Cd, Cr and Pb to see if sorption of metals ions on the jar walls would interfere with the test results. These metal ions, added to the ground water and stored for 6 days in the sample jars, were recovered upon acidification (Table 1). The desorption of metal ions from container walls has been reported by Choa et al. (1968). For this preliminary test, 5.00 µg/L of Cd, Cr and Pb was allowed to sit in ground-water-filled jars (100 mL) for 6 days. Then we added 2 mL of concentrated HNO_3 (GFS), hand swirled the solution for 10 seconds, and removed a 5-mL aliquot. A second 5-mL aliquot was removed 72 hours later, following the same procedure. The results in Table 1 show that an average of 95% of the aqueous metal was recovered immediately after acidification, and aliquots removed 3 days later showed only 2% (not significant at the 95% confidence level) additional analyte recovery. Thus the metals either remained in the laboratory ground-water solution or were desorbed from the jar walls quickly upon acidification.

Table 1. Recovery of Cd, Cr and Pb (4.90 µg/L) from ground water stored in the sample jars and allowed to equilibrate for 6 days before being acidified with 2 mL of concentrated HNO_3.

	Acidification period			
	Less than 10 minutes		72 hours	
	Amount added (µg/L)	Percent recovered	Amount added (µg/L)	Percent recovered
Cd	4.65	94.9	4.72	96.3
	4.72	96.3	4.85	99.0
Cr	4.48	91.4	4.58	93.5
	4.48	91.4	4.69	95.7
Pb	4.93	100.2	4.72	96.3
	4.72	96.3	5.01	102.2
Average recovery	95.1%		97.2%	

Analysis

Silver, arsenic, barium, cadmium, copper, chromium and lead were determined by Graphite Furnace Atomic Absorption (GFAA) using a Perkin-Elmer (PE) model 403 Atomic Absorption Spectrophotometer (AAS) coupled with a PE model 2200 heated graphite atomizer. Instrumental procedures followed the general guidelines provided in the manufacturer's instrument manual (Perkin-Elmer 1981). Hand injections of either 20, 50 or 100 µL were employed for the analytes mentioned above.

For the determination of Se, a matrix modifier—0.015 mg Pd and 0.01 mg $Mg(NO_3)_2$—was added so that the charring temperature could be raised to 1200°C. Of this group, only As and Se determinations required deuterium background correction.

Mercury was determined by Cold Vapor Atomic Absorption (CVAA). We employed a 48-mL aliquot for the Hg determinations, following a modified Hatch and Ott (1968) procedure. Aliquots of 48 mL of ground water were reduced with 2 mL of 10% v/v stannous chloride and then sparged with Hg-free air. The reduced Hg vapor passed through a $Mg(ClO_4)_2$ water vapor trap into an optical cell designed to enhance detection (Tuncel and Atoman 1980). The optical cell was positioned in the light path of the PE model 403 AAS.

Mercury was determined the same day that well casings were removed from ground-water-filled jars to limit volatilization of Hg from solution (Coyne and Collins 1972, Lo and Wai 1975) and to avoid vapor contamination associated with storage in poly containers (Cragin 1979). All of the other metals were determined within 2 weeks after the last exposure period.

Analysis procedures were designed to achieve detection limits of 1% or less of the present domestic water quality levels set by the EPA (Table 2). Selenium, determined by graphite furnace, was the only metal with a detection limit slightly above this level (Table 2). Method Detection Limits (MDLs) were established following the procedure outlined in the Federal Register (1984) for the analysis of a sample in a given solution The MDL estimate requires that a minimum of seven replicate determinations be made of an analyte concentration that is one to five times the estimated detection level.

Table 2 EPA interim primary drinking wrtu quality levels (1983) and the method detection limits (MDL).

Metal	EPA primary drinking water levels (µg/L)	MDL (µg/L)
Ar	50	0.48
Ba	1000	2.4
Cd	10	0.059
Cu	1000	4.3
Cr	50	0.16
Pb	50	0.11
Hg	2.0	0.010
Se	10	0.21
Ag	50	0.12

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Table 3. Summary of ANOVA and LSD determinations for average analyte concentrations (μg/L). Materials with common underlining are not different at the 95% confidence level as determined by the LSD.

Days	Well casing					
	a. Barium					
1	Control	PTFE	PVC	SS304	SS316	(LSD = 1.4)
	4.5	6.0	6.6	7.1	7.7	
5	PTFE	Control	PVC	SS304	SS316	(LSD = 2.1)
	5.3	5.8	6.6	7.8	9.9	
20	PTFE	Control	PVC	SS304	SS316	(LSD = 2.2)
	5.5	59	61	7.4	11.3	
40	PTFE	PVC	Control	SS304	SS316	(LSD = 2.0)
	5.2	5.6	5.9	7.0	10.1	
	b. Chromium					
1	Control	PTFE	PVC	SS304	SS316	(LSD = 9.76)
	0.20	0.22	1.23	1.60	6.06	
5	Control	PTFE	PVC	SS316	SS304	(LSD = 0.31)
	0.20	0.22	1.12	1.79	3.34	
20	PTFE	Control	PVC	SS316	SS304	(LSD = 1.17)
	0.19	0.22	1.20	3.30	4.61	
40	Control	PTFE	PVC	SS316	SS304	(LSD = 1.04)
	0.21	0.21	1.11	2.53	5.13	

Days	Well casing					
	c. Lead					
1	Control	PTFE	SS316	SS304	PVC	(LSD = 1.45)
	0.16	0.35	0.90	1.14	2.46	
5	Control	PTFE	SS316	SS304	PVC	(LSD = 1.53)
	0.21	0.27	1.27	1.56	2.23	
20	Control	PTFE	SS316	PVC	SS304	(LSD = 2.80)
	0.14	0.35	1.00	1.04	2.86	
40	PTFE	Control	PVC	SS316	SS304	(LSD = 1.52)
	0.21	0.33	0.78	1.26	2.06	
	d. Copper					
1	PVC	SS304	Control	PTFE	SS316	(LSD = 12.0)
	9.4	10.7	11.9	12.1	35.8	
5	PTFE	PVC	Control	SS304	SS316	(LSD = 12.4)
	7.8	9.9	10.1	11.0	42.6	
20	PVC	PTFE	Control	SS304	SS316	(LSD = 38.5)
	6.8	8.3	10.1	26.1	81.2	
40	PVC	PTFE	SS304	Control	SS316	(LSD = 17.2)
	4.4	5.2	11.5	14.0	82.3	

The MDL is obtained by multiplying the standard deviation of the *replicate* measurements by the appropriate one-sided *t*-statistic corresponding to $n-1$ degrees of freedom at the 99% confidence level.

Each sample aliquot with a determined analyte concentration above the MDL was analyzed at least twice. Analyte concentrations were based on the average peak heights from a strip chart recording.

Aqueous calibration standards fox Ag, As, Cd, Cr, Cu, Pb, Hg and Se were prepared by diluting 1000-mg/L certified atomic absorption stock solutions (Fisher Scientific Corp.). A Ba stock standard was made by dissolving a weighed amount of $Ba(NO_3)_2$ (Baker, Reagent Grade) in deionized water. Working standards were prepared in deionized water acidified to 2% v/v with HNO_3 (GFS).

Calibrations were established by determining three *different* concentration standards in triplicate. Standards were randomly introduced throughout the course of sample analysis, and all of the calibration curves were linear over the concentration range *examined.* To see if the intercepts were significantly different from *zero,* we compared the residuals for the models with an intercept and for the models with zero intercept using the *F*-ratio at the 95% confidence level. Analyte concentrations in the samples and controls were determined based on the slope and intercept *only* if the intercept was deemed significant. Otherwise, a zero-intercept linear model was employed.

To assess leaching of metals from the surfaces of the four well-casing materials, an analysis of variance (ANOVA) was performed on those metals (Ba, Cr, Cu and Pb) that had been consistently found above the established MDL for the four well-casing materials and the control. If a significant

difference was detected by the ANOVA among the average analyte concentrations in the ground water for a given material, then a Least-Significant-Difference (LSD) analysis was performed. Both analyses (ANOVA and LSD) used the 95% confidence level. The results of these analyses established which well casings contributed particular analytes to the ground water over and above those contributed by other well casings or the control for the different exposure periods (Table 3). In addition the aqueous metal concentrations that exceed 1% of the EPA drinking water quality level were identified. This low-level warning criterion was chosen since this study did not always establish the native levels present in the ground water. Thus, the contribution of metals from the well casings could range from one or more orders of magnitude above the background concentrations.

RESULTS

Barium

The analysis of the 1-day exposure samples showed that all of the ground-water-filled vessels containing pipe sections had aqueous Ba concentrations that were significantly greater than that of the control; however, all of the values were low (Table 3a). The subsequent exposure periods do not follow this pattern but instead established that SS 316 was the only material that consistently contributed significant levels of Ba to the solution relative to the other samples and the control (Fig. 1a). The average increase in aqueous concentration for the ground water exposed to SS 316 was about 70% compared to the control. After 5 days of exposure, ground water in contact with SS 316 developed aqueous Ba concentrations that exceeded 1% of the drinking water quality level established by the EPA. None of the other well casings tested produced aqueous Ba concentrations that exceeded 1% of the EPA drinking water quality criterion or were significantly different from the control after the initial exposure period.

Cadmium

We did not use ANOVA with Cd since the majority of concentrations determined were below the MDL (Appendix A). After 1 day of exposure, both ground-water solutions containing SS 316 and PVC had aqueous Cd that exceeded 1% of the EPA drinking water quality level.

Figure 1b shows the average Cd concentrations determined for the control and well casings. It appears that Cd is initially released from SS 316 and PVC but becomes resorbed onto the well casing with time. Stainless steel 316 contributes approximately an order of magnitude (more than 10% of the EPA drinking water quality level in some cases) more Cd than PVC for equivalent exposure periods.

Chromium

Beyond the 1-day exposure, the analysis consistently demonstrated that both stainless steel well casings contributed significantly greater quantities of Cr to the ground water than the control or the other materials tested (Table 3b). These metal well casings, along with PVC, increased Cr concentrations in the ground water above 1% of the EPA drinking water quality level (Fig. 1c). The extent of the Cr contamination coming from the PVC was three to five times less than that coming from the SS 304, which usually showed the highest average contamination for a given exposure period, the exception being the initial exposure period.

The ANOVA and LSD tests failed to distinguish any difference between the materials for the 1-day exposure because of the large variation among the the three SS 316 samples. If SS 316 is removed, the analysis shows both PVC and SS 304 to contribute significantly greater quantities of Cr to the ground water than do the control and PTFE. The only material that showed a consistent trend was SS 304 Fig. 1c), which created increasing concentrations of Cr with time. Throughout the experiment there was no significant difference for Cr between the control and the PTFE well casing.

Lead

The first two exposure periods showed PVC to leach the greatest amount of Pb and to be significantly different from the control and PTFE. The two longest exposure periods showed that SS 304 leached the greatest amount of Pb to ground water; however, the levels observed in solution for SS 304 were only statistically different from the rest for the 40-day exposure period (Table 3c). The average levels obtained for both of the stainless steels and for PVC consistently exceeded 1% of the EPA drinking water quality standard (Fig. 1d).

The most distinctive trend was the decrease in Pb with increasing time of exposure for PVC (Fig. 1d). Both stainless steel well casings showed slight decreases in Pb levels after aqueous concentration maxima were obtained. The Pb that was initially released was resorbed by the PVC and stainless steel well casings. Throughout the experiment, there was no significant difference among the control, SS 316 and PTFE.

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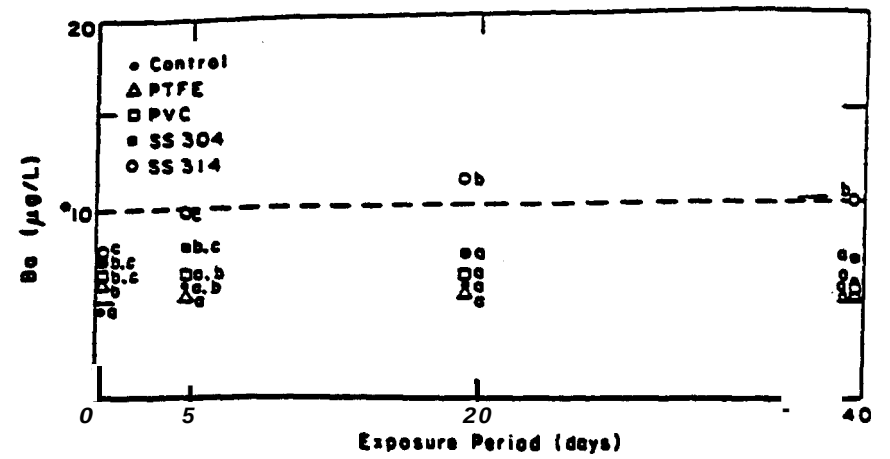
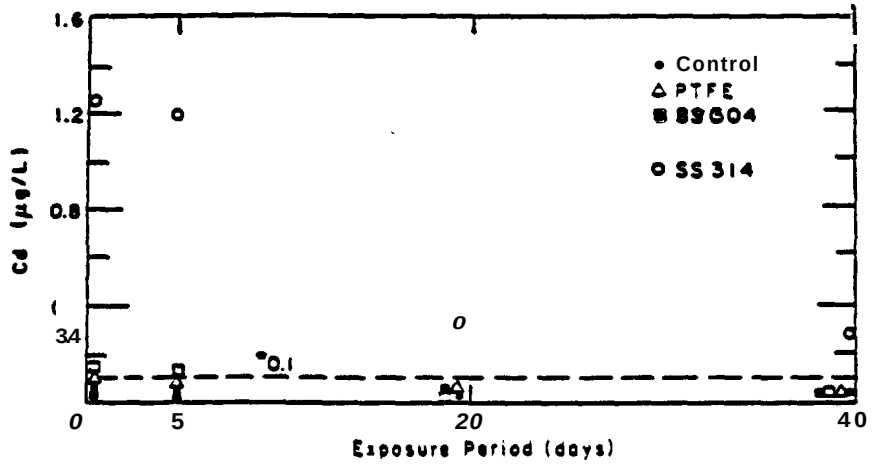
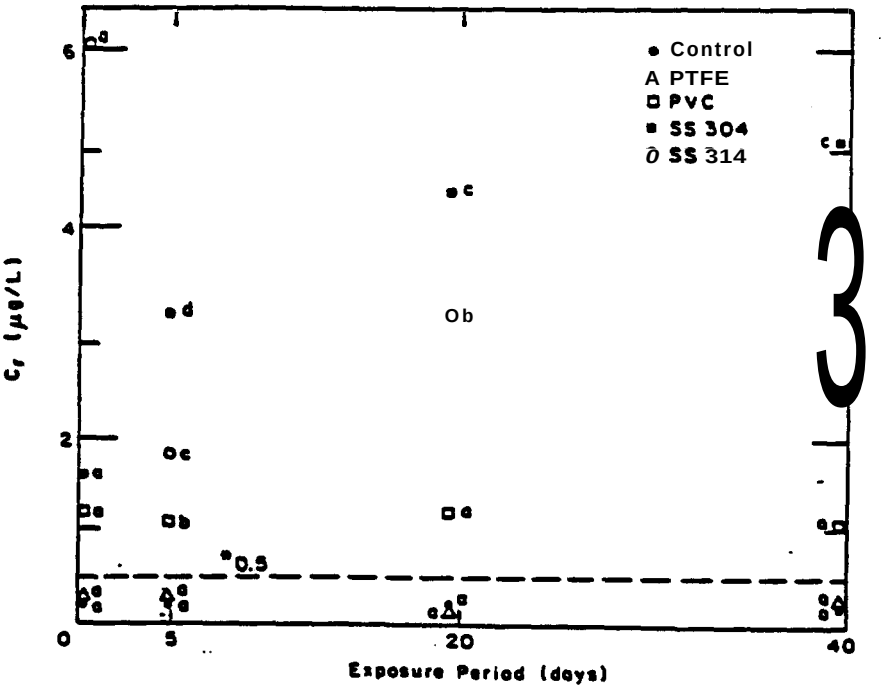


a. Ba.

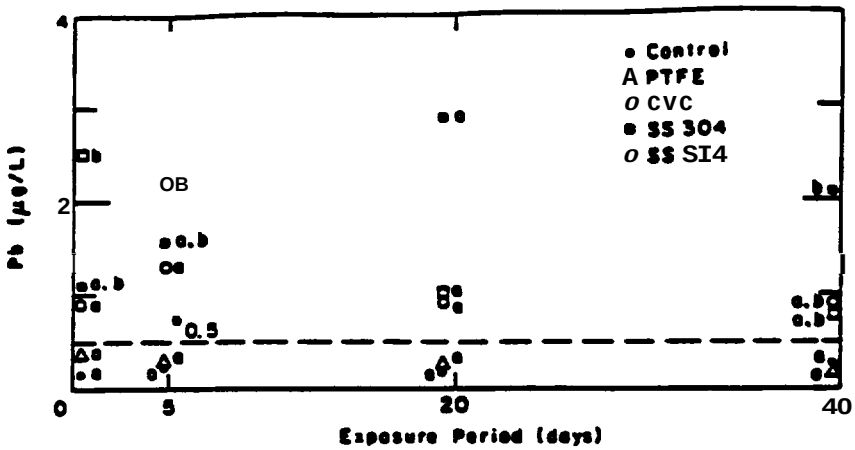


b. Cd.

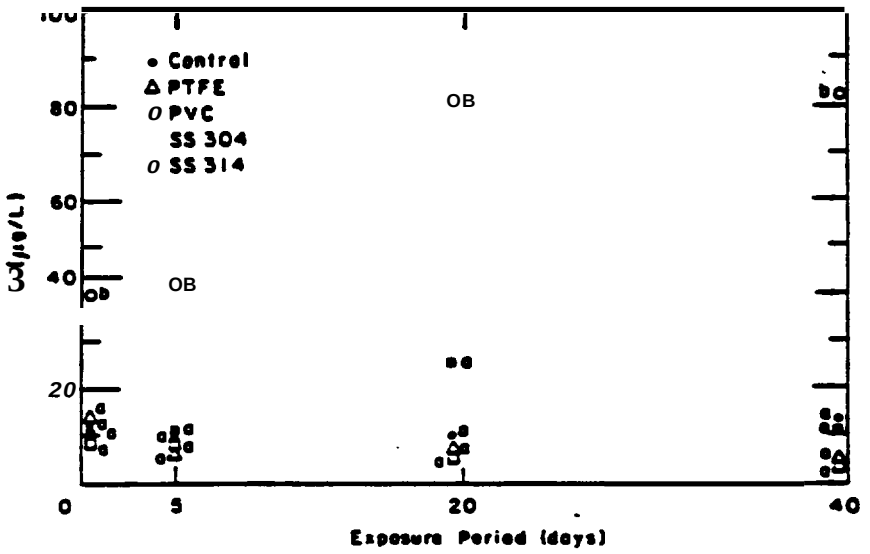


c. Cr.

Figure 1. Ground-water leaching of metals from well casings being examined. Common letters next to points denote no significant difference at the 0.05% confidence interval as determined by ANOVA and LSD.



d. Pb.



e. Cu.

Figure 1 (cont'd).

Copper

The statistical analysis distinguished SS 316 as the only material that contributed significantly more Cu when exposed to ground water than the other materials tested (Table 3d). Aqueous concentrations exceeded 80 µg/L for SS 316 versus about 10 µg/L for the other materials and the control.

Both PTFE and PVC well casing showed a general trend of decreasing Cu with increasing time of exposure and often showed concentrations below the control (Fig 1e). This trend, along with the lack of any trend with respect to the control, demonstrates that these two plastic pipes provided the substrate for sorption.

Arsenic, mercury, selenium and silver

The determinations for As, Hg, Se and Ag were not statistically analyzed because the majority of the concentrations were at or below the established MDLs. Based on the analysis methods employed, none of the well casings consistently contributed As, Hg or Ag above 1% or Se above 2% of the EPA drinking water quality level.

DISCUSSION

Ground water was collected from a domestic well system and stored in sealed 2-L glass bottles

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for approximately 24 hours prior to being transferred into test Ground water collected in this fashion is aerated at the faucet and exposed to an oxygen-rich environment every time the lid of the container is removed. Handling the ground water in this manner most likely changed the oxidation potential, facilitating oxidation reactions (Stumm and Morgan 1970). We made no attempt to simulate the natural ground-water redox state or to quantitatively assess the *chemical* equilibria that existed during the course of this experiment.

There was visible rust on 11 of 24 sections of the stainless steel pipes (Table 4). Each pipe section was carefully examined prior to submersion and *after* removal from the ground water. In this experiment and in a previous one (Hewitt 1989), oxidation on the stainless steel was predominantly found on the wall. If oxidation is providing *sites* for sorption *or* release mechanisms, then the freshly cut surfaces were most likely not a major factor in the behavior of these two materials. Fresh surfaces *on* the PVC pipe is not an experimental artifact *since* PVC well screen is made by slotting the pipe.

It was apparent from the values determined for the control samples that the three 2-L glass bottles used to transport the ground water had different concentrations of aqueous Cu (Appendix A). The range of aqueous Cu concentrations most likely reflect the residence time of the ground water in the household and well plumbing. Three distinct populations of Cu concentration were determined for the controls at the 99% confidence level (X_1 = 9.8±0.0, n = 4; X_2 = 10.3±0.22, n = 5; X_3 = 16.0±0.0, *n* = 3). Differences between adjacent mean concentrations were established by testing against the maximum variance determined for all *of* populations (i.e., X_1X_2 and X_2X_3).

The groups established by the three Cu populations were then tested to determine *if* any of the other metals found above its MDL were also significantly different. Table 5 presents the averages and standard deviations for the metal groups based on the Cu populations for the controls. *Only* Pb shows the same increasing mean concentration trend as the Cu groupings; however, the averages for the adjacent Pb groups were not significantly different at the *95%* or even the 80% confidence level when analyzed in the same manner as the Cu populations. This analysis establishes that only Cu was significantly influenced by the sample preparation procedure. Mixing the ground water from the three collection bottles would have eliminated

Table 4. Physical state of stainless steel pipes after *exposure* to ground wrta.

	Section											
	1	2	3	4	5	6	7	8	9	10	11	12
SS 304	WR	WR	—	—	WR	—	WR	WR	ER	WR	WR	WR
SS 316	—	—	—	—	ER	—	—	—	—	—	—	ER

KEY: WR = rust on wall; ER = rust on edge; dash means no rust.

Table 5. Average metal concentrations for the controls based on the groups established by the Cu populations (µg/L).

Populations		*Cu*	*Cr*	*Pb*	*As*	*Ba*
1	Avg.	9.8*	0.22	0.11	0.55	5.2
	Std. Dev.	0.0	0.021	0.00	0.114	0.92
2	Avg.	10.3*	0.20	0.25	0.48	5.8
	Std. Dev.	0.19	0.032	0.154	0.00	0.29
3	Avg.	16.0*	0.22	0.28	0.48	5.6
	Std. Dev.	0.0	0.021	0.048	0.00	0.75

* Statistically different at *the 99%* confidence level.

Table 6. Summary of results.

	Ba	Cd	Cr	Pb	Cu
Materials that leached >1% of the EPA drinking water quality level in ground-water solutions.	SS 316 PVC	SS 316 PVC	SS 304 SS 316 PVC	SS 304 PVC SS 316	NA*
Material that showed the highest average overall amount of analyte leached	SS 316	SS 316	SS 304	SS 304	SS 316

* Does not apply.

this artifact. The level of Cu leached from the SS 316 far exceeded the difference between the established populations.

The results of this study support our previous work (Hewitt 1989) showing that PTFE is the least reactive material, whereas both PVC urd stainless steel well casings influence aqueous concentrations of metals in laboratory ground-water solutions. A in the first study, the variance among the stainless steel replicates was oftal the greatest, indicating that this material is susceptible to producing random error. Both studies found that SS 316 and PVC leach *and* sorb Cd; in addition, these two materials, along with SS 304, sorb Pb. Studies in the future should be conducted under anoxic conditions to see if oxidation of the stainless steel is simply an artifact of these experiments. If corrosion of stainless steel is absent under reducing conditions, then we might expect less random variation and less of an influence on the metal analytes in ground-water solutions.

A summary of the results (Table 6) *clearly* shows that the stainless steels were the greatest sources of contamination under these experimental conditions. When PVC leached metals (Pb, G and Cd) that exceeded 1% of the EPA drinking water quality specifications into solution, there was always a trend showing a decrease in concentration with time of exposure. This would suggest that the leaching of Pb, G and Cd from PVC is a surface process and is small. Most *likely* the initial release could be decreased by more extensive cleaning before the pipes are used. The same statement does not apply to the stainless steel well casings. In the cases of leached Cu from SS 316 and leached Cr from SS 304, the concentrations of these metals continually increased with time over 40 days. It is possible that stainless steels *could* supply these analytes to ground water over an extended period of time, perhaps the entire life of the casing.

CONCLUSION

Among the four types of well casings tested, PTFE was the only material that did not leach any of the nine metals examined. The other materials tested in this experiment (PVC, SS 304 and SS 316) compromised laboratory ground-water samples by contributing analytes of interest (Ba, Cd. G, Pb and Cu). Investigations where only trace metals are of interest should use PTFE below the saturated zone. PVC would be the appropriate second choice since its influence on metal analytes appears predictable and small. In contrast, the two *stainless* steel materials should be avoided.

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APPENDIX A: LEVELS OF CD, PB, CR, BA AND CU DETERMINED IN GROUND-WATER SOLUTIONS (~~µG~~ µg/L).

Pipe	Replicate	Time (days)	Number	Cd	Pb	Cr	Ba	Cu
Cntrl	1	1	1	< D*	0.11	0.21	4.2	9.8
Cntrl	2	1	2	< D	0.11	0.19	4.6	9.8
Cntrl	3	1	3	< D	0.26	0.21	U	16.0
Cntrl	1	5	4	< D	0.40	0.15	5.5	10.5
Cntrl	2	5	5	< D	0.11	0.24	5.8	9.8
Cntrl	3	5	6	< D	0.11	0.20	6.1	10.1
Cntrl	1	20	7	< D	0.11	0.24	6.1	10.1
Cntrl	2	20	8	< D	0.11	0.22	6.1	9.8
Cntrl	3	20	9	< D	0.19	0.20	5.5	10.5
Cntrl	1	40	10	< D	0.42	0.20	5.8	10.1
Cntrl	2	40	11	< D	0.24	0.20	5.7	16.0
Cntrl	3	40	I2	< D	0.33	0.24	6.3	16.0
PTFE	1	1	1	< D	0.40	0.19	5.9	10.8
PTFE	2	1	2	< D	0.26	0.28	6.1	9.8
PTFE	3	1	3	< D	0.40	0.19	5.9	15.7
PTFE	1	5	4	0.117	0.40	0.24	4.9	91
PTFE	2	5	5	< D	0.30	0.21	5.5	8.4
PTFE	3	5	6	< D	0.11	0.21	5.5	5.9
PTFE	1	20	7	0.117	0.40	0.21	5.8	15.3
PTFE	2	20	8	< D	0.30	0.16	5.2	4.9
PTFE	3	20	9	< D	0.36	0.19	5.5	4.6
PTFE	1	40	10	< D	0.11	0.21	4.9	4.3
PTFE	2	40	11	< D	0.11	0.16	5.5	7.0
PTFE	3	40	12	< D	0.40	0.26	5.2	4.3
PVC	1	1	1	0.109	2.19	1.13	6.7	9.4
PVC	2	1	2	0.125	3.09	1.40	7.0	9.8
PVC	3	1	3	0.175	2.11	1.15	6.1	91
WC	1	5	4	0.075	2.39	1.15	73	8.0
WC	2	5	5	0.142	2.43	1.30	6.4	13.2
WC	3	5	6	0.109	1.57	0.91	6.1	8.4
WC	1	20	7	< D	2.11	1.30	6.4	11.9
WC	2	20	a	< D	0.66	1.40	5.8	4.3
WC	3	20	9	< D	0.34	0.91	6.1	4.3
WC	1	10	10	< D	0.93	1.08	61	4.3
PVC	2	10	11	< D	0.75	1.03	5.2	4 3
WC	3	40	12	< D	0.66	1.22	5.5	4.6
SS 304	1	1	1	< D	0.48	1.22	6.7	9d
SS 304	2	1	2	< D	0.88	1.13	7.0	13.2
SS 304	3	1	3	< D	2.05	2.45	7.6	91
SS 304	1	5	4	< D	1.25	3.33	73	9d
SS 304	2	5	5	< D	0.96	3.21	8.2	8.0
SS 304	3	5	6	< D	2.47	3.48	7.9	15.3
SS 304	1	20	7	0.092	0.80	4.36	if	91
SS 304	2	20	8	< D	2.81	3.87	7.6	49.7
SS 304	3	20	9	< D	4.98	5.59	7.3	19.6
SS 304	1	40	10	< D	2.97	5.10	6.7	91
SS 304	2	10	11	< D	1.47	4.56	6.4	9.4
SS 304	3	40	I2	< D	1.73	5.73	7 9	15.9
SS 316	1	1	1	2.629	0.41	1.48	7.0	27.5
SS 316	2	1	2	0.209	0.60	1.29	7.3	35.5
SS 316	3	1	3	0.926	1.70	15.36	8.7	44.5
SS 316	1	5	4	0.217	0.96	1.81	8.5	372
SS 316	2	5	5	2.990	2.30	1.69	11.5	37.6
SS 316	3	5	6	0.451	0.55	1.86	91	W
SS 316	1	20	7	0.326	1.50	3.45	12.3	102.2
SS 316	2	20	8	0.376	0.76	2.96	9.3	56.7
SS 316	3	20	9	0.326	0.75	3.50	12.3	84.8
SS 316	1	10	10	0.267	0.67	3.18	11.5	97.3
SS 316	2	40	11	0.384	0.75	1.94	9.0	77.2
SS 316	3	40	12	0.209	2.36	2.45	9.8	72.3

* Less than MDL.

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