N42237.AR.000220
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INTERIM MEASURE WORK PLAN FOR SITE 11, OLD CAMDEN COUNTY LANDFILL PHASE I ACTIVITIES NSB KINGS BAY GA

3/1/1994

ABB ENVIRONMENTAL

NSB Kings Bay Administrative Record
Document Index Number

31547-000
19.04.00.0011

INTERIM MEASURE WORK PLAN FOR SITE 11, OLD CAMDEN COUNTY LANDFILL PHASE 1 ACTIVITIES

CONTRACT TASK ORDER NO. 094

NAVY CLEAN - DISTRICT 1

CONTRACT NO. N62467-89-D-0317

MARCH 1994

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA
29419-9010

Release of this document requires the prior
notification of the chief official of the activity studied.

The engineering work described and professional opinions rendered in this report, *Interim Measures Work Plan for Site 11, Old Camden County Landfill, Phase I Activities*, dated March 1994, for work at Naval Submarine Base, Kings Bay, Georgia, were conducted or developed using commonly accepted engineering practices and currently applicable standards. The scope of engineering services described in this report was conducted under the supervision of a State of Georgia registered professional engineer.

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Expires December 31, 1994

The geologic work and professional opinions rendered in the Final Interim Measure Work Plan for Site 11, Old Camden County Landfill, March, 1994, were conducted or developed in accordance with commonly accepted procedures consistent with applicable standards of practice.

Eric G. Nelson

Professional Geologist No. 539
Expires December 31, 1995

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INTERIM MEASURE WORK PLAN
FOR SITE 11, OLD CAMDEN COUNTY LANDFILL
PHASE 1 ACTIVITIES

CONTRACT TASK ORDER NO. 094
NAVY CLEAN - DISTRICT 1
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NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

Prepared for:

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March 1994

FOREWORD

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the 1986 Superfund Amendments and Reauthorization Act (SARA), the 1976 Resource Conservation and Recovery Act (RCRA) as augmented by the 1984 Hazardous and Solid Waste Amendments (HSWA), and as directed in Executive Order 12580 of January 1987, the Department of Defense (DOD) conducts an Installation Restoration (IR) Program for evaluating and remediating problems related to releases and disposal of toxic and hazardous materials at DOD facilities.

The Naval Assessment and Control of Installation Pollutants (NACIP) program was developed by the Navy to implement the IR Program for all Naval and Marine Corps facilities. The NACIP program was originally conducted in three phases: (1) Phase I, Initial Assessment Study, (2) Phase II, Confirmation Study (including a Verification Step and a Characterization Step), and (3) Phase III, Planning and Implementation of Remedial Measures. The three-phase IR Program was modified and updated to be congruent with the CERCLA/SARA and RCRA/HSWA-driven DOD IR Program.

The updated nomenclature for the RCRA/SARA process is as follows:

- Preliminary Assessment and Site Inspection
- Remedial Investigation
- Feasibility Study
- Planning and Implementation of Remedial Design

This Interim Measure (IM) Work Plan focuses on the acquisition of environmental data of known and acceptable quality, which will facilitate design of an IM that addresses volatile organic compounds in groundwater associated with Site 11, Old Camden County Landfill, at Naval Submarine Base, Kings Bay, Georgia. The IM Work Plan discusses the objectives of the IM activities; describes the technical and management approach that will be implemented to meet these objectives; describes the pilot-scale IM system, operations, and monitoring; and discuss the performance evaluation process of the pilot-scale system to support design of a full-scale IM system.

Southern Division Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) has the responsibility for implementation of the Navy and Marine Corps IR Program in the southeastern and midwestern United States. Questions regarding this report should be addressed to the Public Affairs Office, Naval Submarine Base, Kings Bay, Georgia, at (912) 673-4714.

EXECUTIVE SUMMARY

In August 1992, as part of the RCRA Facility Investigation/Site Inspection (RFI/SI) of the Old Camden County Landfill at the Naval Submarine Base (NSB) Kings Bay, ABB Environmental Services, Inc. (ABB-ES) confirmed that contaminated groundwater, assumed to be emanating from the landfill, has migrated off site toward the Crooked River Plantation Subdivision. The plume, found in the surficial aquifer from 9 to 57 feet below ground surface, extends 460 to 780 feet west-northwest of the NSB Kings Bay property line. Volatile organic compounds (VOCs) detected include chlorinated solvents such as vinyl chloride, dichloroethene, trichloroethene and tetrachloroethene, and fuel-related VOCs such as benzene, toluene, ethylbenzene, and xylenes.

This Work Plan addresses Phase I, the pilot-scale studies of the Interim Measure (IM) that addresses VOCs within the groundwater. The purpose of this Work Plan is the acquisition of environmental data of known and acceptable quality that will facilitate full-scale design of an IM. The pilot-scale operation and testing phase of the IM will support evaluation of:

- the effectiveness of a preliminary groundwater extraction (GWE) system using an array of conventional recovery wells;
- the use of a complete GWE system to hydraulically control further migration of VOC contaminated groundwater originating at Site 11;
- actual and projected concentration levels of VOCs and other constituents within the GWE system discharge that supports future treatment/discharge operations;
- the effectiveness and efficiency of air stripping technology in reducing VOC concentrations in the extracted groundwater to established state and federal Maximum Contaminant Levels (MCLs);
- the effectiveness and efficiency of biotechnology, using a methanotrophic rotating biological contactor (mRBC), in reducing VOC concentrations to MCLs; and
- future VOC-contaminated groundwater treatment and subsequent effluent discharge options.

The pilot-scale GWE system will include as many as six groundwater recovery wells placed to withdraw affected groundwater from selected "hot spots" within the surficial aquifer. The pilot-scale treatment systems to be evaluated include pretreatment and air stripping technology to treat the majority of the extracted groundwater, and treatment using an mRBC to evaluate biological treatment of the groundwater.

Following this first phase of the IM activities, the data collected will be evaluated for efficiency and effectiveness of these technologies in addressing long-term IM goals. The pilot-scale IM system will continue operation while system performance is evaluated and design recommendations are developed for the Phase II, full-scale system.

Revisions to Draft Final Interim Measure Work Plan for Site 11, Old Camden County Landfill, Phase I Activities

1. Georgia Environmental Protection Division comments addressed and text revised accordingly. Refer to Appendix D for comments and responses.

2. The following appendices added:

   Appendix A: Air Emission
   -- Lowest Achievable Emission Rate
   -- Request for Discharge: Air Permitting

   Appendix B: Request for Authorization for Groundwater Discharge into the NSB Kings Bay Land Application System

   Appendix C: Request for Authorization for Groundwater Discharge into the St. Marys' Point Peter Sewage Treatment Facility

   Appendix D: Response to Georgia Environmental Protection Division Comments

Interim Measure Work Plan
For Site 11, Old Camden County Landfill
Phase 1 Activities

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GLOSSARY OF ACRONYMS

AAC	acceptable ambient criteria
AASHTO	American Association of State Highway and Transportation Officials
ABB-ES	ABB Environmental Services, Inc.
ARF	analytical request form
AST	air stripping treatment
ASTM	American Society for Testing and Materials
bgs	below ground surface
BOD	biological oxygen demand
°C	degrees celsius
CAP	Corrective Action Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action, Navy's
CLM	Crystal Lake Methanotroph
CLP	Contract Laboratory Program
COC	Chain of Custody
COD	chemical oxygen demand
1,2-DCE	cis-1,2-Dichloroethene
DOD	Department of Defense
DOT	Department of Transportation
DQOs	Data Quality Objectives
EPD	Environmental Protection Division
ETP	Engineering Treatability Parameters
°F	degrees fahrenheit
fps	feet per second
ft/ft	feet per foot
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometry
GIS	geologic information system
g/l	grams per liter
gpm	gallons per minute
GWE	groundwater extraction
HASP	Health and Safety Plan
HRT	hydrologic retention time
HSO	Health and Safety Office
HSWA	Hazardous and Solid Waste Amendments
ID	Induced Draft
IM	Interim Measure

GLOSSARY OF ACRONYMS (Continued)

L	liter
LAER	lowest achievable emission rate
LAS	land application system
LEL	lower explosive limit
m^3	cubic meters
MCLs	Maximum Contaminant Levels
mg/l	millions per liter
ml	milliliter
MLW	mean low water
MMO	methane monooxygenase
pMMO	particulate methane monooxygenase
sMMO	soluble methane monooxygenase
mRBC	methanotrophic rotating biological contractor
MS/MSD	mass spectrometry and matrix spike duplicate
NACIP	Naval Assessment and Control of Installation Pollutants
NEESA	Naval Energy and Environmental Support Activity
NSB	Naval Submarine Base
O&M	operational and maintenance
OB3b	Methylosinus trichosporium
ORP	Oxidation Reduction Potential
OVA	Organic Vapor Analyzer
PID	photoionization detector
PIW	private irrigation well
PM	Project Manager
PMP	Project Management Plan
POTW	publicly owned treatment works
PPE	Personnel Protective Equipment
ppm	parts per million
PVC	polyvinyl chloride
QA	quality assurance
QA/QC	quality assurance/quality control
QAM	Quality Assurance Manager
QAP	Quality Assurance Plan
QAPP	Quality Assurance Project Plan
QC	quality control
QRB	Quality Review Board
RCRA	Resource Conservation and Recovery Act
RE	Resident Engineer
RFI	Resource Conservation and Recovery Act Facilities Investigation
RFI/CMS	Resource Conservation and Recovery Act Facilities Investigation/Corrective Measure Study
RO	reverse osmosis
RPD	relative percent difference
RW	recovery wells

GLOSSARY OF ACRONYMS (Continued)

SARA	Superfund Amendments and Reauthorization Act
SOP	Standard Operating Procedure
SOPQAM	Standard Operating Procedures Quality Assurance Manual
SOUTHNAVFACENGCOM	Southern Division, Naval Facilities Engineering Command
SOW	Statement of Work
SSC	Site Safety Coordinator
SVOC	semi-volatile organic compound
TCL	Target Compound List
TCL/TAL	Target Compound List/Target Analyte List
TCL-VOA	Target Compound List-Volatile Organic Analysis
TCLP	Toxicity Characteristic Leaching Procedure
TIC	tentatively identified compound
TLC	Technical Lead Coordinator
TOM	Task Order Manager
TSS	total suspended solids
USEPA	United States Environmental Protection Agency
VOA	volatile organic analysis
VOC	volatile organic compound

1.0 INTRODUCTION

Under contract to the U.S. Department of the Navy (Navy) Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), this Interim Measure (IM) Work Plan was prepared for Site 11, the Old Camden County Landfill, located on the Naval Submarine Base (NSB) in Kings Bay, Georgia. This Work Plan was prepared under the Comprehensive Long-term Environmental Action Navy (CLEAN) Contract No. N62467-89-D-0317, Contract Task Order No. 094.

The purpose of this IM Work Plan is to outline the objectives of Phase I IM activities, describe the technical and management approach that will be implemented by the project team to meet these objectives, describe the pilot-scale IM system, operations and monitoring, and evaluation of the pilot-scale system performance to support design of a full-scale IM system. The following subsections describe the site, provide the objectives of the IM, provide a conceptual model to facilitate an understanding of the existing conditions at the site, and provide an overview of the organization of the IM Work Plan.

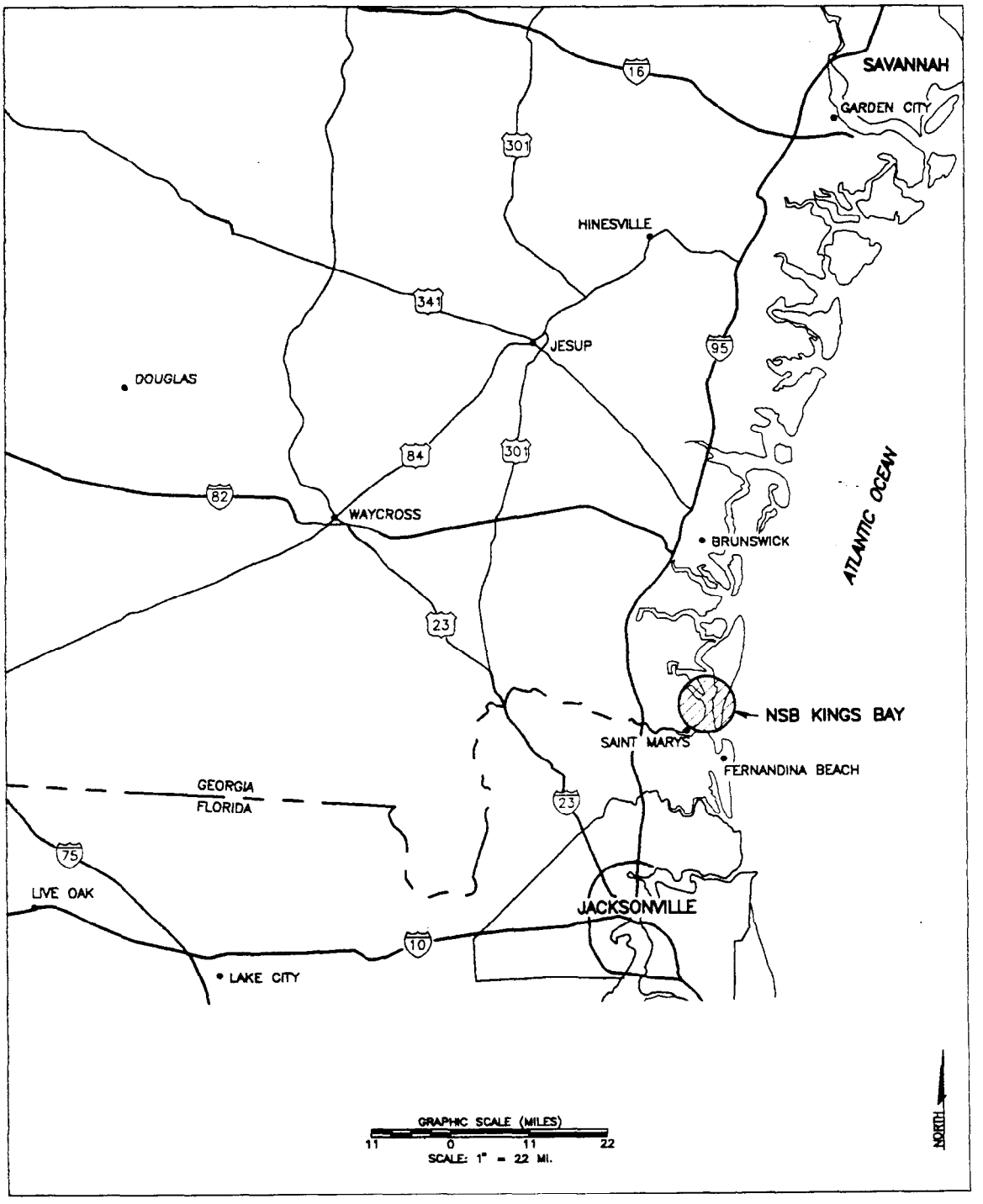
1.1 SITE DESCRIPTION. NSB Kings Bay is located in Camden County in southeastern Georgia, approximately 6 miles north of the Florida-Georgia state line. Kings Bay is an arm of Cumberland Sound, which is connected to the Atlantic Ocean via St. Marys Inlet. Figure 1-1 shows the general location of NSB Kings Bay.

Most of the land near NSB Kings Bay is rural. Only 8 percent of the land in the county is developed. Most development has occurred in the cities of St. Marys, Woodbine, and Kingsland. The developed land consists mostly of light residential with some commercial areas. Camden County's potential for residential or industrial development is reduced by poor soil drainage properties caused by shallow groundwater. Undeveloped land consists of forests, marshes, and swamps (ABB-ES, 1993a). Wetlands comprise more than one-third of Camden County's total acreage.

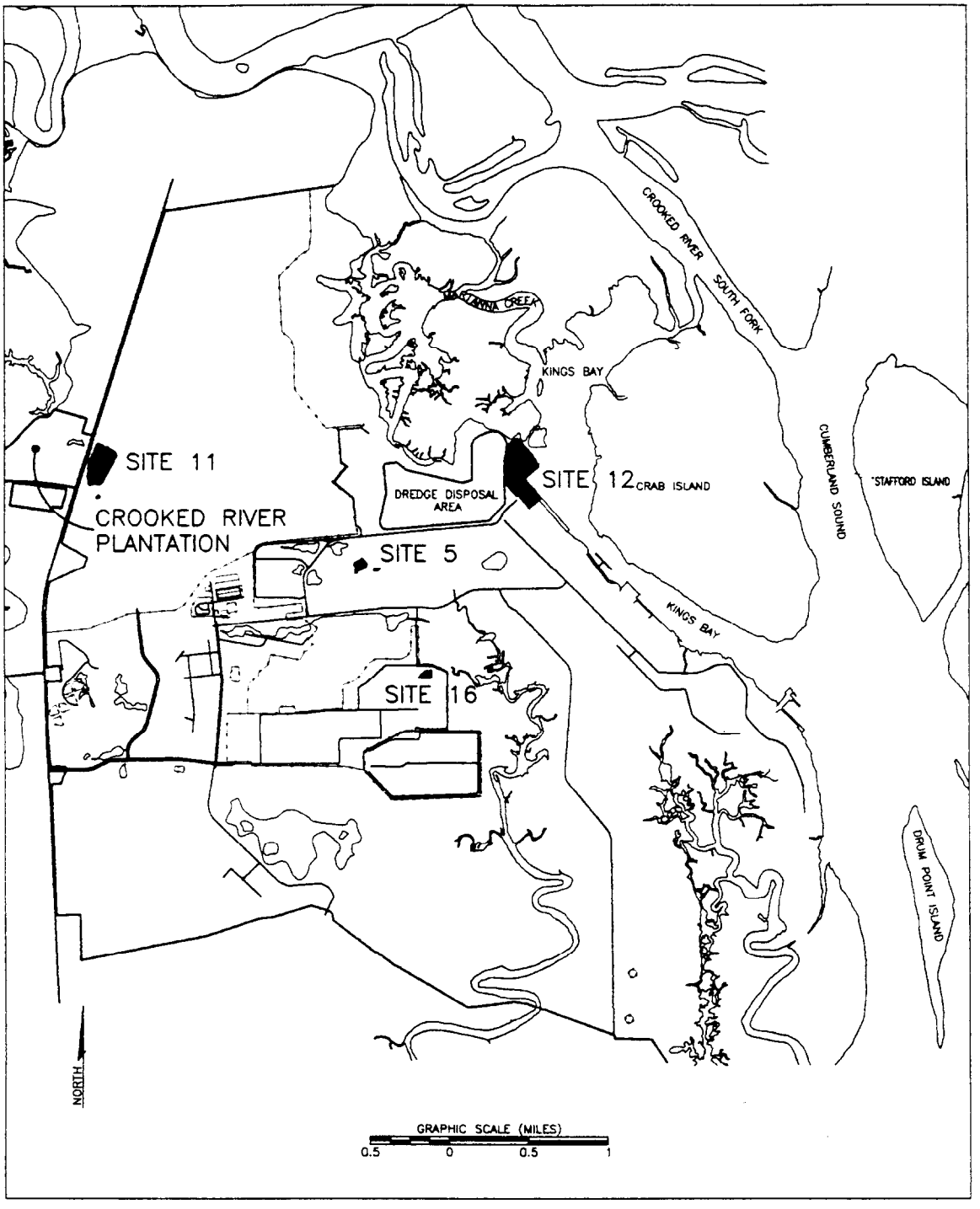
Site 11, the Old Camden County Landfill, is located in the western portion of the NSB Kings Bay, as shown on Figure 1-2. The landfill occupies approximately 35 acres situated along the northwest boundary of the NSB. The landfill was operated by Camden County from 1974 to 1981 and reportedly received no hazardous waste. Approximately 500,000 cubic yards of waste were disposed of at the landfill, reportedly consisting of general household waste, office waste, scrap paper and wood, and sludge and grit from the NSB Kings Bay sewage treatment plant. Burning of wastes before burial was allowed during the first year the landfill operated; however, this practice was disallowed after 1975.

The landfill was a trench-and-fill operation with trenches oriented in a southeast to northwest direction. The trenches were reportedly 575 to 775 feet long, 35 to 50 feet wide, and approximately 12 feet below ground surface (bgs). The landfill ceased operations in October 1981 and was covered with 2 feet of fill. The landfill surface is currently vegetated with grasses, weeds, and pine saplings.

Crooked River Plantation Subdivision (Figure 1-2) is a residential development of 630 homes west of the landfill. The subdivision was built on 260 acres west of Spur 40 during the 1980s. A marsh fronts the north and west perimeter of the subdivision. An informal survey of the Crooked River Plantation Subdivision residents was performed to obtain information regarding private irrigation wells (PIWs). Based on the survey responses, more than 90 homes in the subdivision



DWN: DMF	PROJECT NO.: 08503.02	TITLE: REGIONAL LOCATION MAP	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 1-1		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3-10-94			



DWN: DMF	PROJECT NO.: 08503.02	TITLE: SITE LOCATION MAP	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 1-2		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3-10-94			

have PIWs that draw groundwater from the surficial aquifer for non-potable uses such as lawn irrigation and washing outdoor items.

1.2 IM OBJECTIVE. This Work Plan focuses on the acquisition of environmental data of known and acceptable quality, which will facilitate design of an IM that addresses volatile organic compounds (VOC) contaminants within the groundwater. The IM Work Plan was developed according to applicable U.S. Environmental Protection Agency (USEPA), state, and SOUTHNAVFACENGCOM guidance documents.

The overall objective of the IM is to hydraulically control movement of the VOC plume within the surficial aquifer and to convey the extracted VOC-contaminated groundwater to an on-site treatment facility or to an existing off-site treatment facility. This overall objective will be achieved in a phased approach. The first phase will collect site-specific data to support long-term corrective measures, while in the process focus on collection of VOC-contaminated groundwater from known areas of highest contamination. This first phase will continue operation of the pilot-scale system while design activities are conducted for a full-scale IM system. The second phase will be designed to meet the overall IM objective of VOC-contaminated groundwater plume stabilization within the surficial aquifer.

This IM Work Plan specifically addresses Phase I activities that include pilot-scale IM system installation and operation, as well as monitoring and evaluation of the pilot-scale IM system. This IM Work Plan specifically addresses Phase I activities that include pilot-scale IM system installation and operation, as well as monitoring and evaluation of the pilot-scale IM system. Phase I of the IM will support evaluation of:

- the effectiveness of the preliminary groundwater extraction (GWE) system using an array of conventional recovery wells,
- the use of a complete GWE system to hydraulically control further migration of VOC-contaminated groundwater originating at Site 11,
- actual and projected concentration levels of VOCs and other constituents within the GWE system discharge that supports future treatment/discharge options,
- a treatment system that incorporates air stripping technology to reduce levels of VOC contaminants within the extracted groundwater to Maximum Contaminant Levels (MCLs), and
- an alternative treatment system, which incorporates biotechnology, using a methanotrophic rotating biological contractor (mRBC).

Phase I Continuance of the IM will involve the continued operation of the pilot-scale GWE system to maintain the capture zone(s) that were created during Phase I. This phase may also include continued operation of the pilot-scale treatment system to provide additional performance data that supports full-scale IM design and long-term corrective measures. The pilot-scale treatment system may be phased-out, either partially or totally, if existing treatment systems can sufficiently handle effluent from the GWE system.

The Data Quality Objectives (DQOs) of this IM are qualitative and quantitative descriptions that support an environmental decision or action. The intended use

of the data and the necessary level of precision and accuracy determine the scope of the DQOs. Data collected during the IM pilot-scale effort at NSB Kings Bay will be used to support design and specifications for the construction and long-term operation of the full-scale IM. Specific DQOs are as follows:

- Evaluate the use of groundwater extraction as a means to hydraulically control VOC plume movement.
- Evaluate the efficiency of air stripping as a viable option to remediate VOCs from the groundwater.
- Evaluate the efficiency of *ex situ* biological treatment technology as an alternative option to remediate VOCs from groundwater.

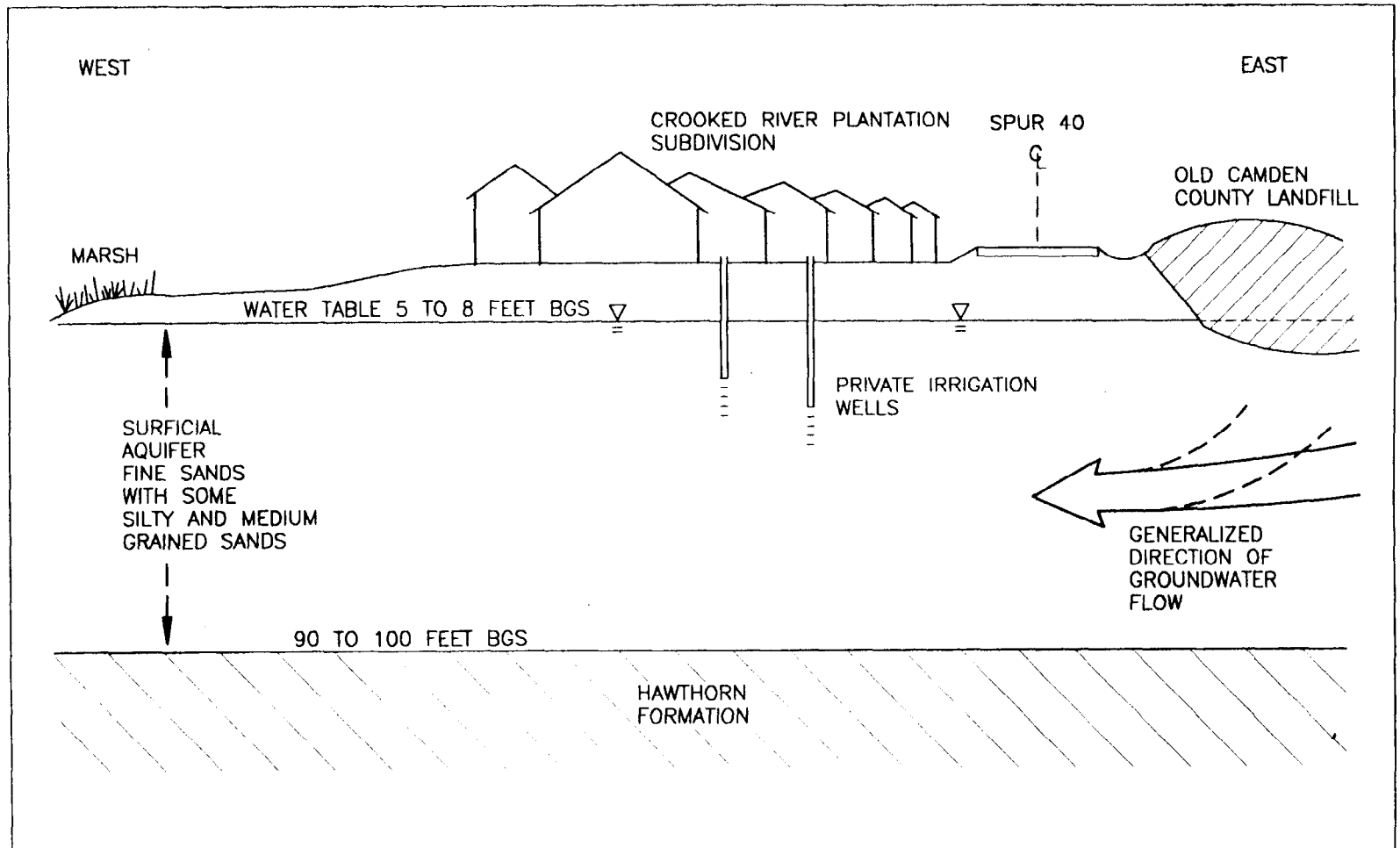
1.3 CONCEPTUAL MODEL. This conceptual model is provided to facilitate an understanding of the hydrogeologic and contaminant characteristics within the surficial aquifer, as well as provide a brief discussion of the proposed method to control the plume.

1.3.1 Hydrogeology The conceptual model of the hydrogeologic setting discussed below describes the general physical conditions of the site that affect contaminant migration.

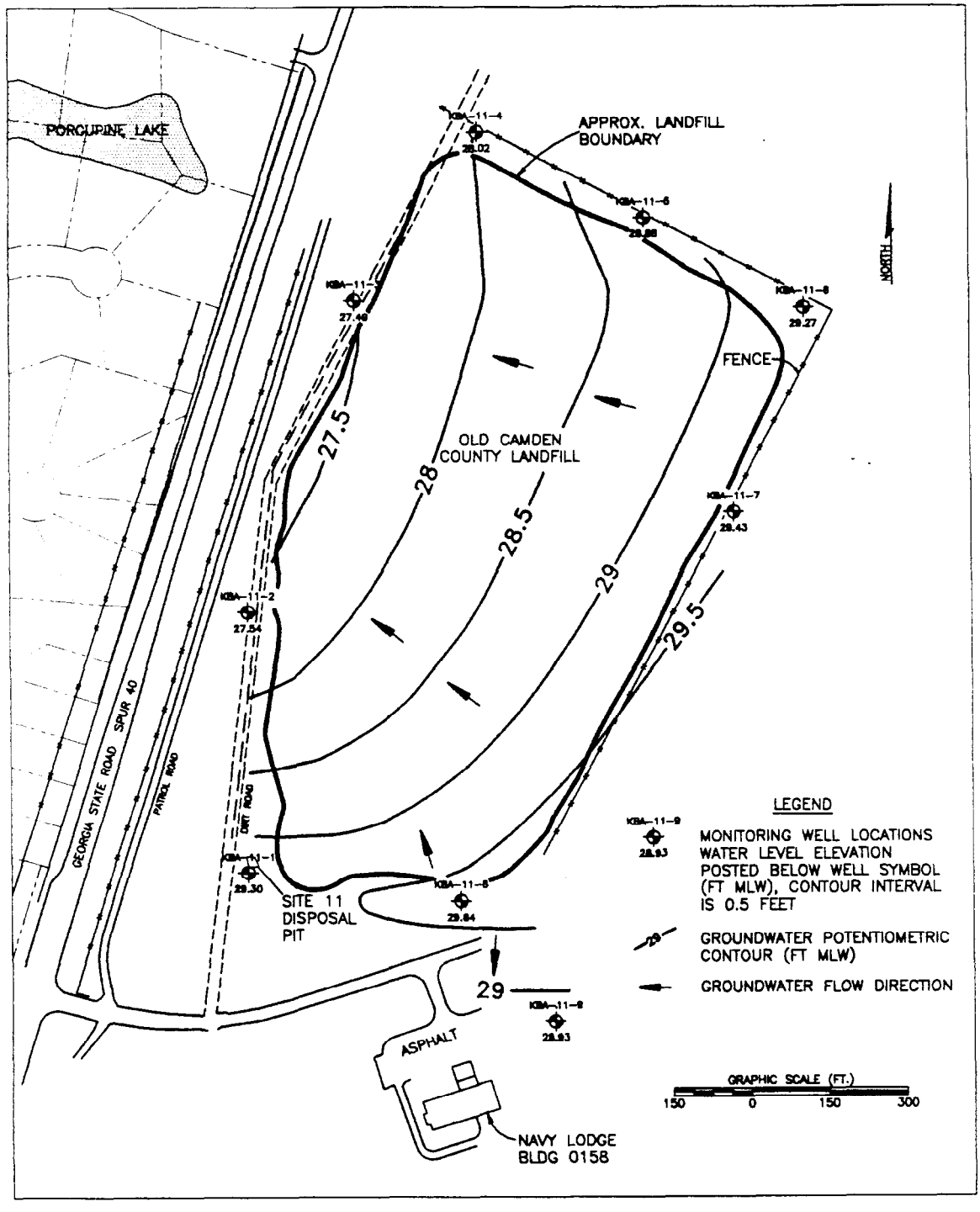
The landfill surface and surrounding area is characterized by relatively flat to gently sloping surface topography with elevations between approximately 30 to 40 feet above mean low water (MLW). Surface runoff infiltrates into the permeable sands of the surficial aquifer. The surficial aquifer is a relatively homogeneous, water table aquifer and consists mainly of fine-grained to medium-grained silty sands, as shown in Figure 1-3. The base of the surficial aquifer is the Hawthorn Formation. This formation is from 380 to 530 feet thick and consists of clays and limestones. The water table is approximately 5 to 8 feet bgs. The aquifer thickness is approximately 90 feet in the vicinity of the landfill. The overall hydraulic gradient in the vicinity of the landfill slopes gently towards the west-northwest, as shown in Figure 1-4. In general, groundwater flows laterally in this direction and ultimately discharges to the marsh. Some localized variations in groundwater flow exist, such as the potential mounding affects localized in the area of monitoring well KBA-11-8.

The primary potable source aquifer in the vicinity of the landfill, part of the Floridan Aquifer System, is between 470 to 570 feet bgs. It is separated from the surficial aquifer by the Hawthorn Formation and a secondary confined aquifer.

1.3.2 Contaminant Groundwater sampling results from the Interim Corrective Measure Screening Investigation at the Old Camden County Landfill, Site 11, at NSB Kings Bay indicated that VOC contaminants are present within the surficial aquifer. Vinyl chloride, cis-1,2-dichloroethene, and other fuel-related VOC contaminants were detected. The VOC contamination is present below the site and the Crooked River Plantation Subdivision. The spatial distribution of the VOCs appears limited to the upper 60 feet of the surficial aquifer in the subdivision and along the boundary of the landfill. Beneath the landfill, VOC contaminants were detected at depths of 85 feet bgs. The overall hydraulic gradient in the vicinity of the landfill is approximately 0.003 feet per foot (ft/ft) towards the west-northwest. The VOCs appear to have migrated within the groundwater laterally toward the subdivision through advective transport and dispersion.



DWN: DMF	PROJECT NO.: 08503.02	TITLE: SURFICIAL AQUIFER CONCEPTUAL MODEL	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 1-3		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3-10-94			



DWN: DMF	PROJECT NO.: 08503.02	TITLE: GROUNDWATER POTENTIOMETRIC SURFACE MAP JANUARY 14, 1993	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 1-4		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3-10-94			

1.3.3 Plume Control Restraining the plume will be accomplished by use of a groundwater extraction system to withdraw groundwater contaminated with VOCs from the surficial aquifer. The pilot-scale groundwater extraction system will include recovery wells at four to six locations. The recovery wells will be positioned in areas with the highest concentrations of contaminants along the western side of the landfill and right-of-way of Spur 40, recovery wells 1 through 4 are shown in Figure 1-5; the position of the fifth and sixth locations will be decided following an initial pumping test. The treatment system for the extracted contaminated groundwater will use air stripping technology and *ex situ* biotechnology applications.

1.4 OVERVIEW/ORGANIZATION. This IM Work Plan for Phase I is organized into sections that present Technical Approach, GWE and Treatment System(s) descriptions and pilot-scale operation, and specific plans that include a Monitoring Plan, the Engineering Evaluation Plan, Data Management Plan, Project Management Plan, and the Health and Safety Plan. Some of these sections reference associated appendices that give more detailed descriptions or additional data.

The contents of the IM Work Plan for Phase I are described below:

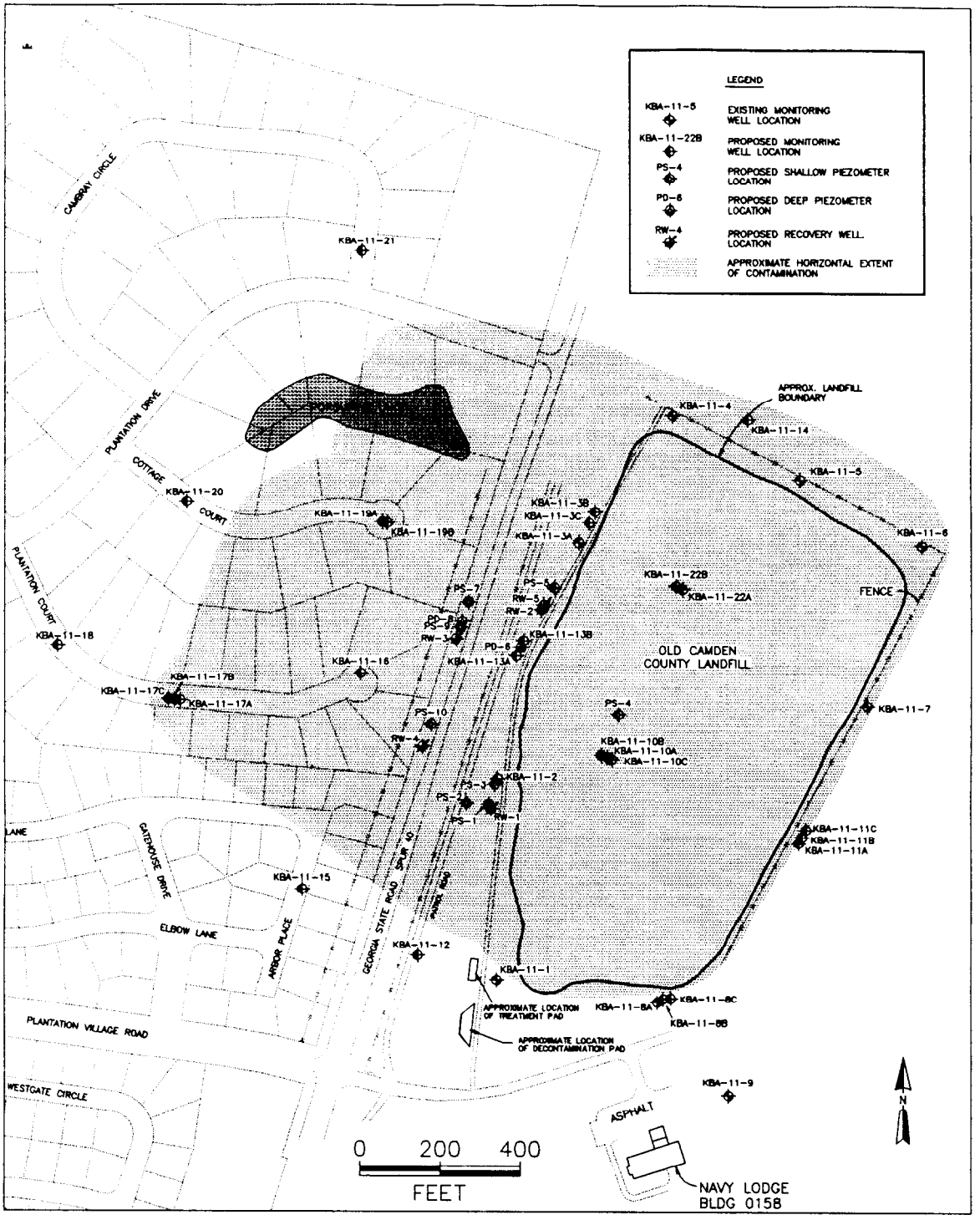
- Section 1.0, Introduction, describes Site 11; the purpose and DQOs of the IM activities; a conceptual model of the site's hydrogeologic conditions, occurrence of VOC contamination in the groundwater, and proposed plume control; and an overview of the organization of the Work Plan.

- Section 2.0, Technical Approach, presents a broad-based description of the planned approach to meeting the DQOs and achieving the goals of this IM project. This section addresses groundwater extraction to hydraulically control the VOC plume, planned pilot-scale treatment technologies, performance standards, and specific goals or criteria. A site-specific IM pilot-scale process flow diagram is also provided.

- Section 3.0, System Description, describes the pilot-scale extraction and conveyance system; treatment system and discharge of treated effluent; utility needs and power consumption; and a discussion of potential necessary air and discharge permits.

- Section 4.0, Operations, addresses the phased-operation of the pilot-scale GWE system; the operation and process control of the air stripping treatment (AST) technology unit, with associated pretreatment; and the pilot-scale test of the mRBC unit.

- Section 5.0, Monitoring Plan, presents the overall plan of activities and methodologies that will be used to monitor the hydraulic and contaminant reduction performance of the GWE and treatment system. This plan includes strategies for data collection and procedural guidance for data collection activities.



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DWN: NLW	PROJECT NO.: 08503	TITLE: PROPOSED MONITORING WELL, RECOVERY WELL, AND PIEZOMETER LOCATIONS	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 3-1		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3/10/94			

- Section 6.0, Engineering Evaluation Plan, addresses the plan for the evaluation of the pilot-scale GWE and conveyance systems, suitability of the selected technologies to cleanup the extracted groundwater to the specified goals as a full-scale system, performance of the instrumentation and controls, and reevaluation of discharge options and permits. A discussion of the Evaluation and Recommendations Report is also included.

- Section 7.0, Data Management Plan, presents the procedures for recording and maintaining field records of hydrogeologic information, hydraulic performance, and treatability data, as well as database management.

- Section 8.0, Project Management Plan, presents the project organization, including team members and responsibilities associated with the IM Phase I activities. The project sequence providing interrelated task activities is also included.

- Section 9.0, Health and Safety Plan, addresses the requirements necessary to promote safe working conditions during the IM pilot-scale installation and operational activities.

2.0 TECHNICAL APPROACH

This section describes the technical approach upon which the pilot-scale recovery and treatment systems are based in order to meet the DQOs and goals of this IM project.

2.1 GROUNDWATER EXTRACTION. Initially in Phase I (and Phase I Continuance) of the IM, groundwater contaminated with the constituents of concern, primarily VOCs, will be extracted from the surficial aquifer at areas previously identified as those with the greatest concentrations. Data from initial pumping tests (Phase I) and continued operation of the pilot-scale system (Phase I Continuance) will be used to design the full-scale IM GWE system (Phase II). This final phase of the IM will extract groundwater contaminated with VOCs from areas throughout the plume to control plume movement.

The pilot-scale GWE system includes an array of four to six recovery wells installed along the western side of the landfill and along Georgia Spur 40 to extract the contaminated groundwater from areas upgradient of the Crooked River Plantation Subdivision. Optimum pumping rates for each of the recovery wells will be based on specific capacity of each well and set drawdown levels of between 10 and 20 feet. A description of the GWE system is provided in Section 3.0. The pilot-scale operation of these pumping wells will provide operational and maintenance (O&M) performance characteristics of the GWE system. Further discussion of performance standards for the pilot-scale GWE system are provided in Subsection 2.3.

Performance data from the pilot-scale IM system will be evaluated and used to support full-scale IM design and implementation activities. The full-scale IM will be designed to extract VOC-contaminated groundwater and hydraulically control the movement of VOCs within the surficial aquifer.

Pilot-scale testing of the GWE system will also provide information for the Resource Conservation and Recovery Act (RCRA) Facilities Investigation/Corrective Measure Study (RFI/CMS) and Corrective Action Plan (CAP) such as:

- transmissivity and storativity,
- sustainable yield,
- hydraulic head data,
- refine water quality understanding,
- treatability parameters, and
- anisotropic nature of the aquifer.

2.2 TREATMENT. Many treatment technologies are available for treatment of VOCs. Air stripping and biological treatment have been selected for pilot-scale study. The technologies evaluated include:

- Activated Carbon Adsorption,
- Biological Treatment,
- Reverse Osmosis,
- Ozonation, and
- Air Stripping.

These technologies are discussed in greater detail below.

Activated Carbon Adsorption Activated carbon adsorption can be used to remove a variety of constituents from liquid or gaseous streams. The process of adsorption onto activated carbon involves contacting a waste stream with the carbon where the carbon selectively adsorbs constituents by a variety of attractive forces in which molecules are attracted to the internal pores of the carbon granules. Carbon adsorption is generally considered as a potential removal process for organic constituents that are nonpolar, of low solubility, or of high molecular weight.

Most carbon adsorption systems utilize granular-activated carbon in flow-through columns. These systems are efficient and relatively simple to operate if properly designed. The most obvious maintenance consideration associated with activated carbon treatment is the replacement and disposal or regeneration of spent carbon.

The adsorption process is nonspecific. Therefore the carbon will adsorb all constituents attracted to it, hazardous and nonhazardous alike. This means the naturally occurring nonhazardous organic content of the groundwater can be adsorbed, using the available pore space and causing the carbon to become depleted quickly, thereby increasing operating and replacement costs.

Activated carbon is commonly used following an air stripping process to remove the remaining less volatile constituents from the stream. This minimizes carbon replacement requirements and generally is the most cost efficient method when dealing with less volatile constituents at greater concentrations than found in the groundwater at NSB Kings Bay.

Based on current understanding of the constituents of concern for this phase of the IM, an activated carbon adsorption process was not chosen. This method would not produce greater benefit to the chosen air stripping process. This option will be retained for future consideration, especially after initial operations of the Phase I pilot-scale test.

Biological Treatment The function of biological treatment is to remove organic matter from the waste stream through microbial degradation. There is considerable flexibility in biological treatment because of the variety of processes and adaptability of the microorganisms. Aerobic bioremediation of chlorinated solvents can be achieved by methanotrophic (methane-degrading) bacteria co-metabolism. Co-metabolism is the concomitant breakdown of an organic compound by non-specific enzymes associated with the microbial breakdown of other carbon-source compounds. Chlorinated solvents such as vinyl chloride and *cis*-1,2-dichloroethene (1,2-DCE) have been demonstrated to be readily degraded in the presence of an active population of methanotrophic bacteria attached to mRBC disks.

One benefit of a rotating biological disc reactor is the large flow variations that can be handled. The modular construction provides flexibility to meet increases or decreases in treatment demands. Information collected from using the mRBC unit as a pilot-scale unit can be applied toward designing *in situ* and *ex situ* biological degradation techniques.

A pilot-scale test of biological treatment technologies will be applied to the treatment of groundwater at NSB Kings Bay. An 1-gallon per minute (gpm) waste stream will be diverted from the main waste stream to the mRBC. This flow was chosen to minimize the size of the mRBC pilot-scale test biological treatment

plant, thereby providing a cost-effective, on-site treatability study. The 1 gpm is sufficient to evaluate biological treatment of the groundwater through the mRBC. This treatability study will provide a basis for alternative biological treatment solution option that may be applied to the Phase II IM and/or the final Corrective Measure.

Reverse Osmosis Osmosis is the spontaneous flow of solvent (e.g., water) from a dilute solution through a semi-permeable membrane to a more concentrated solution. Reverse osmosis (RO) is the application of sufficient pressure to the concentrated solution to overcome the osmotic pressure and force the net flow of water (permeate) through the membrane toward the dilute phase. This allows the concentration of solute (impurities) to be built up in a circulating system on one side of the membrane while relatively pure water is transported through the membrane. Ions and small molecules in true solution can be separated from water by this technique.

In treatment of hazardous waste streams, the use of RO is primarily limited to polishing low flow streams containing highly toxic contaminants. In general, good removal can be expected for high molecular weight organics and charged anions and cations. Low molecular weight organic compounds and water are more difficult to separate with a physical separation process such as RO.

RO units are subject to chemical attack, fouling, and plugging. Pretreatment requirements can be extensive including suspended solids removal, pH adjustments, and removal of oxidizers, oil and grease. Low concentrations of organic compounds may encourage biological growth on the membrane. The solute stream, generally 10 to 25 percent of the feed volume, will be a concentrated stream that will still require treatment and disposal.

RO is not considered an efficient technology for treating the groundwater at NSB Kings Bay, based on current knowledge of constituents of concern.

Ozonation Ozone has been used for many years, primarily for the disinfection of municipal drinking water. Ozone's oxidation potential means that it can react rapidly with a large number of organic compounds and oxidizable inorganic compounds and that it can destroy bacteria and viruses. Complete oxidation of organic compounds to nitrogen and carbon dioxide gas can be obtained with some compounds if sufficient doses and reaction time are used. The ozonation process is nonspecific and ozone supply can be depleted in the oxidation of nonhazardous constituents that are not a concern. Ozone is typically generated on-site as needed. No storage of strong oxidants are needed. Ozone generation is energy intensive and equipment is costly.

In the ozonation process, stripping of the more volatile organics is a significant removal pathway for compounds that are difficult to oxidize. Organic compounds with relatively high Henry's Law Constants and double bonds (trichloroethane and dichloroethane) are not readily oxidized by ozone and the off-gas must be treated. All ozone systems also should include some type of ozone-destruction equipment to prevent excess ozone from entering the environment.

Ozonation is not considered a cost effective technology for treating the groundwater at NSB Kings Bay based on current knowledge of constituents of concern.

Air Stripping Air stripping is a mass transfer process in which volatile constituents in water or soil are transferred to gas. Air stripping is used to remove volatile organics from aqueous waste streams. Generally components with Henry's Law Constants greater than 0.003 atmospheres - m^3 (cubic meters) per mole can be effectively removed by air stripping (USEPA, 1985). The constituents of concern in groundwater at Site 11 meet this criteria.

Diffused aeration stripping uses an aeration basin similar to standard wastewater treatment aeration basins. Water flows through the basin from one side to the other with air dispersed through diffusers at the bottom of the basin. The air-to-water ratio and the maintenance requirements are significantly lower than the packed tower strippers.

Since the constituents are transferred to the gas stream, the gas stream also may require treatment before discharge to the atmosphere. Typical gas stream treatment following an air stripper involves vapor phase carbon adsorption.

The constituents of concern in the groundwater at NSB Kings Bay are easily removed by the air stripping technologies. A form of air stripping technology, diffused aeration, generally is less sensitive to scaling or suspended solids than a standard, packed tower air stripping column. The diffused aeration process has fewer pretreatment and maintenance requirements and is considered a cost effective approach to meeting the goals and objectives of the IM.

The treatment system will collect, treat, and discharge water extracted from the surficial aquifer by the pilot-scale GWE system, as well as other fluids generated during the Phase I installation and operation activities. The streams that will be treated by this system include:

- groundwater from the recovery wells;
- vehicle and equipment decontamination water;
- treatment area spills, leaks, and washdown water;
- process area storm water (if contaminated);
- decontamination pad storm water (if contaminated); and
- water from preliminary aquifer pumping test(s) and well development.

The treatment system will have the capacity to treat groundwater and wastewater streams and reduce effluent contaminant concentration levels to USEPA-established MCLs. MCLs are concentrations that are generally accepted as drinking water standards. Where MCLs are not established, the estimated effluent contaminant concentration will be evaluated by the facility receiving the effluent discharge flow. Further discussion of these performance standards is provided in Subsection 2.3.

Flow through the treatment system is expected to be approximately 40 gpm. The actual flow rate will depend on optimum flow rates from each of the recovery wells, and actual flows from the decontamination pad and treatment pad sumps. The maximum design flow for the pilot-scale treatment system will be 60 gpm, providing additional capacity for additional recovery wells or storm water as needed. A description of the treatment system and process diagrams are provided in Section 3.0.

Two pilot-scale treatment systems will be evaluated for suitability as a treatment method for full-scale IM implementation. Most of the water will be treated using air stripping technology for removal of the VOCs. If necessary,

the treatment system will include pretreatment for removal of heavy metals, iron and carbonate, and air stripping for removal of VOCs. The second pilot-scale treatment system will accept a small stream (1 gpm) which will be biologically treated to reduce VOC concentration levels. The 1 gpm stream required for pilot-scale testing of the mRBC is sufficient to collect the data needed to evaluate biological treatment of the groundwater. Higher flows are more easily and cost effectively handled by the air stripping pilot-scale unit. Therefore, the bulk of the water will be treated through the air stripping treatment system. Both systems will be evaluated for effectiveness and efficiency as a long-term IM treatment approach.

During the initial pumping test conducted during Phase I activities, groundwater samples will be collected. These samples will be analyzed for heavy metals, iron, and carbonate concentrations to determine requirements for pretreatment of the groundwater. Pilot-scale pretreatment will be designed to:

1) ensure MCLs for metals are met at the system discharge (if metals are detected above MCL concentrations),

2) ensure efficient and effective operation of the air stripper, and

3) collect data to design a full-scale pretreatment system, if needed.

If pretreatment is determined to be necessary, then treatability tests (bench-scale jar tests) will be performed to define pretreatment requirements, such as types and quantities of chemical additives.

If pilot-scale system pretreatment is determined to not be necessary to meet these goals, then pretreatment will not be performed. This IM Work Plan discusses pretreatment in case pretreatment is necessary.

The effluent from both treatment systems will meet requirements for discharge to a sanitary sewer which runs to a publicly owned treatment works (POTW) for the City of Saint Marys or to the base's land application system (LAS). Prior to discharge to either facility, a request to discharge will be submitted to the appropriate state agency and facility operators.

2.3 PERFORMANCE STANDARDS. The performance of the pilot-scale GWE system will be evaluated on the ability of the system to hydraulically control the migration of the VOC plume. The ability of the pilot-scale GWE system to hydraulically control the plume will be measured against several performance standards. These standards, however, will be applied subjectively because of the preliminary nature of the pilot-scale test. Operational characteristics of the pilot-scale GWE system will provide a basis for the development of site-specific standards for the full-scale GWE system. These standards are:

- wells should provide a steady, sustainable yield,
- wells should have a moderately high efficiency of more than 65 percent, and,
- the radius of influence of each well should be measurable (or projected) so that well interference effects that create cumulative drawdowns can be evaluated for future (Phase II full-scale system) recovery well placement.

The pilot-scale treatment system will have the capacity to treat the extracted groundwater to concentration levels at or below MCLs prior to discharge. During pilot-scale operation, groundwater data will be collected to evaluate if treatment is needed and performance standards required for full-scale IM operation. Currently, available groundwater data does not sufficiently support a no-treatment alternative for the groundwater extracted during pilot-scale testing. Treatment of the groundwater extracted during pilot-scale testing is needed to ensure the receiving treatment facility will not be adversely affected by the IM discharge stream. The treatment system effluent will be discharged to an existing treatment facility equipped with an aeration and activated sludge process.

The performance standards provided in Table 2-1 list treatment system performance goals for treated discharge. This table does not reflect cleanup goals for the aquifer. Cleanup standards for the groundwater have not been addressed in this IM Work Plan. Establishment of cleanup goals for the final remedial action effort(s) will be addressed in the final CAP.

2.4 PROJECT SEQUENCE. The IM activities will be conducted in a phased approach. A generalized IM activities/logic diagram that shows the phased approach and interrelated nature of the activities is provided as Figure 2-1. Phase I activities involve installation of pilot-scale GWE, conveyance, and treatment system; operation of the combined system; evaluation of the pilot-scale tests; and recommendations for the design of a full-scale system. Phase I Continuance activities may include the continuance of operations of the pilot-scale GWE/treatment system while initial tests are evaluated. Design activities and installation of a full-scale IM are part of the future Phase II activities. The long-term operation of the full-scale GWE and treatment system (Phase II) will minimize further migration of VOC contaminants within the groundwater emanating from Site 11 until a final corrective measure can be implemented.

2.5 SPECIFIC GOALS AND CRITERIA. The overall objective of the interim measure is to ultimately achieve hydraulic control of the VOC plume emanating from NSB Kings Bay Site 11, Old Camden County Landfill. The chosen method for hydraulic control is groundwater extraction through the use of extraction wells. Full-scale design of an extraction system to attain hydraulic control will be possible as a result of this pilot-scale test.

Phase I of the IM includes pilot-scale testing to select the most effective and efficient recovery and treatment process for the extracted groundwater. The pilot-scale studies include pretreatment (if necessary), air stripping technologies using either a packed-tower aeration unit or an air sparging unit, and biological treatment using a mRBC unit. Specific goals of the pilot-scale GWE system are to: (1) install groundwater recovery wells in suspected areas of highest VOC contamination, and (2) perform pumping tests to measure aquifer parameters and observe responses under various pumping conditions.

Specific goals of the pilot-scale conveyance and treatment system are to: (1) install a conveyance system to collect and transport recovered groundwater for treatment, (2) install a groundwater treatment system to treat VOC-contaminated groundwater for proper disposal, and (3) measure raw and treated groundwater quality to appraise treatment performance effectiveness and efficiency. Accomplishments of these goals will allow the IM project team to assess groundwater recovery and treatment performance and recommend refinements to improve stabilization of the VOC-contaminated groundwater plume.

Table 2-1 Treatment System Performance Criteria

Constituent of Concern	Est. Influent Conc. (µg/l)	Performance Criteria[1] (µg/l)
Benzene	5	5
2-Butanone	580	(3)
Chlorobenzene	10	(3)
1,4-Dichlorobenzene	12	75
1,1-Dichloroethane	24	(3)
1,2-Dichloroethane	9	5
cis-1,2-Dichloroethene	3,600	70
trans-1,2-Dichloroethene	23	100
1,2-Dichloropropane	6	5
Ethylbenzene	41	700
2-Hexanone	70	(3)
4-Methyl-2-pentanone	110	(3)
Tetrachloroethene	3	5
Toluene	840	1,000
Trichloroethene	45	5
Xylenes (total)	120	10,000
Vinyl Chloride	310	2
Iron	57 mg/l	3 mg/l[2]

Sources:

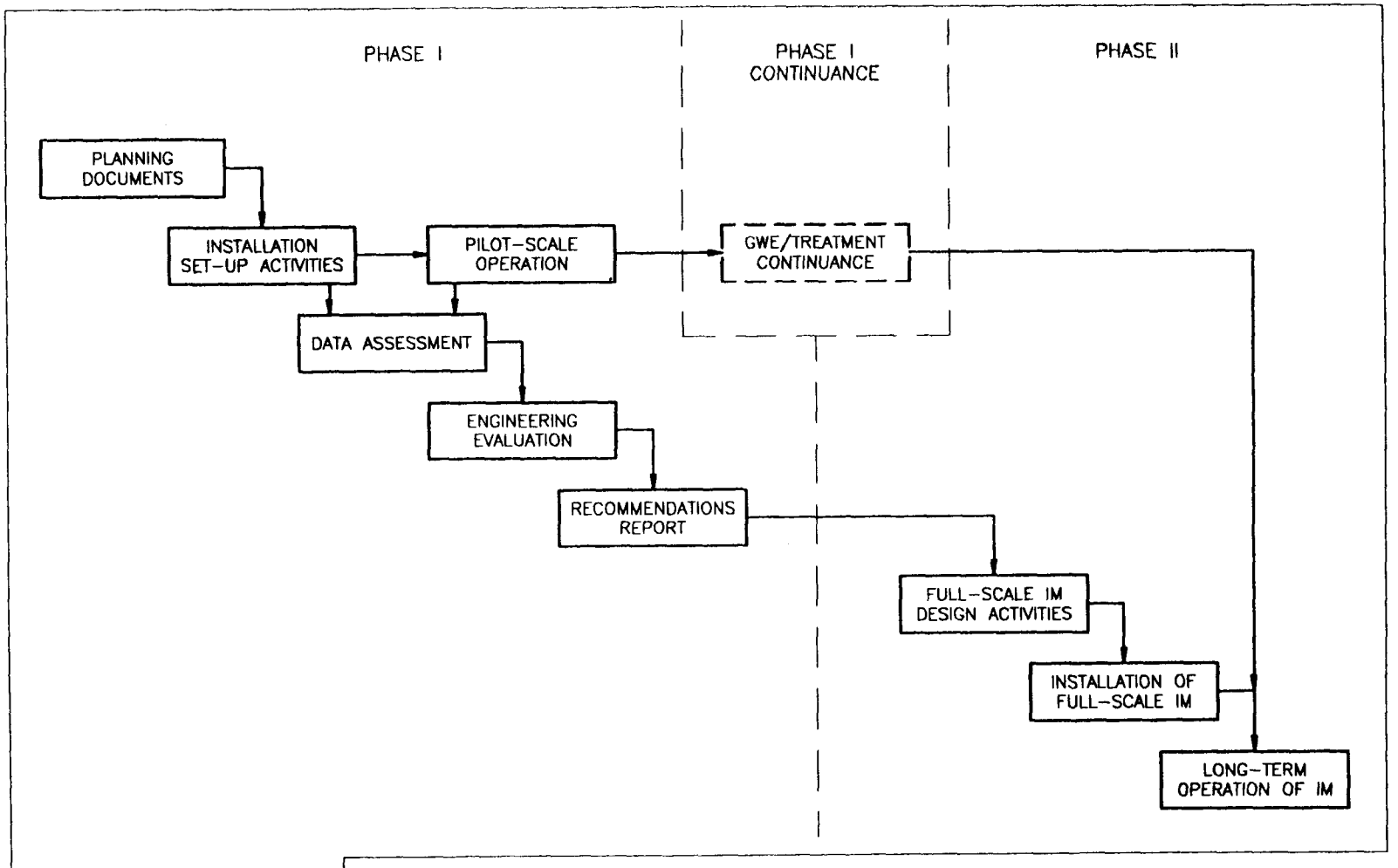
(1) Performance criteria are applied to the treated effluent. They are the maximum containment levels for constituents of concern as established by the State of Georgia (1993) and USEPA (1992).

(2) Based on air stripper operation requirements.

(3) No MCL or health-based advisory established. Final system design will provide effluent concentrations. Discharge criteria for the compounds will be evaluated by facility receiving effluent discharge.

Notes:

Conc. = concentration
Est. = estimated
mg/l = milligrams per liter
µg/l = micrograms per liter



DWN: DMF	PROJECT NO.: 08503.02	TITLE: GENERALIZED INTERIM MEASURE (IM) ACTIVITIES/ LOGIC CHART	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 2-1		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3-10-94			

The criteria in performing these pilot-scale tests include:

- Placement of recovery wells to gain information needed to design a system that will attain hydraulic control. The pilot-scale (Phase I and Phase I Continuance) well placement has been designed to withdraw VOC-contaminated groundwater from selected "hot-spots" within the surficial aquifer.

- Treatment of the extracted groundwater through pretreatment processes (if required) and air stripping for removal of VOCs before discharge to a treatment works. The treatment system has been designed for discharge effluent to meet MCLs, where available, for VOCs. Other VOC discharge criteria will be evaluated by the facility receiving the effluent.

- Biological treatment of a 1 gpm stream of the extracted groundwater to evaluate effectiveness of *in situ* and *ex situ* biological treatment. This system has been designed to meet MCLs for select chlorinated solvents. The waste stream from the biological treatment will undergo secondary treatment through the air stripping system.

The goals of performing the pilot-scale tests are to:

- Evaluate the suitability of recovery wells in achieving hydraulic control of the VOC plume.

- Determine if treatment is necessary for discharge of the groundwater, or if direct discharge to a treatment works is a viable option.

- Determine which treatment technology is most effective and efficient with the least cost, if treatment is necessary for full-scale (Phase II) IM operation.

- Determine if pretreatment is required and to define pretreatment parameters such as types and quantities of chemical additives.

3.0 SYSTEM DESCRIPTION

This section presents a description of the pilot-scale extraction and conveyance system; treatment system and discharge; utility requirements; and necessary air and construction permits.

3.1 WELLS. During the IM, two types of wells will be installed on and adjacent to NSB Kings Bay. These will consist of recovery wells for extracting VOC-contaminated groundwater and observation wells for monitoring performance of the recovery system (water level measurements).

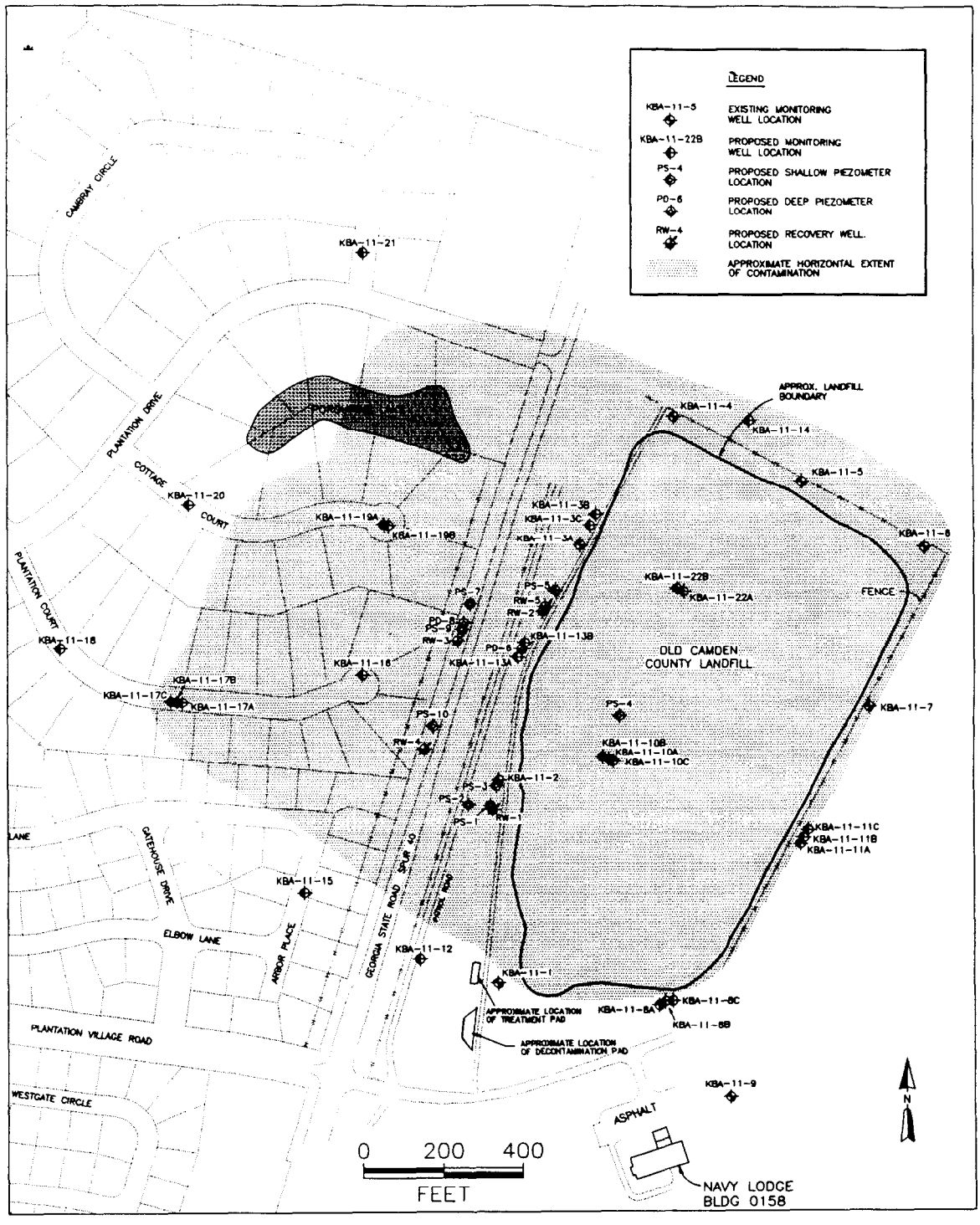
As many as six groundwater recovery wells (RWs) will be installed using mud rotary methods at four to six locations west of the landfill (Figure 3-1). Also indicated in this figure are the proposed monitoring wells as part of the Supplemental RCRA Facility Investigation (RFI). Construction of these monitoring wells is discussed in the Supplemental RFI Work Plan. Two of the recovery well locations will be adjacent to the landfill and two locations will be along the western Spur 40 right-of-way. Installation of wells RW-2 and RW-3 will continue while an initial aquifer pumping test is conducted on the first well, RW-1. Aquifer response due to the pumping stress at RW-1 will be analyzed in the field. Preliminary interpretation of the radius-of-influence will be assessed to determine the optimum location of RW-4. The addition of the fifth and sixth wells, RW-5 and RW-6, will be based on several factors that may be observed during the initial pumping test at RW-1. These factors may include:

- preliminary radius-of-influence data,
- vertical head potential relationships, and
- stratigraphic unit/contaminant relationships within the aquifer.

The groundwater recovery wells will be constructed in a 12-inch-diameter borehole using a 6-inch-diameter Schedule 10S type 304 stainless-steel, flush-joint, threaded well casing and wire wrap, 0.030-inch continuous slot well screen. As shown in Figure 3-2, a sump (5 feet in length) will be placed below a 50-foot length of 6-inch-diameter well screen. Two centralizers will be used in the construction of the recovery wells. One will be placed at the bottom of the screen section and one at the top of the screen section.

The annulus surrounding the screen will be backfilled with a coarse sand pack and tremied into place 2 feet above the screen. A 2-foot bentonite seal will be placed above the sand pack using bentonite pellets or flakes (Hole Plug™ or similar). The remaining annulus above the seal will be grouted to the point of well vault installation. All material depths will be tagged and recorded by an engineer or hydrogeologist.

As part of the recovery well system, a piezometer will be installed within the annular sand pack of the recovery well to monitor water levels within the recovery well filter pack. The piezometer will be constructed with an 1-inch-diameter, Schedule 40, flush-jointed riser made of polyvinyl chloride (PVC) and 1-inch-diameter Schedule 40 PVC slotted screen (0.030-inch slots). The screened interval length will extend from 10 feet above the bottom of the associated recovery well to the top of the recovery well screen. Comparisons of water levels within the well casing and the filter pack piezometer will provide data for evaluation of well efficiency.



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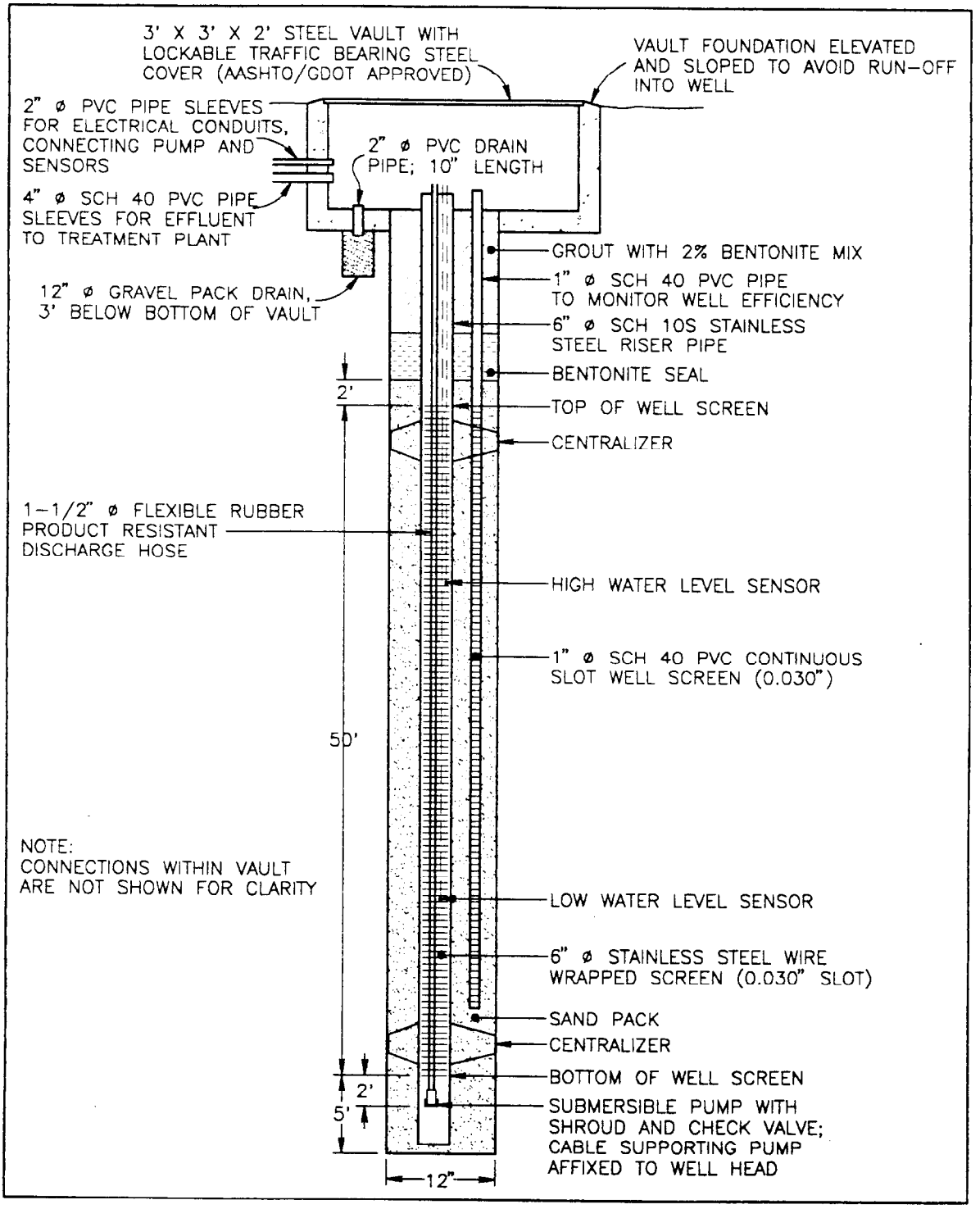
DWN: NLW	PROJECT NO.: 08503	TITLE: PROPOSED MONITORING WELL, RECOVERY WELL, AND PIEZOMETER LOCATIONS	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 3-1		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3/10/94			



DWN: DMF	PROJECT NO.: 08503.02	TITLE: RECOVERY WELL DETAIL	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 3-2		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3-10-94			

The submersible pumps for the recovery system were designed using associated flow and head loss calculations. Flow estimates have been based on preliminary hydraulic conductivity estimates from previous studies and drawdown estimates of 5 to 20 feet. Total head loss associated with the GWE and conveyance systems will range from approximately 40 to 65 feet. This includes pipe friction losses in 1.5-inch-diameter PVC pipe, elevation head loss, and minor losses due to fittings, bends, valves, and meters.

Based on these design calculations, three submersible pump models have been selected for the recovery wells. A 1/3-horsepower pump with flow range of 5 to 13 gpm will be used for the initial pumping test at RW-1. Based on pump performance and effective drawdown during this initial test, one of two alternative submersible pumps may be selected for installation in the recovery wells. The two other alternative pumps are 1/3-horsepower and 1/2-horsepower models with flow ranges of 3 to 9 gpm and 10 to 20 gpm, respectively. Well performance during development of each well may also refine the selection of the pump best suited for a specific recovery well.

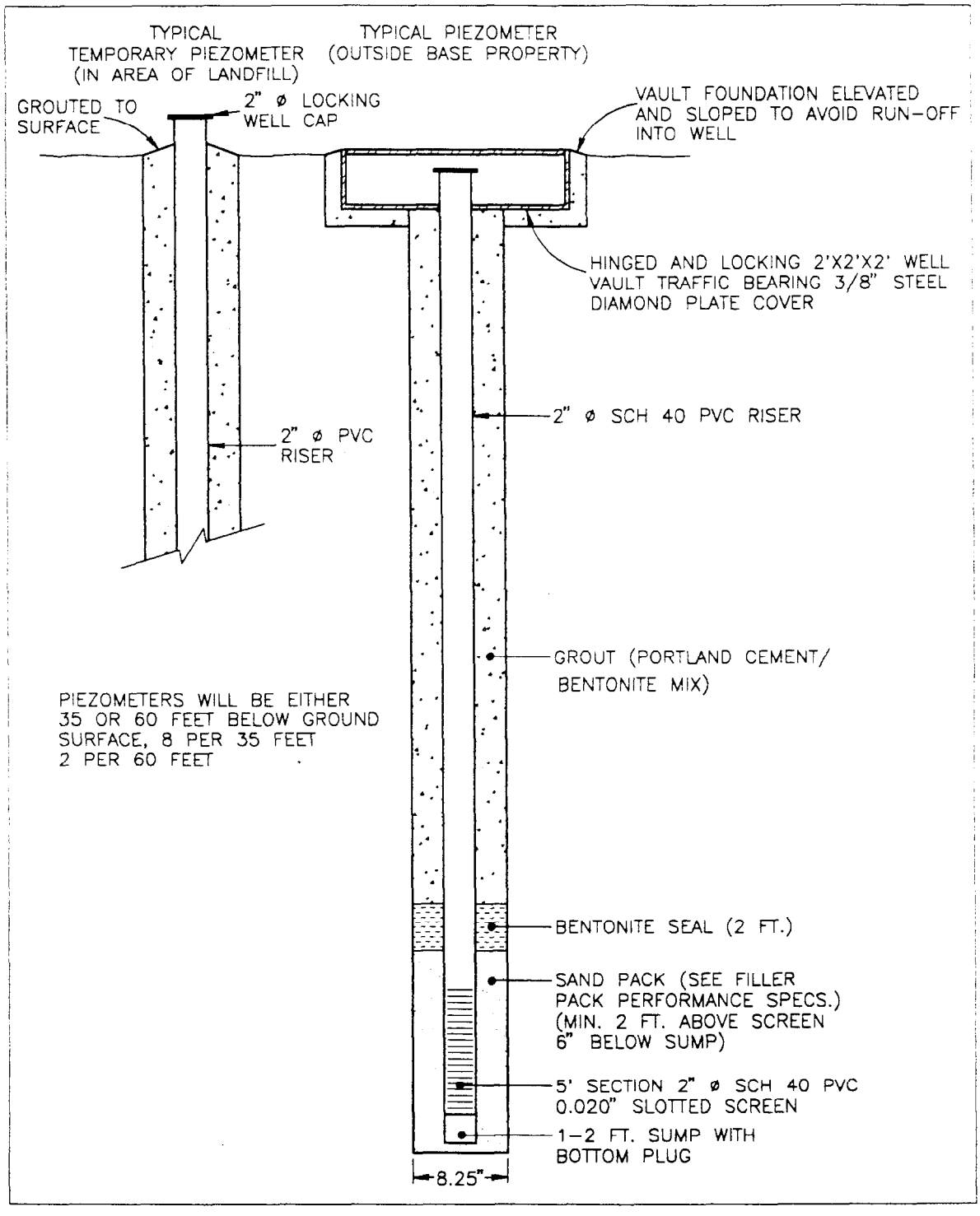
Ten observation wells or piezometers will be installed using hollow-stem auger methods (4.25 inside diameter) at eight locations surrounding the recovery wells (Figure 3-1). Some of these observation wells will be clustered in pairs.

Observation wells will be constructed of 2-inch-diameter Schedule 40 PVC riser pipe and 0.020-inch slotted screen sections to depths of 35 and 60 feet. Screen sections will be 5 feet in length (Figure 3-3). The annulus surrounding the screen will be backfilled with a sand pack to 2 feet above the screen. A 2-foot thick bentonite seal will be placed above the sand pack. The remaining annulus above the seal will be grouted to the point of well vault installation. Observation wells installed on NSB property may be completed without well vaults. All material depths will be tagged and recorded.

Well vaults for both recovery and observation wells (off NSB property) will be flush-mounted 22-gauge steel, water-resistant, welded boxes with a minimum 3/8-inch locking padlock guard steel lid. All on-site observation wells/piezometers will be equipped with lockable, expandable-seal caps. All recovery wells will be installed and secured with lockable covers. Any wells installed on the right-of-way will be designed to withstand an H20 loading, per American Association of State Highway and Transportation Officials (AASHTO) standards. All others will be designed to withstand H15 loads. Each cover plate requires a metal marker stamped by the Contractor. This imprinted marker will be installed using rivets. The dimensions for each of the vaults will be 3 by 3 by 2 feet for the recovery wells and 2 by 2 by 2 feet for the observation wells.

Subsurface soil samples will be collected during drilling of the boreholes for recovery well and observation well installation in accordance with USEPA Region IV Standard Operating Procedures Quality Assurance Manual (SOPQAM) and Naval Energy and Environmental Support Activity (NEESA) guidance. Samples will be collected at 5-foot intervals from ground surface down to completion depth with a standard 24-inch split spoon. Samples will be descriptively logged using the Unified Soil Classification System, American Society for Testing and Materials (ASTM) D 2488-24.

All drilling and well installations are in accordance with USEPA Region IV SOPQAM and SOUTHNAVFACENGCOM guidelines.



DWN: DMF	PROJECT NO.: 08503.02	TITLE: OBSERVATION WELL DETAIL	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 3-3		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3-10-94			

3.2 CONVEYANCE. The contaminated water piping system will consist of Schedule 40 PVC piping, check valves, hand-operated ball valves, and in-line flow meters. PVC piping will be sized to maintain a minimum velocity of 2 feet per second (fps) and a maximum velocity of 12 fps. A separate conveyance line will be installed from each recovery well to a manifold at the treatment system (Figure 3-4 and Figure 3-5).

Two PVC swing check valves will be installed in each conveyance line. To prevent backflow from entering the recovery well, one check valve will be installed in the recovery well vault downstream of the flexible discharge line-quick-connect. The other check valve will be installed downstream of the ball valve at the manifold to prevent combined influent from entering individual conveyance lines.

A totalizing flow meter will be installed in each conveyance line at the manifold to monitor discharge. The flow meter will provide total flow in gallons. Flow rates will be determined by calculating total flow over elapsed time intervals.

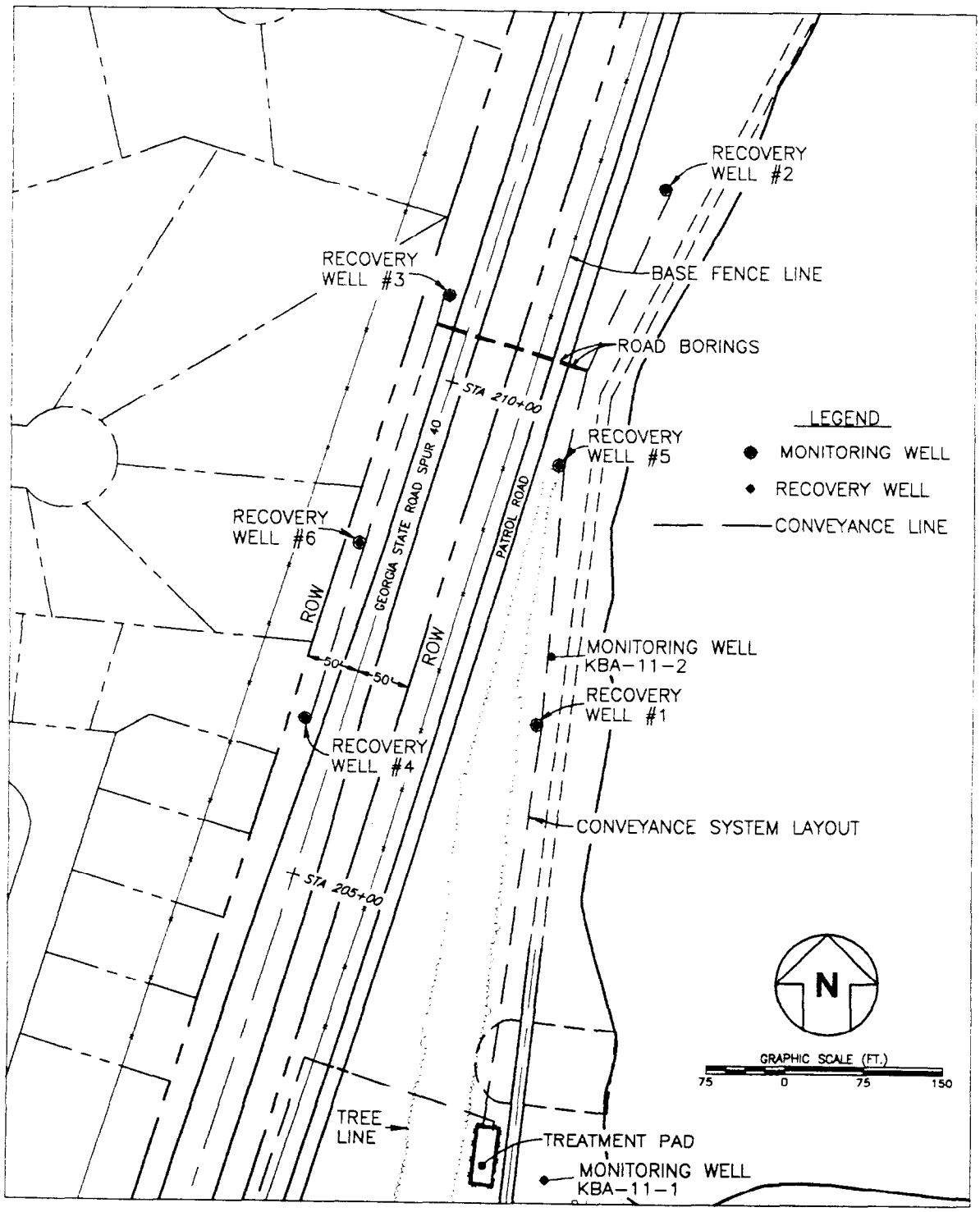
To isolate and/or regulate specific flow rates from each recovery well, a hand-operated full-port ball valve will be installed in each conveyance line at both the manifold and the well head.

Conveyance piping will be installed to a depth sufficient to prevent crushing from vehicular travel. To facilitate the placement of conveyance piping under paved roads, two 10-inch steel casing road bores will be installed under Georgia Spur 40 and the paved security road (Figure 3-6).

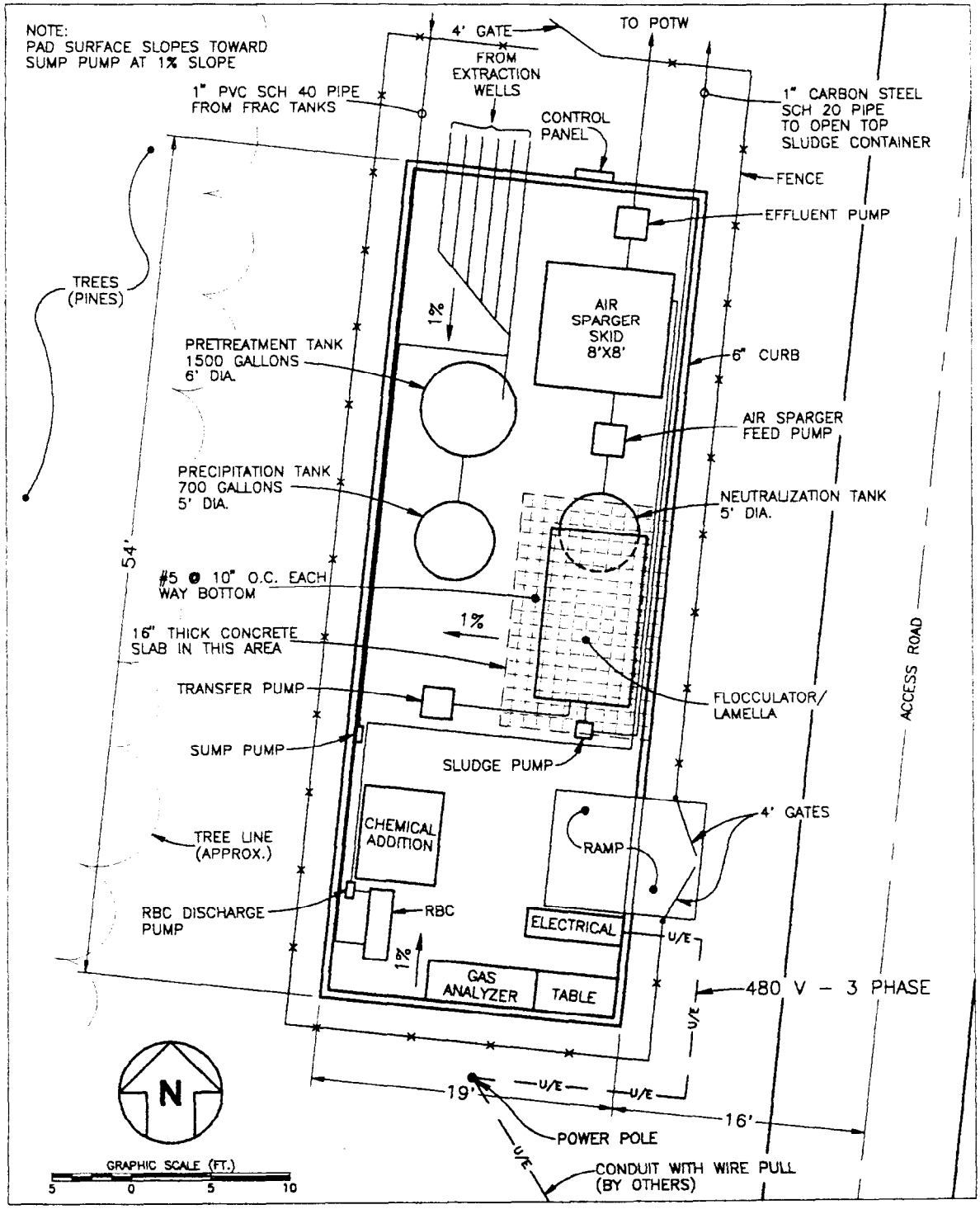
Before start-up of the treatment system, all conveyance piping will be pressure tested as required by the IM Treatment and Conveyance System specifications.

3.3 TREATMENT SYSTEM. Groundwater extracted by the GWE system will contain VOCs. Air stripping technologies, including packed tower aeration units and air sparging units, are effective treatment processes for removing VOCs from wastewater. All the constituents found in the groundwater and listed in Table 2-1 are readily volatilized, including 1,2-dichloroethane, cis-1,2-dichloroethene, 1,2-dichloropropane, trichloroethene, and vinyl chloride, which can be reduced to concentrations below MCLs by air stripping. Two air stripping technology options, a packed tower aeration unit and an air sparger, are being evaluated for Phase I of the IM. Factors that will support the selection of one of these options include cost, availability, pretreatment, and vapor treatment requirements. This determination will be made during the initial pumping tests performed during Phase I of the IM. A technical memorandum will be issued describing selection criteria and providing the final system design. This technical memorandum will serve as an addendum to the Work Plan. The terms air stripper and air sparger are used interchangeably in this document to refer to either of the air stripping technologies. A Process Flow Diagram is provided as Figure 3-7.

As discussed in Section 2.0, a pretreatment unit for removing iron from the water may be installed upstream of the air stripper unit so that fouling of the air stripper will be minimized. Preliminary water quality information indicates iron concentrations of 47 milligrams per liter (mg/l) and 56 mg/l in filtered and unfiltered groundwater samples, respectively. Pretreatment may consist of chemical addition, flocculation and sedimentation of the oxidized metals, followed by neutralization of the water. The appropriate pretreatment technology(s) will be selected based on water quality results obtained from

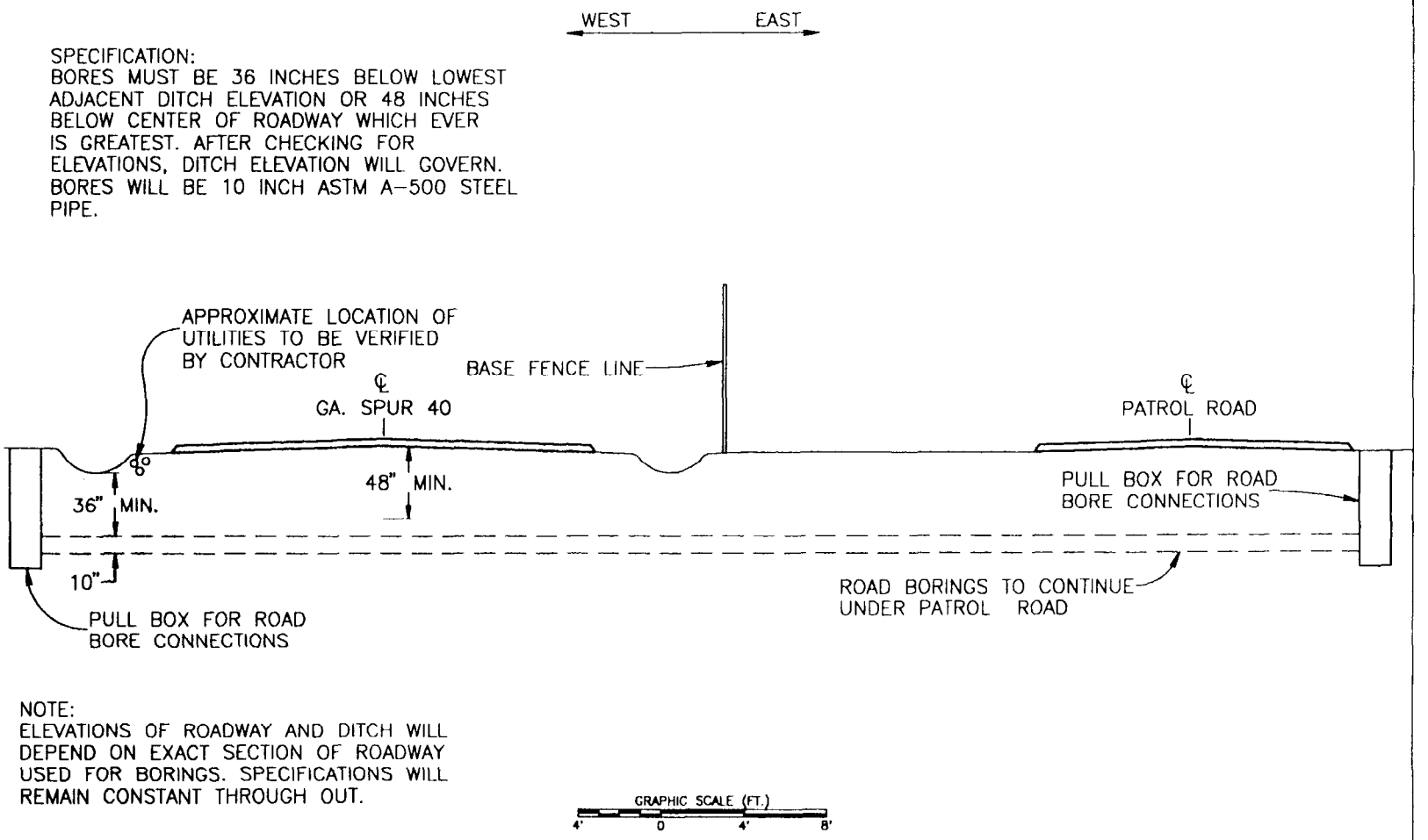


DWN: DMF	PROJECT NO.: 08503.02	TITLE: RECOVERY WELL LOCATIONS CONVEYANCE LAYOUT AND ROAD BORING ALONG SPUR 40	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 3-4		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3-10-94			



DWN: DMF	PROJECT NO.: 08503.02	TITLE: TREATMENT PAD	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 3-5		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3-10-94			

SPECIFICATION:
BORES MUST BE 36 INCHES BELOW LOWEST ADJACENT DITCH ELEVATION OR 48 INCHES BELOW CENTER OF ROADWAY WHICH EVER IS GREATEST. AFTER CHECKING FOR ELEVATIONS, DITCH ELEVATION WILL GOVERN. BORES WILL BE 10 INCH ASTM A-500 STEEL PIPE.



NOTE:
ELEVATIONS OF ROADWAY AND DITCH WILL DEPEND ON EXACT SECTION OF ROADWAY USED FOR BORINGS. SPECIFICATIONS WILL REMAIN CONSTANT THROUGH OUT.

DWN: DMF	PROJECT NO.: 08503.02	TITLE: ROAD BORE CROSS SECTION	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 3-6		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3-10-94			

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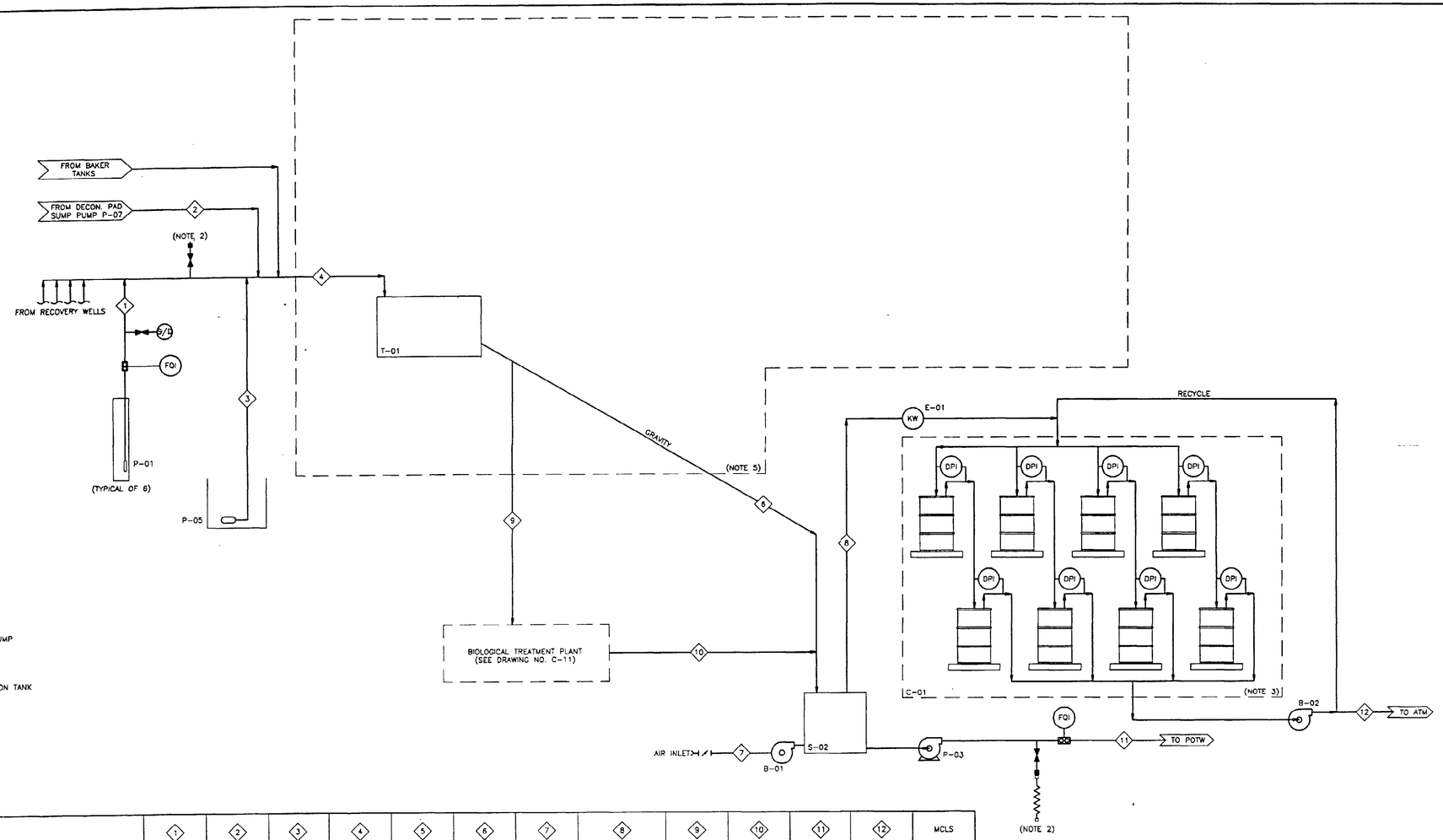

ABBREVIATIONS

B-01 – BLOWER
B-02 – CARBON ID FAN
C-01 – CARBON UNIT
E-01 – PREHEATER

P-01A THROUGH E – RECOVERY PUMPS

P-03 – EFFLUENT PUMP

P-05 – TREATMENT PAD SUMP PUMP

P-07 – DECONTAMINATION PAD SUMP PUMP

S-02 – AIR SPARGER
T-01 – PRETREATMENT TANK/EQUALIZATION TANK

LEGEND OF SYMBOLS

POSITIVE DISPLACEMENT PUMP
DIAPHRAGM PUMP (ELECTRICAL)
SUBMERGED SUMP PUMP
CENTRIFUGAL PUMP
FLOW TOTALIZER INDICATOR
DIRECT CONNECTION
DIRECT CONNECTION BLOCK VALVE IN CAP
ELECTRICAL CONNECTION
PACKAGED EQUIPMENT OR INTEGRAL UNITS
FLOW STREAM
HEATER
FLEXIBLE HOSE
PIPE ENDED WITH CAP
IN-LINE DEVICE
AGITATOR
DRAIN
SAMPLE TAP
SAMPLE TAP/DRAIN
PRIMARY PROCESS
NOT PIPING
ELECTRICAL
LINE BREAK OR RESUMPTION POINT
QUICK DISCONNECT
GLOBE VALVE
GATE VALVE
CHECK VALVE
BALL VALVE
BUTTERFLY VALVE IN LIQUID LINES, LOUVER IN AIR SERVICE

NOTES

1. FOR LEGEND OF SYMBOLS SEE THIS SHEET.
2. FOR RECYCLE.
3. CARBON TO BE PLACED ON PALLETS.
4. PRETREATMENT MAY BE INSTALLED AT A LATER DATE.

	1	2	3	4	5	6	7	8	9	10	11	12	MCLS
FLOW STREAM	RECOVERY WELLS (TYP.)	DECON. SUMP	TREATMENT PAD SUMP	INFLUENT		SPARGER FEED	AIR *	VAPOR EFFLUENT	RBC FEED	RBC EFFLUENT	DISCHARGE	VAPOR TO ATM	DISCHARGE CRITERIA
PARAMETER													
AVG. FLOW RATE gpm	8			40		40			1	1	40		
DESIGN													
PUMP FLOW RATE gpm	8	5	5	60		60		*	1	1	60		
DESIGN TOTAL lb/hr	4003.2	2502	2502	30,024		30,024			8.3	8.3	30,024		
SOLIDS lb/hr	2.0			15.3		15.3							
IRON mg/l	3			3		3			55.6				
MANGANESE mg/l	0.434			0.434		0.434			0.434				
ALKALINITY AS $CaCO_3$ mg/l	296			296		296			296				
SULFATE mg/l	26			26		26			26				
HARDNESS AS $CaCO_3$ mg/l	251			251		251			251				
DISSOLVED SOLIDS mg/l	319			319		319			319				
SUSPENDED SOLIDS mg/l	510			510		510			510				
BENZENE ug/l	5			5		5		0.0017 mg/m^3	5		0.12		5
2-BUTANONE ug/l	580			580		580			580		580		
CHLOROBENZENE ug/l	10			10		10		0.0034 mg/m^3	10		0.35		
1,4-DICHLOROBENZENE ug/l	12			12		12		0.0040 mg/m^3	12		0.55		75
1,1-DICHLOROETHANE ug/l	24			24		24		0.0081 mg/m^3	24		0.61		
1,2-DICHLOROETHANE ug/l	9			9		9		0.0029 mg/m^3	9		0.80		5
CIS-1,2-DICHLOROETHENE ug/l	3600			3600		3600		1.2294 mg/m^3	3600		63.28		70
TRANS-1,2-DICHLOROETHENE ug/l	23			23		23		0.0080 mg/m^3	23		23		100
1,2-DICHLOROPROPANE ug/l	6			6		6		0.0020 mg/m^3	6		0.34		5
ETHYLBENZENE ug/l	41			41		41		0.0140 mg/m^3	41		0.85		700
2-HEXANONE ug/l	70			70		70			70		70		
4-METHYL-2-PENTANONE ug/l	110			110		110			110		110		
TETRACHLOROETHENE ug/l	3			3		3		0.0010 mg/m^3	3		0.03		5
TOLUENE ug/l	840			840		840		0.2835 mg/m^3	840		24.57		1000
TRICHLOROETHENE ug/l	45			45		45		0.0154 mg/m^3	45		0.67		5
XYLENES (TOTAL) ug/l	120			120		120		0.0410 mg/m^3	120		2.05		10,000
VINYL CHLORIDE ug/l	310			310		310		0.1076 mg/m^3	310		0.40		2

* – TO BE DETERMINED BY VENDOR

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ABB Environmental Services Inc.

DWN:	PROJECT NO.:
DMF	08503.02
CHKD: KDS	FIGURE NO.: 3-7
DATE: 3-10-94	

TITLE: PROCESS FLOW DIAGRAM AIR SPARGER UNIT

IM WORK PLAN
NAVAL SUBMARINE BASE KINGS BAY, GEORGIA

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analysis of groundwater discharge samples collected from RW-1 during the initial pumping test (early portion of Phase I).

The average flow rate from six recovery wells is estimated to be 40 gpm. The maximum design flow rate of the treatment system will be 60 gpm to allow for potentially higher yields from the recovery wells and to allow for treatment of storm water and decontamination water as needed.

The pilot-scale treatment sequence proposed includes three steps: possible pretreatment (including clarification), air stripping, and vapor treatment. The Piping and Instrumentation Diagram is provided as Figure 3-8. The key components are described below.

3.3.1 Pretreatment If pretreatment is necessary, groundwater from the recovery wells, equipment decontamination pad, and treatment system sump will be discharged to the Pretreatment Tank. The Pretreatment Tank will provide some equalization of the influent streams to minimize possible variations in flow rates or water quality and, therefore, maximize the efficiency of the treatment system. To oxidize the iron, potassium permanganate will be added automatically to the Pretreatment Tank based on the oxidation reduction potential as monitored by a meter. Other metals also may be oxidized by this process. Assuming process flow rate of 60 gpm, the 1,500-gallon, carbon-steel tank provides a 25-minute retention time while the contents are agitated. Retention time will increase with decreases in flow rate.

The Pretreatment Tank will gravity flow to the Precipitation Tank where the pH of the waste stream will be increased to 8.5 to 9.0 to reduce the solubility of the oxidized metals. Caustic will be added based on the pH of the tank discharge as monitored by an in-line pH meter. Assuming process flow rate of 60 gpm, the 1500-gallon carbon-steel tank provides a retention time of 25 minutes while the contents are agitated. Retention time will increase with decreases in flow rate.

Liquid level indicators and switches in the Pretreatment and Precipitation Tanks will control the operation of the recovery well pumps and a system pump. A high liquid level in the Pretreatment Tank will activate an alarm and shut off the recovery well pumps. A low liquid level in the Precipitation Tank also will actuate an alarm and will shut off the Transfer Pump. The level switches will have a time delay to restart the pumps to avoid excessive cycling of the pumps.

A Transfer Pump will be used to transfer the waste stream to the Flocculator/ Lamella unit where the water first enters a flash mix compartment. Polymer will be automatically added to the flash mix compartment, that will have a capacity of approximately 10 gallons. The next compartment will be a slow mix or flocculation compartment where flocs are allowed to form and are kept in suspension by agitation. The feed stream flows from the flocculation compartment to the Lamella, or inclined plate separator, where the solids are removed from the wastewater stream.

The Lamella, designed for efficient removal of settleable solids, will have several major components that include inlet and outlet chambers, plate packs, a sludge chamber, and a clean water chamber. The influent stream will be introduced to the Lamella at the feed box which directs flow to individual plates. The stream flows upward under laminar conditions, allowing solids to settle while a supernatant exits from the plates through orifice holes above each

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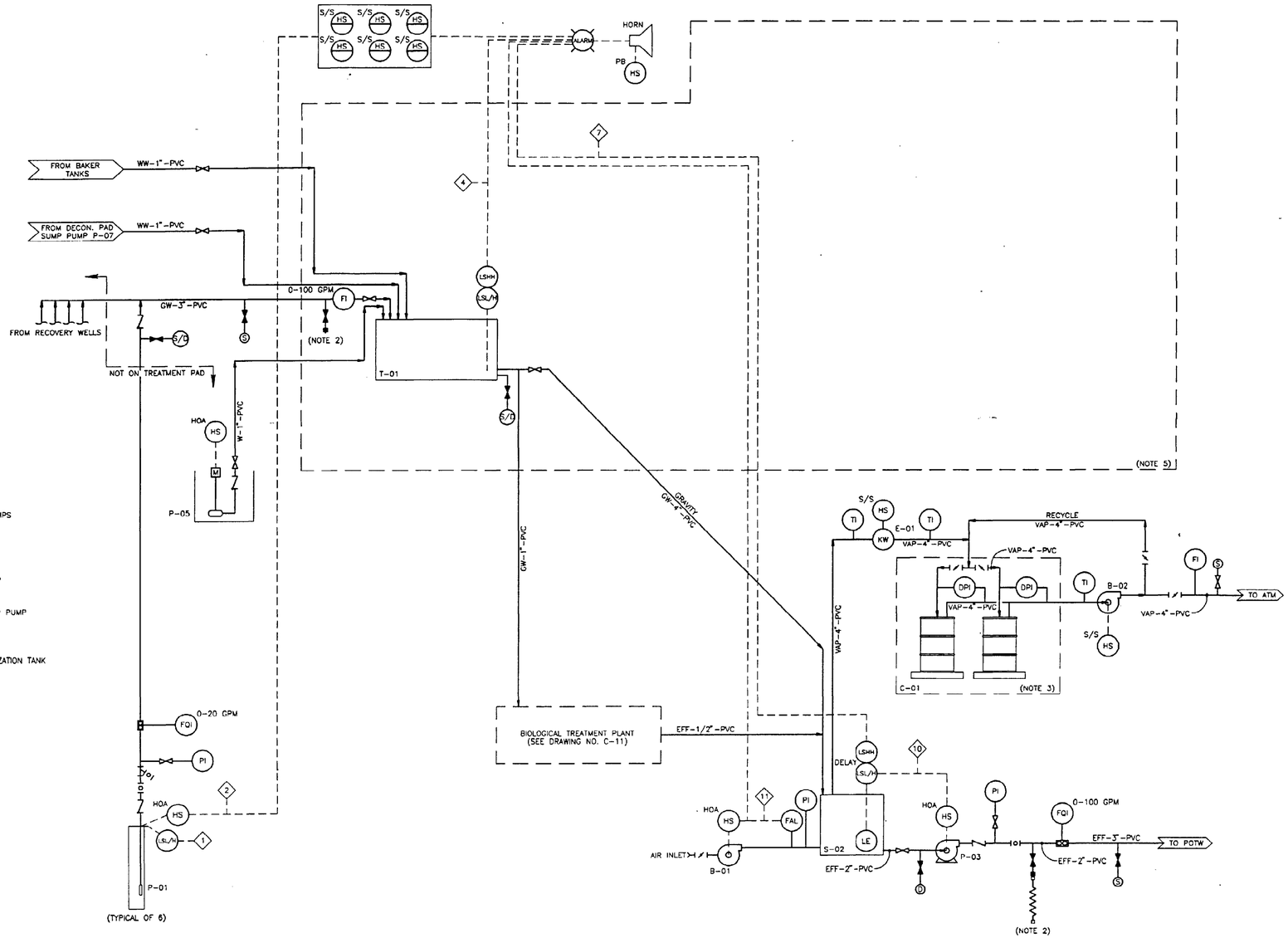

ABBREVIATIONS

B-01 – BLOWER
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S-02 – AIR SPARGER
T-01 – PRETREATMENT TANK/EQUALIZATION TANK

LEGEND OF SYMBOLS

- POSITIVE DISPLACEMENT PUMP
- DIAPHRAGM PUMP (ELECTRICAL)
- SUBMERGED SUMP PUMP
- CENTRIFUGAL PUMP
- FLOW TOTALIZER INDICATOR
- DIRECT CONNECTION
- DIRECT CONNECTION BLOCK VALVE IN CAP
- ELECTRICAL CONNECTION
- PACKAGED EQUIPMENT OR INTEGRAL UNITS
- LOGIC OR SEQUENTIAL CONTROL
- HEATER
- FLEXIBLE HOSE
- ALARM STROBE
- PIPE ENDED WITH CAP
- IN-LINE DEVICE
- AGITATOR
- DRAIN
- SAMPLE TAP
- SAMPLE TAP/DRAIN
- PRIMARY PROCESS
- NOT PIPING
- ELECTRICAL
- LINE BREAK OR RESUMPTION POINT
- QUICK DISCONNECT
- GLOBE VALVE
- GATE VALVE
- CHECK VALVE
- BALL VALVE
- BUTTERFLY VALVE IN LIQUID LINES, LOUVER IN AIR SERVICE
- Y STRAINER WITH BALL VALVE

NOTES

1. FOR LEGEND OF SYMBOLS SEE THIS SHEET.
2. FOR RECYCLE.
3. CARBON TO BE PLACED ON PALLETS. SEE SHEET C-10 FOR ADDITIONAL INFORMATION.
4. PRETREATMENT MAY BE INSTALLED AT A LATER DATE.

INTERLOCKS

1. LOW LEVEL WILL STOP PUMP. DE-ACTIVATION OF LOW LEVEL (OR HIGH LEVEL SWITCH) WILL START PUMP. A TIME DELAY WILL PREVENT PUMP CYCLING.
2. REMOTE HAND SWITCH CAN ALSO START/STOP PUMP.
3. DELETED
4. HIGH LEVEL IN EQUALIZATION TANK WILL SHUT OFF RECOVERY WELL PUMPS. LOW LEVEL SWITCH WILL START PUMP. HIGH-HIGH LEVEL WILL ACTIVATE HORN.
5. DELETED
6. DELETED
7. HIGH-HIGH LEVEL IN AIR SPARGER WILL SHUT OFF RECOVERY WELL PUMPS AND ACTIVATE HORN.
8. DELETED
9. DELETED
10. LOW LEVEL IN AIR SPARGER SUMP WILL SHUT OFF EFFLUENT PUMP. DE-ACTIVATION OF LOW LEVEL (OR HIGH LEVEL SWITCH) WILL START PUMP. A TIME DELAY WILL PREVENT PUMP CYCLING.
11. LOW FLOW WILL SHUT OFF BLOWER AND ACTIVATE HORN.

NOTES

1. THE INSTRUMENT LEGEND IS BASED ON ISA STANDARD.
2. THE LETTER "A" IS USED FOR ALL ANALYSIS VARIABLES. TERMS ARE PLACED OUTSIDE THE INSTRUMENT CIRCLE TO DENOTE THE SPECIFIC VARIABLES. SOME EXAMPLES ARE:
   - ORP – OXIDATION REDUCTION POTENTIAL
   - pH – pH
   - TOC – TOTAL ORGANIC CARBON
3. A DEVICE THAT CONNECTS, DISCONNECTS, OR TRANSFERS ONE OR MORE CURRENTS MAY BE EITHER A SWITCH, A RELAY, OR AN ON-OFF CONTROLLER, DEPENDING ON THE APPLICATION.

   A SWITCH, IF IT IS ACTIVATED BY HAND OR DEVICE IS USED FOR ALARM, PILOT LIGHT, SELECTION INTERLOCK, OR SAFETY.

   A CONTROLLER, IF THE DEVICE IS USED FOR NORMAL ON-OFF OPERATING CONTROL SUCH AS A SIMPLE HEATING THERMOSTAT.

   A RELAY, IF IT IS AUTOMATIC AND IS NOT THE FIRST SUCH DEVICE IN A LOOP I.E., IT IS ACTIVATED BY A SWITCH OR AN ON-OFF CONTROLLER.
4. A CONTROL OR SENDING DEVICE OR RELAY HAVING A DISPLAY FUNCTION SHOULD HAVE THE APPROPRIATE DISPLAY LETTERS AFTER THE MEASURED VARIABLE DESIGNATION, e.g. AIC DESIGNATES ANALYSIS INDICATING CONTROL STATION.
5. ALARM AND SWITCH DESIGNATIONS SHALL BE FOLLOWED BY A SUFFIX TO INDICATE ACTUATION, I.E., L (LOW), H (HIGH), LL (LOW-LOW SHUTDOWN), HH (HIGH-HIGH SHUTDOWN), HL (HIGH AND LOW).
6. USE OF MODIFYING TERMS HIGH, LOW, AND MIDDLE OR INTERMEDIATE SHALL CORRESPOND TO VALUES OF THE MEASURED VARIABLE, NOT OF THE SIGNAL, UNLESS OTHERWISE NOTED.

GENERAL PIPING AND INSTRUMENTATION DIAGRAM
INSTRUMENTATION IDENTIFICATION

SYMBOL	FIRST LETTER	EXAMPLES															
	MEASURED OR INITIATING VARIABLE	SENSING DEVICE			DISPLAY DEVICE						CONTROL DEVICE (NOTE 4)						
		PRIMARY ELEMENT	TRANSMITTER		INDICATOR	RECORDER	INTEGRATING INDICATOR	ALARM (NOTE 5)			CONTROLLER (NOTES 3 & 4)			CONTROL VALVE	SELF-ACTUATING VALVE	SWITCH (NOTES 3, 5 & 6)	RELAY CONVERTER OR COMPUTING DEVICE (NOTE 3)
			BLIND	INDICATING				LOW	HIGH	HIGH & LOW	BLIND	INDICATING	RECORDING				
A	ANALYSIS (NOTE 2)	AE	AT	AIT	AI	AR		AAL	AAH	AAHL	AC	AIC	ARC	AV		AS	AY
F	FLOW	FE	FT	FIT	FI	FR	FQI	FAL	FAH	FAHL	FC	FIC	FRC	FV	FCV	FS	FY
L	LEVEL	LE	LT	LIT	LI	LR		LAL	LAH	LAHL	LC	LIC	LRC	LV	LCV	LS	LY
P	PRESSURE	PE	PT	PIT	PI	PR		PAL	PAH	PAHL	PC	PIC	PRC		PCV	PS	PY
T	TEMPERATURE	TE	TT	TIT	TI	TR		TAL	TAH	TAHL	TC	TIC	TRC	TV	TCV	TS	TY

GENERAL INSTRUMENTS

- INSTRUMENT FOR SINGLE MEASURED VARIABLE AND ANY NUMBER OF FUNCTIONS. INSTRUMENT IS MOUNTED LOCALLY.
- INSTRUMENT IS MOUNTED IN FRONT OF PANEL

HAND ELECTRIC SWITCH DESIGNATION

S/S = START/STOP
HOA = HAND/OFF/AUTO
PB = PUSH BUTTON

LINE IDENTIFICATION

GW-2"-PVC
- PIPING MATERIAL
- LINE SIZE
- LINE SERVICE

LINE SERVICE DESIGNATION

GW – GROUND WATER
WW – WASTE WATER
S – SLUDGE
EFF – TREATED EFFLUENT
VAP – VAPOR

ABB ASEA BROWN BOVERI	ABB Environmental Services Inc.	DWN: DMF CHKD: KDS DATE: 3-10-94	PROJECT NO.: 08503.02 FIGURE NO.: 3-8	TITLE: PIPING AND INSTRUMENTATION DIAGRAM AIR SPARGER UNIT	IM WORK PLAN NAVAL SUBMARINE BASE KINGS BAY, GEORGIA

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plate. Solids slide down the plates into a sludge hopper where further thickening of the sludge occurs. This additional thickening is achieved due to compression in the quiescent zone made possible by feeding the plates from the side rather than the bottom. The sludge compartment has pitched sides and access hatches. Solids will be periodically pumped to a Sludge Holding Tank that will be located in the Storage (Frac) Tank Area.

Solids will be allowed to settle in the 20,000-gallon Sludge Holding Tank. Water will be periodically decanted from the tank. When the Sludge Holding Tank reaches capacity, the sludge will be dewatered by a mobile unit (services will be subcontracted). The filtrate will be returned to the treatment system. The resulting sludge cake will be drummed and analyzed to determine proper disposal.

The overflow from the Lamella will be discharged to the Neutralization Tank where the pH of the stream will be decreased to between 7 and 7.5. Addition of acid will be based on the pH of the Air Stripper discharge. Based on process flow of 60 gpm, this 600-gallon carbon-steel tank provides a retention time of 10 minutes while the contents are agitated. The water level in this tank will control an Air Stripper Feed Pump. A low level in the tank will shut off the Feed Pump. The level switch will have a time delay to restart the pump to avoid excessive cycling of the pump.

3.3.2 Air Stripping Technology The water will be transferred by the Air Stripper Feed Pump to the Air Stripper where volatilization of the VOCs is achieved. As discussed in Section 2.0, the Air Stripper may be a packed tower or low-profile design. The performance standards of the Air Stripper unit allow for the reduction of VOCs to concentration levels below MCLs. The Air Stripper design includes a blower to provide aeration of the unit. Air flow may be regulated with an inlet damper.

A low level switch in the Air Stripper sump will shut off the Effluent Pump. The level switch will have a time delay to restart the pump to avoid excessive cycling of the pump. A high level in the sump will actuate an alarm. The Effluent Pump will discharge treated water to the City of Saint Marys' POTW system, pending approval from the city. Connection to the sewer system will be made at a manhole located at the Crooked River Elementary School. Alternatively, the base's LAS may be used if discharge to the city's POTW is not accepted.

Effluent will be monitored for compliance with the performance standards as outlined in the Monitoring Plan, Section 5.0. Effluent from the Air Stripper can be diverted to a storage tank for retreatment and recycled through the pilot-scale treatment system if the system is not meeting performance criteria. Recovery well pumps can be turned off until the system is functioning properly.

3.3.3 Vapor Treatment Based on maximum concentrations of VOCs found within the groundwater during previous studies and assuming 100 percent volatilization, the total organic maximum emission rate from the Air Stripper will be less than 0.19 pounds per hour. A carbon adsorption unit will be installed to remove these VOCs in the vapor effluent from the Air Stripper before emission of the vapor stream to the atmosphere. Air monitoring of the air stripper and stack emissions will be performed and recorded throughout the operation of the pilot scale test as outlined in Section 5.0. Further discussion of air emissions and lowest achievable emission rate (LAER) is contained in Appendix A.

Target ranges for discharge vapor volatile organic concentrations are based on acceptable ambient criteria (AAC) calculated using guidance from the Georgia Department of Natural Resources, Environmental Protection Division, Air Pollution Compliance Program: "Guideline for Ambient Impact Assessment of Toxic Air Pollutant Emissions" (GADNR, 1984). To estimate expected ambient air quality concentrations during the pilot test, air dispersion modeling was conducted. Maximum predicted impacts following the vapor treatment system were then compared with calculated AACs to ensure public health would not be threatened during the system operation.

The USEPA SCREEN model was used to predict air quality impacts for each chemical of concern. SCREEN uses a number of conservative assumptions and provides conservative estimates of ambient air concentrations. This model is recommended by the USEPA for conducting dispersion modeling for air pathway analyses. Based upon discussions with staff at the Georgia Air Protection Branch, the SCREEN model is the preferred screening model for estimating air quality impacts.

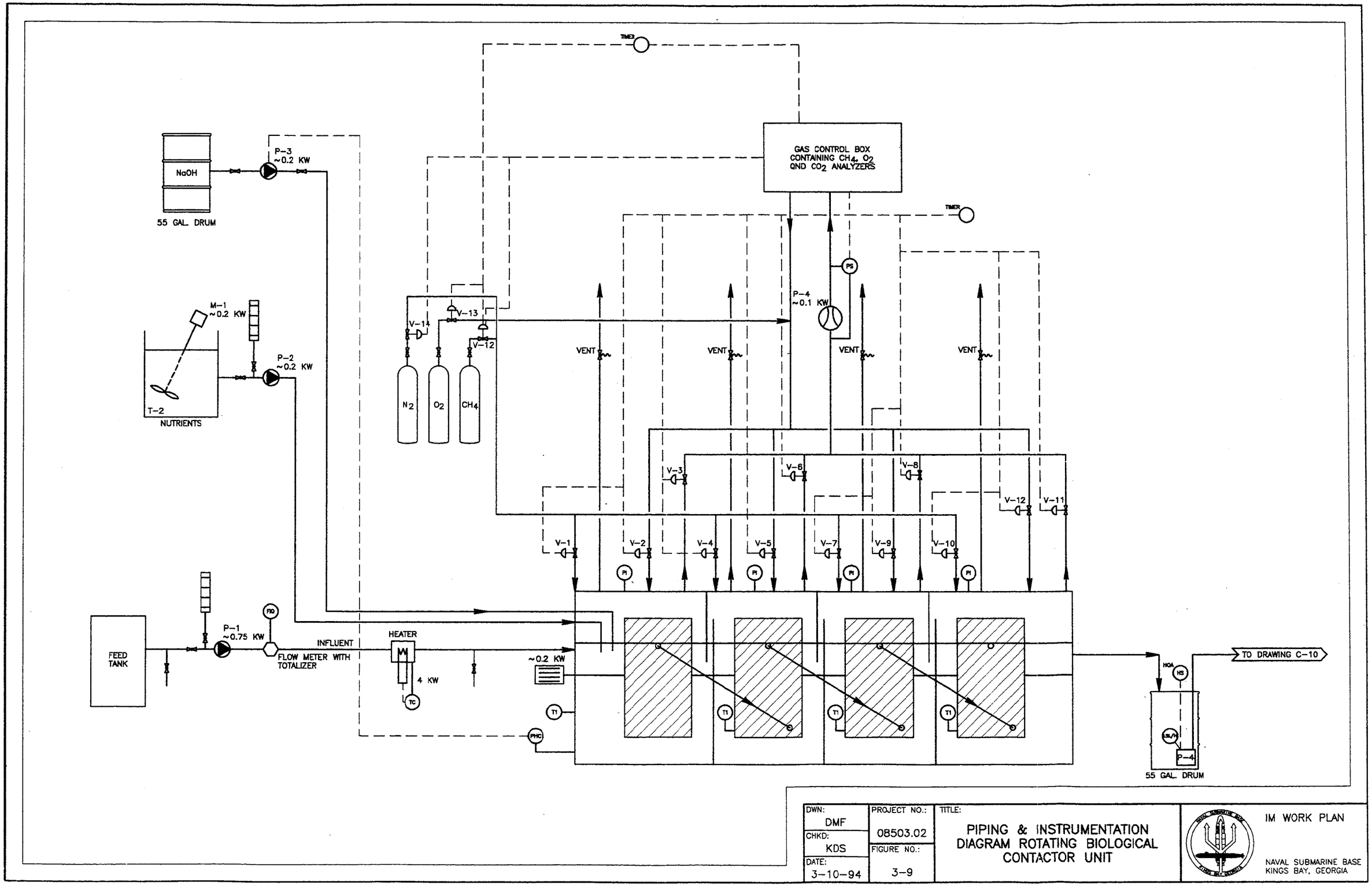
Daily stack monitoring for vinyl chloride will be conducted during the pilot study to collect actual air emission data. The modeling shows that a concentration of 37 mg/m^3 of vinyl chloride at the stack should not exceed a maximum ground level concentration of 0.01004 mg/m^3 for worst case meteorological conditions. This is less than the required AAC. If a stack concentration of 3.7 mg/m^3 of vinyl chloride is exceeded (providing a minimum safety factor of 10 times the AAC), corrective measures to reduce emissions will be initiated. The on-site laboratory that will be used initially for this stack monitoring will use a maximum detection limit of 0.1 mg/m^3. When analytical functions are transferred to an off-site laboratory, this maximum detection limit will continue to be used.

3.3.4 *Ex Situ* Biological Treatment The pilot-scale mRBC reactor and ancillary equipment will consist of an equalization tank, the mRBC unit, a methane/oxygen monitoring and control unit, a nutrient delivery system, and a pH control system. A Piping and Instrumentation for the pilot-scale mRBC is provided as Figure 3-9.

The storage tank that was used to store water from the initial pumping test will be used as a Feed Tank (T-1) to supply groundwater to the mBRC. A Metering Pump (P-1) will transfer the contaminated groundwater at a set flow rate (24 hours per day, seven days per week). A totalizing flow meter will be used to monitor flow rate.

The influent line will be equipped with a thermostat-controlled electric immersion heater to compensate for potential heat losses that could adversely affect the operation of the bioreactor. The temperature of the mRBC will be maintained at the prevailing groundwater temperature.

The pilot-scale mRBC unit will consist of a 80 by 30 by 25-inch (length by width by height) aluminum tank with internal baffles separating the reactor into four compartments. Contaminated groundwater will enter the first compartment and pass through each compartment via external orifices or internal openings in the compartment walls. A central shaft supporting corrugated plastic media on which microorganisms attach and form a biological film will be rotated. The rotating shaft and plastic media will be partially submerged in the liquid phase of the reactor, which allows contact between the microorganisms, methane, oxygen, contaminants, and nutrients.



DWN: DMF	PROJECT NO.: 08503.02	TITLE: PIPING & INSTRUMENTATION DIAGRAM ROTATING BIOLOGICAL CONTACTOR UNIT	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 3-9		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3-10-94			

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The gas phase of the reactor will also be separated into four compartments by baffles. The atmosphere in each compartment will be controlled independently. Each compartment will be connected to a gas control box via a manifolded tubing arrangement. The Gas Analyzer/Control Box will contain analyzers for methane, oxygen, and carbon dioxide. A multi-circuit timer will be used to energize and de-energize solenoid valves, allowing gas to be analyzed from one compartment at a time. An Air Pump (P-4) will transport the gas to the gas analyzer/control box and back to each compartment. Gas analyzers will sense if oxygen and/or methane levels are below the set point values, and a solenoid valve will open to allow flow of oxygen or methane to the compartment for a set time interval. The timer will be set so that each compartment is analyzed and monitored for a long enough period to allow adjustment to the desired level.

Because a mixture of methane and oxygen is explosive in the range of 5 to 59 percent, methane in oxygen (5 to 15 percent in air) measures have to be taken to maintain the methane concentration below the lower explosive limit (LEL). If the methane concentration reaches a level of 50 percent of the LEL the valve to the methane cylinder will close. If a methane concentration in the explosive range is detected, then the reactor compartment will be automatically purged with nitrogen and an alarm initiated. The timer display will show the current position of the on/off valves. A pressure switch sensing differential pressure over the Gas Pump (P-4) will cause the methane and oxygen valves to close and initiate an alarm in case of no flow to the gas control box.

To protect the reactor from excessive pressure, each reactor compartment is equipped with a pressure relief valve venting to atmosphere.

Metering Pump (P-2) will transfer nutrients from a 250-gallon nutrient tank equipped with a Mixer (M-1). The nutrient solution will be prepared periodically by mixing weighed amounts of dry nutrients and water.

The pH of the reactor contents will be adjusted when necessary to maintain a pH in the range of 6 to 8. A Metering Pump (P-3) will receive a signal from the pH controller and pumps sodium hydroxide from a 55-gallon drum to the first compartment of the reactor as required.

The effluent from the mRBC will gravity flow to an open top drum and then be transferred to the air stripper discharge point by a submersible pump equipped with a float switch.

The gas control equipment, metering pumps, and other sensitive equipment will be enclosed to protect them from rain and wind.

3.4 DISCHARGE. Liquid effluent from the air stripper will be collected in the air stripper sump. The Effluent Pump will discharge the pilot-scale system effluent to a manhole for the City of Saint Marys' sanitary sewer system pending approval from the city. If approval is not obtained from the city, the base's LAS may be used. Conveyance of the fluids will be through 3-inch PVC pipe. One hand-operated gate valve will be installed in the effluent line to isolate the system.

Effluent from the mRBC will be conveyed through 1/2-inch PVC piping to the Air Stripper sump.

3.5 UTILITIES. Utilities required for the treatment system include power and water. NSB Kings Bay will supply both. Electric power will be supplied through a tie-in to an existing transformer located approximately 1,500 feet along U.S.S. Jackson Road. Four power poles will be installed inside the compound to provide electrical service to the treatment pad, decontamination pad, field office, and field laboratory (Figure 3-10).

Water will be supplied by tapping an existing 6-inch pipeline located in the same area as the transformer. A 1.5-inch PVC pipe will be installed from the existing line to the decontamination pad (Figure 3-10). From the decontamination pad, two 3/4-inch PVC lines will be installed to provide water to the treatment pad and the field office.

3.6 PERMITS. Preliminary screening modeling indicates that ambient air quality guideline values will be met both on-base and off-base. However, due to Georgia Environmental Protection Division requirements, activated carbon will be used to polish the vapor effluent from the air stripper before discharge to the atmosphere.

When actual design data is available from vendors, a letter will be sent to the Georgia Department of Natural Resources, Air Pollution Control Division, describing the pilot-scale treatment system and an estimate of the air stripper stack emissions. If air modeling conducted by the state indicates an air quality problem, then an air permit will likely be required.

Treated water effluent will be discharged to the City of Saint Marys' POTW, pending approval, or to the base's LAS and, therefore, will not require a permit from the state.

Construction of the recovery wells on the right-of-way of Spur 40 will require well construction permits from the Georgia Department of Transportation (DOT). Installation of conveyance piping will require clearance from the Georgia DOT for installation of the piping below Georgia Spur 40. The piping design and well locations have incorporated Georgia DOT's requirements.

The gas phase of the reactor will also be separated into four compartments by baffles. The atmosphere in each compartment will be controlled independently. Each compartment will be connected to a gas control box via a manifolded tubing arrangement. The Gas Analyzer/Control Box will contain analyzers for methane, oxygen, and carbon dioxide. A multi-circuit timer will be used to energize and de-energize solenoid valves, allowing gas to be analyzed from one compartment at a time. An Air Pump (P-4) will transport the gas to the gas analyzer/control box and back to each compartment. Gas analyzers will sense if oxygen and/or methane levels are below the set point values, and a solenoid valve will open to allow flow of oxygen or methane to the compartment for a set time interval. The timer will be set so that each compartment is analyzed and monitored for a long enough period to allow adjustment to the desired level.

Because a mixture of methane and oxygen is explosive in the range of 5 to 59 percent, methane in oxygen (5 to 15 percent in air) measures have to be taken to maintain the methane concentration below the lower explosive limit (LEL). If the methane concentration reaches a level of 50 percent of the LEL the valve to the methane cylinder will close. If a methane concentration in the explosive range is detected, then the reactor compartment will be automatically purged with nitrogen and an alarm initiated. The timer display will show the current position of the on/off valves. A pressure switch sensing differential pressure over the Gas Pump (P-4) will cause the methane and oxygen valves to close and initiate an alarm in case of no flow to the gas control box.

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The effluent from the mRBC will gravity flow to an open top drum and then be transferred to the air stripper discharge point by a submersible pump equipped with a float switch.

The gas control equipment, metering pumps, and other sensitive equipment will be enclosed to protect them from rain and wind.

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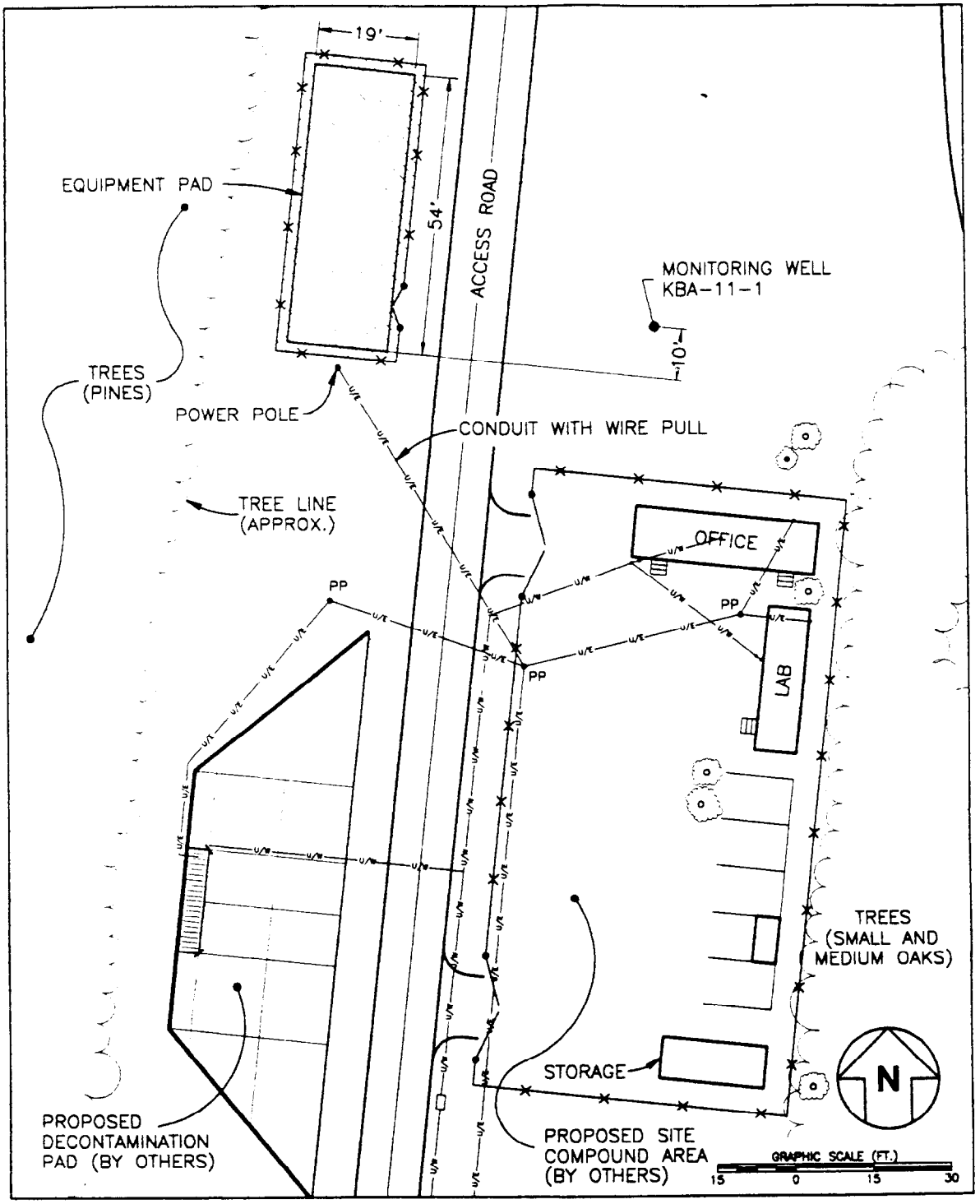
Effluent from the mRBC will be conveyed through 1/2-inch PVC piping to the Air Stripper sump.



DWN: DMF	PROJECT NO.: 08503.02	TITLE: SITE COMPOUND UTILITIES	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 3-10		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3-10-94			

4.0 OPERATIONS

This section addresses the phased operation of the pilot-scale GWE system, the operation and process control of the air stripping treatment technology, and the pilot-scale test of the mRBC unit.

4.1 GROUNDWATER EXTRACTION. Extraction of the VOC contaminated groundwater from selected locations along the western boundary of the Old Camden County Landfill and Georgia Spur 40 will be conducted in a staged approach. Activities associated with this staged approach include:

- an initial aquifer pumping test,
- pilot-scale start-up activities, and
- pilot-scale test operations.

The initial aquifer pumping test will be conducted as a preliminary test during the recovery well installation activities. Hydraulic performance data from this initial test should substantiate proposed recovery well locations and flow estimates. The start-up activities include well performance testing and background monitoring of hydraulic head conditions within the surficial aquifer. The pilot-scale test operations include three periods of groundwater extraction testing from first one recovery well, then two wells, and finally all the wells. These pilot-scale test operations are designed to provide: (1) hydraulic head data that supports delineation of the actual capture zone, and (2) variations in the feed-stream flow for treatment process performance monitoring. Following the testing operations, the extraction system may continue to operate as Phase I Continuance of the IM, until the full-scale Phase II IM has been implemented. The activities associated with the three stages of Phase I are discussed in further detail in the following subsections.

4.1.1 Initial Aquifer Pumping Test An aquifer pumping test will be conducted during the initial IM field activities to provide preliminary information regarding site-specific hydraulic performance and aquifer response to pumping stress. A submersible pump will be temporarily installed in recovery well RW-1 and pumped over a 25-hour period.

Discharge from the recovery well will be maintained at a constant flow rate. Flow rates from the well will be controlled using back-pressure created by partially closing the in-line ball valve. Flow rate will be measured using a totalizing flow meter to record successive cumulative flow readings over a set time interval. Preliminary estimates of flow are expected to be approximately 7 to 15 gpm. Discharge water will be collected in one of two 20,000-gallon storage tanks staged to the site.

Drawdown of water levels within RW-1, observation wells, and an existing monitoring well will be measured by pressure transducers and recorded by a data logger. Water level measurements will be taken by these instruments at a logarithmic sampling rate. Measurements will also be taken manually using a water level indicator on a periodic basis, as outlined in Subection 5.1. Pumping levels or drawdown within the recovery well are designed to be approximately 6 to 15 feet. Efforts will be taken to ensure the pumping level will not drop below the top of screen in the recovery well.

The IM team will conduct this pumping test. The test will be staffed by an IM hydrogeologist, engineer, or senior technician during the 25-hour monitoring period.

This pumping test will provide hydraulic data for evaluation of aquifer parameters. Hydraulic performance data from this initial test should substantiate proposed discharge flow rate estimates and pump (capacity) design. Aquifer response to the stress created by pumping from RW-1 will provide preliminary information to verify anticipated drawdowns within the recovery wells, evaluate the effects of pumping on vertical potential and stratigraphic relationships within the surficial aquifer, and evaluate the radius of influence. Also, a sample of the groundwater discharge will be collected for analysis of engineering treatability parameters (ETPs) and other analytes discussed in Section 5.0. If pretreatment is determined to be necessary, additional samples will be collected to perform bench-scale treatability tests (jar tests) to define pretreatment chemical concentrations and quantities needed (see Subsection 4.2.2.).

4.1.2 Start-up Activities The start-up activities include oversight of pump installation activities, setup and trial testing of the hydrologic data logger/pressure transducer instruments, well performance testing, and background monitoring. Submersible pumps equipped with shrouds will be installed in each of the recovery wells. Pumps will be placed below the screened section of the wells. Setup of the hydrologic instruments will be performed by IM field staff. Trial testing of these data loggers and transducers will be conducted in accordance with the instrument manufacturers recommendations during the installation of transducers into the recovery-well piezometers, observation wells, and selected monitoring wells.

Well performance testing will be conducted on each well separately by pumping water from each of the recovery wells at three different flow rates for a set period. These tests, referred to as step-drawdown tests, will be conducted over a 5-hour (300-minute) period by pumping at three successively increasing flow rates during three 100-minute intervals. Drawdown of the water level within the wells will be measured by the pressure transducers and recorded by the data logger unit. Water level measurements will be taken at a logarithmic sampling rate. Flow rates will be measured using a totalizing flow meter to record successive cumulative flow readings over a set interval. Hydraulic performance data collected from each of the recovery wells provides information to evaluate the specific capacity, well efficiency, and optimum flow rates.

Background monitoring of hydraulic head within the surficial aquifer at each of the recovery wells, observation wells, and selected monitoring wells will be conducted to establish a baseline of water level fluctuations caused by natural conditions or external effects. Water levels will be monitored with the pressure transducers and hydrologic data logger units. Measurements will be taken at a linear sampling rate. Measurements will also be taken manually using a water level indicator on a periodic basis, as outlined in Subsection 5.1. The baseline data provides information for the assessment of water level fluctuations due to natural conditions such as aquifer recharge, cyclic effects caused by tidal influence, or non-cyclic barometric effects. Also, this baseline provides information for the assessment of external effects caused by pumping from other wells such as the neighboring subdivision PIWs.

4.1.3 Pilot-Scale Test Operations The pilot-scale test operations include three stages of aquifer pumping from first one recovery well, then two wells, and finally all the wells. Each pumping stage will start by turning on the submersible pump and adjusting the ball valve in synchronous time with the start of the hydrologic data logger unit(s). Discharge from the recovery wells will be maintained at a constant flow rate during each of the three phases. Flow rates from each well will be controlled utilizing back-pressure created by partially closing two in-line ball valves; one valve at the wellhead and the other at the conveyance piping manifold. Flow rates will be measured for each well using the respective totalizing flow meter to record successive cumulative flow readings over a set interval.

Drawdown of water levels within the recovery wells, observation wells, and selected monitoring wells will be measured by the pressure transducers and recorded by the data logger units. Water level measurements will be taken by these instruments at a logarithmic sampling rate. Measurements will also be taken manually using a water level indicator on a periodic basis, as outlined in Subsection 5.1.

The IM team will conduct these test operations and have a representative on-site during each of the three pumping stages. Each pumping stage will be staffed with an IM hydrogeologist, engineer, or senior technician around-the-clock during the first three days of each of the three pumping stages. After the third day of each stage, the test will be staffed with the same team members working two 10-hour periods. The resident engineer will provide system oversight during the mid-day period between shifts.

The first stage of the pilot-scale test operations will be conducted by pumping from a single recovery well for seven days. Preliminary estimates of flow are expected to be approximately 7 to 15 gpm. Pumping level or drawdown within the recovery well is designed to be approximately 6 to 15 feet. Efforts will be taken to ensure the pumping level will not drop below the top of screen in the recovery well. Flow rates and water levels will be measured and recorded as described in the above paragraphs.

This pumping test will provide hydraulic data for the evaluation of aquifer parameters, boundary conditions and anisotropic effects, and the effective capture zone; all of which are discussed in greater detail in Section 6.0 of this IM Work Plan. Also, variations within the water quality of the recovery well discharge may be observed during this pumping phase.

At completion of the first pumping stage, a recovery phase test will be conducted to allow the surficial aquifer to reach equilibrium. This phase will start by turning off the power to the submersible pump and shutting off the ball valve in synchronous time with the step start of the hydrologic data logger unit(s). As with the pumping stages of the pilot-scale test operations, the water levels in the wells will be measured by the pressure transducers and recorded by the data logger units. Water level measurements will be taken by these instruments at a logarithmic sampling rate. Measurements will also be taken manually using a water level indicator on a periodic basis, as outlined in Subsection 5.1.

The second stage of the pilot-scale test operations will be conducted by pumping from two recovery wells for a period of seven days following the single well test recovery phase. Preliminary estimates of flow are expected to be approximately 7 to 15 gpm. Pumping levels, or drawdown within the recovery wells are designed

to be approximately 6 to 15 feet. Efforts will be taken to ensure the pumping level will not drop below the top of screen in each of the recovery wells to minimize oxidation/encrustation of the well screen(s). Flow rates and water levels will be measured and recorded as described in the above paragraphs.

This pumping test will provide hydraulic data for the evaluation of aquifer parameters; effects caused by boundary conditions, the anisotropic nature of the aquifer, and well interference; and the effective capture zone due to pumping from two wells. These parameters and potential effects are discussed in greater detail in Section 6.0 of this IM Work Plan.

The third stage of the pilot-scale test operations will be conducted by pumping from all the recovery wells. This pumping stage will commence after day seven of the second pumping stage has been completed. No recovery phase test will be associated with the two-well test (second pumping phase); the third stage begins by sequentially starting the submersible pumps in the remaining wells. Starting of the pumps should be staggered at timed intervals and synchronized with the hydrologic data logger unit(s) and set at constant flow rates. Preliminary estimates of flow are expected to be approximately 7 to 10 gpm. Pumping levels, or drawdown within the recovery wells are designed to be approximately 6 to 12 feet. Efforts will be taken to ensure the pumping level will not drop below the top of the screen in each of the recovery wells. Flow rates and water levels will be measured and recorded as described in the above paragraphs.

This pumping test will provide hydraulic data for the evaluation of the effectiveness of multiple recovery wells for the extraction of VOC-contaminated groundwater and the actual capture zone caused by discharging wells, both of which are discussed in greater detail in Section 6.0 of this IM Work Plan.

4.2 AIR STRIPPER TREATMENT SYSTEM. The air stripper treatment system will consist of either an air sparger (Option A) or an air stripper tower (Option B). The selected option will depend on pretreatment and vapor treatment requirements for each option. The operating parameters for each option are similar and the use of the terms "air stripper" or "air sparger" are used interchangeably in the following discussion to indicate the air stripping technology chosen.

4.2.1 Pre-Start-Up Prior to start-up, all equipment will be checked for proper working order. Proper lubrication procedures will be followed and oil levels checked on all rotating equipment. The rotational direction of all drives and mixers will be verified. All tankage will be checked to confirm it is clean and free of debris. All automatic instrumentation and controls will be calibrated and checked for proper functioning and control logic. Normally, the system will be operated manually initially and then switched to automatic control once proper operation is verified.

If pretreatment is needed, the chemical reagents and polymer will be prepared at the proper concentrations (to be determined in bench-scale testing) and the automated delivery systems checked for proper operation.

Performance tests will be conducted by the Subcontractor or suppliers as the equipment is installed to check the hydraulic and mechanical operability of each piece of equipment.

4.2.2 Start-Up During the pumping test of the recovery wells, samples will be analyzed using the on-site laboratory for various parameters to finalize the

requirements for pretreatment of groundwater. If chemical precipitation is required, bench-scale tests may be performed to determine types and quantities of chemicals to be added. Based on the pretreatment requirements, the appropriate pretreatment equipment will be delivered and installed. The following discussion incorporates operation procedures for all the pretreatment equipment that may be needed.

Following installation of the equipment, the recovery wells will discharge to the Pretreatment Tank. Initially, only one or two submersible pumps will be started. Also, a hose will be connected to the recycle taps and the effluent valve will be closed to allow recycle of the process stream until verification is received that discharge criteria can be met. At start-up, the feed rate and pump operation will be optimized before chemical addition is started. Chemical addition will help to maintain treatment without the buildup of scale, which is not required for start-up and can be optimized later in the start-up sequence.

The Pretreatment Tank will fill to the height of the discharge nozzle, which will allow the feed stream to fill the Precipitation Tank. Upon deactivation of the low level switch in the Precipitation Tank, the Transfer Pump will start. The Transfer Pump will transfer the process stream to the Flocculator/Lamella. As the Lamella is filling, the chemical addition systems will be started (if needed for pretreatment).

The Permanganate Addition System (if needed) will automatically add permanganate to the Pretreatment Tank based on Oxidation Reduction Potential (ORP) in the tank. Permanganate addition rates and ORP targets will be determined by preliminary bench-scale tests.

The Caustic Addition System (if needed) will automatically add caustic to the Precipitation Tank based on the pH of the tank discharge. Caustic addition rates will be determined by preliminary bench-scale tests. The pH target is 9 to 9.5.

Polymer addition (if needed) can be started at a reduced rate, as there is a reduced feed rate at start-up. Polymer addition rates also will be determined by preliminary bench-scale tests.

Once the Lamella has filled, the process stream will gravity flow to the Neutralization Tank. Upon deactivation of the low level switch in the Neutralization Tank, the Air Stripper Feed Pump will start. The feed pump will transfer the process stream to the Air Stripper. The Acid Addition System (if needed) will automatically add acid to the Neutralization Tank based on the pH of the tank discharge. Acid addition rates will be determined by preliminary bench-scale tests. The pH target is 7 to 7.5.

As water enters the Air Stripper, the Blower will force air through the Air Stripper and the Carbon Induced Draft (ID) Fan will pull the Air Stripper effluent vapors through the carbon adsorbers.

Once steady state has been reached in the recycle mode, samples can be collected and analyzed on-site to determine the quality of the effluent. If the effluent meets the discharge criteria, the discharge valve will be opened to allow the water to discharge. The treated effluent will be analyzed hourly, using the on-site laboratory, for performance criteria (Subsection 2.3) until steady state is reached. Section 5 discusses in detail the analytical program, including the off-site laboratory duplication of sample analyses.

Feed from the Recovery Well Pumps will be slowly increased until steady state is reached. If at steady state the process pumps are cycling too often, the ball valves at the discharge of the process pumps can be closed slightly to induce a pressure drop and to cut back flow where needed.

4.2.3 Operation and Process Control During Phase I, a minimum of one operator per shift will be on-site to operate and monitor the system 24 hours per day. The operator will also be responsible for operating the groundwater extraction system and various on-site duties. The system may be retrofitted to minimize operator requirements during the continued operation of the system.

Pumps During normal operation, the process pumps will be on automatic operation. Each pump will shut down at low level and restart either with deactivation of the low level switch or with a high level switch. Each pump is operated with a Hand/Off/Auto switch that enables the operator to operate the pump in each mode. For automatic operation based on the level switch control, place the pump switch in the Auto position.

Mixers During normal operation and always during chemical addition, all mixers should be in operation. Each mixer is equipped with a Start/Stop switch. If no liquid is in the tank, the mixer should be turned off.

Chemical Addition The chemical addition systems are automated, except for the polymer addition in the flash mix compartment of the Flocculator/Lamella. Each system is equipped with a Start/Stop switch. The automated addition is based on a 4 to 20 milliamp signal received by the pump from the analytical probe for that system.

Each unit is equipped with an indicator for monitoring the pH, or ORP of the system. The Permanganate Addition System will add permanganate to the Pretreatment Tank based on the ORP indicated in the tank. The permanganate will oxidize metals, mainly iron, to prevent oxidation in downstream components where fouling can occur.

The Caustic Addition System will add caustic to the Precipitation Tank based on the pH downstream of the tank. The pH is monitored with a pH probe installed in-line. A pH of 9 to 9.5 will be maintained to form insoluble hydroxides that can be removed in later clarification stage.

The Polymer Addition System will add polymer to the flash mix compartment of the Flocculator/Lamella. The polymer will aid in the settling efficiency of the hydroxide sludges.

The Acid Addition System will add acid to the Neutralization Tank based on pH downstream of the tank. The pH is monitored with a pH probe installed in-line. A pH of 7 to 7.5 will be maintained to meet discharge criteria to the POTW.

Sludge Handling Periodically, the sludge will be removed from the sludge compartment of the Lamella. The Sludge Pump will transfer the sludge to the Sludge Holding Tank. Some sludge may stay in the Lamella, leaving a slight sludge blanket aids in the settling efficiency of the unit.

The frequency that sludge removal will be required will be determined based on actual operating experience. If a continuous removal rate can be set, this will provide the best conditions for efficient settling. Otherwise, more frequent

sludge removals that leave a slight sludge blanket are better than less frequent removals.

The Sludge Holding Tank has a 20,000-gallon capacity. As sludge is discharged from the Lamella, further thickening of the sludge will occur in the holding tank, and a supernatant will form on top of the sludge. The supernatant will be decanted off the top of the tank and transferred to the Pretreatment Tank for reprocessing.

Air Stripper The process water enters the Air Stripper through a spray pipe that disperses the water evenly across the unit. Air is released into the unit via the blower. Exhaust air exits the unit and is pulled by an ID to the carbon unit. The water is discharged to a sump that is an integral part of the stripper and the Effluent Pump transfers the water to the discharge point.

The sump is equipped with a high and low level switch. Low level in the sump will shut off the Effluent Pump. The pump will restart either with deactivation of the low level switch or with a high level switch. High-high level will activate the horn to sound.

The Blower is equipped with a high pressure switch to shut off the Blower and to activate the horn on high pressure.

Carbon Unit Before reaching the carbon adsorber, the vapor stream will be heated by the Preheater to reduce the humidity of the stream. The vapors from the Air Stripper will be pulled through the Preheater and carbon adsorber by the Carbon ID Fan. The VOCs transferred from the groundwater to the vapor stream in the Air Stripper will be adsorbed by the carbon before discharge to the atmosphere. To ensure that particulate is not entrained in the vapor effluent, the adsorber will be operated in the downflow configuration.

The carbon adsorber(s) will be connected with flexible hoses to simplify changeout procedures. To determine the breakthrough point for the adsorber, a sample will be collected at the adsorber discharge and analyzed for vinyl chloride. If a detectable concentration of vinyl chloride is present, the adsorber has reached breakthrough and needs to be replaced.

4.2.4 Discharge NSB Kings Bay will submit requests for discharge of the treated groundwater to the Georgia Department of Natural Resources. One request will be for authorization to discharge into the NSB Kings Bay upper base LAS. The other request will be for authorization to discharge into the City of St. Marys' Point Peter sewage treatment facility. Appendix B contains the NSB Kings Bay LAS discharge request with response from the state and Appendix C contains the St. Marys' Point Peter discharge request. At this time, no response to the St. Marys' discharge request has been received.

The connection to the base LAS will be via a 3-inch PVC Schedule 40 pipe. This will be connected to a manhole across the street from the Navy lodge. This will then discharge to the base LAS system. If approval is granted by the City of St. Marys, the effluent stream may be split. A portion of the effluent would then be transferred to the City of St. Marys' Point Peter Plant. This will be accomplished via a manhole located approximately 1,000 feet south of the pilot-scale treatment pad. This manhole is located at the Crooked River Elementary School.

Effluent from the system will be sampled daily for the duration of the Phase I operations and analyzed on-site as detailed in the Monitoring Plan (Section 5.0). If at any time effluent does not meet discharge criteria, effluent can be diverted temporarily to the 20,000-gallon storage tanks. If the storage tanks are full, then the Recovery Well Pumps can be shut off, and the system can be placed in recycle mode until the treatment system adequately treats the groundwater for discharge.

4.2.5 Alarm Conditions Each pump will shut down at low level and restart either with deactivation of the low level switch or with a high level switch. High-high level switches will activate the horn to alarm the operator to check the system. If tankage is not totally enclosed, the operator must correct the downstream problem that is causing a system backup or must adjust pumping rates to prevent overflow conditions.

If the Air Stripper Blower is shut off on high pressure, the horn will be activated. A scale buildup around the Air Stripper diffuser piping can cause a high pressure condition.

Chemical addition failure will not cause failure to meet discharge criteria and is not an alarm condition.

4.3 ROTATING BIOLOGICAL CONTACTOR. A mRBC reactor, designed to promote biological degradation of organic compounds in groundwater, will be used to evaluate full-scale treatment potential.

Aerobic bioremediation of chlorinated solvents present in the groundwater will be achieved by methanotrophic (methane-degrading) bacteria co-metabolism. Co-metabolism is the concomitant breakdown of an organic compound by non-specific enzymes associated with the microbial breakdown of other carbon-source compounds. The enzyme produced by methanotrophic bacteria to catalyze the breakdown of methane, the primary carbon source for methanotrophic bacteria, is methane monooxygenase (MMO). The soluble form of MMO produced by methanotrophic bacteria is a non-specific enzyme that can also break down chlorinated solvents such as vinyl chloride and 1,2-DCE if they are in the presence of the methanotrophs. Chlorinated solvents such as vinyl chloride and 1,2-DCE have been demonstrated to be readily degraded in the presence of an active population of methanotrophic bacteria attached to mRBC disks.

Groundwater will be continuously pumped from the pretreatment tank through the mRBC reactor. Mineral nutrients will be added to the passing groundwater from the nutrient delivery system. Methane, the carbon source for the methanotrophic bacteria, will be continuously monitored and supplied to the mRBC system using the methane/oxygen analyzer and control system. Oxygen required for biological degradation of VOCs will also be monitored and regulated in the mRBC reactor using the methane/oxygen analyzer and control system. Groundwater pH will be monitored and controlled using a pH control system.

4.3.1 Start-up The bioreactor will be started up in a batch mode to allow the biofilm to be established prior to continuous feeding. The mRBC will be filled to its operating volume (250 liters) with groundwater. Nutrients and an inoculum will be added and the head space of the reactor will be maintained at 20 percent methane and 10 percent oxygen. Carbon dioxide will be added to 2 to 3 percent of the headspace (this will speed up initial growth). This will be accomplished by adding sodium bicarbonate to the liquid media if adding gas is not practical.

Chemicals and Nutrients Concentrated nutrients will be added to each of the four chambers (containing 63 liters) to the following concentrations in grams per liter (g/l): $NaNO_3$ 2.0, $MgSO_4$ 0.2, $CaCl_2$ 0.02, KCl 0.04, $FeSO_4K7H_2O$ 0.03, KH_2PO_4 0.14, and Na_2HPO_4 0.2. The ferrous sulfate will not be added if the groundwater contains sufficient iron (the media contains 0.6 mg/l of iron).

The medium should be copper free. The addition of 0.018 g/l Na_2EDTA will chelate trace copper for start-up. Copper-free media enhances the expression of soluble MMO; however, during continuous flow, copper will not be removed from the groundwater. Removing it during initial start-up will, hopefully, increase the proportion of soluble methane monooxygenase (sMMO) expressing versus the particulate methane monooxygenase (pMMO) expressing methanotrophs in the initial biofilm.

During continuous flow operation, only $NaNO_3$ and phosphate will be added.

Inoculum Bacteria will be grown up for inoculation. Site-specific methanotrophs and/or cultures such as Crystal Lake Methanotroph (CLM) or Methylosinus trichosporium (OB3b) will be used. A liter (L) of groundwater will be collected from the water extracted during the initial pump test and the indigenous bacteria will be cultured for use in the mRBC. It is not the intent to work with a pure culture but rather promote the growth of bacteria suitable for the field conditions. A source culture will be maintained in a laboratory. This culture will have gone through several transfers (to ensure the "purity" of the culture) in serum bottles prior to scaling up to larger batches.

To scale up, one to two serum bottles (40 milliliter [ml] inocula) will be added to a carboy with 4 to 5 L of growth media and a 20 percent CH_4 headspace in air. A gas bag with methane will be attached to the carboy. Aeration will be accomplished with a magnetic stir bar. The bacteria will be added to the reactor (or stored, i.e., placed in a refrigerator) when they turn bright pink rather than salmon, which is the color they later become.

Ten L of culture should be sufficient for inoculation of each chamber. It may be advantageous to mass culture the organisms in the laboratory, then concentrate the bacteria by centrifugation and save them under refrigeration for shipment to the site. This cannot be done more than one month prior to the seeding of the reactor.

Start-up, continuous flow The biofilm should establish itself within two to three weeks of inoculation. When a pink film has developed on the plastic media, the reactor is ready to receive a continuous flow of contaminated groundwater. The flow will be increased stepwise from a low initial flow rate. The rate of increase will depend on the response of the system to the increasing load of contaminants. A tentative feed schedule is as follows:

Day	Flow (gpm)	HRT (hours)
1-3	0.10	11.0
4-6	0.15	7.3
7-9	0.20	5.5
10-13	0.30	3.7
14-16	0.40	2.8
17-19	0.50	2.2
20-21	0.60	1.8
22-23	0.80	1.4
24	1.00	1.1

Notes:

HRT = hydrologic retention time
gpm = gallons per minute

This schedule may change due to actual performance of the reactor during start-up. The flow will not be increased if the effluent from the mRBC does not meet the target effluent criteria with respect to VOCs. When the maximum (or near maximum) hydraulic loading has been established, the reactor will be operated at a hydraulic load that is somewhat lower than the maximum for the remaining test period.

The methane and oxygen concentrations in the gas phase will be maintained at 2 percent and 20 percent, respectively (the dissolved oxygen concentration in the liquid phase should be at least 2 mg/l).

4.3.2 Steady State Operation The reactor will be operated at a "steady state" condition for a number of weeks following the establishment of an optimum flow rate that yields effluent concentrations at or below MCLs. The analytical schedule is provided in Section 5.0. Changes to operational variables will be made in response to changes in analytical parameters.

The influence of the separate reactor compartments will be monitored during the steady-state operation period, as well as the option of cycling the methane to compartments on an alternating on/off schedule.

At the end of the test period (time permitting), tests that shock the system may be conducted to evaluate stability and recovery rates. Examples of such changes are drastic changes to the methane or oxygen concentrations, peak flow rate, temperature, and pH.

4.4 RESIDUALS MANAGEMENT. As sludge is transferred from the Lamella to the Sludge Holding Tank, further thickening of the sludge will occur, and a supernatant will form on top of the sludge. The supernatant will be decanted off the top of the tank and transferred to the Pretreatment Tank for reprocessing. When the tank is full and further decanting is ineffective, a subcontractor will be hired to filter the contents of the tank. The resulting filter cake will be drummed for disposal.

Samples from each drum will be collected. Composite samples for batches of four drums will be analyzed for Toxicity Characteristic Leachate Procedure (TCLP) parameters to determine disposal options.

Spent carbon from the vapor treatment process will require disposal. Samples from each drum will be collected. Composite samples for batches of four drums will be analyzed for TCLP parameters to determine disposal (or recycle) options.

If the analytical results for the residuals are less than the TCLP threshold values, the residuals may be handled as solid waste and disposed in a permitted, Subtitle D landfill. If the analytical results for the residuals are greater than the TCLP threshold values, the residuals will be labelled and disposed as a hazardous waste.

4.5 STORM WATER MANAGEMENT. Process area and Decontamination Pad storm water will be collected in the respective sump and processed through the treatment system. Containment for the tanks and process equipment has been designed in accordance with 40 Code of Federal Regulations (CFR) 264 Subpart J and I. The containment has sufficient excess capacity to contain run-on or infiltration from a 25-year, 24-hour rainfall event. The floor of the containment area will be sloped to the Treatment Pad Sump.

All rainfall events will be recorded. Excessive rainfalls will be transferred from the sumps to a storage tank. The storage tank will be sampled and analyzed on-site to determine if treatment is needed or if direct discharge to a treatment works is possible.

5.0 MONITORING PLAN

This section addresses the data collection strategy that will be implemented to monitor performance of the Phase I and Phase I Continuance IM activities. Sampling procedures, field measurements, data collection quality assurance requirements, and specified sample analyses are included in this Monitoring Plan.

5.1 DATA COLLECTION STRATEGY. The intended uses for the data obtained during IM activities are: (1) to evaluate the use of groundwater extraction as a means to hydraulically control VOC plume movement; (2) to measure the efficiency of air stripping as a viable option to remediate VOCs from the groundwater; and, (3) to measure the efficiency of *ex situ* biological treatment technology as an alternative option to remediate VOCs from the groundwater.

During the IM activities, physical and chemical data will be collected to measure the efficiency of the system and to provide information for future installation of a permanent GWE recovery system. Physical data includes the description of geological materials utilizing grain size analysis and hydraulic information such as water levels, flow rates, and well performance. Chemical data generated by both an off-site laboratory and an on-site gas chromatograph (GC) analysis include analysis of selected soils, groundwater, and off-gases from air strippers.

5.1.1 Hydraulic Monitoring During the operation of the treatment facility, specific hydraulic data will be collected and monitored. Periodic measurements of water levels in the observation wells, recovery wells, and existing monitoring wells must be taken at different intervals during the pumping phase. The observation well water levels will be monitored every 2 hours during test start-up, then twice daily after three days. Recovery wells will be monitored hourly during test start-up then four times daily after three days. Existing monitoring wells will be monitored daily. The recovery well and observation well water levels will be electronically monitored using pressure transducers linked to several data loggers. Water levels will also be checked periodically with a water level indicator to confirm drawdowns. The testing and monitoring will be conducted by an IM hydrogeologist, engineer, or senior technician.

Periodic measurements of flow rates and total flow, in gpm, will be taken from each recovery well. Flow rates will be monitored once every 3 hours at a minimum. Precipitation events will be monitored using rain gauges indicating when the event occurred, duration of event, and the quantity of rainfall that fell. Barometric pressures during the tests will be recorded by a gauge linked to one of the data loggers.

5.1.2 Sampling Description Samples will be collected from each recovery well at the influent manifold to verify the concentration levels of the constituents of concern. In addition, samples of the combined flow will be periodically collected at the influent pipe leading into the pretreatment unit. Following the treatment process, samples will be periodically collected from the effluent pipe prior to discharges to the POTW manhole. To verify percentages of constituents being removed, samples of off-gases will be periodically collected prior to treatment and post-treatment by the carbon adsorption unit. There will be a total of seven sample locations on the influent side and two sample locations on the effluent side. All sample points are located inside the treatment area fencing to ensure that no interference or outside tampering is encountered.

Refer to Subsection 5.3 for type of samples and frequency of samples to be collected.

5.1.3 Sampling Procedures

5.1.3.1 General The quality of sample collection techniques is assured by keying the sampling technique used to both the media/matrix to be sampled and the analytes of interest. For example, samples intended for semivolatile organic compound (SVOC) analyses are collected in glass bottles; samples for VOC analyses are collected in Teflon®-septum-capped glass vials with "zero" headspace to minimize diffusive and evaporative losses; and most samples for inorganic analyses are collected in linear polyethylene bottles.

Sample containers will be prepared in a manner consistent with USEPA protocol, as noted in the following subsection.

Acquisition of environmental samples also requires specialized collection techniques to preserve their integrity and ensure that a representative portion of the source is collected. Media-specific sample collection techniques are specified in the following sections.

Further, unless the proper sample bottle preparation and sample preservation measures are taken in the field, sample composition can be altered by contamination, degradation, biological transformation, chemical interactions, and other factors during the time between sample collection and analysis. Steps taken to maintain the *in situ* characteristics required for analysis may include refrigeration of samples at 4 degrees celsius (°C), freezing, pH adjustment, and chemical fixation. Samples are preserved according to the protocol established for the specific analytical method selected to obtain the desired data. Table 5-1 provides specific information on sampling equipment, restrictions, materials, and appropriate use of equipment applicable to the IM activities. Table 5-2 provides more specific information on bottle requirements, preservation methods, and holding times.

5.1.3.2 Sample Identification Samples collected for laboratory analysis during the field investigation will be labeled in accordance with the standard sample identification protocol described below.

The sample identification will be up to nine characters in length. The general sample identification will have the form ##T##[I] [D] where # represents any decimal digit, T represents any valid type identification, I represents any valid depth interval character, and D represents any valid sample descriptor character. Brackets placed around a character indicate that the character is optional (e.g., [I] means the depth interval identification may be 1, 2, or 0 characters wide).

The first two characters of the general sample identification are decimal digits that specify the site from which the sample was obtained (e.g., Site 11 would be denoted 11). Both characters are mandatory.

Table 5-1 Groundwater Sampling Equipment, Restrictions, Materials and Appropriate Use

Equipment Type	Use	Permissible Parameter Group	Restrictions and Precautions
Pumps (1)			
1. Positive Displacement Pumps			
a. Submersible (gear drive)	Purging	All parameter groups	1,4
	Influent/Effluent Sampling	Demands, nutrients	none
		Metals	1,4
		VOCs, and ETPs	1,4
		Extractable Organics	
b. Bladder pump (no gas contact)	Purging	All parameter groups	3,4
	Sampling	Demands, nutrients	none
		Metals	4,7
		VOCs and Extractable Organics	3,4,6
2. Suction Lift Pumps			
a. Centrifugal	Purging	All parameter groups	4,5,6,8
b. Peristaltic	Purging	All parameter groups	4,5,6,8
	Sampling	Demands, nutrients	none
		Metals	23
		Extractable Organics	9
3. Bailer Purging			
	Sampling	Demands, nutrients	none
		Metals	11
		VOCs and Extractable Organics	10

Notes:

VOC = volatile organic compound
ETP = engineering treatability parameters

Key to Restrictions and Precautions

1. Pump must be equipped with a check valve to prevent backflow of purged water into the well.

2. If purging or sampling for organics or metals, this device may be used when no other pumping device is available, since lines cannot be practically constructed of inert materials.

3. If purging or sampling for organics or metals, pump housing should be of stainless steel and Teflon™ construction.

4. If used as a non-dedicated system, pump must be cleaned between wells. Delivery tubing should be precleaned and precut at the base of operations or laboratory. If the same tubing is used during the sampling event, it must be cleaned and decontaminated between use.

Table 5-1 (Continued) Groundwater Sampling Equipment, Restrictions, Materials and Appropriate Use

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5. When purging for organics or metals, the entire length of tubing (or pipe) or the portion which comes in contact with the formation water should be constructed of Teflon™ or stainless steel. If other materials (i.e., rigid PVC, polyethylene or polypropylene) are used, the following protocols must be followed: 1) contact with formation waters will be minimized by slowly withdrawing the pump from the water column during the last phase of purging, thus removing from the well any water which has contacted the exterior of the pump and/or tubing; 2) a single well volume must be removed with the sampling device before sampling begins. Tygon™ must never be used for purging when organics are of interest.

6. If sampling for organics or metals, the entire length of tubing (or pipe) or the portion which will come in contact with the formation water must be constructed of Teflon™ or stainless steel.

7. Pump and delivery tubing must be constructed of stainless steel or suitable non-metallic materials.

8. Must be equipped with foot valve to prevent backflow of purged water into the well.

9. All components of the sample collection system contacting the sample water must be constructed of Teflon™, stainless steel or glass. The system must be configured such that the sample is collected <u>before</u> the pump head.

10. If purging or sampling for organics or metals, construction must be of stainless steel or Teflon™.

11. Equipment must be constructed of stainless steel or suitable non-metallic materials.

23. The flexible tubing used for the peristaltic pump should be medical grade silicone tubing. Delivery tubing must be constructed of suitable non-metallic materials.

Table 5-2 Sample Container and Preservation Requirements

Parameter	Matrix	Holding Time (from time of collection)	Container	Preservative	Minimum Sample Size[1]
Volatile organic compounds	Water	14 days	Two 40 ml vials with Teflon™-lined caps	4 drops concentrated HCl, 4 °C	40 ml
Phosphate, total	Water	24 days	Polyethylene or glass bottle	4 °C	40 ml
Nitrate and Nitrite	Water	28 days	Polyethylene or glass bottle	Adjust pH to >2.0 H_2SO_4	125 ml
Hardness	Water	28 days	Polyethylene or glass bottle	4 °C	125 ml
Total dissolved solids	Water	7 days	Polyethelene or glass bottle	4 °C	500 ml
Total suspended solids	Water	7 days	Polyethylene or glass bottle	4 °C	500 ml
Total volatile suspended solids	Water	7 days	Polyethylene or glass bottle	4 °C	500 ml
Total organic carbon	Water	28 day	Polyethelene or glass bottle	4 °C $HCl HSO_4$<2	1,000 ml
Metals (other than mercury)	Water	180 days	Polyethylene or glass bottle	HNO_3 to pH<2	100 ml
pH	Water	immediately	Polyethylene or glass bottle	4 °C	125 ml
Color	Water	48 hours	Polyethylene or glass bottle	4 °C	250 ml

Notes:

ml = milliliter.
HCl = hydrochloric acid.
°C = degrees Celsius.
H_2SO_4 = sulfuric acid.
HNO_3 = nitric acid.

[1]Additional sample must be collected for matrix spike or matrix spike duplicate samples.

The third and fourth character of the general sample identification is mandatory. It is a character that denotes the sample type. Valid characters are the following:

SB = Subsurface Soil (Soil Boring)
GW = GroundWater
SW = Surface Water
OC = Off-Gas Pre-Carbon
OP = Off-Gas Post-Carbon
IW = Influent from Well
IC = Influent Combined Flow
PS = Intermediate Process Sample
ET = Effluent from Treatment Facility
FB = Field Blank
RB = Rinsate Blank
TB = Trip Blank

The fifth and sixth characters of the general sample identification are composed of a integer between 00 and 99 (e.g., 01, 02...). This number identifies the location at which the sample was collected. Sample locations associated with the conveyance system and treatment system will be assigned a permanent station number. These locations will be tagged by the Residential Engineer (RE) and recorded.

The seventh and eight characters of the general sample identification are present only under certain conditions. These characters are depth interval identifiers and serve to describe the depth bgs at which the sample was obtained (e.g., a sample collected at 4 feet bgs would be denoted 04).

The ninth character of the general sample identification differentiate samples of the same type that are obtained from the same location. This condition will occur when duplicates are collected. The valid character for field duplicates is "D."

All samples are to be labeled using the numbering system regardless of being an on-site quality control (QC) sample or an off-site laboratory sample. This will allow for consistency and less confusion in the field.

5.1.3.3 **Sample Staging Shipment** Preparation of samples for shipment is performed in the following manner:

1. Label bottles with sample number and sample type (e.g. influent to treatment, effluent from treatment). Each sample set will have a unique sample number. Labels will be secured with tape.

2. Stage samples for analysis in the on-site field laboratory refrigerator.

3. Check DOT regulations to ensure that samples are packaged correctly for transportation. Should any problems or questions arise with preparation of samples for shipment, contact the task leader.

5.1.3.4 **Data Tracking and Handling** The following procedures are to be used for data tracking and handling before, during, and after a field investigation for both on-site and off-site laboratory samples.

1. Prior to initiating a sampling episode, create a task-specific Sample Tracking Form (Figure 5-1). Enter the IM sample location, type sample (media), and then place an "X" in the top half of each square of the column for which an analysis is proposed. Copy the resulting tracking form, along with projected sampling dates and name of analytical laboratory or indicate on-site laboratory, and send it to the RE. The RE will then contact either the analytical laboratory or on-site laboratory and pass on the above information.

2. While the sampling episode is underway, complete the task-specific Sample Tracking Form based on the chain-of-custody (COC) records. Enter the date sampled, date shipped, analytical laboratory or indicate on-site laboratory, airbill number (if shipping), and then place an "x" in the bottom half of each square in the column for which an analysis is actually requested. When entering field duplicates, identify it with a sample identifier plus a "D" (e.g., MW-101D). If a replicate sample is sent to a second laboratory, identify it with a sample identifier plus a "R" (e.g., MW-101R). Identify the second laboratory in the appropriate column. Send a copy of the resulting tracking form, along with a copy of all COCs and analytical request forms (ARFs), to the RE at the completion of the sampling episode.

3. The RE will maintain an electronic sample tracking database. In addition to the information contained in the Sample Tracking Form, the database will keep track of when the data results are due, sample status, and any problems or changes encountered by the analytical or on-site laboratory. As analytical data are received from the laboratory, the samples will be logged in as "Analyses Received" in the sample tracking database. Results will then be forwarded to the Task Order Manager (TOM) and stored in a task-specific trans-file.

5.1.4 Precision and Accuracy Precision is defined as the agreement among individual measurements of the same chemical constituent in a sample, obtained under similar conditions. Field and laboratory precision will be expressed as relative percentage difference (RPD) where:

$$RPD = \frac{(X1 - X2) \times 100}{(X1 + X2)/2}$$

where:

RPD = relative percentage difference between duplicate results
X1 and X2 = results of duplicate analyses
$|X1 - X2|$ = absolute difference between duplicates X1 and X2

The field duplicates planned for each sampling event are listed in Subsection 5.3.5. Precision objectives apply to both field and laboratory duplicates. However, field duplicates based on the analytical results take into account the level of error introduced by field sampling techniques, field conditions, and analytical variability. The RPD of all laboratory duplicates will be reported by the laboratory, and the RPD of field duplicates will be calculated to evaluate the sample precision.

SAMPLE TRACKING FORM

CLIENT INFORMATION NAME _____
COMPANY _____
MAILING ADDRESS _____

PURCHASE ORDER/JOB NUMBER _____

WHERE TO SEND REPORT DIRECTLY TO CLIENT
BCI - NAME _____

ANALYSES REQUESTED BY: _____
TECHNICAL PROJECT MANAGER

APPROVED BY: _____
PROJECT MANAGER

DATE RECEIVED _____
LAB LOCATION _____
RESULTS DUE _____
CLIENT I.D. NO. _____

SOLID WASTE DATA FILE
DATA DOCUMENTATION REQUIRED
ENTERED IN COMPUTER

TYPE OF SAMPLE _____
LIST ANY HAZARDS _____
FILTERED IN FIELD NON-FILTERED

SPECIAL PROCEDURE

ADDITIONAL INFORMATION OR SPECIAL PROCEDURES:

SAMPLE IDENTIFICATION	LAB NUMBERS	DATE SAMPLED	SAMPLED BY	ANALYSES REQUIRED

DWN: NLW	PROJECT NO.: 08503	TITLE: SAMPLE TRACKING FORM	IM WORK PLAN
CHKD: TLK	FIGURE NO.: 5-1		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 8/23/93			

Accuracy is defined as the degree to which the analytical measurement reflects the true concentration level present. Accuracy will be measured as percentage recovery for matrix spikes as the primary criterion and percentage recovery of the surrogate spikes as a secondary QC criterion for gas chromatography/mass spectrometry (GC/MS) analyses.

A matrix spike is a sample (of a particular matrix) to which predetermined quantities of standard solutions of certain target analytes are added prior to sample extraction/digestion and analysis. Samples are split into replicates, one replicate spiked and both aliquots analyzed.

Accuracy can also be evaluated using the recovery of surrogate spikes in the organic analyses. These spikes consist of organic compounds similar to the analytes of interest in chemical composition, extraction, and chromatography but which are not normally found in environmental samples. These compounds are spiked into all blanks, standards, and samples prior to analysis.

Percentage recoveries of the surrogate and matrix spikes will be reported by the laboratory for all analyses associated with the samples. Variations from 100 percent recovery may be due to matrix interferences, laboratory spike handling procedures, or sample heterogeneities between replicates. The percentage recovery of the spikes can be calculated from the following equation:

$$\%\ Recovery = \frac{X - B \times 100}{T}$$

where:

X = measured amount in sample after spiking
B = background amount in sample
T = amount of spike added

Accuracy is difficult to evaluate for the entire data collection activity, especially the sampling component. Field and trip blanks will be used in addition to the matrix and surrogate spiked samples to evaluate data accuracy in the investigations.

Accuracy of analyses of tentatively identified compounds (TICs) from GC/MS analyses is estimated by the use of internal standards. Internal standards are organic compounds similar to surrogate that are spiked into samples. The responses of the instrumentation to these spiked compounds are used to provide a semi-quantitative estimate of non-target compounds identified by the use of a GC/MS library search.

In GC/MS VOC analyses, the surrogate compounds can be used as the internal standards. However, in GC/MS semivolatile analyses, a set of compounds different from those used as surrogate are utilized for calculation of TICs.

5.1.5 Completeness and Comparability Completeness is a measure of all information necessary for a valid study. It is defined as the total amount of acceptable data divided by the total number of samples multiplied by 100. The Quality Assurance (QA) objective for this project is to obtain acceptable data

for all samples collected. Completeness will be evaluated by carefully comparing project objectives with the proposed data acquisition and resulting potential shortfalls in needed information.

Comparability is a measure of the confidence with which one data set can be compared to another. Following the procedures and SOPs contained within this Monitoring Plan will help to ensure comparability of data.

5.2 SAMPLING AND FIELD MEASUREMENTS.

5.2.1 Operations Monitoring During the pilot-scale operation, specified locations will be sampled to observe the level of concentrations coming into and out of the treatment facility. In addition, samples of process water from specific pieces of equipment will be sampled periodically to monitor the efficiency of the system. Locations to be sampled are listed below.

- Pretreatment tank (system influent)
- Air sparger effluent (water)
- Air sparger effluent (vapor)
- Primary carbon unit effluent (vapor)
- Stage I (single well GWE test) - sample recovery well discharge from sample tap at manifold
- Stage II (two well GWE test) - sample discharge from the recovery well's sample taps at the manifold
- Stage III (all well GWE test) all sample taps at manifold
- Phase I Continuance (Stage III continued) - all sample taps at manifold and from pretreatment tank

Refer to Tables 5-3 and 5-4 for operations monitoring schedule.

5.2.2 Collection Procedures Samples will be periodically sampled from dedicated valves tapped into conveyance system. The procedures are as follows:

- Place a bucket below sample/drain valve on appropriate tank.
- Open drain valve and allow tap to flush for 5 seconds.
- Place collection container (i.e., 40-milliliter [ml] amber vial, 100-ml polyethylene or glass bottle, etc.) at tap and fill container.
- Before capping, ensure a meniscus of liquid is present at the rim to reduce potential for air in the vial. This pertains to 40-ml vials only.

Table 5-3 Phase I and Phase I Continuance Operations Monitoring Schedule

Sampling Location	Frequency Period	Period	Analysis	On site/ Off site[1,2]	No. Samples
Phase I					
Pretreatment Tank	1/day	49 days	Volatiles	On site	49
Pretreatment Tank	1 every other week	8 weeks	Metals, ETPs	Off site	4
Air Sparger Effluent (water)	1/day	49 days	Volatiles, pH	On site	49
Air Sparger Effluent (Water)	1/week	49 days	TSS, BOD	Off site	49
Air Sparger Effluent (vapor)	1/week	8 weeks	Volatiles	On site	8
Stack Effluent (vapor)	1/day	49 days	Volatiles	On site	49
Primary Carbon Unit Effluent (vapor)	1/week	8 weeks	Volatiles	On site	8
Initial Pumping Test	1/event		Volatiles, Metals, ETPs	Off site	
Stage I P-OIA, drawdown	1/day	5 days	Volatiles	On site	5
Stage I P-OIA, drawdown	1/event (day 5)	5 days	TCL, TAL, ETPs	Off site	1
Stage I P-OIA, single well pumping test	1/day	7 days	Volatiles	On site	7
Stage I P-OIA, single well pumping test	1/event	7 days	ETPs	Off site	1
Stage I P-OIA, single well pumping test	2/event	7 days	TCL, TAL	Off site	2
Stage II P-OIA & B, two well pumping test at well	1/day/well	7 days	Volatiles	On site	14
Stage II P-OIA & B, two well pumping test	1/week/well	1 week	TCL, TAL	Off site	2
Stage III, five well pumping test at well	1 every other day	30 days	Volatiles	On site	5
Stage III, five well pumping test	1/week	5 weeks	TCL, TAL	Off site	5
Phase I Continuance					
Air Sparger Effluent (water)	1/week		Volatiles	Off site	
Pretreatment Tank	1 every other week		Metals, Selected ETPs	Off site	

Notes:

BOD = biochemical oxygen demand
ETP = engineering treatability parameters, as indicated in Table 5-5.
SVOC = semivolatile organic compound
TAL = target analyte list
TCL = target compound list - VOCs, SVOCs, pesticides, and polychlorinated biphenyl compounds
TSS = total suspended solids
VOC = volatile organic compound

[1] Methods of analysis by off-site analytical laboratory and on-site laboratory is listed on Table 5-5.
[2] Five percent of samples analyzed in the on-site laboratory will be submitted for off-site VOC analysis.

Table 5-4 Sample Collection Frequency For Methanotrophic Rotating Biological Contactor

Parameter	Influent	Stage #1	Stage #2	Stage #3	Effluent	Headspace
VOCs	daily	daily	daily	daily	daily	as needed
pH	continuous	continuous	continuous	continuous	continuous	-----
Nitrate	2/week	2/week	2/week	2/week	2/week	-----
Phosphate	2/week	2/week	2/week	2/week	2/week	-----
Total Suspended Solids	1/week	-----	-----	-----	1/week	-----
Total Volatile Suspended Solids	1/week	-----	-----	-----	1/week	-----
Methane	-----	-----	-----	-----	-----	continuous
Oxygen	-----	-----	-----	-----	-----	continuous
Carbon Dioxide	-----	-----	-----	-----	-----	continuous

Note:

VOC = volatile organic compound

The following associated data will be recorded when collecting samples:

- ambient temperature,
- daily amount of precipitation,
- time sample was collected, and
- unusual events (i.e., samples were collected during rain event).

When sampling recovery wells at the manifold, allow 3 hours between influent and effluent sampling to ensure that the water being sampled is representative of the same volume of water that was sampled for influent analysis.

Vapor sample collection will be performed using Tedlar bags, following Method 18, Section 7 of 40 CFR Part 60, Appendix A. The procedures are as follows:

- Before collecting the sample, fill the new bag with nitrogen and allow gas to remain in bag for a minimum of 1/2 hour to purge the bag and to check for leaks.

- Empty all the nitrogen from the bag immediately before sampling by connecting the pump to suction the bag and evacuating bag until a no-flow condition is met.

- Connect one end of sample line to a leakless Teflon™-coated diaphragm sump and the other end at the centroid of the stack.

- Start the pump to yield a flow of 0.5 liters per minute.

- After allowing time to purge the line several times, connect the pump discharge to the valve on the Tedlar bag and fill bag.

- Shut off pump when bag is full; close the valve on the Tedlar bag and disconnect the sample lines.

Protect the Tedlar bag and its container from sunlight and record the following associated parameters:

- the stack temperature,
- barometric pressure,
- ambient temperature,
- sampling flow rate,
- stack flow rate, and
- initial and final sampling time on the data sheet.

5.3 SAMPLE ANALYSIS.

5.3.1 Sample Custody The control of a sample for off-site analysis is accomplished through a COC record. COC is initiated during sample container preparation by the laboratory and will be maintained through sample collection, shipment, storage, and analysis as a legal record of possession of the sample.

Possession will be traceable by means of a COC form (Figure 5-2), which will remain with the samples at all times and bears the name of the person responsible for the samples. Procedures for maintaining the appropriate sample custody information will be in accordance with USEPA Region IV SOPs (USEPA, 1991).

CHAIN OF CUSTODY RECORD

Page ___ of ___

PROJECT NO. | PROJECT NAME

SAMPLERS (SIGNATURE)

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO OF CON-TAINERS	SAMPLE TYPE											REMARKS INDICATE SOIL/WATER/AIR SEDIMENT/SLUDGE

RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)	RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)
RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)	RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)
RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED FOR DISPOSAL BY (SIGNATURE)	DATE/TIME	REMARKS	

DWN: NLW	PROJECT NO.: 08503	TITLE: CHAIN OF CUSTODY FORM
APPD: TLK	FIGURE NO.: 5-2	
DATE: 8/23/93		

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Samples are identified by using a sample label attached to the sample container. The following information is included on the sample container label:

- project number,
- field identification or sample station number (a unique number identifying the sample),
- date and time of sample collection,
- type of sample (e.g., water, soil, sediment) and a brief description of the sampling location,
- the signature(s) of the sampler(s),
- whether the sample is preserved or unpreserved,
- the general types of analyses to be conducted, and
- any relevant comments regarding the sample.

A COC form will be used to record the custody of all samples or other physical evidence collected and maintained by the IM team. The following information must be supplied in the indicated spaces in detail to complete the COC record:

- site name and address;
- project number;
- project name;
- signature of sampler in the designated signature blank;
- the sampling station number, date, and time of sample collection, and a brief description of the type of sample and the sampling location;
- the sample bottle type (i.e., 40 ml glass) plus the intended analysis (i.e., target compound list-volatile organic analysis [TCL-VOA]);
- for each sample the number of containers for each bottle type; and
- field investigator and subsequent transferee(s) signatures. (Both the person relinquishing the samples and the person receiving them must sign the form along with the date and time this occurred.)

When samples are relinquished to a shipping company for transport, the tracking number from the shipping bill/receipt shall be recorded on the sample COC form. As necessary, IM personnel will use carriers (e.g., United Parcel Service, Federal Express, Greyhound) to ship samples. In these cases, the airbill becomes part of the COC.

All samples shall be accompanied by the COC record. The original and one copy of the record will be shipped inside the shipping container if samples are

shipped. One copy of the record will be retained by the field investigator. The original record will be transmitted to the field investigator after samples are accepted by the laboratory. This copy will become part of the project records. The COC record will be signed and dated upon receipt by the laboratory. Custody tracking shall be maintained by the laboratory from sample receipt through storage, analysis, and disposal in accordance with the individual laboratory's Quality Assurance Plan (QAP).

In the event that a legal COC is required for a project, custody will begin at the time of receipt of the clean sample containers from the contract laboratory. The COC form has appropriate spaces to allow signatures and dates to document the transfer of the cleaned sample containers from the laboratory to the sample team. In addition, use of custody seals will be implemented during shipment of bottles and samples to document the integrity of the samples and bottles. The custody seal will be placed on the shipping container so that it cannot be opened without breaking the seal. The seal will be signed, dated, and the time recorded by the field investigator. By using a unique sample identification number for each sample, all ancillary records can be traced to specific sampling events.

The control of a sample collected for on-site analysis is accomplished by the Sample Tracking Form (see Figure 5-1). The Sample Tracking Form will be initiated during sample container preparation by the on-site laboratory technician and will be maintained through sample collection, storage, and analysis, as a record of possession of the sample.

Possession and history of the sample will be traceable by means of the Sample Tracking Form and a laboratory data book, maintained by the on-site laboratory technician. The Sample Tracking Form will be signed by the sampler and the on-site laboratory technician. The laboratory data book will remain with the on-site laboratory technician or RE.

The on-site laboratory technician will perform weekly reviews of all on-site sample collection, analysis, and analytical results. On-site laboratory data will be put into table format and transmitted to the TOM. Electronic and hard copies of the on-site laboratory data will be maintained, both on-site and in the IM project files.

On-site laboratory data will be tabulated in a format that will include at a minimum:

- project name and number,
- sample identification or sample station number,
- sample date and time,
- sample matrix (air, groundwater, intermediate process sample, etc.)
- sample type (discrete, grab, etc.),
- sample preservation,
- sample analysis,
- date and time of analysis,
- name of analyst,
- analytical results,
- any variations in sample quality assurance/quality control (QA/QC), and
- any other relevant comments regarding the sample.

5.3.2 Sample Containers, Preservation, and Holding Times For most sampling episodes, the IM team will obtain sample containers from a NEESA-approved analytical laboratory. NEESA requires all subcontract analytical laboratories to have a current and comprehensive QAP and sample container requirements that meet USEPA Contract Laboratory Program (CLP) QA requirements.

Preservatives, controlled holding times, and selected container materials may be required to avoid sample degradation or alteration prior to laboratory analysis. Common preservation techniques include pH control, chemical complexation, and refrigeration or freezing. Holding times are controlled to minimize the time between sample collection and analysis, which in turn minimizes the reaction time for potential mechanisms of analyte loss or alteration. Selected container materials may be required to minimize sorption, leaching, or other interactions between the sample and the container. Amber containers may be required to block the sunlight and reduce photolytic degradation in selected analytes. In general, preservatives, holding times, and container materials are selected to inhibit biological activity, retard degradation or other alteration processes, reduce volatility, and/or reduce sorption, leaching, and complexation. Sufficient sample volumes must be collected to accommodate specified analytical methods and to allow for the analysis of laboratory QA/QC samples, where required.

5.3.2.1 Sample Containers In general, samples for organic analysis should be stored in glass containers and samples for inorganic analysis should be stored in plastic containers. As container specifications depend on the analyte and sample matrix types (as indicated in Table 5-2), separate samples should be collected when both organic and inorganic analyses are required. Containers should be kept in the dark (to minimize biological or photoxidation/photolysis breakdown of constituents) until they reach the analytical laboratory. The sample container should generally allow approximately 5 to 10 percent air space ("ullage") to allow for expansion or vaporization if the sample is heated during transport (1 L of water at 4 °C expands by 15 ml if heated to 130 degrees fahrenheit [°F]/55 °C). Important exceptions include volatile organic analysis (VOA), chemical oxygen demand (COD), and biological oxygen demand (BOD), all of which do not allow headspace in the container. When sample containers are stored on-site, the containers should be kept sealed and away from solvents that are also being stored. Ideally, solvents should be kept in separate facilities from clean containers and organic-free water.

5.3.2.2 Preservation Techniques Preservation techniques for selected analytes are presented in Table 5-2. Reagents required for sample preservation will generally be added to the sample containers by the analytical laboratory prior to shipment. In some instances, preservatives may be added in the field by ABB Environmental Services, Inc. (ABB-ES) personnel. Samples will be preserved immediately upon collection in the field. In general, aqueous samples of low concentration organics (or soil samples of low or medium concentration organics) are cooled to 4 °C with ice.

Low concentration aqueous samples for metals are preserved with nitric acid, whereas low or medium concentration soil samples for metals are cooled to 4 °C. Samples that should not be immediately preserved in the field include the following.

- Samples collected within a hazardous waste site that are known or thought to be highly contaminated with toxic materials should not be preserved. Barrel, drum, closed container, spillage, or other

source samples from hazardous waste sites are not to be preserved with any chemical. These samples may be preserved with ice, if necessary.

- Samples that have extremely low or high pH or samples that may generate potentially dangerous gases should not be preserved.

- Water samples with a considerable solids content may require filtering prior to preservation with nitric acid. These samples can be preserved with ice and returned to the laboratory for filtering and preservation.

All samples preserved with chemicals shall be clearly labelled. If containers are preserved by the analytical laboratory, additional preservatives will be from the same source. The following subsections describe the procedures for preparing and adding chemical preservatives.

Addition of acids such as sulfuric acid (H_2SO_4), hydrochloric acid (HCl), or nitric acid (HNO_3) or bases such as sodium hydroxide (NaOH) should be done following these mixing procedures. Addition of the following acids or bases may be specified for sample preservation:

Acid or Base	Concentration	Amount Required for Preservation[1,2]
HCl	1:1 dilution of concentrated HCl (6N)	5-10 ml
H_2SO_4	1:1 dilution of concentrated H_2SO_4 (18N)	2-5 ml
HNO_3	Undiluted concentrated HNO_3 (16N)	2-5 ml
NaOH	400 grams solid NaOH in 870 ml water (10N)	2 ml

[1] Amount of HCl, H_2SO_4, or HNO_3 to add (at the specified strength) per liter of water to reduce the sample pH to less than 2, assuming that the water is initially at pH 7, is poorly buffered, and does not contain particulate matter.
[2] Amount of NaOH to raise pH of 1 liter of water to 12.

HCl, H_2SO_4, and NaOH should be analytical reagent grade and should be diluted to the required concentration with double-distilled, deionized water in the laboratory performing the analyses or by field personnel. This procedure should be followed prior to conducting field sampling. HNO_3 for metals preservation must be ultra-purified metals grade HNO_3.

The approximate volumes needed to acidify 1 L of neutral water to a pH of less than 2 (or raise the pH to 12) are shown in the last column of the above table. However, if the water is more alkaline or acidic, contains inorganic or organic buffers, or contains suspended particles, more acid or base may be required. The final pH must be checked using narrow-range pH paper. Never dip pH paper into the sample; apply a drop of sample to the pH paper using the stirring rod.

Sample acidification or base addition should proceed as follows:

- Check initial pH of sample with wide range (0 to 14) pH paper.

- Fill sample bottle to within 5 to 10 ml of final desired volume and add about half of estimated acid or base required, stir gently, and check pH with medium range pH paper (pH 0 to 6 or pH 7.5 to 14).

- Add acid or base a few drops at a time while stirring gently. Check for final pH using narrow range (0 to 2.5 or 11 to 13) pH paper; when desired pH is reached, cap sample bottle, and seal.

Sulfide Preservation Samples for sulfide analysis must be preserved by the addition of 4 drops (0.2 ml) of 2N zinc acetate solution per 100 ml sample. The sample pH is then raised to 9 using NaOH solution (1 to 2 drops). The 2N zinc acetate solution is made by dissolving 220 grams of zinc acetate in 870 ml of distilled water to make 1 L of solution.

Preservation of Organic Samples Containing Residual Chlorine Some organic samples containing residual chlorine must be treated to remove this chlorine upon collection. Test the samples for residual chlorine using USEPA Method 330.4 or 330.5 (field test kits are available for this purpose). If residual chlorine is present, add 0.008 percent sodium thiosulfate (80 mg/l of sample) to the sample vial first, then fill the vial to at least half volume with sample. Add the acid and then fill the remainder of the vial as per the stated procedure.

5.3.3 Calibration Procedures and Frequency

5.3.3.1 Calibration Procedures for Laboratory Equipment These procedures are described in the SOPs prepared by the participating laboratory submitted separately.

5.3.3.2 Calibration Procedures and Frequency for Field Instruments Each piece of equipment will be calibrated prior to each day's use. Data is recorded on the form shown as Figure 5-3. The procedures described below apply to the specific instrument noted. If other instruments are used, the manufacturer's calibration procedures are followed.

Y.S.I. S-C-T Meter (Model No. 33)

Temperature Probe

1. Using an American National Standards Institute-approved thermometer, immerse both probes into a beaker of water, and note any differences for the field probe.

2. Recalibrate as necessary.

Specific Conductance Meter

1. Calibrate meter and probe using the calibration control and the red-line on the meter dial (Y.S.I. S-C-T Meter, Model No. 33).

2. Turn the function switch to read conductivity on the ten scale (x 10) and then depress the cell test button, noting the deflection. If the needle falls more than 2 percent of the reading, clean the probe and retest.

ABB ENVIRONMENTAL SERVICES INC.

FIELD INSTRUMENTATION & QUALITY ASSURANCE RECORD

PAGE _____ OF _____

PROJECT _____ JOB NUMBER _____ DATE _____

FIELD INSTRUMENTATION CALIBRATION DATA

INSTRUMENT TYPE / I.D. #

CALIBRATION INFORMATION

CREW # 1	USE	TEMP COMP.	BUFFERS USED / METER VALUE	CONDUCTIVITY READINGS
_____	☐ pH ☐ TEMPERATURE ☐ CONDUCTIVITY	☐ YES ☐ NO	☐ pH 4 _____ ☐ pH 7 _____ ☐ pH 10 _____	METER VALUE DIFF _____ STANDARD VALUE _____ METER VALUE _____
_____	☐ pH ☐ TEMPERATURE ☐ CONDUCTIVITY	☐ YES ☐ NO	☐ pH 4 _____ ☐ pH 7 _____ ☐ pH 10 _____	METER VALUE DIFF _____ STANDARD VALUE _____ METER VALUE _____
_____	PHOTOIONIZATION AIR QUALITY MONITORING DEVICE		☐ ZERO W/ BACKGROUND ☐ ZERO W/ ZERO AIR	SPAN GAS VALUE _____ METER VALUE _____
_____	_____		_____	

CREW # 2	USE	TEMP COMP.	BUFFERS USED / METER VALUE	CONDUCTIVITY READINGS
_____	☐ pH ☐ TEMPERATURE ☐ CONDUCTIVITY	☐ YES ☐ NO	☐ pH 4 _____ ☐ pH 7 _____ ☐ pH 10 _____	METER VALUE DIFF _____ STANDARD VALUE _____ METER VALUE _____
_____	☐ pH ☐ TEMPERATURE ☐ CONDUCTIVITY	☐ YES ☐ NO	☐ pH 4 _____ ☐ pH 7 _____ ☐ pH 10 _____	METER VALUE DIFF _____ STANDARD VALUE _____ METER VALUE _____
_____	PHOTOIONIZATION AIR QUALITY MONITORING DEVICE		☐ ZERO W/ BACKGROUND ☐ ZERO W/ ZERO AIR	SPAN GAS VALUE _____ METER VALUE _____
_____	_____		_____	

FLUIDS / MATERIALS RECORD

DEIONIZED WATER SOURCE: ☐ ABB STATION ☐ PORTABLE STATION ☐ OTHER _____

DECONTAMINATION FLUIDS: ☐ LIQUI-NOX ☐ TSP SOLUTION ☐ 20 % HNO3 LOT NO. _____ ☐ OTHER _____ LOT NO. _____

CALIBRATION FLUIDS: ☐ pH BUFFER 4 LOT NO. _____ 7 LOT NO. _____ 10 LOT NO. _____ ☐ COND. STANDARD LOT NO. _____

FILTRATION PAPER (S): ☐ LO LOAD SIZE _____ LOT NO. _____ ☐ VACUUM SIZE _____ LOT NO. _____ ☐ PRESSURE SIZE _____ LOT NO. _____

☐ HNO3 LOT NO. _____
☐ H2SO4 LOT NO. _____
☐ HCL LOT NO. _____
☐ NaOH LOT NO. _____
☐ ZnNOC LOT NO. _____
☐ NaTSIO LOT NO. _____
☐ HNO3 LOT NO. _____
☐ ALK.-TOB TOC LOT NO. _____
☐ _____ LOT NO. _____
☐ _____ LOT NO. _____

SAMPLE CREW ID CREW # 1 TYPE _____ CREW # 2 TYPE _____

NAMES: _____ NAMES: _____

_____ _____ _____ / SAMPLER SIGNATURE

RB 08-10-89

DWN: NLW	PROJECT NO.: 08503	TITLE: FIELD INSTRUMENT QUALITY ASSURANCE RECORD	IM WORK PLAN
CHKD: TLK	FIGURE NO.: 5-3		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
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3. Using at least two buffer solutions, which will most likely bracket the expected values for conductivity, note accuracy of the water and probe and clean probe if necessary.

Specific Ion Meter

pH Probe

1. Place electrodes and buffer solutions in a water bath at the temperature of the water to be sampled. After temperature equilibrium, measure temperature and adjust the temperature compensation knob for this temperature.

2. If using refillable probes, remove electrode cap and check that filling solution is above the filling mark.

3. Immerse the probe in the pH 7 buffer solution and adjust the calibration control to read the appropriate pH. Check the pH buffer solution for correct pH value at the equilibrated temperature.

4. Remove the probe, rinse with distilled water and then immerse in either the pH 4 or pH 10 buffer solution, depending on the expected pH of the sample.

5. If the meter does not register the correct pH for that buffer solution, adjust the calibration knob on the back of the instrument to obtain the pH of the buffer.

6. After rinsing, insert the pH probe into the flow cell and allow the probe to come to equilibrium with the sample water.

7. The pH probe is stored in the ambient air overnight.

pH Calibration

pH Standardization The pH sensor should be standardized before each use after long storage. First, moisten the electrode body with tap water and carefully remove the plastic storage cap covering the tip of the electrode. Care should be taken not to bend the body of the electrode as this can result in damage to the internal element.

For first time use after long storage, immerse the lower end of the electrode in tap water for 30 minutes. This hydrates the pH bulb and prepares the ceramic wick for contact with test solutions. If air bubbles are present in the pH bulb, shake the electrode downward to fill the bulb with solution.

Prepare a small sample of pH 7.00 buffer solution and measure the temperature of the buffer. Rinse the pH electrode with distilled water and immerse the pH bulb in the reference buffer. Set the compensation dial in the Tripar front panel to the temperature of the buffer, allow several minutes for the sensor to reach equilibrium and stir the sensor slightly to dislodge any possible air bubbles from the electrode tip. Using the "Standardize" potentiometer, adjust for a reading of 7.00 on the Tripar display.

pH Slope Adjustment Very infrequently, the pH slope adjustment may require re-calibration. This adjustment is available at the Tripar readout rear panel. To accomplish this adjustment, prepare a test solution of pH 4 or 10. Measure the temperature of the solution and make the appropriate setting at the pH "Compensation" dial. Rinse the pH electrode in distilled water and immerse in the buffer solution. Allow several minutes for the sensor to equilibrate and stir the electrode slightly. Using the pH "Slope" potentiometer available at the rear panel, adjust the Tripar readout module for a reading equal to the value of the buffer solution. For best results, the pH "Standardize" and "Slope" adjustments should be repeated at least once. Note that some interference may be seen on the pH reading if the Tripar conductivity sensor is present in the same test solution as the pH sensor.

Photoionization Meters

HNu With the probe attached to the instrument, turn the function switch to the battery check position. The needle on the meter should read within or above the green battery area on the scale plate. If the needle is in the lower position of the battery arc, the instrument should be recharged prior to any calibration. If red LED comes "on", the battery should be recharged. Next, turn the function switch to the on position. In this position the ultraviolet light source should be on. To zero the instrument, turn the function switch to the standby position and rotate the zero potentiometer until the meter reads zero. Clockwise rotation of the zero potentiometer produces an upscale deflection while counter-clockwise rotation yields a down-scale deflection. If the span adjustment setting is changed after zero is set, the zero should be rechecked and adjusted if necessary. Wait 15 to 20 seconds to ensure that the zero reading is stable. If necessary, readjust the zero.

The instrument is now ready for calibration by switching the function switch to the proper measurement range.

Using non-toxic analyzed gas mixtures available from the manufacturer in pressurized containers, connect the cylinder with the analyzed gas mixture to the end of the probe with a piece of tubing. Open the valve of the pressurized container until a slight flow is indicated and the instrument draws in the volume of sample required for detection. Now adjust the span potentiometer so that the instrument is reading the stated value of the calibration gas.

If the instrument span setting is changed, the instrument should be turned back to the standby position and the electronic zero should be readjusted if necessary. If the instrument does not calibrate, it may be necessary to clean the probe or the lamp connection.

5.3.4 Analytical Program

5.3.4.1 Analytical of Parameters Laboratory analyses may be scheduled for air, water (groundwater, influent, treatment process effluent), soil, or waste samples. Based on historical information regarding potentially hazardous material use and disposal, previous site assessments, and legislative mandates,

IM project team may select some or all of the following parameter groups for analysis:

- VOCs,
- metals, and
- ETPs.

Individual contaminants comprising the analytical fractions noted above are contained in USEPA's Hazardous Substance List and/or the analytical methods selected.

Parameters for analysis during operations monitoring are summarized in Table 5-5. All vapor samples collected from the air sparger and carbon absorption units will be analyzed in the on-site laboratory for the 10 VOCs listed in Table 5-5.

The analytical program for aqueous samples (groundwater influent and effluent) includes on-site and off-site analysis of chemical and physical parameters. VOC analysis of aqueous samples will be done on site and off site as indicated on Table 5-3. Parameters for on-site analysis are listed on Table 5-5. Off-site analysis of aqueous samples will include the Target Compound List (TCL) and TAL analytes listed in Table 5-6. Other parameters for analysis in aqueous samples include a select list of metals and engineering and treatability parameters (Table 5-5).

Several parameters will be monitored in association with operation of the mRBC unit. The parameters include nitrate and nitrite, phosphate, total volatile suspended solids, oxygen, and methane (see Table 5-5).

5.3.4.2 On-Site Analytical Procedures On-site analytical procedures include physical and chemical measurements of vapor and aqueous samples. Table 5-5 includes information regarding the methods of analysis associated with monitoring the IM operations. These methods include the use of colorimetric test kits, field GC, and real time measurements.

Colorimetric test kits will be used for measurements of nitrate, nitrite, and phosphate. Each test kit employs the use of an indicator solution which reacts with the analyte to produce a color change. The intensity of the resulting color is directly related to the concentration of the analyte in the sample.

Samples collected for on-site VOC analysis will be analyzed using a Hewlett Packard 5890 GC or equivalent. The GC will be equipped with a purge-and-trap unit for use in analysis of aqueous samples. Air samples will be injected directly into the GC. The GC will also be equipped with two detectors, a photometric ionization detector (PID) and electrolytic conductivity (Hall) detector. The Hall detector will be calibrated to measure concentrations of benzene, toluene, xylenes, and ethylbenzene. The PID will be calibrated to measure concentrations of 1,2-dichloroethane, cis-1,2-dichloroethene, trans-1,2-dichloroethene, tetrachloroethene, trichloroethene, and vinyl chloride.

QA/QC procedures for the on-site laboratory are discussed in this paragraph. Duplicate samples will be collected and analyzed at a frequency of 10 percent of the total number of samples. A method blank will be analyzed at the beginning of each day. Cleaning blanks will be analyzed, as necessary, to check for carryover of contaminants from a previous analysis. Matrix spike and matrix spike duplicate analyses will be done at a frequency of 5 percent of the total

Table 5-5 Analytical Requirements for Phase I IM Activities

Parameter	Analytical Method	Constituent	Reference
VOCs (on site)	USEPA Method 5030/8010 & 5030/8020 (Modified)	Benzene 1,2-Dichloroethane cis-1,2-Dichloroethene trans-1,2-Dichloroethene Ethylbenzene Tetrachloroethene Toluene Trichloroethene Xylenes (total) Vinyl Chloride	(1) (2)
VOCs (off site)	1990 CLP SOW	TCL (Table 2-2)	(3)
SVOCs	1990 CLP SOW	TCL (Table 2-2)	(3)
Pesticides and PCBs	1990 CLP SOW	TCL (Table 2-2)	(3)
Metals	USEPA Method 6010	Cadmium Chromium Iron Manganese	(2)
	USEPA Method 7421	Lead	
	1991 CLP SOW	TAL (Table 2-2)	(4)

See notes at end of table.

Table 5-5 (Continued) Analytical Requirements for Phase I IM Activities

Parameter	Analytical Method	Constituent	Reference
mRBC Parameters			
* Nitrate and Nitrite	Field Test Kit		
* Phosphate (total)	Field Test Kit		
* TSS	USEPA Method 160.2		(5)
* Total Volatile Suspended Solids	USEPA Method 160.2M		(5)
* Oxygen/Methane/Carbon Dioxide	Field Method		
Engineering Treatability (ETPs)			
* pH	Field Method		
* Chloride	USEPA Method 325.2		(5)
* TOC	USEPA Method 415.1		(5)
* TSS	USEPA Method 160.2		(5)
* TDS	USEPA Method 160.1		(5)
* Hardness, total (as $CaCO_3$)	USEPA Method 130.2		(5)
* BOD (5-day)	USEPA Method 405.1		(5)

Notes:

BOD = biochemical oxygen demand
mRBC = methanotrophic Rotating Biological Contactor
SVOCs = semivolatile organic compounds
TAL = target analyte list
TCL = target compound list
TOC = total organic carbon
TSS = total suspended solids
TDS = total dissolved solids
USEPA = U.S. Environmental Protection Agency
VOCs = volatile organic compounds

References:

(1) Test Methods for Evaluating Solid Waste, Physical Chemical Methods, SW-846, 3rd Edition, USEPA 1986.
(2) ABB-ES' Treatability Laboratory Standard Operating Procedures.
(3) Contract Laboratory Program (CLP) Statement of Work (SOW) for Organic Analysis.
(4) CLP SOW for Inorganic Analysis.
(5) Methods for Chemical Analysis of Water and Wastes, USEPA-600/4-79-020, revised March 1983.

Table 5-6 Target Compound List (TCL) and Target Analyte List (TAL)

Parameter: Volatile Organic Compounds
Method: Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration.

Chloromethane	cis-1,3-Dichloropropene
Bromomethane	Trichloroethene
Vinyl Chloride	Dibromochloromethane
Chloroethane	1,1,2-Trichloroethane
Methylene Chloride	trans-1,3-Dichloropropene
Acetone	Bromoform
Carbon Disulfide	2-Hexanone
1,1-Dichloroethene	4-Methyl-2-Pentanone
1,1-Dichloroethane	Tetrachloroethene
1,2-Dichloroethene (total)	1,1,2,2-Tetrachloroethane
Chloroform	Toluene
1,2-Dichloroethane	Benzene
2-Butanone	Chlorobenzene
1,1,1-Trichloroethane	Ethylbenzene
Carbon Tetrachloride	Styrene
Bromodichloromethane	Xylene (total)
1,2-Dichloropropane	

Parameter: Semivolatile Organic Compounds
Method: Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration.

Phenol	Acenaphthene
bis(2-Chloroethyl)ether	2,4-Dinitrophenol
2-Chlorophenol	4-Nitrophenol
1,3-Dichlorobenzene	Dibenzofuran
1,4-Dichlorobenzene	2,4-Dinitrotoluene
1,2-Dichlorobenzene	Diethylphthalate
2-Methylphenol	4-Chlorophenyl-phenylether
2,2'-oxybis(1-Chloropropane)	Fluorene
4-Methylphenol	4-Nitroaniline
N-Nitroso-di-n-propylamine	4,6-Dinitro-2-methylphenol
Hexachloroethane	N-Nitrosodiphenylamine
Nitrobenzene	4-Bromophenyl-phenylether
Isophorone	Hexachlorobenzene
2-Nitrophenol	Pentachlorophenol
2,4-Dimethylphenol	Phenanthrene
bis(2-Chloroethoxy)methane	Anthracene
2,4-Dichlorophenol	Carbazole
1,2,4-Trichlorobenzene	Di-n-butylphthalate
Naphthalene	Fluoranthene

See notes at end of table.

Table 5-6 (continued) Target Compound List (TCL) and Target Analyte List (TAL)

Parameter: Semivolatile Organic Compounds (Continued)

4-Chloroaniline	Pyrene
Hexachlorobutadiene	Butylbenzylphthalate
4-Chloro-3-methylphenol	3,3'-Dichlorobenzidine
2-Methylnaphthalene	Benzo(a)anthracene
Hexachlorocyclopentadiene	Chrysene

Parameter: Semivolatile Organic Compounds - continued
Method: Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration.

2,4,6-Trichlorophenol	bis(2-Ethylhexyl)phthalate
2,4,5-Trichlorophenol	Di-n-octyl phthalate
2-Chloronaphthalene	Benzo(b)fluoranthene
2-Nitroaniline	Benzo(k)fluoranthene
Dimethylphthalate	Benzo(a)pyrene
Acenaphthylene	Indeno(1,2,3-cd)pyrene
2,5-Dinitrotoluene	Dibenz(a,h)anthracene
3-Nitroaniline	Benzo(g,h,i)perylene

Parameter: Organochlorine Pesticide and PCB Compounds
Method: Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration.

alpha-BHC	Endosulfan sulfate
beta-BHC	4,4'-DDT
delta-BHC	Methoxychlor
gamma-BHC (Lindane)	gamma-Chlordane
Heptachlor	alpha-Chlordane
Aldrin	Toxaphene
Heptachlor epoxide	Aroclor-1016
Endosulfan I	Aroclor-1221
Dieldrin	Aroclor-1232
4,4'-DDE	Aroclor-1242
Endrin	Aroclor-1248
Endosulfan II	Aroclor-1254
4,4'-DDD	Aroclor-1260
Endrin aldehyde	

Parameter: Inorganic Analytes
Method: Contract Laboratory Program Statement of Work for Inorganic Analysis

Aluminum	Cobalt	Potassium
Antimony	Copper	Selenium
Arsenic	Iron	Silver
Barium	Lead	Sodium
Beryllium	Magnesium	Thallium

See notes at end of table.

Table 5-6 (continued) Target Compound List (TCL) and Target Analyte List (TAL)

Parameter: Inorganic Analytes (Continued)		
Cadmium	Manganese	Vanadium
Chromium	Mercury	Zinc
Calcium	Nickel	Cyanide

Notes:

PCBs = polychlorinated biphenyls
TAL = target analyte list
TCL = target compound list

number of samples. A known concentration of bromofluorobenzene surrogate will be added to each sample and the percentage of recovery calculated and recorded.

Real time measurements of carbon dioxide, oxygen, and methane will be done using various electronic analyzers. The mRBC unit employs three gas analyzers that continuously measure headspace gases in the unit. The measurements are recorded on a strip chart.

5.3.4.3 Off-Site Analytical Procedures The off-site laboratory program for IM operations monitoring includes analysis of physical and chemical parameters. All off-site analyses will be conducted according to USEPA-approved methods. Table 5-5 summarizes analytical methods to be used for the off-site analyses. The subcontract laboratory will be qualified to perform CLP analyses, will have an active QA/QC program, and will be NEESA-approved. QA/QC procedures are specified in the various analytical methods to be used for the IM off-site laboratory program. Details of QA/QC procedures for individual analyses can be found in the references cited in Table 5-5.

The off-site laboratory program includes analysis of a minimum of 5 percent of all samples analyzed in the on-site laboratory. Off-site analysis of air and aqueous samples, analyzed in the on-site laboratory for the target VOCs, will include TCL VOCs. All SVOC, pesticide, PCB, metals, and engineering treatability parameter analyses (excluding pH) conducted as part of IM operations monitoring will be done by the off-site laboratory. Table 5-3 provides information on the location and frequency of sample collection for off-site analyses.

5.3.4.4 Turnaround Times With the exception of TCL and TAL analyses, data from off-site laboratory samples should be submitted to IM personnel within 30 days of receiving the sample. TCL and TAL analyses will be conducted on a 7-day turnaround schedule. Analysis on field samples will be complete within 24 hours from the time the sample is collected. On-site analysis of treated water effluent will be completed within 2 hours from the time the sample is collected.

5.3.5 Quality Control Samples A brief description of QC samples and frequency of collection is presented below. Selected definitions were obtained from USEPA Region IV SOPs (USEPA, 1991).

Duplicate Samples Duplicate samples are two or more samples collected simultaneously into separate containers from the same source under identical conditions. One duplicate will be collected for every 10 samples of a single matrix except for Level V samples in which the frequency will be one every 20 samples. Duplicate samples are intended to assess the homogeneity of the sampled media and the precision of the sampling protocol.

Trip Blanks Trip blanks are prepared by the laboratory using organic-free, ASTM Type II organic-free water prior to the sampling event and are kept with the investigative samples throughout the sampling event and are packaged and shipped with the investigative samples. These containers should never be opened prior to laboratory analysis.

One trip blank will be included with each shipment of samples scheduled for volatile organic analysis. Trip blanks are required for assessing the potential for samples becoming contaminated with volatile organic compounds during the sampling tasks or in transit.

Equipment Rinsate Blanks Equipment rinsate blanks are collected by running organic-free deionized water over and/or through sample collection equipment after it has been decontaminated. Equipment rinsate blanks will be collected at a frequency of one per day per type of sampling tool used. These blanks are used to assess the adequacy of decontamination procedures and to trace potential cross contamination.

Matrix Spike and Matrix Spike Duplicates Matrix spike and matrix spike duplicates (MS/MSD) samples are additional samples collected in the field from a single sampling location. These samples are spiked in the laboratory with a known compound (or set of compounds) of known concentration. The concentration detected, after analysis, provides an estimate of the amount of compound "lost" (e.g., sorbed to glassware, volatilized, degraded) during the analytical procedure. A comparison of the original concentration to the final concentration provides data concerning analytical precision and accuracy. One set of MS/MSD samples will be collected per 20 or fewer samples per matrix or every 14 days.

Field Water Blanks Field water blanks include a complete set of samples collected from each water source used in the investigation. One set of samples will be collected from each water source (potable, deionized, and organic-free) used at the beginning of the project. Intermediate samples may be collected if deemed necessary. These samples should account for potential artifacts that could be introduced through decontamination procedures.

Preservative Blanks Preservative blanks are prepared by filling sample containers with organic-free water and adding the appropriate preservative. One set of preservative blank samples will be collected at the initiation of the field sampling program. These blanks should identify potential artifacts that may be introduced through the use of preservatives in sample containers.

5.3.6 Corrective Action Corrective or preventive actions to improve project quality will be implemented if potential or existing conditions are identified that may have an adverse impact on data quantity or quality. Corrective actions may be immediate or long-term. Corrective action identification, implementation, and recording will be conducted in accordance with the CLEAN Quality Assurance Project Plan (QAPP). Any member of the NSB Kings Bay IM program who identifies a condition adversely affecting quality can initiate corrective action by completing a nonconformance report, or by issuing a memo to the Quality Assurance Manager (QAM). The written communication must identify the condition and explain how it may affect data quantity or quality.

Immediate corrective action is applied to spontaneous, nonrecurring problems, such as instrument malfunctions. Staff who detect or suspect nonconformance to previously established criteria or protocol in equipment, instruments, data, or methods should immediately notify his or her Task Leader and the RE. If the problem is limited in scope, the Task Leader decides on the corrective action measure, documents the solution, and notifies the RE, TOM, and the QAM in a memorandum. If the problem has impaired the quality of the project or could reoccur in the future, the TOM will follow procedures outlined in the Contractor's CLEAN QAPP and a Corrective Action form will be placed with the project files.

Corrective actions may also be initiated as a result of performance evaluations; system audits; laboratory and field comparison studies; QA project audits conducted by the QAM or Navy CLEAN QA specialists; or other activities. The QAM

is responsible for documenting notifications, recommendations, and final decisions. The TOM is jointly responsible for notifying program staff and implementing the agreed-upon course of action. The QAM is responsible for verifying the efficacy of the implemented actions. To the extent possible, the development and implementation of preventive and corrective actions should be timed to not adversely impact project schedules or subsequent data generation and processing activities. The QAM will also be responsible for developing and implementing routine program controls to minimize the need for corrective actions.

6.0 ENGINEERING EVALUATION PLAN

An evaluation of the hydraulic and chemical data collected during the IM installation and start-up activities will be performed following the initial 45-day pilot-scale testing period. The evaluation will be of the components of the groundwater extraction and treatment system including: the groundwater extraction system, the conveyance system, the Air Stripper treatment system, the mRBC system, and the discharge permit and options. These systems will be evaluated for their ease of implementation, effectiveness in meeting remediation objectives, cost effectiveness, and schedule constraints. Additionally, other technologies will be evaluated, as appropriate, for meeting remediation objectives. These evaluations will be compiled into an Evaluation and Recommendations Report.

6.1 GROUNDWATER EXTRACTION SYSTEM EVALUATION. Evaluation of the GWE system includes the interpretation and assessment of hydraulic and chemical data collected during the initial aquifer pumping test, pilot-scale start-up activities, and pilot-scale test operations. These data will be used to evaluate aquifer parameters, well performance characteristics, and optimum extraction methodologies for the full-scale GWE/Treatment system IM. Hydraulic performance data from the initial aquifer pumping test will be evaluated prior to the installation of a fifth and sixth recovery well to support selection of the most effective well locations and depths of RW-5 and RW-6, discharge rates, and treatment system process flow rates. Evaluation of the pilot-scale test start-up activities includes analysis of the well performance tests from each of the recovery wells and interpretation of background monitoring data from within the surficial aquifer. Evaluation of hydraulic data from the three pumping stages and recovery phase of the pilot-scale test operations includes: (1) analysis and interpretation of the hydraulic head data that supports delineation of the actual capture zone, and (2) analysis of the variations in the waste-stream flow for treatment process performance monitoring. The activities associated with GWE system evaluation are discussed in further detail in the following subsections.

6.1.1 Evaluation of Initial Aquifer Pumping Test The aquifer pumping test, conducted during the initial IM field activities, will provide preliminary information regarding site-specific hydraulic performance of a recovery well and aquifer response to a pumping stress. Hydraulic data will be analyzed for the evaluation of aquifer parameters. Hydraulic performance data from this initial test should substantiate preliminary design estimates of discharge flow rates and pump (capacity) needs. Aquifer response to the stress created by pumping from RW-1 will provide preliminary information to verify anticipated drawdowns within the other recovery wells, evaluate the effects of pumping on vertical potential and stratigraphic relationships within the surficial aquifer, and evaluate the radius of influence. The results of the analysis of VOCs, ETPs, and other analytes in groundwater will be reviewed; then input to an air stripping technology model; and the results will be evaluated for potential process changes to the pilot-scale treatment system.

6.1.2 Evaluation of Well Performance Tests and Background Monitoring Data Analysis of step-drawdown tests for each of the recovery wells will be performed to evaluate performance of each of the wells. Drawdown data for each of the consecutive steps will be plotted, and the Hantush-Bierschenk method of analysis will be used to estimate optimum yield (based on selected pumping levels). The slope and y-intercept values will be used to calculate well efficiency. Specific

capacity estimates based on the stepped-flow rates will be calculated for each recovery well.

Water levels within the surficial aquifer at each of the recovery wells, observation wells, and selected monitoring wells will be plotted and matched with rainfall events and barometric changes. The established background or baseline of water levels will be assessed for level fluctuations due to natural conditions such as aquifer recharge, cyclic effects caused by tidal influence, or non-cyclic barometric effects. Also, the baseline data will be assessed for external effects caused by pumping from other wells such as the neighboring subdivision PIWs.

6.1.3 Evaluation of Pilot-Scale Test Operations Each of the three pilot-scale test pumping stages and the recovery phase will generate hydraulic data that support the evaluation of radius of influence due to a pumping stress on the surficial aquifer and the resulting capture zone.

The first pumping stage (from a single well location) will provide hydraulic data for the evaluation of aquifer parameters, boundary conditions and anisotropic effects, and the effective capture zone. Drawdown data versus time and drawdown versus distance will be plotted and analyzed by appropriate methods. These analytical method(s) will be selected based on the type of head response seen in the observation wells. Also, variations within the water quality of extracted groundwater will be evaluated.

The residual drawdown observed within the recovery well after the submersible pump has been shut-off will be analyzed using the Theis recovery method.

The second pumping stage (from two well locations) will provide hydraulic data for the evaluation of aquifer parameters; effects caused by boundary conditions, anisotropic nature of the aquifer, well interference; and the effective capture zone due to pumping from these wells. Drawdown data versus time and drawdown versus distance will be plotted and analyzed by appropriate methods. These analytical method(s) will be selected based on the type of head response seen in the observation wells. Also, variations within the water quality of extracted groundwater will be evaluated.

The third pumping stage (from all wells) will provide hydraulic data for the evaluation of wellfield (cumulative drawdown) interference and the effectiveness of multiple recovery wells for the extraction of VOC-contaminated groundwater. Drawdown data versus distance will be plotted and analyzed by appropriate methods. A map of the multiple well capture zone will be generated by superimposition of multiple-well cone of depression data over the natural water table. Also, variations within the water quality of extracted groundwater will be evaluated.

A computer-based analytical flow model will be used to assess several additional GWE wells linked to the pilot-scale GWE system for the purpose of full-scale system recommendations. This will allow the IM project team to evaluate the impact and effectiveness of additional wells in the system, by adding recovery wells at other locations within the plume or adding of horizontal collector wells to control VOC plume movement. During the modeling and the continued operation of the GWE system (Phase II), additional operational data will be collected to confirm Phase I results.

6.2 CONVEYANCE SYSTEM EVALUATION. The conveyance system, including piping layout, materials of construction, fittings, valves, flow meters, well headers, and well vaults, will be evaluated for long-term effectiveness and cost.

Piping Layout The potential for leaks, excessive pressure drops or build ups, and water hammer effects will be monitored throughout the start-up and pilot test operation of the system. The existing line sizes and layout will be evaluated for applicability to the flow rates anticipated in full-scale implementation. In performing this evaluation, the following parameters will be monitored and logged on a weekly basis:

- pressure at each well head and at manifold,
- total flow for each week,
- notation of any noticeable water hammer effects, and
- inspection of fittings and valves at manifold and well heads for leaks.

Materials of Construction At the end of the 45-day test, two piping locations will be chosen to be disconnected and evaluated for deterioration or scaling effects.

Fittings and Valves, Well Headers, and Well Vaults On a weekly basis, a walkdown of the entire piping system including the fittings and valves at each well vault, well header, and manifold will be performed to inspect for leaks or problems. Valves will be checked for proper opening and seating on closure. Results of the walkdown will be logged. The ability to manifold piping at an earlier stage to minimize piping requirements will be evaluated.

Any problems that are noted during the operation of the system will be evaluated for the urgency to correct the problem. All leaks will be repaired immediately.

6.3 TREATMENT SYSTEM EVALUATION. Treatment system influent and effluent concentrations, removal efficiencies for the constituents of concern, flow rates, and vapor emissions will be monitored throughout the pilot-scale test (Phase I activities). These parameters will be evaluated against performance criteria for the treatment system. The ability of the treatment system to meet performance criteria at higher full-scale operation flow rates and modification requirements will be evaluated. The evaluation will include an evaluation of applicable technologies and cost estimates for long-term full-scale (Phase II) operation. Full-scale pretreatment, vapor treatment, and overall O&M requirements will be evaluated. The influent VOC concentrations will also be evaluated and the possibility of discharging without treatment will be considered. Appropriate documentation will be supplied to the Georgia Department of Natural Resources, NSB Kings Bay LAS operator(s), and the City of St. Marys. No changes of the Phase I discharging criteria from the treatment system discharge will be made without the prior approval of Georgia EPD, the City of St. Marys, or NSB Kings Bay LAS personnel.

During the Phase I activities of the IM for Site 11, all of the extracted groundwater will be treated before discharge to either the upper base LAS or the City of St. Marys' Point Peter facility. After evaluation of the Phase I operations, if it is deemed possible to discharge without treatment to either

facility, proof of the ability for the city or base treatment facility to treat the groundwater will be submitted to Georgia EPD and the City of St. Marys. No changes in effluent discharge criteria presented for the Phase I activities will occurr without approval of Georgia EPD and the selected treatment facility.

The parameters to be monitored for the IM treatment system evaluation include:

1) Permanganate Addition System -

- Chemical consumption rates
- ORP Probe placement and feedback and response speed
- Efficiency in iron removal (influent and effluent concentrations)
- Requirements for heavy metal and carbonate removal (influent and effluent concentrations)

2) Caustic Addition System -

- Chemical consumption rates
- pH Probe placement and feedback and response speed

3) Polymer Addition System -

- Chemical consumption rates
- Efficiency in floc formation
- Sludge volume generated

4) Acid Addition System -

- Chemical consumption rates
- pH Probe placement and feedback and response speed

5) Sludge Handling System -

- Sludge volume generated
- Frequency of sludge transfer to holding tank
- Settling efficiency in Sludge Holding Tank
- Frequency of sludge dewatering
- Sludge dewatering additives needed
- Sludge Holding Tank size

6) Flocculator/Lamella -

- Flash Mixer and Flocculator Mixer speed
- Sludge settling capacity
- Percent solids in sludge
- Efficiency (influent and effluent total suspended solids [TSS] concentration)

- Capacity for additional flow

7) Air Stripper -

- Efficiency (influent and effluent VOC concentrations)
- Corrosion and/or scaling problems, especially at diffusers
- Blower operation
- Capacity for additional flow

8) Vapor Treatment -

- Efficiency (influent and effluent VOC concentrations)
- Blower operation
- Capacity for additional flow
- Carbon usage rates
- Carbon costs and disposal costs
- Change-out frequency and method

9) Pumps -

- Discharge pressure
- Cycling due to level switch placement
- Capacity for additional flow or head loss

The Rotating Biological Reactor will be evaluated for applicability as a full-scale (Phase II) remediation technology. Parameters to be monitored (with respect to controlled hydraulic loading rates) for this evaluation include:

- VOC degradation rates,
- methane utilization rates, and
- sludge production rates.

6.4 INSTRUMENTATION AND CONTROLS. In addition to the instrumentation and controls evaluated as part of the system performance evaluation, extraction well instrumentation and controls will be evaluated for accessibility and value of information received. Requirements for additional control, indication or recording abilities will be evaluated for full scale implementation requirements.

All instrumentation and controls will be evaluated for accessibility and placement. Level switches will be evaluated for effectiveness and efficiency in pump control. Sample points, drains, and valves will be evaluated for placement.

The entire treatment and conveyance system will be evaluated for safety throughout the operation of the system. Items that will be monitored include:

- chemical storage,
- chemical addition methods,
- potential for carbon fire,
- trip, slip or fall hazards,
- mechanical hazards (guards around rotating parts, gas cylinder placement, etc.),

- electrical hazards (proper grounding, electrical cord placement and usage, etc.), and

- proper lighting.

6.5 DISCHARGE PERMIT/OPTIONS. The discharge permit to the POTW will be evaluated. Estimated full-scale system flow rates and constituent concentrations will be evaluated for long-term discharge to the POTW. The USEPA Fate and Treatability Estimator for discharge to POTWs (USEPA Fate Model) will be used to determine requirements to ensure that discharge to the POTW will not adversely affect the facility's operation or effluent quality. Emphasis will be placed on obtaining approval to discharge without treatment.

If the City of St. Marys does not approve discharge to POTW, discharge to the NSB Kings Bay LAS will be evaluated.

6.6 EVALUATION AND RECOMMENDATIONS REPORT. The Evaluation and Recommendations Report will incorporate results of the evaluations discussed above and will recommend a full scale system (Phase II) for implementation as an IM. The final report will be submitted to Georgia EPD for approval.

7.0 DATA MANAGEMENT PLAN

Two broad categories make up data management for the IM activities: sample data management and field data management. Sample data management consists of tracking and reporting the origin, location, and results of a set of chemical data obtained from the analysis of an environmental sample. Field data management consists of documenting and reporting the results of measurements made in the field. Documentation procedures for the IM activities have been established to ensure accurate tracking and reporting of on-site and off-site laboratory data and field measurement data. These documentation procedures are discussed in the following subsections.

7.1 FIELD MEASUREMENTS, SAMPLING, AND PILOT-SCALE OPERATIONS DOCUMENTATION. Data collected during the IM Phase I activities will be recorded in logbooks, sampling forms, and on hydraulic data sheets, while in the field. Two copies of each will exist, one in the field office and the other in the residing home office. The originals will be kept locked at the home office.

The log books will contain a detailed record of site, sampling, and hydrologic activities as they occur. Maintaining proper records is a significant aspect of sample collection. At the time the samples are collected, the following will be recorded in the field logbook:

- location identification,
- surface elevation,
- sample type and depth,
- date and time of sampling,
- project and sample designations,
- sample identification,
- analyses requested,
- pump type and setting,
- discharge rates and volume, and
- signature(s) of the sampler(s).

At the time hydraulic data is collected, the following will be recorded in the field logbook:

- pump type and setting,
- discharge rates and volume,
- transducer setting,
- reference levels,
- transducer parameters,
- data logger and transducer serial numbers,
- name(s) and signature(s) of sampler(s),
- location identification,
- surface elevation, and
- date and time of sampling.

The logbooks will be hardbound, have consecutively numbered pages, and be maintained in black or blue ink.

Field sampling forms that are completed during sample collection will serve as a backup to the logbooks and an accessible, prompt reference for each sample collected. At the time the samples are obtained, the following will be recorded on the sampling forms:

- sample location identification,
- sample type and depth,
- date and time of sampling,
- project and sample designations,
- sample identification,
- analyses requested, and
- signature(s) of the sampler(s).

The sampling forms will be completed in ink and filed in the field office prior to shipping them to the home office.

Hydraulic data forms will be completed while conducting pumping tests. Hydraulic Data Sheets will include discharge/flow data sheets, water level record data sheets, and computer files of hydraulic head and transducer parameters. The completed hydraulic data sheets will serve as a backup to the logbooks and an accessible, prompt reference for obtaining hydraulic information. Data will be collected interactively with the pumping test and will contain:

- site name,
- pumping well location identification,
- depth of pumping well,
- screen setting,
- depth to water,
- elevation,
- pump type and setting,
- date and time,
- volume,
- discharge flow rates, and
- signature(s) of the hydrogeologist or engineer.

The hydraulic data forms will be completed in ink and filed in the field office prior to shipping originals to the home office.

7.2 DATA FORMAT. Raw analytical data generated for each sample collected during IM field activities will be presented in a spreadsheet format. Each spreadsheet will include the following information:

- parameter;
- sampling medium;
- sampling location identification;
- laboratory analysis identification number;
- date sampled, extracted, and analyzed;
- dilution factor;

- method number;
- analyte;
- contract required quantitation limit or on-site laboratory practical quantification limit;
- concentration of each analyte; and,
- units of concentration.

These comprehensive tables will be included as an appendix to the IM Evaluation Report which will be prepared at the conclusion of IM activities. The comprehensive tables will then be used to create summary tables that present only those compounds detected within each parameter for each sample collected. Summary tables will be created for each media sampled during the IM investigation and presented in the IM Evaluation Report.

Hydraulic data will also be presented in tabular form. These tables will include:

- site name,
- pumping well location identification,
- depth of pumping well,
- screen setting,
- depth to water,
- elevation,
- pump type and setting,
- date and time, and
- discharge flow rates.

Results of aquifer test analysis, as well as selected examples of graphical plots used for hydraulic data interpretation, will be provided. Specific capacity and well efficiencies will be reported for each recovery well.

Other results presented in tabular form will include data from the Pretreatment Process and performance data for the treatment system. Results pertaining to the pretreatment process will include types and quantities of process chemical(s). Performance of the treatment system with regards to flow variations will be recorded in tables as well as plotted.

7.3 DATA EVALUATION. Chemical and physical data collected during IM activities will be used to evaluate the effectiveness of the remedial measures used during the IM study and to further evaluate the source and extent of contamination at the site. These physical data (e.g., groundwater and surface water elevations and flow, drawdown, soil composition and transport characteristics, hydraulic conductivity), and chemical data (laboratory analyses and field screening data) will be integrated to provide a basis for design of the full-scale (Phase III IM) for the site.

All sampling locations will be plotted on scaled maps and will include boundaries of sampling area, sample location identification, and levels of contamination at each sampling location.

Chemical and physical data associated with each sampling location will be presented using graphical displays, where applicable. To aid in the interpretation of chemical data, a geologic information system (GIS) will be used, where applicable, to show the horizontal and vertical extent of contamination at the site. Outputs from the system will be scaled plan maps and cross-sectional maps displaying isopach plots of geologic contours and isopleth plots of the drawdown effects within the aquifer (cone[s] of depression) and capture zone(s).

8.0 PROJECT MANAGEMENT PLAN

8.1 OBJECTIVE. The Project Management Plan (PMP) will be implemented to successfully manage the overall IM project. The PMP will be used by the TOM to:

- facilitate communication among the IM project team and subcontractors, SOUTHNAVFACENGCOM, and Base personnel;
- control project cost and schedule;
- staff the project with qualified personnel experienced in environmental investigation, engineering studies, and interim measure activities;
- manage subcontractor work performance and costs; and
- ensure the performance of critical activities and the successful completion of the scope of work.

8.2 PROJECT SEQUENCE. The IM activities follow an interrelated task sequence, discussed in Subsection 2.4, Project Sequence. Milestones are assigned to accurately gauge the progress of the work. Based on the milestones completed, the measure of "physical percent complete" will be applied to the status of each activity during each quarterly reporting period. The activities are discussed below.

8.2.1 Review and Approval of IM Work Plan The draft final IM Work Plan will be delivered to the regulatory agencies, USEPA Region IV, and Georgia EPD for staff review of the Work Plan. Regulatory review comments on the draft final IM Work Plan will be addressed in the final IM Work Plan. This revised document will be submitted to the regulatory agencies for final review. The IM Work Plan becomes final after these comments are addressed.

8.2.2 IM Field Activities Initial activities will involve planning and preparation, field equipment organization, and mobilization. Mobilization will involve on-site preparation and layout of all the IM well locations at Site 11. Utility and access clearances will be the responsibility of the RE. Subcontractor mobilization of drilling rigs, support equipment, materials, and supplies will be performed.

The IM activities will include installation of recovery wells and observation wells, treatment and conveyance system setup, initial operations, sample and data collection, management, field analysis of samples, and shipment of selected samples from NSB Kings Bay to an off-site analytical laboratory.

8.2.3 Laboratory Analysis Analysis of the environmental samples and QA/QC samples for TCL/TAL constituents, geotechnical, and ETPs will begin as samples are received from the field.

8.2.4 Data Evaluation Data validation of the samples will begin as analytical results are received from the laboratory. Interpretation of the geological data, hydraulic data, analytical data, and field observations will be performed, as discussed in Section 6.0, Engineering Evaluation Plan.

8.2.5 IM Phase I Evaluation and Recommendations The draft IM Phase I Evaluation and Recommendations Report (IM Report) will provide a basis for design of the full-scale IM system. The draft IM Report will be reviewed by Georgia EPD and USEPA Region IV. The Georgia EPD and USEPA will provide NSB Kings Bay with comments to the draft IM Report.

The draft final IM Report will be generated after receipt of regulator comments to the draft IM Report. This version will address comments and incorporate revisions on the basis of Georgia EPD and USEPA Region IV review of the draft IM Report. This draft final will be submitted to both Georgia EPD and USEPA Region IV. The document will be reissued as final. If comments are received within 30 days of submittal, they will be addressed accordingly in the final IM Report.

8.3 PROJECT ORGANIZATION.

8.3.1 Management Authority The overall strategy for executing this IM incorporates a team approach among the SOUTHNAVFACENGCOM, NSB Kings Bay, and the Contractors project personnel to accomplish the goals of the IM at Site 11. Although the project is under the overall management of NSB Kings Bay, SOUTHNAVFACENGCOM is responsible to NSB, and the Contractor is responsible to SOUTHNAVFACENGCOM. Communications among the various team entities will be accomplished through the TOM, RE, and IM Technical Lead.

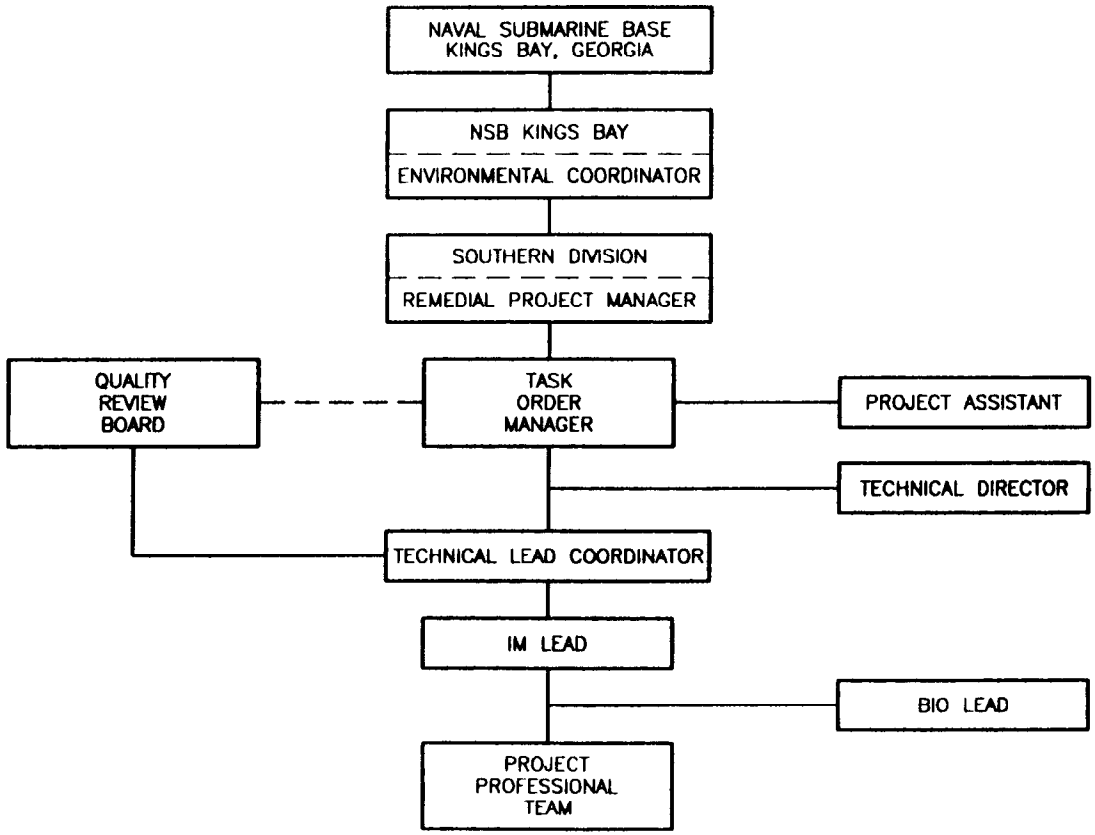
The IM project team has overall responsibility for executing the PMP such that the IM Phase I activities and the IM report meet the project objectives. The Contractor is responsible for pilot-scale system installation and operation, data collection, validation, and interpretation, as well as the preparation of the IM Report. IM project team members with management authority for execution of these responsibilities include the TOM, Quality Review Board (QRB) members, IM Technical Lead, the RE, and the Site Safety Coordinator (SSC). An organization chart presenting the interaction between these positions is shown in Figure 8-1. Specific responsibilities assigned to these team members are described below.

8.3.1.1 Program Manager (PM) All work is ultimately coordinated by the PM who has final responsibility and authority for work performed under Navy CLEAN. As a senior level manager who established policies and procedures for project execution, the PM oversees TOMs on this and several other CLEAN projects. The PM ensures compliance with contractual issues, client directives, and acceptable quality for project deliverables.

Contractors corporate management delegates to the PM full authority to mobilize the resources necessary to complete assigned task orders. As the direct contact between SOUTHNAVFACENGCOM and other program and project staff, the PM is responsible for negotiating and communicating contractual obligations including program objectives, schedules, budgets, and deliverables.

8.3.1.2 Task Order Manager The TOM is primarily responsible for maintaining contact with SOUTHNAVFACENGCOM and NSB Kings Bay, addressing their concerns, processing the billings, and monitoring and reporting of the total project performance. The TOM is also available for review and advice on the project deliverables, budget control, project staffing, and adherence to the Statement of Work.

PROJECT STRUCTURE



DWN: DMF	PROJECT NO.: 08503.02	TITLE: PROJECT STRUCTURE	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 8-1		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3-10-94			

The TOM communicates with the client and arranges for the resolution of review comments and their incorporation into appropriate documents. He will oversee corrective actions and, as appropriate, initiate communication with other designated parties regarding project progress.

The TOM has ultimate responsibility for producing deliverables that are satisfactory to the client and cost-effective. To accomplish this, the TOM assists the QRB chairman in developing an internal project review schedule, provides written instructions and frequent guidance to the project team, and monitors budgets and schedules.

8.3.1.3 **Technical Lead Coordinator (TLC)** The TLC is responsible for the overall technical activities at NSB Kings Bay and the successful performance of each assignment. In addition to responsibility for overall technical quality, the TLC monitors all task order activities to ensure consistency among the task orders.

8.3.1.4 **IM Technical Lead** The IM Technical Lead is responsible for the successful performance of the IM activities. In addition to responsibility for overall technical quality, the IM Technical Lead monitors the IM activities to ensure compliance with project objectives and scope.

8.3.1.5 **Quality Review Board Chairman** As a senior consultant, the QRB Chairman is available throughout the project for technical guidance, advice, and review. He is available to provide a thorough review of final work products; he assists the PM, TOM, and Technical Lead on technical and quality issues.

8.3.1.6 **Resident Engineer** The RE is responsible for management and coordination of the on-site operations conducted by the IM project team, other task order project teams, and all subcontractors. The RE reports to the TOM and provides an on-site communication link with NSB Kings Bay personnel. The RE is responsible for subcontractor oversight, verifies material quantities and certifies work performed. The RE will also conduct daily kick-off meetings which will include an overview of the day's activities and any health and safety issues.

8.3.1.7 **Site Safety Coordinator** The SSC has the ultimate responsibility to stop any operation that threatens the health or safety of the IM field team or the surrounding population. The SSC is responsible for ensuring that all team members adhere to the site safety requirements. He/she also assists in conducting site briefings and performs the final safety check.

8.3.2 Staffing/Personnel The TOM is responsible for selecting, coordinating, and scheduling staff and subcontractors. He/she will provide Contractor's staff with relevant experience from Contractor offices near the base (whenever practical). Personnel will be selected on the basis of their prior NSB Kings Bay experience, technical experience, and their ability to commit to the project. He/she will select subcontractors on the basis of their overall experience and experience in similar hydrogeologic settings.

8.3.3 Qualifications

8.3.3.1 **Contractor's Staff** The IM project team will be assembled to provide SOUTHNAVFACENGCOM and NSB Kings Bay with a group of qualified hydrogeologists, environmental scientists, and engineers capable of providing a multidisciplinary approach to the IM activities at Site 11. The team will be selected on the basis

of their previous experience at NSB Kings Bay, their knowledge of engineering studies and IM field efforts, IM reports, and their environmental QA/QC experience.

8.3.3.2 **Subcontractors** Subcontractor services will be necessary for site preparation activities, drilling and well installation, conveyance system installation, and treatment system installation. Appropriate project personnel will provide management and field oversight of the Subcontractors during the IM activities.

8.3.3.3 **Critical Activities** Critical activities are those required to successfully gather the necessary information to meet the DQOs of this project. Critical activities for the IM include the implementation of field activities; proper QA/QC; the appropriate validation, interpretation, and use of acquired data; and report generation. This project will be managed to ensure that these critical activities are successfully performed.

9.0 HEALTH AND SAFETY PLAN

This Health and Safety Plan (HASP) outlines health and safety policies specific to Phase I and II activities of the IM. A comprehensive HASP will be provided with the RFI Work Plan which outlines project personnel and health and safety policies, provides a brief site characterization, outlines potential hazards, protective measures, monitoring for the site, and summarizes decontamination procedures. In addition, the comprehensive HASP includes material safety data sheets for chemicals that may be encountered and provides emergency information, such as a map to the hospital and emergency telephone numbers.

9.1 INTERIM MEASURES INSTALLATION ACTIVITIES. The pilot-scale GWE system will include as many as six recovery wells installed at four to six locations in areas found to contain the highest concentrations of VOC contaminants (see Figure 1-5). Submersible pumps will be installed in the wells and groundwater will be discharged to the pilot-scale treatment system. This treatment system includes collection of extracted groundwater, possible pretreatment for removal of heavy metals, iron and carbonate, air stripping, and *ex situ* biological treatment for removal of VOCs. If pretreatment is necessary, it will include an 1,800-gallon equalization tank for collection of groundwater from recovery wells. This tank also may be used for monitoring or chemical addition, if needed. The pretreatment process(es) may include aeration, chemical addition, precipitation, sedimentation, filtration, and dewatering. Work conducted during IM activities will be in the areas shown on Figures 9-1 and 9-2.

9.1.1 Hazardous Substances The contaminants of concern that may be present are listed in Table 2-1.

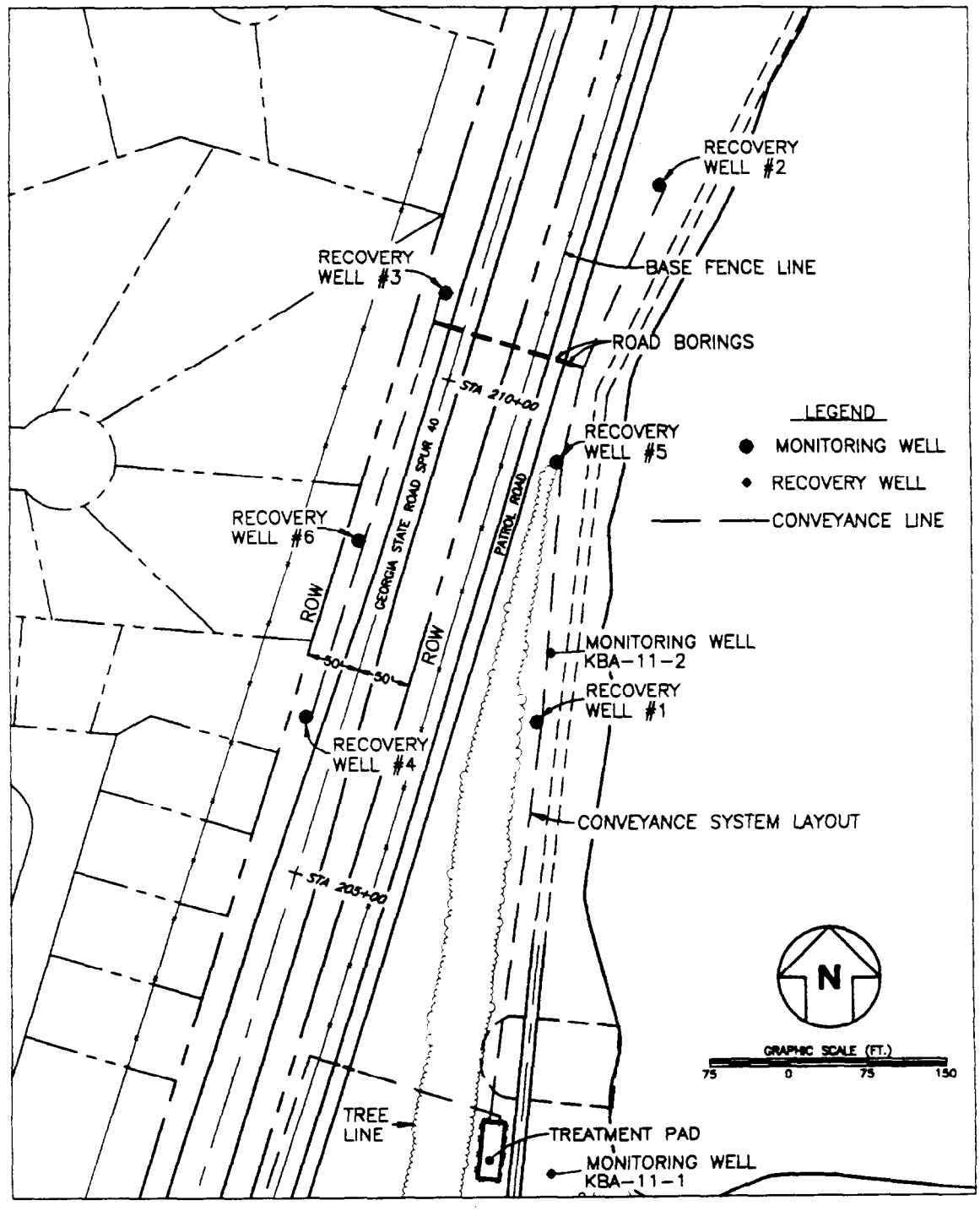
9.1.2 Site Risks The following are the health hazards and safety hazards that are expected to be encountered.

9.1.2.1 **Health Hazards**. Health hazards consist primarily of potential exposure to contaminated soils and groundwater.

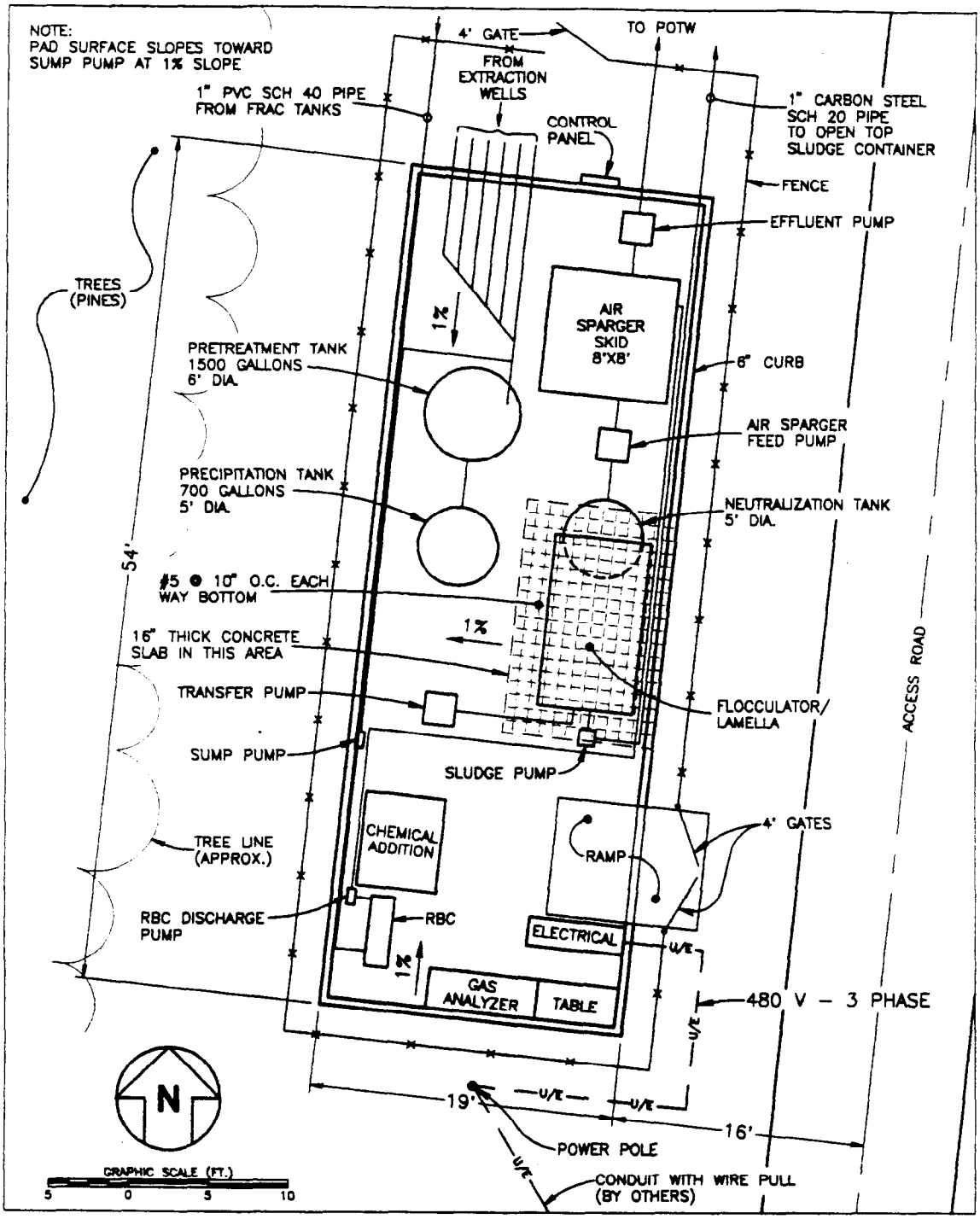
9.1.2.2 **Safety Hazards** Safety hazards include those hazards that personnel may be exposed to that are unrelated to hazardous wastes. These include hazards such as heat stress, operation and presence around heavy equipment, lifting of objects, vehicle traffic, slips, trips, and falls, as well as snake, tick, and spider bites. Extreme caution should be exhibited by all personnel while conducting work around drill rigs, backhoes, and other heavy equipment. During hot days, personnel should take time to drink fluids and cool off to avoid overheating and symptoms related to heat stress.

Lifting of heavy objects should be done with caution. Personnel should assist one another with moving heavy objects or use the appropriate equipment to accomplish these tasks. Take care when walking over the landfill or uneven terrain, especially where vegetation may cover the hazard. During all site activities, personnel should be aware of the possibility of an encounter with poisonous snakes, particularly rattlesnakes, and black widow spiders.

9.1.2.3 **Conclusions and Risk Assessment** Based on all available information (nature of the work, potential on-site chemicals and their properties, exposure limits, etc.), hazards associated with conducting the described field work are considered to be low, assuming appropriate health and safety practices are maintained.



DWN: DMF	PROJECT NO.: 08503.02	TITLE: RECOVERY WELL LOCATIONS CONVEYANCE LAYOUT AND ROAD BORING ALONG SPUR 40	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 9-1		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3-10-94			



DWN: DMF	PROJECT NO.: 08503.02	TITLE: TREATMENT PAD	IM WORK PLAN
CHKD: KDS	FIGURE NO.: 9-2		NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 3-10-94			

9.1.3 Protective Measures The following are the protective measures that will be used at the site.

9.1.3.1 Engineering Controls None anticipated.

9.1.3.2 Levels of Protection As only very low level contamination was found during prior sampling, Level D protective equipment will be used initially. Level D protection should only be used when the atmosphere contains no known hazard, all potential airborne contaminants can be monitored for, and work functions preclude splash, immersion, or the potential for unexpected inhalation or contact with hazardous levels of any chemical.

Snake guards may be required for any activities in densely vegetated areas.

9.1.4 Monitoring It is intended that real time monitoring instrumentation will be used to monitor the work environment to ensure the appropriate level of protection for the site team.

9.1.4.1 Air Sampling To the extent feasible, the presence of airborne contaminants will be evaluated through the use of direct reading instrumentation. Air monitoring frequency will be performed as needed or, at a minimum, on an hourly basis during drilling activities; the frequency will be a minimum of twice a day during other installation activities. Information gathered will be utilized to ensure the adequacy of the levels of protection being used at the site, and may be used as the basis for upgrading or downgrading the levels of protection in conformance with action levels provided in this Health and Safety Plan and at the direction of the site SSC.

The following sampling equipment will be used at the Site. Refer to Chapter 7.0 of the CLEAN Health and Safety Plan for information on the calibration and maintenance of the equipment.

1. PORTA-FID Organic Vapor Analyzer (OVA),
2. Draeger pump with Vinyl Chloride 0.5/a and Benzene 0.5/c tubes, and
3. LEL/Oxygen meter.

If the OVA detects a steady measurable quantity of organic vapors greater than background at the source (e.g., borehole, drilling mud or cuttings, soil samples or groundwater), upgrade to Modified Level D. If the OVA reads steadily above background in the breathing zone, begin monitoring with vinyl chloride and benzene draeger tubes. If vinyl chloride levels reach or exceed 0.5 parts per million (ppm) in the breathing zone, upgrade to Level B. If vinyl chloride levels are below 0.5 ppm, but benzene levels are greater than 0.5 ppm, upgrade to Level C. Otherwise continue working at modified Level D until OVA reads 5 ppm above background in the breathing zone, at which time upgrade to Level C. Upgrade to Level B if OVA readings reach or exceed 50 ppm.

The above action limits are summarized below:

Level B Personnel Protective Equipment (PPE) required if:

Vinyl chloride Draeger Tube $\geq$ 0.5 ppm; or
OVA $\geq$ 50 ppm.

Level C PPE required if:

Vinyl chloride Draeger Tube < 0.5 ppm;
Benzene Draeger Tube ≥ 0.5 ppm; and
OVA ≥ 5 ppm but < 50 ppm.

Modified Level D PPE required if:

Vinyl chloride Draeger Tube < 0.5 ppm;
Benzene Draeger Tube < 0.5 ppm; and
OVA > background at the source but < 5 ppm.

Level D PPE acceptable if:

OVA levels at the source are at background.

LEL/Oxygen Meter:

Oxygen ≥19.5% - see above;
Oxygen <19.5% - backoff as Level B PPE required;
LEL >10% at source - continue only using proper precautions; and
LEL >20% at source - backoff.

9.1.4.2 **Personal Monitoring** All contractor personnel on-site will be enrolled in the Contractor's medical surveillance program. In addition, all Contractor personnel on-site will wear a thermoluminescent dosimetry body badge to measure possible exposure to radiation.

9.2 INTERIM MEASURES OPERATIONS. Aquifer characterization tests are being conducted as part of the IM. These tests include a 25-hour pumping test on one of the recovery wells, step-drawdown tests at each recovery well installed and long-term (seven to 10 days) pumping tests at selected recovery wells. Other long-term tests will be performed by pumping simultaneously from two recovery wells and then from all six recovery wells to delineate the pilot-scale GWE system's capture zone.

9.2.1 Hazardous Substances The contaminants of concern that may be present are listed in Table 2-1.

9.2.2 Site Risks The following are the health hazards and safety hazards that are expected to be encountered.

9.2.2.1 **Health Hazards** Health hazards consist primarily of potential exposure to contaminated groundwater and pilot-scale treatment system waste stream.

9.2.2.2 **Safety Hazards** Safety hazards include those hazards that personnel may be exposed to that are unrelated to hazardous wastes. These include hazards such as heat stress, operation and presence around pilot-scale treatment system equipment, lifting of objects, vehicle traffic, slips, trips, and falls, as well as snake, tick, and spider bites. Extreme caution should be exhibited by all personnel while conducting work around the pilot-scale treatment system. During hot days, personnel should take time to drink fluids and cool off to avoid overheating and symptoms related to heat stress.

Lifting of heavy objects should be done with caution. Personnel should assist one another with moving heavy objects or use the appropriate equipment to accomplish these tasks. Take care when walking over the landfill or uneven terrain, especially where vegetation may cover the hazard. During all site activities, personnel should be aware of the possibility of an encounter with poisonous snakes, particularly rattlesnakes, and black widow spiders.

9.2.2.3 **Conclusions and Risk Assessment** Based on all available information (nature of the work, potential on-site chemicals and their properties, exposure limits, etc.), hazards associated with conducting the described field work are considered to be low, assuming appropriate health and safety practices are maintained.

9.2.3 Protective Measures The following are the protective measures that will be used at the site.

9.2.3.1 **Engineering Controls** None anticipated.

9.2.3.2 **Levels of Protection** As only very low level contamination was found during prior sampling, Level D protective equipment will be used initially. Level D protection should only be used when the atmosphere contains no known hazard, all potential airborne contaminants can be monitored for, and work functions preclude splash, immersion, or the potential for unexpected inhalation or contact with hazardous levels of any chemical.

Snake guards may be required for any activities in densely vegetated areas.

9.2.4 Monitoring It is intended that real time monitoring instrumentation will be used to monitor the work environment to ensure the appropriate level of protection for the site team.

9.2.4.1 **Air Sampling** To the extent feasible, the presence of airborne contaminants will be evaluated through the use of direct reading instrumentation. Air monitoring frequency will be a minimum of twice a day. Information gathered will be utilized to ensure the adequacy of the levels of protection being used at the site, and may be used as the basis for upgrading or downgrading the levels of protection in conformance with action levels provided in this HASP and at the direction of the site Health and Safety Office (HSO).

The following sampling equipment will be used at the Site. Refer to Chapter 7.0 of the CLEAN Health and Safety Plan for information on the calibration and maintenance of the equipment.

1. PORTA-FID OVA,
2. Draeger pump with Vinyl Chloride 0.5/a and Benzene 0.5/c tubes, and
3. LEL/Oxygen meter.

If the OVA detects a steady measurable quantity of organic vapors greater than background at the source (e.g., well head, sample tap, tank(s), pilot-scale treatment system equipment), upgrade to Modified Level D. If OVA reads steadily above background in the breathing zone, begin monitoring with vinyl chloride and benzene draeger tubes. If vinyl chloride levels reach or exceed 0.5 ppm in the breathing zone, upgrade to Level B. If vinyl chloride levels are below 0.5 ppm, but benzene levels are greater than 0.5 ppm, upgrade to Level C. Otherwise continue working at modified Level D until OVA reads 5 ppm above background in

the breathing zone at which time upgrade to Level C. Upgrade to Level B if OVA readings reach or exceed 50 ppm.

The above action limits are summarized below:

Level B PPE required if:

Vinyl chloride Draeger Tube ≥ 0.5 ppm; or
OVA ≥ 50 ppm.

Level C PPE required if:

Vinyl chloride Draeger Tube < 0.5 ppm;
Benzene Draeger Tube ≥ 0.5 ppm; and
OVA ≥ 5 ppm but < 50 ppm.

Modified Level D PPE required if:

Vinyl chloride Draeger Tube < 0.5 ppm;
Benzene Draeger Tube < 0.5 ppm; and
OVA > background at the source but < 5 ppm.

Level D PPE acceptable if:

OVA levels at the source are at background.

LEL/Oxygen Meter:

Oxygen ≥19.5% - see above;
Oxygen <19.5% - backoff as Level B PPE required;
LEL >10% at source - continue only using proper precautions; and
LEL >20% at source - backoff.

9.2.4.2 **Personal Monitoring** All contractor personnel on-site will be enrolled in the Contractor's medical surveillance program. In addition, all contractor personnel on-site will wear a thermoluminescent dosimetry body badge to measure possible exposure to radiation.

9.3 HEALTH AND SAFETY PLAN MANAGEMENT. The RE is the General Site Supervisor and has vested authority from the TOM to carry out day-to-day site operations. The RE will be responsible for the initial kick-off Health and Safety Meeting, as well as daily health and safety updates during the morning kick-off meetings.

9.4 HAZARDOUS SUBSTANCE STORAGE. Based on the potential need for pretreatment, three groups of treatment chemicals may be required: acids, caustics, and oxidizers. These will all be stored in 55-gallon barrels and, due to their reactive nature when combined, each group will be stored on separate pallets at an appropriate distance (a minimum of 10 feet) apart.

Compressed gas cylinders will be staged up-right and secured from falling by chaining or tieing each of them to a permanent fixture.

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APPENDIX A

AIR EMISSIONS

LOWEST ACHIEVABLE EMISSION RATE

Target Range for Organic Vapor Air Emissions
Lowest Achievable Emission Rate (LAER)

Description of Air Sparging Pilot Study

Groundwater will be extracted from the area beneath the Old Camden County Landfill to prevent further migration of contaminants in the aquifer. The groundwater is known to contain volatile organic compounds (VOCs) as listed in Table 1. The VOCs will be removed from the groundwater utilizing an air stripping technology before discharge of the water to a treatment works.

The Air Sparger is a diffused aeration system where air is released into the water through diffusers that produce coarse bubbles. Mass transfer occurs across the air-water interface of the bubbles. Exhaust air exits the unit and is directed to a series of activated carbon adsorbers before being discharged through a single PVC stack to be released to the atmosphere at a minimum height of 16 feet.

Design air flow through the Air Sparger is 800 cubic feet per minute for an air to water ratio of 100 to 1 at a water feed rate of 60 gallons per minute.

The pilot study will operate up to 24 hours per day, 7 days per week, for a total of 45 days.

Figure 1 shows the approximate location of the Air Sparger, carbon adsorbers and stack.

Air Emissions

Seventeen chemicals have been identified in the groundwater which may be emitted into the air during the air sparging. These chemicals are listed in Table 1. Tables 2 and 3 provide the estimated emission rates for each chemical following vapor phase carbon adsorption (Column 3). Emission rates were calculated using the maximum groundwater concentration detected at any point in the constituent plume (Table 1, Column 1) and modeling for the Air Sparger and carbon adsorbers using the following equations:

$$C_1/C_0 = [1/(1+kt)]^N$$

Where:
C_0 = initial concentration
C_1 = effluent concentration from the Air Sparger
k = Henry's Law Constant
t = residence time
N = number of stages

And: $R/AW \times 1.203$ = vapor effluent in mg/m^3

Where:
R = concentration transferred to the vapor stream in micrograms per liter
AW = air to water ratio of Air Sparger

These equations have been documented to be a conservative calculation based on actual operating data of the Air Sparger unit to be used at the site.

The vapor phase activated carbon has been documented to remove a minimum of 99 percent of each constituent of concern with a retention time of 1.7 to 2 seconds. Four parallel streams of carbon adsorbers will be used to provide a retention time of 1.8 seconds in each adsorber. Two units will be placed in series to provide a polishing stage and a sample point will be placed between the two units to monitor for breakthrough.

The maximum emission rate from the carbon adsorbers was calculated based on a 99 percent removal efficiency.

Ambient Air Quality Impacts

To estimate expected ambient air quality concentrations during the pilot test, air dispersion modeling was conducted. Maximum predicted impacts were then compared with calculated acceptable ambient concentrations to ensure public health would not be threatened during the system operation.

The United States Environmental Protection Agency (USEPA) SCREEN model was used to predict air quality impacts for each chemical of concern. SCREEN uses a number of conservative assumptions and provides conservative estimates of ambient air concentrations. This model is recommended by the USEPA for conducting dispersion modeling for air pathway analyses. Based upon discussions with staff at the Georgia Air Protection Branch, the SCREEN model is the preferred screening model for estimating air quality impacts.

The point source algorithm in SCREEN was used in the analysis. Flat terrain and rural dispersion were assumed. Concentrations were calculated for the full range of meteorological conditions available in the model. Automated receptor distances from one meter to 50 kilometers were selected for a single wind direction. One additional receptor, 200 feet from the stack, was calculated to represent the nearest public property. Because stack gas temperature is expected to be close to ambient temperature, the default ambient temperature assumed by the model, 293 Kelvin, was also used as the stack gas temperature. The stack gas velocity is based on the blower capacity (800 cubic feet per minute) and stack diameter (4 inches). To reduce the number of model runs and for ease of calculating air quality impacts for each of the chemicals, the model was conducted using a unit emission rate of one pound per hour (lb/hr).

The emission rates and modeled maximum ground level concentrations for each chemical of concern are provided in Tables 2 and 3. Table 4 presents the SCREEN model documentation for calculating the maximum ground level concentrations. Stack parameters used as input to the model are shown in Table 5.

Dimensions of the Air Sparger to be installed are approximately 14 feet long by 8 feet wide by 26 inches high. The unit on a skid will be a height of approximately 3 feet. Due to its size and the height of the stack, the Air Sparger is not expected to affect dispersion of air emissions. The tallest nearby structure to the stack is the Equalization Tank (7 feet high with a 6 foot diameter). The stack height of 16 feet follows Good Engineering Practice (GEP) for stack heights, defined

as the height of a nearby structure plus 1.5 times the lesser of the height or width of the nearby structure. Because the stack height is equivalent to the GEP stack height, building downwash is not expected to occur. The Equalization Tank dimensions were input to the model to confirm that emissions will not be subject to downwash effects.

Table 3 represents the maximum one-hour concentrations that will occur during various dispersion situations following vapor treatment. Table 4 represents the maximum concentrations for a 24-hour averaging time. The maximum predicted one-hour concentration for a 1 lb/hr emission rate was 90.37 $\mu g/m^3$ (Table 4, Page 3). The maximum impact for a 1 lb/hr emission rate occurred at 421 meters for F stability and a 1 meter per second wind speed. Using a factor of 0.4 to convert this one-hour impact to a 24-hour concentration, the maximum 24-hour impact for a 1 lb/hr emission rate is 36.15 $\mu g/m^3$. The USEPA recommends this 0.4 factor to be applied to one-hour results from the SCREEN model to estimate 24-hour impacts. The 24-hour concentration was multiplied by the emission rate for each chemical to obtain the maximum ambient air concentrations as presented in the tables.

Modeling of the dispersion following the Air Sparger without vapor treatment was also performed to estimate the confidence of emissions not exceeding Acceptable Ambient Concentrations (defined below). Table 6 represents the maximum one-hour concentrations that will occur during various dispersion situations following the Air Sparger without vapor treatment. Table 7 represents the maximum concentrations for a 24-hour averaging time following the Air Sparger without vapor treatment.

Acceptable Ambient Concentrations

In the telephone conversation with Ms. Gordon, Mr. Ron Methier indicated that no more recent guidance was available than the July 1984 guidance document followed in determining the Acceptable Ambient Concentrations (AAC). The basis for the calculation of the AAC comes from the toxicity data priority schedule provided in Part III, paragraph 1 of the guidance document. The American Conference of Governmental and Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) recommendations were converted to units of mg/m^3 for each constituent of concern. These values are included in the tables. The TLV values were adjusted for operation 24 hours a day, 7 days a week by multiplying by 40 hours per week and dividing by 168 hours per week. This is required by paragraph 2, Part III of the guidance document. The values were then adjusted by a safety factor that accounts for pollutant exposure to members of the public who may be more sensitive to pollutant effects than the average citizen, as required by paragraph 3. Table 1 indicates known carcinogens as category A, and all other pollutants as category B.

As indicated on Tables 2, 3, 6 and 7, the maximum ground level concentration calculated by the SCREEN model are well below the resulting AACs. The analysis reaffirms that air emissions will result in a negligible impact on air quality during the air sparging pilot test.

Proposed Monitoring

Daily stack monitoring for vinyl chloride will be conducted during the pilot study to collect actual air emission data. The modeling shows that a concentration of 37 mg/m^3 of vinyl chloride

at the stack should not exceed a maximum ground level concentration of 0.01004 mg/m^3 (Table 8) for worst case meteorlogical conditions. This is less than the required AAC. ABB-ES proposes to monitor the stack and to initiate corrective action if the stack concentration exceeds 3.7 mg/m^3, providing a minimum safety factor of 10 times the AAC. If a stack concentration of 3.7 mg/m^3 of vinyl chloride is exceeded, corrective measures to reduce emissions will be initiated. Corrective measures will be defined in an Operations and Maintenance Plan. The on-site laboratory that will be used initially for this stack monitoring will use a maximum detection limit of 0.1 mg/m^3. When analytical functions are transferred to an off-site laboratory, this maximum detection limit will continue to be used.

REQUEST FOR DISCHARGE AIR PERMITTING

Georgia Department of Natural Resources
Environmental Protection Division, Air Protection Branch
4244 International Parkway, Suite 120, Atlanta, Georgia 30354
404/363-7000
Joe D. Tanner, Commissioner
Harold F. Reheis, Director

January 19, 1994

Commanding Officer
Naval Submarine Base
1063 USS Tennessee Avenue
Kings Bay, Georgia 31547-2606

RE: Air Sparging Pilot Study
Dated January 3, 1994

Commanding Officer:

The Air Protection Branch has reviewed the letter dated January 3, 1994 regarding the Air Sparging Pilot Study at the Naval Submarine Base, Kings Bay, Georgia.

We have determined, based on available information, that a permit will not be required at this time. On site soil decontamination can be exempted from permitting per Georgia Rule 391-3-1-.03(6)(g)2.

The letter will be placed on file for reference. Exemption from permitting does not relieve the operator from responsibility for compliance with all applicable emission regulations. Any future projects or modifications will require review and possible permitting through this office.

Thank you for your cooperation. If you have any questions, you may contact me at (404)363-7110.

Sincerely,

James Capp

James A. Capp
Environmental Engineer
Stationary Source Compliance Program

5090
Ser N56/0022
JAN 03 1994

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Georgia Department of Natural Resources
Air Protection Branch
Attn: Gene Drew
4244 International Parkway, Suite 120
Atlanta, GA 30354

Dear Mr. Drew:

This is to provide information regarding an air sparging pilot study to be performed at SUBASE Kings Bay by ABB Environmental Services (ABB-ES) under contract with the Navy. This is to conform to the requirements of Georgia Air Quality Rules.

The pilot study, part of the Interim Measure to remediate contamination at the Old Camden County Landfill site, is fully described in the Air Sparging Pilot Study, enclosure (1). This document also describes the contacts between ABB-ES and the Air Protection Branch regarding this study.

As enclosure (1) confirms that there will be attainment of the Lowest Achievable Emission Rate and that air emissions will result in a negligible impact on air quality during the air sparging pilot test, we believe that an air permit will probably not be necessary for the pilot study.

If you have questions regarding this letter or the enclosed document, please contact Mr. John Garner at 912-673-8845. Please address all correspondence to "Commanding Officer, Naval

Submarine Base, 1063 USS Tennessee Avenue, Kings Bay, Georgia, 31547-2606."

Sincerely,

L.P. SCULLION
CAPTAIN, CEC, USN
PUBLIC WORKS OFFICER
BY DIRECTION OF THE
COMMANDING OFFICER

Encl:
(1) Air Sparging Pilot Study

Copy:
SOUTHNAVFACENGCOM (Dave Dregger)
ABB-ES (Frank Cater)
GA EPD (Bruce Khaleghi)

Subject: **Air Sparging Pilot Study**
Naval Submarine Base, Kings Bay, Georgia

ABB Environmental Services (ABB-ES) is proposing to conduct an air sparging pilot study as part of an Interim Measure at the Naval Submarine Base (NSB) in Kings Bay, Georgia. The purpose of the Interim Measure is to prevent further migration of the contaminated groundwater plume. This letter contains information on expected air emissions and air quality impacts from the air sparging operation. Ms. Norma Gordon, air quality consultant to ABB-ES, first approached the Air Protection Branch of the Georgia Department of Natural Resources regarding the groundwater remediation through telephone calls with Mr. Kurt Churchill and Mr. Tony Curter in January of this year. More recently, on July 15, she discussed this project briefly with Mr. Ron Methier, who recommended that information regarding the pilot study be sent to you.

Additionally, at a project information meeting with Bruce Khaleghi, Unit Coordinator of the Georgia Department of Natural Resources Environmental Protection Division (EPD) Hazardous Waste Management Branch, on 12 August 1993, ABB-ES was informed that treatment of the vapors from the Air Sparger will be required. A review comment of the Interim Measure Work Plan requires attainment of the Lowest Achievable Emission Rate. Based upon these conversations, it is our understanding that an air permit will likely be unnecessary for the pilot study at the NSB. We have attempted to supply all the information you need to evaluate the air quality aspects of this project.

Description of Air Sparging Pilot Study

Groundwater will be extracted from the area beneath the Old Camden County Landfill to prevent further migration of contaminants in the aquifer. The groundwater is known to contain volatile organic compounds (VOCs) as listed in Table 1. The VOCs will be removed from the groundwater utilizing an air stripping technology before discharge of the water to a treatment works.

ENCL(1)

The Air Sparger is a diffused aeration system where air is released into the water through diffusers that produce coarse bubbles. Mass transfer occurs across the air-water interface of the bubbles. Exhaust air exits the unit and is directed to a series of activated carbon adsorbers before being discharged through a single PVC stack to be released to the atmosphere at a minimum height of 16 feet.

Design air flow through the Air Sparger is 800 cubic feet per minute for an air to water ratio of 100 to 1 at a water feed rate of 60 gallons per minute.

The pilot study will operate up to 24 hours per day, 7 days per week, for a total of 45 days.

Figure 1 shows the approximate location of the Air Sparger, carbon adsorbers and stack.

Air Emissions

Seventeen chemicals have been identified in the groundwater which may be emitted into the air during the air sparging. These chemicals are listed in Table 1. Tables 2 and 3 provide the estimated emission rates for each chemical following vapor phase carbon adsorption (Column 3). Emission rates were calculated using the maximum groundwater concentration detected at any point in the constituent plume (Table 1, Column 1) and modeling for the Air Sparger and carbon adsorbers using the following equations:

$$C_1/C_0 = [1/(1+kt)]^N$$

Where:
- C_0 = initial concentration
- C_1 = effluent concentration from the Air Sparger
- k = Henry's Law Constant
- t = residence time
- N = number of stages

And: $R/AW \times 1.203$ = vapor effluent in mg/m^3

Where:
- R = concentration transferred to the vapor stream in micrograms per liter
- AW = air to water ratio of Air Sparger

These equations have been documented to be a conservative calculation based on actual operating data of the Air Sparger unit to be used at the site.

The vapor phase activated carbon has been documented to remove a minimum of 99 percent of each constituent of concern with a retention time of 1.7 to 2 seconds. Four parallel streams of carbon adsorbers will be used to provide a retention time of 1.8 seconds in each adsorber. Two

units will be placed in series to provide a polishing stage and a sample point will be placed between the two units to monitor for breakthrough.

The maximum emission rate from the carbon adsorbers was calculated based on a 99 percent removal efficiency.

Ambient Air Quality Impacts

To estimate expected ambient air quality concentrations during the pilot test, air dispersion modeling was conducted. Maximum predicted impacts were then compared with calculated acceptable ambient concentrations to ensure public health would not be threatened during the system operation.

The United States Environmental Protection Agency (USEPA) SCREEN model was used to predict air quality impacts for each chemical of concern. SCREEN uses a number of conservative assumptions and provides conservative estimates of ambient air concentrations. This model is recommended by the USEPA for conducting dispersion modeling for air pathway analyses. Based upon discussions with staff at the Georgia Air Protection Branch, the SCREEN model is the preferred screening model for estimating air quality impacts.

The point source algorithm in SCREEN was used in the analysis. Flat terrain and rural dispersion were assumed. Concentrations were calculated for the full range of meteorological conditions available in the model. Automated receptor distances from one meter to 50 kilometers were selected for a single wind direction. One additional receptor, 200 feet from the stack, was calculated to represent the nearest public property. Because stack gas temperature is expected to be close to ambient temperature, the default ambient temperature assumed by the model, 293 Kelvin, was also used as the stack gas temperature. The stack gas velocity is based on the blower capacity (800 cubic feet per minute) and stack diameter (4 inches). To reduce the number of model runs and for ease of calculating air quality impacts for each of the chemicals, the model was conducted using a unit emission rate of one pound per hour (lb/hr).

The emission rates and modeled maximum ground level concentrations for each chemical of concern are provided in Tables 2 and 3. Table 4 presents the SCREEN model documentation for calculating the maximum ground level concentrations. Stack parameters used as input to the model are shown in Table 5.

Dimensions of the Air Sparger to be installed are approximately 14 feet long by 8 feet wide by 26 inches high. The unit on a skid will be a height of approximately 3 feet. Due to its size and the height of the stack, the Air Sparger is not expected to affect dispersion of air emissions. The tallest nearby structure to the stack is the Equalization Tank (7 feet high with a 6 foot diameter). The stack height of 16 feet follows Good Engineering Practice (GEP) for stack heights, defined as the height of a nearby structure plus 1.5 times the lesser of the height or width of the nearby

structure. Because the stack height is equivalent to the GEP stack height, building downwash is not expected to occur. The Equalization Tank dimensions were input to the model to confirm that emissions will not be subject to downwash effects.

Table 3 represents the maximum one-hour concentrations that will occur during various dispersion situations following vapor treatment. Table 4 represents the maximum concentrations for a 24-hour averaging time. The maximum predicted one-hour concentration for a 1 lb/hr emission rate was 90.37 $\mu g/m^3$ (Table 4). The maximum impact for a 1 lb/hr emission rate occurred at 421 meters for F stability and a 1 meter per second wind speed. Using a factor of 0.4 to convert this one-hour impact to a 24-hour concentration, the maximum 24-hour impact for a 1 lb/hr emission rate is 36.15 $\mu g/m^3$. The USEPA recommends this 0.4 factor to be applied to one-hour results from the SCREEN model to estimate 24-hour impacts. The 24-hour concentration was multiplied by the emission rate for each chemical to obtain the maximum ambient air concentrations as presented in the tables.

Modeling of the dispersion following the Air Sparger without vapor treatment was also performed to estimate the confidence of emissions not exceeding Acceptable Ambient Concentrations (defined below). Table 6 represents the maximum one-hour concentrations that will occur during various dispersion situations following the Air Sparger without vapor treatment. Table 7 represents the maximum concentrations for a 24-hour averaging time following the Air Sparger without vapor treatment.

Acceptable Ambient Concentrations

In the telephone conversation with Ms. Gordon, Mr. Ron Methier indicated that no more recent guidance was available than the July 1984 guidance document followed in determining the Acceptable Ambient Concentrations (AAC). The basis for the calculation of the AAC comes from the toxicity data priority schedule provided in Part III, paragraph 1 of the guidance document. The American Conference of Governmental and Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) recommendations were converted to units of mg/m^3 for each constituent of concern. These values are included in the tables. The TLV values were adjusted for operation 24 hours a day, 7 days a week by multiplying by 40 hours per week and dividing by 168 hours per week. This is required by paragraph 2, Part III of the guidance document. The values were then adjusted by a safety factor that accounts for pollutant exposure to members of the public who may be more sensitive to pollutant effects than the average citizen, as required by paragraph 3. Table 1 indicates known carcinogens as category A, and all other pollutants as category B.

As indicated on Tables 2, 3, 6 and 7, the maximum ground level concentration calculated by the SCREEN model are well below the resulting AACs. The analysis reaffirms that air emissions will result in a negligible impact on air quality during the air sparging pilot test.

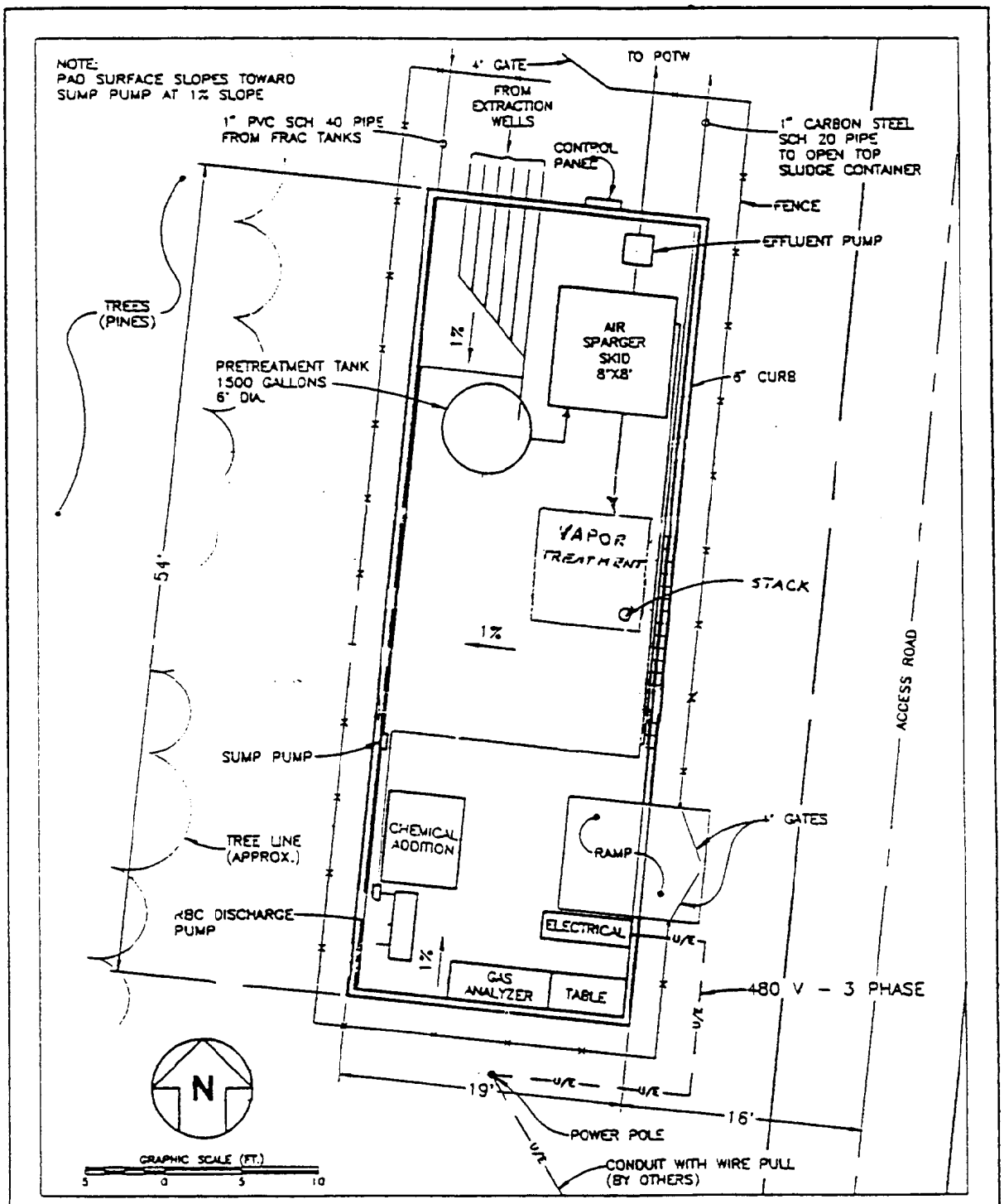
Proposed Monitoring

Daily stack monitoring for vinyl chloride will be conducted during the pilot study to collect actual air emission data. The modeling shows that a concentration of 37 mg/m^3 of vinyl chloride at the stack should not exceed a maximum ground level concentration of 0.01004 mg/m^3 (Table 8) for worst case meteorological conditions. This is less than the required AAC. ABB-ES proposes to monitor the stack and to initiate corrective action if the stack concentration exceeds 3.7 ~~37~~ mg/m^3, providing a minimum safety factor of 10 times the AAC. If a stack concentration of 3.7 ~~37~~ mg/m^3 of vinyl chloride is exceeded, corrective measures to reduce emissions will be initiated. Corrective measures will be defined in an Operations and Maintenance Plan. The on-site laboratory that will be used initially for this stack monitoring will use a maximum detection limit of 0.1 mg/m^3. When analytical functions are transferred to an off-site laboratory, this maximum detection limit will continue to be used.

ATTACHMENTS

FIGURE 1 and

TABLES 1 - 8



DWN:	DES:	PROJECT NO.:	TITLE:
DMF	HF	08503.02	TREATMENT PAD
CHKD: KDS	APPD.: GMB	FIGURE NO.: 1	
DATE 9-14-93	REV.:		

TABLE 1

SCREEN MODEL EVALUATION
GROUNDWATER INFLUENT CONCENTRATIONS
INTERIM MEASURE DESIGN CALCULATIONS
NSB KINGS BAY, GEORGIA

ABB-ES Project No.:	8503-01
Designed By:	V. RULE
Date:	NOVEMBER 24, 1993
Checked By:	S. Pierett
Date:	December 8, 1993

Source Identification: Site 11 Landfill	Max. Influent Flow Rate (GPM) :	60
Source Location: NSB Kingsbay, GA	Max. Air Flow Rate (CFM) :	800
	Emission Pt. Height (St. Height) {ft} :	16
	Max. Hrs. of Operation (hrs/wk) :	168

#	Contaminant Name	Max Conc in Ground Water (ppb)	TLV (Note 2) (mg/m3)	Category (Note 3) (A or B)	AAC (Note 4) (mg/m3)
1	Benzene	5	3	A	0.00238
2	2-Butanone (MEK)	580	590	A	0.46825
3	Chlorobenzene	10	350	A	0.27778
4	1,4-Dichlorobenzene	12	450	B	1.07143
5	1,1-Dichloroethane	24	810	A	0.64286
6	1,2-Dichloroethane	9	40	A	0.03175
7	cis-1,2-Dichloroethene	3600	790	A	0.62698
8	trans-1,2-Dichloroethene	23	790	A	0.62698
9	1,2-Dichloropropane	6	345	A	0.27381
10	Ethylbenzene	41	435	A	0.34524
11	2-Hexanone (MBK)	70	20	A	0.01587
12	MIBK	110	205	A	0.16270
13	Tetrachloroethene	3	335	A	0.26587
14	Toluene	840	375	B	0.89286
15	Trichloroethene	45	270	A	0.21429
16	Total Xylenes	120	435	A	0.34524
17	Vinyl chloride	310	13	A	0.01032

NOTES:
1) BASED ON 1 LB/HR MODEL
2) THRESHOLD LIMIT VALUE
3) CATEGORY A - CARCINOGEN
   CATEGORY B - OTHER
4) ACCEPTABLE AMBIENT CRITERIA

TABLE 2

SCREEN MODEL EVALUATION
ONE HOUR POINT SOURCE CONCENTRATION VALUES
INTERIM MEASURE DESIGN CALCULATIONS
NSB KINGS BAY, GEORGIA

ABB-ES Project No.: 8503-01
Designed By: V. RULE
Date: NOVEMBER 24, 1993
Checked By: S. Pierett
Date: December 8, 1993

Source Identification: Site 11 Landfill
Source Location: NSB Kingsbay, GA

Max. Influent Flow Rate (GPM): 60
Max. Air Flow Rate (CFM): 800
Emission Pt. Height (St. Height){ft} : 16
Max. Hrs. of Operation (hrs/wk) : 168

#	Contaminant Name	Max Conc in Ground Water (ppb)	Max. Vapor Emission From Air Sparger (mg/m3)	Max. Vapor Emission From Carbon (mg/m3)	Maximum Ground Level Concentration (mg/m3)	AAC (Note 2) (mg/m3)
1	Benzene	5	0.12030	0.00120	0.00000	0.00238
2	2-Butanone (MEK)	580	0.93700	0.00937	0.00000	0.46825
3	Chlorobenzene	10	0.24030	0.00240	0.00000	0.27778
4	1,4-Dichlorobenzene	12	0.28800	0.00288	0.00000	1.07143
5	1,1-Dichloroethane	24	0.57700	0.00577	0.00000	0.64286
6	1,2-Dichloroethane	9	0.20650	0.00207	0.00000	0.03175
7	cis-1,2-Dichloroethene	3600	8.56480	0.08565	0.00002	0.62698
8	trans-1,2-Dichloroethene	23	0.55320	0.00553	0.00000	0.62698
9	1,2-Dichloropropane	6	0.14300	0.00143	0.00000	0.27381
10	Ethylbenzene	41	0.98630	0.00986	0.00000	0.34524
11	2-Hexanone (MBK)	70	0.05240	0.00052	0.00000	0.01587
12	MIBK	110	0.06830	0.00068	0.00000	0.16270
13	Tetrachloroethene	3	0.07200	0.00072	0.00000	0.26587
14	Toluene	840	20.19700	0.20197	0.00005	0.89286
15	Trichloroethene	45	0.10800	0.00108	0.00000	0.21429
16	Total Xylenes	120	2.88000	0.02880	0.00001	0.34524
17	Vinyl chloride	310	7.45800	0.07458	0.00002	0.01032

Notes:
1) BASED ON 1 LB/HR MODEL
2) ACCEPTABLE AMBIENT CONCENTRATION

TABLE 3

SCREEN MODEL EVALUATION
24 HOUR POINT SOURCE CONCENTRATION VALUES
INTERIM MEASURE DESIGN CALCULATIONS
NSB KINGS BAY, GEORGIA

ABB-ES Project No.: 8503-01
Designed By: V. RULE
Date: NOVEMBER 24, 1993
Checked By: S. Pierett
Date: December 8, 1993

Source Identification: Site 11 Landfill
Source Location: NSB Kingsbay, GA

Max. Influent Flow Rate (GPM): 60
Max. Air Flow Rate (CFM): 800
Emission Pt. Height (St. Height){ft} : 16
Max. Hrs. of Operation (hrs/wk) : 168

#	Contaminant Name	Max Conc In Ground Water (ppb)	Max. Vapor Emission from Air Sparger (mg/m3)	Max. Vapor Emission from Carbon (mg/m3)	Maximum Ground Level Concentration (mg/m3)	AAC (Note 2) (mg/m3)
1	Benzene	5	0.12030	0.00120	0.00000	0.00238
2	2-Butanone (MEK)	580	0.93700	0.00937	0.00000	0.46825
3	Chlorobenzene	10	0.24030	0.00240	0.00000	0.27778
4	1,4-Dichlorobenzene	12	0.28800	0.00288	0.00000	1.07143
5	1,1-Dichloroethane	24	0.57700	0.00577	0.00000	0.64286
6	1,2-Dichloroethane	9	0.20650	0.00207	0.00000	0.03175
7	cis-1,2-Dichloroethene	3600	8.56480	0.08565	0.00001	0.62698
8	trans-1,2-Dichloroethene	23	0.55320	0.00553	0.00000	0.62698
9	1,2-Dichloropropane	6	0.14300	0.00143	0.00000	0.27381
10	Ethylbenzene	41	0.98630	0.00986	0.00000	0.34524
11	2-Hexanone (MBK)	70	0.05240	0.00052	0.00000	0.01587
12	MIBK	110	0.06830	0.00068	0.00000	0.16270
13	Tetrachloroethene	3	0.07200	0.00072	0.00000	0.26587
14	Toluene	840	20.19700	0.20197	0.00002	0.89286
15	Trichloroethene	45	0.10800	0.00108	0.00000	0.21429
16	Total Xylenes	120	2.88000	0.02880	0.00000	0.34524
17	Vinyl chloride	310	7.45800	0.07458	0.00001	0.01032

Notes:
1) BASED ON 1 LB/HR MODEL
2) ACCEPTABLE AMBIENT CRITERIA

TABLE 4

11-30-93
13:48:37

*** SCREEN-1.1 MODEL RUN ***
*** VERSION DATED 88300 ***

NSB Kings Bay, GA - Interim Measure - TABLE 4 - SCREEN MODEL

SIMPLE TERRAIN INPUTS:

SOURCE TYPE	=	POINT
EMISSION RATE (G/S)	=	.1260
STACK HEIGHT (M)	=	4.88
STK INSIDE DIAM (M)	=	.10
STK EXIT VELOCITY (M/S)	=	46.50
STK GAS EXIT TEMP (K)	=	293.00
AMBIENT AIR TEMP (K)	=	293.00
RECEPTOR HEIGHT (M)	=	.00
IOPT (1=URB,2=RUR)	=	2
BUILDING HEIGHT (M)	=	2.13
MIN HORIZ BLDG DIM (M)	=	1.83
MAX HORIZ BLDG DIM (M)	=	1.83

1 lb/hr

BUOY. FLUX = .00 M**4/S**3; MOM. FLUX = 5.41 M**4/S**2.

*** FULL METEOROLOGY ***

****
*** SCREEN AUTOMATED DISTANCES ***
****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
1.	.0000	0	.0	.0	.0	.0	.0	.0	NA
100.	63.74	3	3.0	3.0	960.0	9.5	12.5	7.6	NO
200.	77.95	5	1.0	1.0	5000.0	13.8	12.3	7.4	NO
300.	85.58	5	1.0	1.0	5000.0	13.8	17.4	9.6	NO
400.	90.19	6	1.0	1.0	5000.0	13.0	15.2	8.1	NO
500.	88.32	6	1.0	1.0	5000.0	13.0	18.4	9.3	NO
600.	82.15	6	1.0	1.0	5000.0	13.0	21.6	10.5	NO
700.	74.60	6	1.0	1.0	5000.0	13.0	24.8	11.6	NO
800.	67.03	6	1.0	1.0	5000.0	13.0	27.9	12.6	NO
900.	60.24	6	1.0	1.0	5000.0	13.0	31.0	13.6	NO
1000.	54.27	6	1.0	1.0	5000.0	13.0	34.1	14.5	NO
1100.	49.14	6	1.0	1.0	5000.0	13.0	37.2	15.3	NO
1200.	44.69	6	1.0	1.0	5000.0	13.0	40.2	16.2	NO
1300.	40.82	6	1.0	1.0	5000.0	13.0	43.2	16.9	NO
1400.	37.44	6	1.0	1.0	5000.0	13.0	46.2	17.7	NO
1500.	34.48	6	1.0	1.0	5000.0	13.0	49.2	18.5	NO
1600.	31.87	6	1.0	1.0	5000.0	13.0	52.1	19.2	NO
1700.	29.55	6	1.0	1.0	5000.0	13.0	55.1	19.9	NO
1800.	27.50	6	1.0	1.0	5000.0	13.0	58.0	20.6	NO
1900.	25.66	6	1.0	1.0	5000.0	13.0	60.9	21.3	NO
2000.	24.01	6	1.0	1.0	5000.0	13.0	63.8	22.0	NO
2100.	22.59	6	1.0	1.0	5000.0	13.0	66.7	22.6	NO
2200.	21.30	6	1.0	1.0	5000.0	13.0	69.5	23.1	NO
2300.	20.13	6	1.0	1.0	5000.0	13.0	72.4	23.7	NO
2400.	19.07	6	1.0	1.0	5000.0	13.0	75.2	24.2	NO

TABLE 4 (continued)

2500.	18.09	6	1.0	1.0	5000.0	13.0	78.0	24.7	NC
2600.	17.20	6	1.0	1.0	5000.0	13.0	80.9	25.3	NO
2700.	16.38	6	1.0	1.0	5000.0	13.0	83.7	25.8	NO
2800.	15.62	6	1.0	1.0	5000.0	13.0	86.5	26.3	NO
2900.	14.92	6	1.0	1.0	5000.0	13.0	89.2	26.8	NO
3000.	14.27	6	1.0	1.0	5000.0	13.0	92.0	27.3	NO
3500.	11.75	6	1.0	1.0	5000.0	13.0	105.7	29.3	NO
4000.	9.914	6	1.0	1.0	5000.0	13.0	119.2	31.1	NO
4500.	8.525	6	1.0	1.0	5000.0	13.0	132.6	32.8	NO
5000.	7.443	6	1.0	1.0	5000.0	13.0	145.7	34.4	NO
5500.	6.579	6	1.0	1.0	5000.0	13.0	158.7	36.0	NO
6000.	5.876	6	1.0	1.0	5000.0	13.0	171.6	37.4	NO
6500.	5.295	6	1.0	1.0	5000.0	13.0	184.4	38.8	NO
7000.	4.806	6	1.0	1.0	5000.0	13.0	197.0	40.2	NO
7500.	4.405	6	1.0	1.0	5000.0	13.0	209.6	41.4	NO
8000.	4.059	6	1.0	1.0	5000.0	13.0	222.0	42.5	NO
8500.	3.759	6	1.0	1.0	5000.0	13.0	234.4	43.5	NO
9000.	3.496	6	1.0	1.0	5000.0	13.0	246.6	44.6	NO
9500.	3.264	6	1.0	1.0	5000.0	13.0	258.8	45.6	NO
10000.	3.058	6	1.0	1.0	5000.0	13.0	270.9	46.6	NO
15000.	1.825	6	1.0	1.0	5000.0	13.0	388.4	55.0	NO
20000.	1.295	6	1.0	1.0	5000.0	13.0	501.0	60.4	NO
25000.	.9922	6	1.0	1.0	5000.0	13.0	609.8	65.0	NO
30000.	.7986	6	1.0	1.0	5000.0	13.0	715.6	69.0	NO
40000.	.5755	6	1.0	1.0	5000.0	13.0	920.2	74.6	NO
50000.	.4466	6	1.0	1.0	5000.0	13.0	1117.4	79.3	NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:

421.	90.37 for 1 lb/hr	6	1.0	1.0	5000.0	13.0	15.9	8.4	NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)
DWASH=NO MEANS NO BUILDING DOWNWASH USED
DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

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**********************************
*** SCREEN DISCRETE DISTANCES ***
**********************************
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*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
61.	59.82	2	3.0	3.0	960.0	9.5	12.3	6.8	NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)
DWASH=NO MEANS NO BUILDING DOWNWASH USED
DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

```
*********************************************
*  SUMMARY OF TERRAIN HEIGHTS ENTERED FOR   *
*     SIMPLE ELEVATED TERRAIN PROCEDURE     *
*********************************************
```

TERRAIN HT (M)	DISTANCE RANGE (M) MINIMUM	MAXIMUM

TABLE 4 (continued)

```
-------        --------      --------
     0.             1.        50000.
     0.            61.           --

*** CAVITY CALCULATION - 1 ***        *** CAVITY CALCULATION - 2 ***
 CONC (UG/M**3)        =    .0000      CONC (UG/M**3)        =    .0000
 CRIT WS @10M (M/S)    =   99.99       CRIT WS @10M (M/S)    =   99.99
 CRIT WS @ HS (M/S)    =   99.99       CRIT WS @ HS (M/S)    =   99.99
 DILUTION WS (M/S)     =   99.99       DILUTION WS (M/S)     =   99.99
 CAVITY HT (M)         =    3.25       CAVITY HT (M)         =    3.25
 CAVITY LENGTH (M)     =    3.02       CAVITY LENGTH (M)     =    3.02
 ALONGWIND DIM (M)     =    1.83       ALONGWIND DIM (M)     =    1.83

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S.  CONC SET = 0.0

     ****************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ****************************************

 CALCULATION          MAX CONC     DIST TO    TERRAIN
  PROCEDURE          (UG/M**3)     MAX (M)     HT (M)
--------------      -----------   -------    -------
SIMPLE TERRAIN        90.37          421.        0.

*****************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
*****************************************************
```

for 1 lb/hr input

TABLE 5

STACK PARAMETERS

Source Type:	Point	
Emission Rate:	0.1260 g/s	(1 lb/hr)
Stack Height:	4.88 meters	(16 feet)
Stack Inside Diameter:	0.1 meters	(4 inches)
Stack Exit Velocity:	46.5 m/s	(152.7 ft/s)
Stack Gas Exit Temp:	293 K	(68 °F)
Ambient Air Temp:	293 K	(68 °F)
Receptor Height:	0 meters	
Nearby Structure Height:	2.13 meters	(7 feet)
Minimum Horizon Dim:	1.83	(6 feet)
Maximum Horizon Dim:	1.83	(6 feet)

TABLE 6

SCREEN MODEL EVALUATION
ONE HOUR POINT SOURCE CONCENTRATION VALUES
FOLLOWING AIR SPARGER WITHOUT CARBON
INTERIM MEASURE DESIGN CALCULATIONS
NSB KINGS BAY, GEORGIA

ABB-ES Project No.: 8503-01
Designed By: V. RULE
Date: NOVEMBER 24, 1993
Checked By: S. Pierett
Date: December 8, 1993

Source Identification: Site 11 Landfill
Source Location: NSB Kingsbay, GA

Max. Influent Flow Rate (GPM): 60
Max. Air Flow Rate (CFM): 800
Emission Pt. Height (St. Height){ft} : 16
Max. Hrs. of Operation (hrs/wk) : 168

#	Contaminant Name	Max Conc in Ground Water (ppb)	Max. Vapor Emission from Air Sparger (mg/m3)	Maximum Ground Level Concentration (mg/m3)	AAC (Note 2) (mg/m3)
1	Benzene	5	0.12030	0.00003	0.00238
2	2-Butanone (MEK)	580	0.93700	0.00025	0.46825
3	Chlorobenzene	10	0.24030	0.00006	0.27778
4	1,4-Dichlorobenzene	12	0.28800	0.00008	1.07143
5	1,1-Dichloroethane	24	0.57700	0.00016	0.64286
6	1,2-Dichloroethane	9	0.20650	0.00006	0.03175
7	cis-1,2-Dichloroethene	3600	8.56480	0.00231	0.62698
8	trans-1,2-Dichloroethene	23	0.55320	0.00015	0.62698
9	1,2-Dichloropropane	6	0.14300	0.00004	0.27381
10	Ethylbenzene	41	0.98630	0.00027	0.34524
11	2-Hexanone (MBK)	70	0.05240	0.00001	0.01587
12	MIBK	110	0.06830	0.00002	0.16270
13	Tetrachloroethene	3	0.07200	0.00002	0.26587
14	Toluene	840	20.19700	0.00546	0.89286
15	Trichloroethene	45	0.10800	0.00003	0.21429
16	Total Xylenes	120	2.88000	0.00078	0.34524
17	Vinyl chloride	310	7.45800	0.00202	0.01032

Notes:
1) BASED ON 1 LB/HR MODEL
2) ACCEPTABLE AMBIENT CONCENTRATION

TABLE 7

SCREEN MODEL EVALUATION
24 HOUR POINT SOURCE CONCENTRATION VALUES
FOLLOWING AIR SPARGER WITHOUT CARBON
INTERIM MEASURE DESIGN CALCULATIONS
NSB KINGS BAY, GEORGIA

ABB-ES Project No.: 8503-01
Designed By: V. RULE
Date: NOVEMBER 24, 1993
Checked By: S. Pierett
Date: December 8, 1993

Source Identification: Site 11 Landfill
Source Location: NSB Kingsbay, GA

Max. Influent Flow Rate (GPM): 60
Max. Air Flow Rate (CFM): 800
Emission Pt. Height (St. Height){ft} : 16
Max. Hrs. of Operation (hrs/wk) : 168

#	Contaminant Name	Max. Conc in Ground Water (ppb)	Max Vapor Emission from Air Sparger (mg/m3)	Maximum Ground Level Concentration (mg/m3)	AAC (Note 2) (mg/m3)
1	Benzene	5	0.12030	0.00001	0.00238
2	2-Butanone (MEK)	580	0.93700	0.00010	0.46825
3	Chlorobenzene	10	0.24030	0.00003	0.27778
4	1,4-Dichlorobenzene	12	0.28800	0.00003	1.07143
5	1,1-Dichloroethane	24	0.57700	0.00006	0.64286
6	1,2-Dichloroethane	9	0.20650	0.00002	0.03175
7	cis-1,2-Dichloroethene	3600	8.56480	0.00093	0.62698
8	trans-1,2-Dichloroethene	23	0.55320	0.00006	0.62698
9	1,2-Dichloropropane	6	0.14300	0.00002	0.27381
10	Ethylbenzene	41	0.98630	0.00011	0.34524
11	2-Hexanone (MBK)	70	0.05240	0.00001	0.01587
12	MIBK	110	0.06830	0.00001	0.16270
13	Tetrachloroethene	3	0.07200	0.00001	0.26587
14	Toluene	840	20.19700	0.00218	0.89286
15	Trichloroethene	45	0.10800	0.00001	0.21429
16	Total Xylenes	120	2.88000	0.00031	0.34524
17	Vinyl chloride	310	7.45800	0.00081	0.01032

Notes:
1) BASED ON 1 LB/HR MODEL
2) ACCEPTABLE AMBIENT CONCENTRATION

TABLE 8

11-30-93
13:51:51

*** SCREEN-1.1 MODEL RUN ***
*** VERSION DATED 88300 ***

NSB Kings Bay, GA - Interim Measure - TABLE 8 - STACK MONITORING

SIMPLE TERRAIN INPUTS:

SOURCE TYPE	=	POINT
EMISSION RATE (G/S)	=	.1400E-01 = 37 mg/m³ @ Stack
STACK HEIGHT (M)	=	4.88
STK INSIDE DIAM (M)	=	.10
STK EXIT VELOCITY (M/S)	=	46.50
STK GAS EXIT TEMP (K)	=	293.00
AMBIENT AIR TEMP (K)	=	293.00
RECEPTOR HEIGHT (M)	=	.00
IOPT (1=URB,2=RUR)	=	2
BUILDING HEIGHT (M)	=	2.13
MIN HORIZ BLDG DIM (M)	=	1.83
MAX HORIZ BLDG DIM (M)	=	1.83

BUOY. FLUX = .00 M**4/S**3; MOM. FLUX = 5.41 M**4/S**2.

*** FULL METEOROLOGY ***

****
*** SCREEN AUTOMATED DISTANCES ***
****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
1.	.0000	0	.0	.0	.0	.0	.0	.0	NA
100.	7.083	3	3.0	3.0	960.0	9.5	12.5	7.6	NO
200.	8.661	5	1.0	1.0	5000.0	13.8	12.3	7.4	NO
300.	9.509	5	1.0	1.0	5000.0	13.8	17.4	9.6	NO
400.	10.02	6	1.0	1.0	5000.0	13.0	15.2	8.1	NO
500.	9.813	6	1.0	1.0	5000.0	13.0	18.4	9.3	NO
600.	9.128	6	1.0	1.0	5000.0	13.0	21.6	10.5	NO
700.	8.289	6	1.0	1.0	5000.0	13.0	24.8	11.6	NO
800.	7.447	6	1.0	1.0	5000.0	13.0	27.9	12.6	NO
900.	6.693	6	1.0	1.0	5000.0	13.0	31.0	13.6	NO
1000.	6.030	6	1.0	1.0	5000.0	13.0	34.1	14.5	NO
1100.	5.460	6	1.0	1.0	5000.0	13.0	37.2	15.3	NO
1200.	4.965	6	1.0	1.0	5000.0	13.0	40.2	16.2	NO
1300.	4.535	6	1.0	1.0	5000.0	13.0	43.2	16.9	NO
1400.	4.160	6	1.0	1.0	5000.0	13.0	46.2	17.7	NO
1500.	3.831	6	1.0	1.0	5000.0	13.0	49.2	18.5	NO
1600.	3.541	6	1.0	1.0	5000.0	13.0	52.1	19.2	NO
1700.	3.284	6	1.0	1.0	5000.0	13.0	55.1	19.9	NO
1800.	3.055	6	1.0	1.0	5000.0	13.0	58.0	20.6	NO
1900.	2.851	6	1.0	1.0	5000.0	13.0	60.9	21.3	NO
2000.	2.668	6	1.0	1.0	5000.0	13.0	63.8	22.0	NO
2100.	2.510	6	1.0	1.0	5000.0	13.0	66.7	22.6	NO
2200.	2.367	6	1.0	1.0	5000.0	13.0	69.5	23.1	NO
2300.	2.237	6	1.0	1.0	5000.0	13.0	72.4	23.7	NO
2400.	2.119	6	1.0	1.0	5000.0	13.0	75.2	24.2	NO

TABLE 8 (continued)

2500.	2.010	6	1.0	1.0	5000.0	13.0	78.0	24.7	NO
2600.	1.911	6	1.0	1.0	5000.0	13.0	80.9	25.3	NO
2700.	1.820	6	1.0	1.0	5000.0	13.0	83.7	25.8	NO
2800.	1.736	6	1.0	1.0	5000.0	13.0	86.5	26.3	NO
2900.	1.658	6	1.0	1.0	5000.0	13.0	89.2	26.8	NO
3000.	1.586	6	1.0	1.0	5000.0	13.0	92.0	27.3	NO
3500.	1.306	6	1.0	1.0	5000.0	13.0	105.7	29.3	NO
4000.	1.102	6	1.0	1.0	5000.0	13.0	119.2	31.1	NO
4500.	.9473	6	1.0	1.0	5000.0	13.0	132.6	32.8	NO
5000.	.8270	6	1.0	1.0	5000.0	13.0	145.7	34.4	NO
5500.	.7310	6	1.0	1.0	5000.0	13.0	158.7	36.0	NO
6000.	.6529	6	1.0	1.0	5000.0	13.0	171.6	37.4	NO
6500.	.5883	6	1.0	1.0	5000.0	13.0	184.4	38.8	NO
7000.	.5340	6	1.0	1.0	5000.0	13.0	197.0	40.2	NO
7500.	.4894	6	1.0	1.0	5000.0	13.0	209.6	41.4	NO
8000.	.4510	6	1.0	1.0	5000.0	13.0	222.0	42.5	NO
8500.	.4177	6	1.0	1.0	5000.0	13.0	234.4	43.5	NO
9000.	.3885	6	1.0	1.0	5000.0	13.0	246.6	44.6	NO
9500.	.3627	6	1.0	1.0	5000.0	13.0	258.8	45.6	NO
10000.	.3398	6	1.0	1.0	5000.0	13.0	270.9	46.6	NO
15000.	.2028	6	1.0	1.0	5000.0	13.0	388.4	55.0	NO
20000.	.1439	6	1.0	1.0	5000.0	13.0	501.0	60.4	NO
25000.	.1102	6	1.0	1.0	5000.0	13.0	609.8	65.0	NO
30000.	.8873E-01	6	1.0	1.0	5000.0	13.0	715.6	69.0	NO
40000.	.6394E-01	6	1.0	1.0	5000.0	13.0	920.2	74.6	NO
50000.	.4963E-01	6	1.0	1.0	5000.0	13.0	1117.4	79.3	NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:

421.	10.04	6	1.0	1.0	5000.0	13.0	15.9	8.4	NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)
DWASH=NO MEANS NO BUILDING DOWNWASH USED
DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

```
*********************************************
*  SUMMARY OF TERRAIN HEIGHTS ENTERED FOR   *
*     SIMPLE ELEVATED TERRAIN PROCEDURE     *
*********************************************
```

TERRAIN HT (M)	DISTANCE RANGE (M) MINIMUM	MAXIMUM
0.	1.	50000.

```
*** CAVITY CALCULATION - 1 ***
 CONC (UG/M**3)       =    .0000
 CRIT WS @10M (M/S)   =   99.99
 CRIT WS @ HS (M/S)   =   99.99
 DILUTION WS (M/S)    =   99.99
 CAVITY HT (M)        =    3.25
 CAVITY LENGTH (M)    =    3.02
 ALONGWIND DIM (M)    =    1.83

*** CAVITY CALCULATION - 2 ***
 CONC (UG/M**3)       =    .0000
 CRIT WS @10M (M/S)   =   99.99
 CRIT WS @ HS (M/S)   =   99.99
 DILUTION WS (M/S)    =   99.99
 CAVITY HT (M)        =    3.25
 CAVITY LENGTH (M)    =    3.02
 ALONGWIND DIM (M)    =    1.83
```

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S. CONC SET = 0.0

```
****************************************
*** SUMMARY OF SCREEN MODEL RESULTS ***
****************************************
```

TABLE 8 (continued)

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	10.04	421.	0.

for 37 mg/m³ @ stack

```
**************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
**************************************************
```

APPENDIX B

REQUEST FOR AUTHORIZATION FOR GROUNDWATER DISCHARGE INTO THE NSB KINGS BAY LAND APPLICATION SYSTEM

Georgia Department of Natural Resources

205 Butler Street, S.E., East Floyd Tower, Atlanta, Georgia 30334

Reply To:
Industrial Wastewater Program
Suite 1070
404/656-4887

Joe D. Tanner, Commissioner
Harold F. Reheis, Director
David Word, Assistant Director
Environmental Protection Division
404/656-4713

February 4, 1994

L. P. Scullion
Captain, CEC, USN
Public Works Officer
Department of the Navy
Naval Submarine Base
1063 USS Tennessee Avenue
Kings Bay, GA 31547-2606

Re: LAS Permit No. GA 03-751

Dear Captain Scullion:

The Georgia Environmental Protection Division acknowledges receipt of your December 30, 1993 letter requesting to tie treated water from groundwater remediation into the sanitary sewer system governed by the referenced permit. As we understand the proposal, this is a pilot-scale testing project which is expected to last up to ten months. Maximum water generated will be 86,400 gpd. Water will be treated to EPA Maximum Contaminant Levels (MCL's).

We are hereby approving the addition of remediated groundwater to the wastewater treatment system for the specified ten month period beginning February 15, 1994. Operation and monitoring of the groundwater remediation will be in accordance with the December 1993 proposal entitled "Request for Authorization for Groundwater Discharge into the NSB Kings Bay Land Application System, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay, Georgia, Contract No. N62467-89-D-0317." You should comply with the pertinent enforcement action by the Hazardous Waste Management Program governing groundwater remediation under the old Camden County Landfill across State Road Spur 40 from the Crooked River Plantation Subdivision. Stipulations contained in the referenced LAS permit will remain the same.

If you have any questions, please contact Mr. Larry Kloet at 404-656-4887.

Sincerely,

Michael S. Creason

Michael S. Creason, P.E.
South Unit Coordinator
Industrial Wastewater Program

MSC:bk
cc: Madeleine Kellam

5090
Ser N56/4562
DEC 30 1993

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Georgia Department of Natural Resources
Attn: Mr. Larry Hedges
Industrial Wastewater Program Manager
205 Butler Street, SE, Suite 1070
Atlanta, GA 30354

Dear Mr. Hedges:

This is to formally request your authorization to allow discharge of treated groundwater to SUBASE Upper Base Wastewater Treatment Plant and Land Application System, Las Permit No. GA 03-751.

We are providing for your information two copies of Request For Authorization For Groundwater Discharge into the NSB Kings Bay Land Application System, enclosure (1), and one copy of Draft Final RFI Interim Report For Site 11, Volumes I & II, enclosure (2). The RFI Interim Report has been reviewed and accepted by the Environmental Protection Division. Mr. Bruce Khaleghi and Ms. Madeleine Kellam are our contacts in EPD's Hazardous Waste Department.

Groundwater will be extracted from five recovery wells installed near the Old County Landfill (Site 11) on SUBASE property. The water will be treated on-site to meet State and Federal drinking water standards and will then be discharged to a manhole for delivery to the LAS system.

Currently, the LAS operates at approximately 64 percent of its permitted capacity of 1.5 million gallons per day (gpd). The proposed maximum treatment system discharge flow of 86,400 gpd (60 gpm, 24 hours per day) would represent approximately 5.7 percent additional flow. The Wastewater Treatment Plant, an Aerobic Facultative Process, includes two large lagoons equipped with surface aerators. This process allows aerobic and anaerobic degradation zones. The additional aerobic zone has the ability to degrade chlorinated organics more readily than a conventional system. Anaerobic degradation takes place in a "quiet zone". The process generates minimal sludge and discharges through sand filters to a land application system. This facility has discharge requirements of 10 mg/l BOD and 10 mgl TSS. The treated groundwater discharge to the facility will not adversely affect these parameters.

The intended duration for discharge to the LAS is up to ten months. This includes six weeks of pilot scale testing to begin

5090
Ser N56/4562
DEC 30 1993

February 10, 1994 and eight months of continued operation of the treatment system during the design and implementation of a full-scale Interim Measure

As ABB Environmental Services is the operator of the pilot-scale test, we request that you provide a copy of your authorization to them at: ABB Environmental Systems, Inc., Attn: Mr. Frank Cater, 1400 Centerpoint Blvd., Suite 158, Knoxville, TN 37922.

We thank you for your consideration of this request and the continuing assistance you are providing to us and to ABB-ES. If you have questions regarding this request or the enclosed documents, please contact Mr. John Garner at 912-673-8845. Please address all correspondence to "Commanding Officer, Naval Submarine Base, 1063 USS Tennessee Avenue, Kings Bay, GA 31547-2606."

Sincerely,

L.P. SCULLION
CAPTAIN, CEC, USN
PUBLIC WORKS OFFICER
BY DIRECTION OF THE
COMMANDING OFFICER

Encl:
(1) Request For Authorization For Groundwater Discharge
(2) Draft Final RFI Interim Report, Volumes I & II

Copy to:
GaDNR (EPD), Bruce Khaleghi (w/1 copy encl (1))
ABB-ES, Frank Cater (w/o encl)

Blind Copy to:
SOUTHNAVFACENGCOM, Dave Dregger (w/o encl)

REQUEST FOR AUTHORIZATION FOR GROUNDWATER DISCHARGE INTO THE NSB KINGS BAY LAND APPLICATION SYSTEM

NAVAL INSTALLATION RESTORATION PROGRAM
NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

CONTRACT NO. N62467-89-D-0317

DECEMBER 1993

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA
29419-9010

REQUEST FOR AUTHORIZATION FOR GROUNDWATER DISCHARGE INTO THE NSB KINGS BAY LAND APPLICATION SYSTEM

CONTRACT TASK ORDER NO. 94
CONTRACT NO. N62467-89-D-0317

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

Prepared for:

Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina 29418

Prepared by:

ABB Environmental Services, Inc.
1400 Centerpoint Blvd., Suite 158
Knoxville, Tennessee 37932-1968

December 1993

Request for Authorization for
Groundwater Discharge into the
NSB Kings Bay Land Application System

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ACRONYMS

ABB-ES	ABB Environmental Services, Inc.
BOD	biochemical oxygen demand
bgs	below ground surface
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
DQOs	Data Quality Objectives
ETP	engineering treatability parameters
GC	gas chromatograph
gpm	gallons per minute
GPTRAC	General Particle Tracking Module
GWE	groundwater extraction
ICMSI	Interim Corrective Measure Screening Investigation
ID	Induced Draft
IM	Interim Measure
LAS	Land Application System
µg/l	micrograms per liter
mg/l	milligrams per liter
MCLs	Maximum Contaminant Levels
mRBC	methanotrophic Rotating Biological Contactor
MS/MSD	matrix spike and matrix spike duplicate
NPDES	National Pollutant Discharge Elimination System
NSB	Naval Submarine Base
PCBs	polychlorinated biphzenyls
PID	photoionization detector
POTW	Publicly Owned Treatment Works
PVC	polyvinyl chloride
QC	quality control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
s.u.	standard units
SOUTHDIV	Southern Division
SVOCs	semivolatile organic compounds

ACRONYMS (Continued)

TCL	Target Compound List
TDS	total dissolved solids
TSS	total suspended solids
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WHPA	Well Head Protection Area

1.0 INTRODUCTION

The purpose of this document is to provide the information needed for the Georgia Department of Natural Resources to evaluate the request to discharge treated groundwater to the Naval Submarine Base (NSB) Kings Bay sewage treatment facility. The following sections provide current and historic groundwater quality data, modeling of groundwater extraction system capture zones, a description of the groundwater treatment system, and a treatment system operation and discharge monitoring plan.

Additional information and backup data on groundwater quality is available in the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Interim Report (ABB-ES, 1993a). More detailed treatment system design information is available in the Interim Measure Work Plan for Site 11, Old Camden County Landfill Phase I Activities (ABB-ES, 1993b).

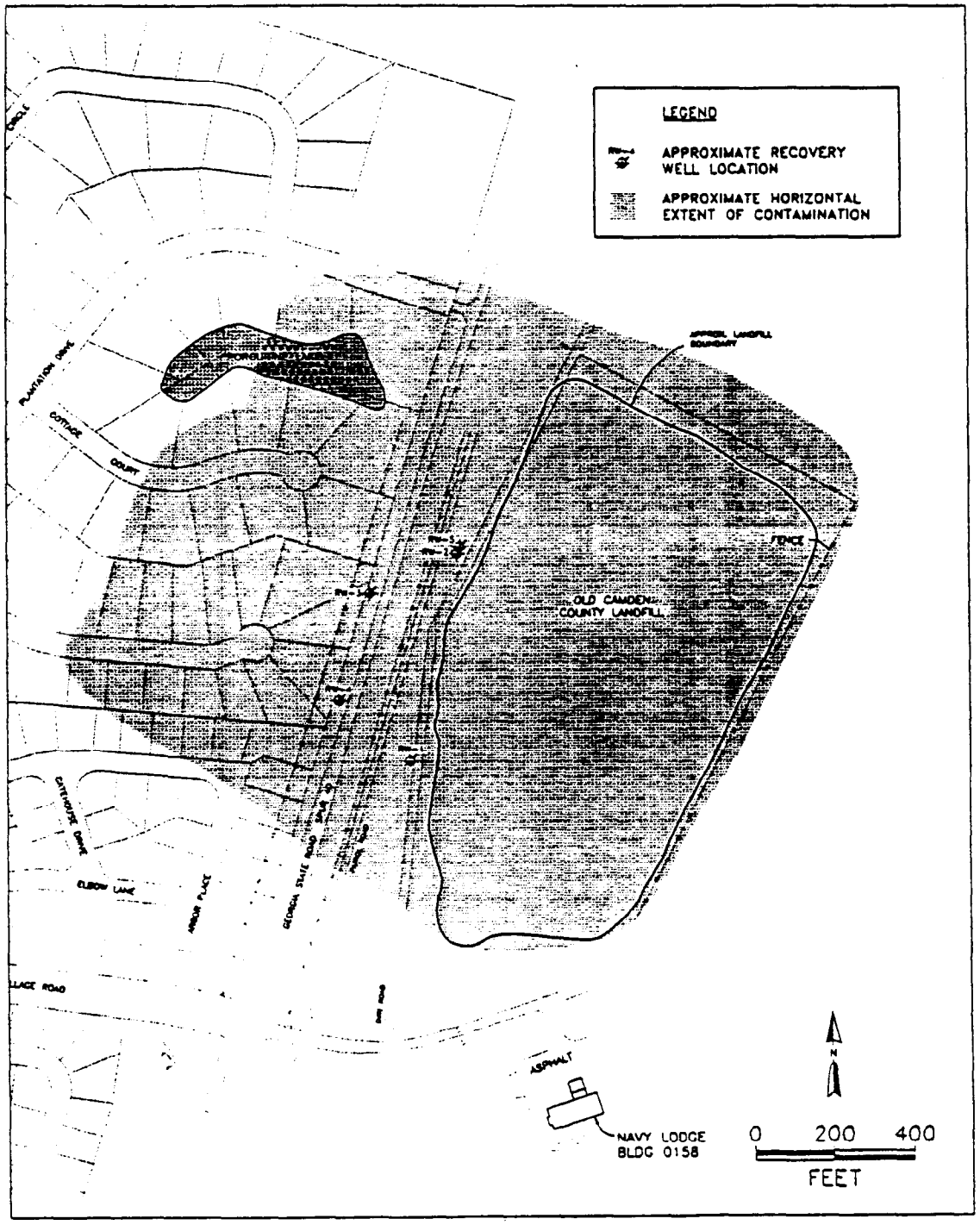
1.1 OBJECTIVE OF INTERIM MEASURE. The overall objective of the Interim Measure (IM) is to hydraulically control movement of the volatile organic compound (VOC) plume within the surficial aquifer. This will be achieved in a phased approach. The first phase will collect site-specific data to support long-term corrective measures, while in the process focus on collection of VOC-contaminated groundwater from known areas of highest contamination. This first phase will continue while design activities are conducted for a full-scale IM system. The second phase, or full-scale IM, will be designed to meet the overall IM objective of stabilization of VOC-contaminated groundwater within the surficial aquifer.

1.2 TREATMENT SYSTEM OVERVIEW.

1.2.1 Plume Definition Groundwater sampling results from the Interim Corrective Measure Screening Investigation (ICMSI) at the Old Camden County Landfill, Site 11, at NSB Kings Bay indicated that VOCs are present within the surficial aquifer. VOCs detected include vinyl chloride, cis-1,2-dichloroethene, and other fuel-related VOC contaminants. The VOC contamination is present beneath the site and extends into the Crooked River Plantation Subdivision. The spatial distribution of the VOCs appears to be limited to the upper 60 feet of the surficial aquifer in the subdivision and along the western boundary of the landfill. Beneath the landfill, VOC contaminants were detected at depths of 85 feet below ground surface (bgs). The overall hydraulic gradient in the vicinity of the landfill is approximately 0.003 foot per foot towards the west-northwest. The VOCs appear to have migrated within the groundwater laterally toward the subdivision through advective transport and dispersion.

Section 2.0 of this document provides a more detailed discussion of groundwater contamination characteristics. Plume plan view contour maps are included in Subsection 2.2.1 of this document.

1.2.2 Groundwater Extraction Controlling the contaminant plume will be accomplished by use of a groundwater extraction (GWE) system to withdraw groundwater contaminated with VOCs from the surficial aquifer. The pilot-scale GWE system will include five recovery wells at four locations. Four wells (RW-1, RW-2, RW-3, and RW-4) are screened between approximately 20 to 70 feet bgs. One location includes a recovery well screened from 6 to 26 feet bgs and nested with well RW-2. The recovery wells, shown in Figure 1-1, are positioned along the



DWN: NLW	PROJECT NO.: 08503	TITLE: APPROXIMATE RECOVERY WELL LOCATIONS AND HORIZONTAL EXTENT OF CONTAMINATION	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: LBH	FIGURE NO.: 1-1		
DATE: 12/15/93			

western side of the landfill and on the western right-of-way of Spur 40 in areas where the highest concentrations of VOCs were detected.

1.2.3 Groundwater Treatment The treatment system will collect, treat, and discharge water extracted from the surficial aquifer by the pilot-scale GWE system. The system will have the capacity to reduce contaminant concentrations in the groundwater to United States Environmental Protection Agency (USEPA)-established Maximum Contaminant Levels (MCLs). MCLs are concentrations that are generally accepted as drinking water standards. Further discussion of these performance standards is provided in Subsection 1.3.

Two pilot-scale treatment systems will be evaluated for suitability as a treatment method for full-scale IM implementation. Most of the water will be treated using air stripping technology for removal of the VOCs. The second pilot-scale treatment system, a methanotrophic Rotating Biological Contactor (mRBC), will accept a small stream (1 gallon per minute) which will be biologically treated for removal of the VOCs. Both systems will be evaluated for effectiveness and efficiency as a long-term IM treatment approach.

During an initial pumping test conducted in October 1993, groundwater samples were collected and analyzed for heavy metals, iron, and carbonate concentrations to determine requirements for metals and carbonate removal prior to air stripping. Analytical results are presented in Subsection 2.1.5. Based on the analytical results, removal of metals and carbonate will not be needed at this time.

1.3 PERFORMANCE STANDARDS. The IM groundwater treatment system operations and effluent will be operated and monitored to:

1) achieve MCLs for constituents of concern at the system discharge,
2) achieve efficient and effective operation of the air sparger, and
3) collect data to design a full-scale treatment system, if needed.

The USEPA considers a discharge to a Publicly Owned Treatment Works (POTW) an "indirect discharge." The General Pretreatment Regulations (40 Code of Federal Regulations (CFR) 403) apply to the site discharge and will be adhered to during operation of the IM treatment system. The purpose of the pretreatment regulations and standards is to prevent the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the sewage treatment facility.

The prohibitions of the pretreatment regulations (40 CFR 403.5.a) are applicable to nondomestic uses and control the introduction of contaminants into POTWs to accomplish the following:

1) prevent interference with the operation (including sludge management) of a POTW, and

2) prevent pass through of contaminants through the POTW.

The term "interference" means a discharge that inhibits or disrupts a POTW, its treatment processes or operations, or its sludge processes, use, or disposal, causing a violation of its discharge permit or other requirements. "Pass through" is any discharge to a POTW in quantities or concentrations that causes a violation of any requirement of the POTW's discharge permit.

The effluent from the IM treatment systems will meet federal, state, and local pretreatment requirements, as applicable, for discharge to the base's Land Application System (LAS). During the pilot-scale testing, the concentrations of constituents of concern to the LAS influent will meet federal drinking water criteria MCLs listed in Table 1-1. Groundwater meeting this criteria will not cause any biological interference or be toxic to the sewage treatment system. Nor will the constituents pass through the facility at any concentrations of concern.

During pilot-scale operation, untreated groundwater analytical data will be collected to evaluate treatment and performance standards required for full-scale IM operation. Currently, available groundwater data does not sufficiently support a no-treatment alternative for the groundwater extracted during pilot-scale testing. Treatment and monitoring of the groundwater extracted during pilot-scale testing will be performed to prevent the receiving treatment facility from being adversely affected by the IM discharge stream. If approved, the treatment system effluent will be discharged to the base's LAS which is an Aerobic Facultative Process.

The proposed performance standards for the treatment system, or MCLs, for the constituents of concern are listed in Table 1-1.

1.4 PROPOSED SCHEDULE. The IM Treatment System is tentatively scheduled to start-up in February 1994. The pilot-scale test operations will take approximately 6 weeks to complete (Phase I). The testing operations will progress as follows:

- Start-up of one recovery well (approximately 10 gpm) and operation for one week.
- Recovery phase for one week - some well development water that has been stored will be treated.
- Start-up of two recovery wells (approximately 17 gpm) and operation for one week.
- Start-up of remaining three recovery wells and operation of all wells for 4 weeks (60 gpm maximum).

Evaluation of the pilot-scale test results and design of a full-scale IM system is expected to require a minimum of 8 months. During this time (Phase I Continuance), the pilot-scale system will continue to operate to maintain the control of migration of constituents that was achieved during the pilot-scale test operations. Discharge to the base's LAS is requested for the duration of the Phase I and Phase I Continuance activities (approximately 10 months). Treatment system discharge during full-scale IM (Phase II) activities will be evaluated and resolved during design of the full-scale system.

Table 1-1 Proposed Treatment System Performance Criteria

Constituent of Concern	Estimated Influent Concentration[1]	Performance Criteria[2] (µg/l)
Benzene	28 µg/l	5
2-Butanone	580 µg/l	No limit[3]
Chlorobenzene	10 µg/l	100
1,4-Dichlorobenzene	12 µg/l	75
1,1-Dichloroethane	100 µg/l	No limit[3]
1,2-Dichloroethane	9 µg/l	5
cis-1,2-Dichloroethene	3,600 µg/l	70
trans-1,2-Dichloroethene	23 µg/l	100
1,2-Dichloropropane	6 µg/l	5
Ethylbenzene	200 µg/l	700
2-Hexanone	70 µg/l	No limit[3]
Methylene Chloride	41 µg/l	5
4-Methyl-2-pentanone	1,400 µg/l	No limit[3]
Tetrachloroethene	24 µg/l	5
Toluene	840 µg/l	1,000
Trichloroethene	45 µg/l	5
Xylenes (total)	155 µg/l	10,000
Vinyl Chloride	1,400 µg/l	2
BOD	14.3 mg/l	*
TSS	9.8 mg/l	*
pH	4 - 6 s.u.	*

Notes:

* = to be set by the Land Application System
BOD = biochemical oxygen demand
µg/l = micrograms per liter
mg/l = milligrams per liter
s.u. = standard units
TSS = total suspended solids

1 Maximum concentration detected from previous studies.

2 Performance criteria are the maximum contaminant levels for constituents of concern as established by the State of Georgia (1993) and USEPA (1993).

3 No MCL or health-based advisory established.

2.0 GROUNDWATER CHARACTERIZATION

2.1 GROUNDWATER INVESTIGATIONS. Previous investigation activities to characterize the nature and extent of groundwater contamination associated with Site 11 include a RFI groundwater monitoring program and three phases of contamination characterization. The first characterization effort was a Phase I Interim Investigation. The second and third phases of contamination characterization are included in the ICMSI. A Supplemental RFI and IM has been planned for the site and the initial implementation began in October 1993. The scope of the RFI groundwater monitoring program, Supplemental RFI, IM, and phases of contamination characterization are briefly described in the following paragraphs. Section 2.2 discusses the results of the investigation activities conducted at Site 11.

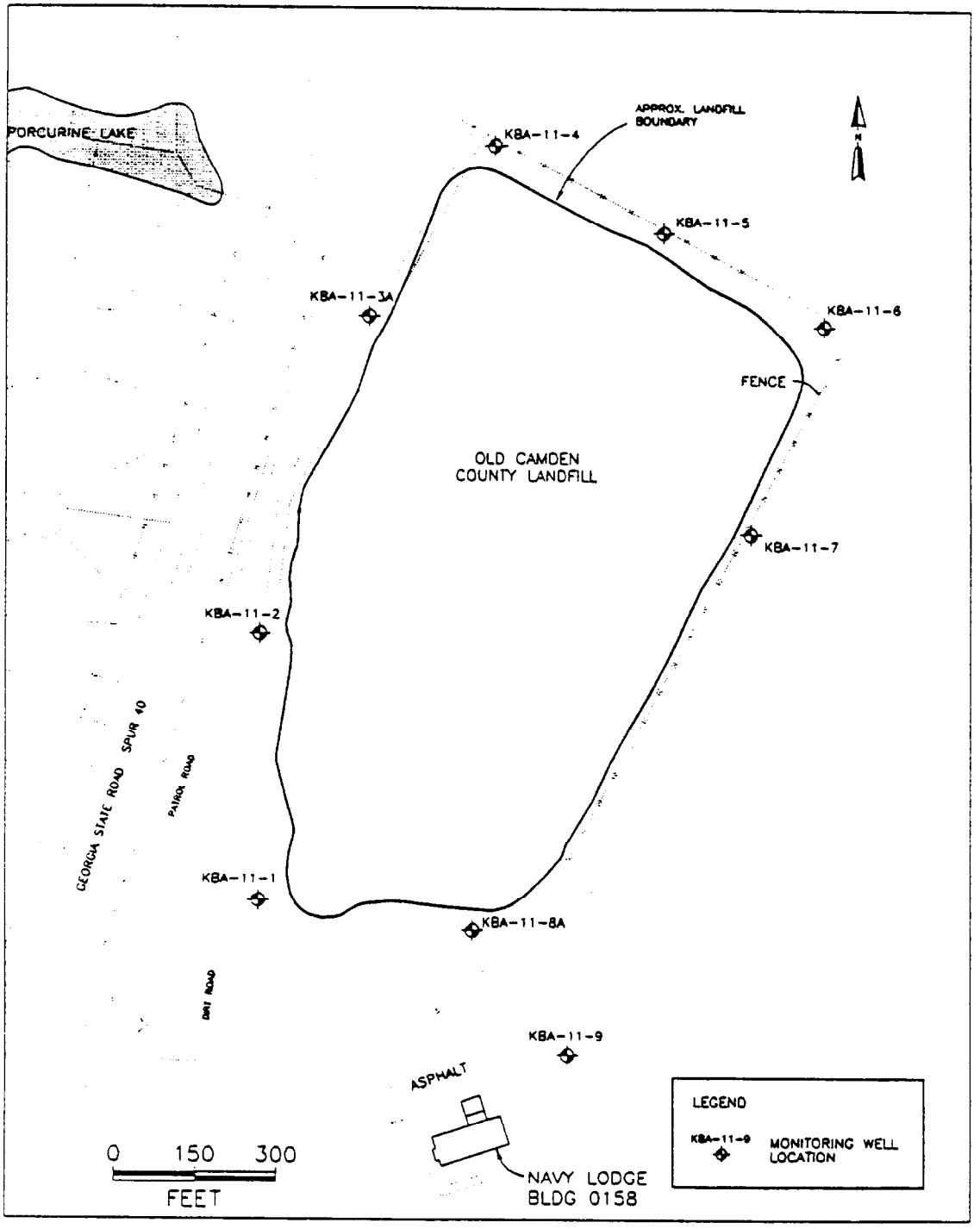
2.1.1 RFI Groundwater Monitoring Program A groundwater monitoring program consisting of six bimonthly sampling events began in February 1992. Nine groundwater monitoring wells, KBA-11-1 through KBA-11-9, were included in the monitoring program (Figure 2-1). These monitoring wells are approximately 13 feet bgs and have 10-foot well screens that intercept the surface of the water table.

Samples from the first two sampling events were analyzed for Appendix IX VOCs, semivolatile organic compounds (SVOCs), organochlorine pesticides and polychlorinated biphenyls (PCBs), dioxins and furans, herbicides, organophosphorus pesticides, and inorganics (including cyanide and sulfide) (Table 2-1). No pesticides, PCBs, herbicides, dioxins, or furans, were detected in the groundwater samples, and the SVOCs detected were attributed to incidental contamination during sampling and/or analysis. The analytical program was reduced after the second sampling event to include Appendix IX VOCs, inorganics (including cyanide and sulfide), total dissolved solids (TDS), and total suspended solids (TSS).

2.1.2 Phase I Interim Investigation The Phase I Interim Investigation was implemented in August 1992 (ABB-ES, 1992). The objective of this investigation was to determine whether VOCs detected in the RFI groundwater monitoring wells had migrated off NSB property. The investigation included collection of 36 groundwater samples using a hydrocone groundwater sampler advanced by direct push technology. These groundwater samples were collected from 25 locations along the western margin of the landfill and on the western right-of-way of Spur 40. Sample depths ranged from 7 to 20 feet bgs, with the exception that one penetration was advanced to a depth of 78 ft bgs. The groundwater samples were analyzed in an on-site laboratory for five target VOCs listed below:

- vinyl chloride,
- chloroethane,
- trans-1,2-dichloroethene,
- trichloroethene, and
- tetrachloroethene.

Five duplicate groundwater samples were sent to an off-site analytical laboratory for confirmatory analysis. These analyses were conducted using SW-846 Methods 8010 and 8020. The analytes for these analyses include the VOCs listed for Appendix IX constituents in Table 2-1.



DWN: NLW	PROJECT NO.: 08503	TITLE: LOCATIONS OF MONITORING WELLS INSTALLED DURING THE RFI - FEBRUARY 1992	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: VAR	FIGURE NO.: 2-1		
DATE: 12/08/93			

KB NSB [LAS 8503.004]#030/93.mlv

Table 2-1 Appendix IX, Groundwater Monitoring List

Volatile Organic Compounds (58 total)
SW-846 Method 8240

Chloromethane	Tetrachloroethene
Bromomethane	1,1,2,2-Tetrachloroethane
Vinyl Chloride	Toluene
Chloroethane	Chlorobenzene
Methylene Chloride	Ethylbenzene
Acetone	Styrene
Carbon Disulfide	Xylene (total)
Trichlorofluoromethane	1,3-Dichlorobenzene
1,1-Dichloroethene	1,4-Dichlorobenzene
1,1-Dichloroethane	1,2-Dichlorobenzene
1,2-Dichloroethene (total)	Acrolein
Chloroform	Iodomethane
1,2-Dichloroethane	Acrylonitrile
2-Butanone	Dibromomethane
1,1,1-Trichloroethane	Ethyl Methacrylate
Carbon Tetrachloride	1,2,3-Trichloropropane
Vinyl Acetate	trans-1,4-Dichloro-2-Butene
Bromodichloromethane	Acetonitrile
1,2-Dichloropropane	3-Chloropropene
cis-1,3-Dichloropropene	Propionitrile
Trichloroethene	Methacrylonitrile
Dibromochloromethane	1,4-Dioxane
1,1,2-Trichloroethane	Methyl Methacrylate
Benzene	1,2-Dibromoethane
trans-1,3-Dichloropropene	1,1,1,2-Tetrachloroethane
2-Chloroethylvinylether	1,2-Dibromo-3-Chloropropane
Bromoform	Pentachloroethane
2-Hexanone	Isobutyl alcohol
4-Methyl-2-Pentanone	Chloroprene

Semivolatile Organic Compounds (acid fraction)
SW-846 Method 8270 (18 total)

Phenol	2,4-Dichlorophenol
2,6-Dichlorophenol	4-Chloro-3-Methylphenol
2-Chlorophenol	2,4,6-Trichlorophenol
2-Methylphenol	2,4,5-Trichlorophenol
2,3,4,6-Tetrachlorophenol	2,4-Dinitrophenol
3-Methylphenol	4-Nitrophenol
4-Methylphenol	4,6-Dinitro-2-Methylphenol
2-Nitrophenol	2,4-Dimethylphenol
Benzoic Acid	Pentachlorophenol

Table 2-1 (Continued) Appendix IX, Groundwater Monitoring List

Semivolatile Organic Compounds (base/neutral fraction)
SW-846 Method 8270 (93 total)

N-Nitrosodimethylamine	Di-n-Octyl Phthalate
Aniline	Benzo(b)Fluoranthene
bis(2-Chloroethyl)Ether	Benzo(k)Fluoranthene
1,3-Dichlorobenzene	Benzo(a)Pyrene
1,4-Dichlorobenzene	Indeno(1,2,3-cd)Pyrene
Benzyl Alcohol	Dibenz(a,h)Anthracene
1,2-Dichlorobenzene	Benzo(g,h,i)Perylene
bis(2-Chloroisopropyl)Ether	2-Picoline
N-Nitroso-Di-n-Propylamine	Methyl methanesulfonate
Hexachloroethane	Ethyl methanesulfonate
Nitrobenzene	Acetophenone
Isophorone	N-Nitrosopiperidine
bis(2-Chloroethoxy)Methane	Phenyl-tert-butylamine
1,2,4-Trichlorobenzene	N-Nitroso-di-n-butylamine
Naphthalene	N-Nitrosodiethylamine
4-Chloroaniline	N-Nitrosopyrrolidine
Hexachlorobutadiene	Benzidine
2-Methylnaphthalene	1,2,4,5-Tetrachlorobenzene
Hexachlorocyclopentadiene	Pentachlorobenzene
2-Chloronaphthalene	1-Naphthylamine
2-Nitroaniline	2-Naphthylamine
Dimethylphthalate	Diphenylamine
Acenaphthylene	Phenacetine
2,6-Dinitrotoluene	4-Aminobiphenyl
3-Nitroaniline	Pentachloronitrobenzene
Acenaphthene	Pronamide
Dibenzofuran	p-Dimethylaminoazobenzene
2,4-Dinitrotoluene	3-Methylcholanthrene
Diethylphthalate	7,12-Dimethylbenz(a)Anthracene
4-Chlorophenyl-phenylether	Pyridine
Fluorene	N-Nitrosomethylethylamine
4-Nitroaniline	N-Nitrosomorpholine
N-Nitrosodiphenylamine	o-Toluidine
1,2-Diphenylhydrazine	Hexachloropropene
4-Bromophenyl-phenylether	p-Phenylenediamine
Hexachlorobenzene	Safrole
Aramite	Isosafrole
Phenanthrene	1,4-Napthoquinone
Anthracene	1,3-Dinitrobenzene
Di-n-Butylphthalate	5-Nitro-o-toluidine
Fluoranthene	1,3,5-Trinitrobenzene
Pyrene	4-Nitroquinoline-1-oxide

Table 2-1 (Continued) Appendix IX, Groundwater Monitoring List

Semivolatile Organic Compounds (base/neutral fraction) (Continued)
SW-846 Method 8270 (93 total)

Butylbenzylphthalate
3,3'-Dichlorobenzidine
Benzo(a)Anthracene
Chrysene
bis(2-Ethylhexyl)Phthalate
Methapyrilene
3,3'Dimethylbenzidine
2-Acetamidofluorene
Hexachlorophene

Chlorinated Dibenzofurans and Dibenzo-p-dioxins
SW-846 Method 8280 (7 total)

Tetrachlorodibenzo-p-dioxins (TCDDs) (total)
2,3,7,8- TCDD (total)
Pentachlorodibenzo-p-dioxins (PeCDDs) (total)
Hexachlorodibenzo-p-dioxins (HeCDDs) (total)
Tetrachlorodibenzofurans (TCDFs) (total)
Pentachlorodibenzofurans (PeCDFs) (total)
Hexachlorodebenzofurans (HeCDFs) (total)

Organochlorine Pesticide and PCB Compounds (30 total)
SW-846 Method 8080

alpha-BHC
beta-BHC
delta-BHC
gamma-BHC (Lindane)
Heptachlor
Aldrin
Heptachlor epoxide
Endosulfan I
Dieldrin
4,4'-DDE
Endrin
Endosulfan II
4,4'-DDD
Endrin aldehyde
Endosulfan Sulfate
4,4'-DDT
Methoxychlor
Chlordane
Toxaphene
Aroclor-1016
Aroclor-1221
Aroclor-1232
Aroclor-1242
Aroclor-1248
Aroclor-1254
Aroclor-1260
Kepone
Chlorobenzilate
Diallate
Isodrin

Organophosphorous Pesticide Compounds (9 total)
SW-846 Method 8140

Triethylphosphorothioate
Thionazin
Sulfotepp
Phorate
Dimethoate
Disulfoton
Methyl Parathion
Ethyl Parathion
Famphur

Table 2-1 (Continued) Appendix IX, Groundwater Monitoring List

Chlorinated Herbicide Compounds (4 total) SW-846 Method 8150			
2,4-D	Silvex	2,4,5-T	Dinoseb
Inorganic Analytes (19 total) SW-846 Methods			
Antimony		Copper	Thallium
Arsenic		Lead	Vanadium
Barium		Mercury	Zinc
Beryllium		Nickel	Tin
Cadmium		Selenium	Cyanide
Chromium		Silver	Sulfide
		Cobalt	

2.1.3 Interim Corrective Measure Screening Investigation The ICMSI was conducted in October and November 1992, with follow-on work conducted in March 1993 (ABB-ES, 1993c). The initial ICMSI conducted in 1992 included collection of 144 groundwater samples from 46 locations in and around the landfill, on the right-of-way of Spur 40, and in Crooked River Plantation Subdivision. Sample depths ranged from 5 to 72 feet bgs. All of the groundwater samples were analyzed in an on-site laboratory for 10 target VOCs listed below:

vinyl chloride	trans-1,2-dichloroethene
trichloroethene	cis-1,2-dichloroethene
tetrachloroethene	benzene
toluene	ethylbenzene
m/p-xylene	o-xylene

Seventeen duplicate groundwater samples were submitted to an off-site laboratory for confirmatory analysis. These analyses were performed according to Contract Laboratory Program (CLP) methods and included Target Compound List (TCL) VOCs (Table 2-2). Two groundwater samples were collected and submitted to the off-site laboratory for analysis of TCL SVOCs.

During the ICMSI field effort, two problems were encountered that necessitated follow-on work. First, the direct push instruments had difficulty with the stratigraphy and frequently met refusal at depths as shallow as 10 feet bgs in the area of the landfill. Second, in the landfill the objective was to penetrate the undisturbed soil between burial trenches, but waste was consistently encountered during penetrations.

The follow-on work for the ICMSI was conducted in March 1993 and included collection of groundwater samples from 16 locations within and to the north of the landfill. Sample depths ranged from 12 to 90 feet bgs. Fifty-four groundwater samples were collected and analyzed in an on-site laboratory for the 10 target VOCs listed for the ICMSI. Five groundwater samples were submitted to an off-site laboratory for analysis of TCL VOCs using CLP methods.

A monitoring well, KBA-11-10, was also installed during the March 1993 field effort. This monitoring well was installed at one of the hydropunch locations in the landfill and is 20 feet deep with a 10-foot well screen.

2.1.4 Supplemental RFI In October and November 1993, groundwater monitoring wells were installed in and around the landfill and in Crooked River Plantation Subdivision. Twenty-five monitoring wells were installed at 15 locations (Figure 2-2). The monitoring wells range in depth from 20 to 95 feet bgs. Results of previous investigations were used to select screened intervals for the monitoring wells. The monitoring wells will be sampled during two groundwater sampling events in January and March 1994. Sample analysis will include all TCL and Target Analyte List (TAL) analytes, plus sulfide, which is not a TAL parameter. A subset of groundwater samples collected during the first groundwater sampling event will be analyzed for Appendix IX constituents.

2.1.5 Interim Measure Groundwater contamination characterization activities associated with the IM include collection of groundwater samples from four recovery wells installed in October and November 1993. These samples were submitted to an off-site laboratory for analysis of TCL and TAL parameters (plus sulfide) using CLP methods.

Table 2-2 Target Compound List and Target Analyte List

Parameter: **Volatile Organic Compounds**
Method: **Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration.**

Chloromethane	cis-1,3-Dichloropropene
Bromomethane	Trichloroethene
Vinyl Chloride	Dibromochloromethane
Chloroethane	1,1,2-Trichloroethane
Methylene Chloride	trans-1,3-Dichloropropene
Acetone	Bromoform
Carbon Disulfide	2-Hexanone
1,1-Dichloroethene	4-Methyl-2-Pentanone
1,1-Dichloroethane	Tetrachloroethene
1,2-Dichloroethene (total)	1,1,2,2-Tetrachloroethane
Chloroform	Toluene
1,2-Dichloroethane	Benzene
2-Butanone	Chlorobenzene
1,1,1-Trichloroethane	Ethylbenzene
Carbon Tetrachloride	Styrene
Bromodichloromethane	Xylene (total)
1,2-Dichloropropane	

Parameter: **Semivolatile Organic Compounds**
Method: **Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration.**

Phenol	Acenaphthene
bis(2-Chloroethyl)ether	2,4-Dinitrophenol
2-Chlorophenol	4-Nitrophenol
1,3-Dichlorobenzene	Dibenzofuran
1,4-Dichlorobenzene	2,4-Dinitrotoluene
1,2-Dichlorobenzene	Diethylphthalate
2-Methylphenol	4-Chlorophenyl-phenylether
2,2'-oxybis(1-Chloropropane)	Fluorene
4-Methylphenol	4-Nitroaniline
N-Nitroso-di-n-propylamine	4,6-Dinitro-2-methylphenol
Hexachloroethane	N-Nitrosodiphenylamine
Nitrobenzene	4-Bromophenyl-phenylether
Isophorone	Hexachlorobenzene
2-Nitrophenol	Pentachlorophenol
2,4-Dimethylphenol	Phenanthrene
bis(2-Chloroethoxy)methane	Anthracene
2,4-Dichlorophenol	Carbazole
1,2,4-Trichlorobenzene	Di-n-butylphthalate
Naphthalene	Fluoranthene

See note at end of table.

Table 2-2 (continued) Target Compound List and Target Analyte List

Parameter: Semivolatile Organic Compounds (Continued)

4-Chloroaniline	Pyrene
Hexachlorobutadiene	Butylbenzylphthalate
4-Chloro-3-methylphenol	3,3'-Dichlorobenzidine
2-Methylnaphthalene	Benzo(a)anthracene
Hexachlorocyclopentadiene	Chrysene

Parameter: Semivolatile Organic Compounds - continued
Method: Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration.

2,4,6-Trichlorophenol	bis(2-Ethylhexyl)phthalate
2,4,5-Trichlorophenol	Di-n-octyl phthalate
2-Chloronaphthalene	Benzo(b)fluoranthene
2-Nitroaniline	Benzo(k)fluoranthene
Dimethylphthalate	Benzo(a)pyrene
Acenaphthylene	Indeno(1,2,3-cd)pyrene
2,5-Dinitrotoluene	Dibenz(a,h)anthracene
3-Nitroaniline	Benzo(g,h,i)perylene

Parameter: Organochlorine Pesticide and PCB Compounds
Method: Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration.

alpha-BHC	Endosulfan sulfate
beta-BHC	4,4'-DDT
delta-BHC	Methoxychlor
gamma-BHC (Lindane)	gamma-Chlordane
Heptachlor	alpha-Chlordane
Aldrin	Toxaphene
Heptachlor epoxide	Aroclor-1016
Endosulfan I	Aroclor-1221
Dieldrin	Aroclor-1232
4,4'-DDE	Aroclor-1242
Endrin	Aroclor-1248
Endosulfan II	Aroclor-1254
4,4'-DDD	Aroclor-1260
Endrin aldehyde	

Parameter: Inorganic Analytes
Method: Contract Laboratory Program Statement of Work for Inorganic Analysis

Aluminum	Cobalt	Potassium
Antimony	Copper	Selenium
Arsenic	Iron	Silver
Barium	Lead	Sodium
Beryllium	Magnesium	Thallium

See note at end of table.

Table 2-2 (continued) Target Compound List and Target Analyte List

Parameter: Inorganic Analytes (Continued)		
Cadmium	Manganese	Vanadium
Chromium	Mercury	Zinc
Calcium	Nickel	Cyanide

Note:

PCBs = polychlorinated biphenyls

Additionally, groundwater samples were collected from monitoring well KBA-11-10 (July 1993) and KBA-RW-01 (October 1993). The purpose of analyzing samples from KBA-11-10 and KBA-RW-01 was to evaluate the treatability of the groundwater with respect to the need for pretreatment. The data are included herein for use in evaluating the wastestream to be treated under this request. The groundwater samples from KBA-11-10 were analyzed by an off-site laboratory for the constituents listed below:

TAL inorganics	Alkalinity (as $CaCO_3$)
Hardness, Total (as $CaCO_3$)	TDS
Volatile Suspended Solids	TSS
Total Volatile Solids	Total Solids
Chloride	Sulfate
Sulfide	Ammonia (as N)
Nitrate and Nitrite (as N)	Kjeldahl Nitrogen (as N)
Biological Oxygen Demand (5 and 20 day)	Chemical Oxygen Demand
Grease and Oil	Total Organic Carbon

The samples from KBA-RW-01, collected in October 1993, were analyzed by an off-site laboratory for select metals (cadmium, chromium, lead, iron, and manganese), total hardness (as $CaCO_3$), TDS, TSS, chloride, and total organic carbon (TOC).

2.2 GROUNDWATER CONTAMINATION. The following subsections summarize available information on contaminants in the groundwater to be treated under the IM. The discussion is organized according to groups of compounds.

2.2.1 Volatile Organic Compounds Table 2-3 summarizes VOC data for the RFI groundwater samples. Eleven chlorinated and nonchlorinated solvents and fuel-related VOCs were detected in groundwater samples from monitoring well KBA-11-2 during the RFI bimonthly sampling events. Vinyl chloride was the only VOC detected above its MCL of 2 $\mu g/l$. In the remaining four wells containing detectable VOCs, one to four VOCs were detected, but none of the VOC concentrations exceeded MCLs. Detection of vinyl chloride in samples from monitoring well KBA-11-2 prompted the Navy to initiate an aggressive investigation of potential VOC contamination of groundwater.

The results of the Phase I Interim Investigation and ICMSI confirmed that VOCs had migrated, via the groundwater, beyond the boundary of the landfill and underneath Crooked River Plantation Subdivision. These chemicals included solvent-related VOCs such as the dichloroethene and vinyl chloride, as well as fuel-related VOCs such as benzene, ethylbenzene, toluene, and xylenes.

Tables 2-4 and 2-5 summarize on-site and off-site analytical data, respectively, for the groundwater samples collected during the Phase I Interim Investigation and the ICMSI. A total of 25 VOCs have been detected in 27 groundwater samples from the plume. Based on off-site laboratory analysis, seven VOCs were detected at concentrations greater than corresponding MCLs promulgated under state and federal drinking water regulations (Table 2-5). The seven VOCs include benzene, 1,2-dichloroethane, cis-1,2-dichloroethene, 1,2-dichloropropane, methylene chloride, trichloroethene, and vinyl chloride. The on-site analytical data (Table 2-4) indicate that tetrachloroethene is also present in groundwater at concentrations that exceed its MCL of 5 $\mu g/l$.

Table 2-3 Summary of Volatile Organic Compound and Semivolatile Organic Compound Analytical Data for the RFI Groundwater Monitoring Program at Site 11

Monitoring Well I.D.	SVOCs Detected	VOCs Detected	Concentration Range (µg/l)	Associated Sample Events
KBA-11-1	None	None		
KBA-11-2	None	vinyl chloride	18 - 160	1,2,3,4,5,6
		1,2-dichloroethene	4.8 - 22	1,2,3,4,5,6
		ethylbenzene	1 J	5
		toluene	1 J - 3 J	2,4,5,6
		xylenes (total)	2 J - 4 J	2,3,5,6
		1,4-dichlorobenzene	1 J	5
		chloroethane	3 J - 5 J	3,5
		methylene chloride	3.3	4
		trichloroethene	1 J	2
		tetrachloroethene	1 J	2
		chloroform	4 J	1
KBA-11-3		chlorobenzene	3 J - 6	1,2,3,4,5,6
	1,4-dichlorobenzene	1,4-dichlorobenzene	4 - 28	1,2,4,5,6
		1,3-dichlorobenzene	15	2,3
	bis(2-ethylhexyl) phthalate		31	2
KBA-11-4		None		
KBA-11-5		xylenes (total)	2	1
		1,4-dichlorobenzene	1 J - 2 J	1,2,3,4
	bis(2-ethylhexyl) phthalate		4 J	2
KBA-11-6		xylenes (total)	2	1
		1,4-dichlorobenzene	1 J - 2 J	1,2,3,4,6
	bis(2-ethylhexyl) phthalate		5 J	2
KBA-11-7	bis(2-ethylhexyl) phthalate	None	94	1

See notes at end of table.

Table 2-3 (Continued) Summary of Volatile Organic Compound and Semi-volatile Organic Compound Analytical Data for the RFI Groundwater Monitoring Program at Site 11

Monitoring Well I.D.	SVOCs Detected	VOCs Detected	Concentration Range (µg/l)	Associated Sample Events
KBA-11-8		vinyl chloride	2 J	1
		ethylbenzene	1 J	1
		xylenes (total)	5	1
		chloroethane	2 J	2
	diethylphthalate		9 J	1
KBA-11-9		xylenes	3 J	1

Notes:

µg/l = micrograms per liter
J = estimated concentration
VOC = volatile organic compound
SVOC = semivolatile organic compound

Source:

ABB-ES, 1993a.

Table 2-4 Summary of On-site Analytical Data for Groundwater Samples Collected during the Phase I Interim Investigation and the Interim Corrective Measure Screening Investigation

Chemical Detected	MCL (µg/l)	Number of Detections/Number of Samples[1]	Concentration Range (µg/l)	Frequency Above MCL
Volatile Organic Compounds				
Benzene	5	24/102	1.0 - 28	17/24
cis-1,2-Dichloroethene	70	56/125	1.3 - 1,100	10/56
trans-1,2-Dichloroethene	100	9/125	5.0 - 21	0/9
Ethyl benzene	700	24/102	2.7 - 200	0/24
Tetrachloroethene	5	8/125	3.2 - 24	7/8
Toluene	1,000	42/102	4.0 - 430	0/42
Trichloroethene	5	4/125	5.9 - 45	4/4
Xylenes (total)	10,000	31/102	2.1 - 155	0/31
Vinyl chloride	2	113/125	1.1 - 1,400	112/113
Total Volatile Organic Compounds	NA	NA	1.0 - 1537	NA

Notes:

µg/l = micrograms per liter
MCL = Maximum Contaminant Level
NA = Not Applicable

[1] The total number of samples includes those samples that contained at least one or more volatile organic compounds.

Sources:

ABB-ES, 1992.
ABB-ES, 1993c.

Table 2-5 Summary of Off-site Analytical Data for Groundwater Samples Collected during the Phase I Interim Investigation and the Interim Corrective Measure Screening Investigation

Chemical Detected	MCL (µg/l)	Number of Detections/Number of Samples[1]	Concentration Range (µg/l)	Frequency Above MCL
Volatile Organic Compounds				
Acetone	NA	11/49	6 - 800	NA
Benzene	5	7/49	1.7 - 5	2/7
Bromomethane	NA	1/49	1.5	NA
2-Butanone (methyl ethyl ketone)	NA	6/49	24 - 580	NA
Chlorobenzene	100	2/49	2.3 - 10	0/2
Chloroform	NA	1/49	3	NA
Carbon Disulfide	NA	6/49	1 - 250	NA
1,2-Dichlorobenzene	600	1/49	6.4	0/1
1,4-Dichlorobenzene	75	4/49	1.8 - 12	0/4
Dichlorodifluoromethane	NA	1/49	5.3	NA
1,1-Dichloroethane	NA	8/49	2 - 100	NA
1,1-Dichloroethene	7	1/49	3.9	0/1
1,2-Dichloroethane	5	1/49	9	1/1
cis-1,2-Dichloroethene	70	13/49	1 - 3,600	3/13
trans-1,2-Dichloroethene	100	2/49	1 - 23	0/2
1,2-Dichloropropane	5	2/49	1 - 6	1/2
Ethylbenzene	700	10/49	2 - 41	0/10
2-Hexanone (methyl butyl ketone)	NA	4/49	16 - 70	NA
Methylene chloride	5	3/49	3 - 41	2/3
4-Methyl-2-pentanone	NA	7/49	12 - 110	NA
Tetrachloroethene	5	1/49	3	0/1
Toluene	1,000	9/49	2 - 840	0/9
Trichloroethene	5	6/49	3 - 45	2/6
Xylenes (total)	10,000	9/49	1 - 120	0/9
Vinyl chloride	2	7/49	1.4 - 310	6/7
Semivolatile organic compounds				
2,4-Dimethylphenol	NA	1/2	280	NA
2-Methylphenol	NA	1/2	7	NA
4-Methylphenol	NA	1/2	120	NA

See notes at end of table.

Table 2-5 (Continued) Summary of Off-site Analytical Data for Groundwater Samples Collected during the Phase I Interim Investigation and the Interim Corrective Measure Screening Investigation

Chemical Detected	MCL (µg/l)	Number of Detections/Number of Samples[1]	Concentration Range (µg/l)	Frequency Above MCL
Diethylphthalate	NA	2/2	2 - 50	NA
Naphthalene	NA	1/2	20	NA

Notes: µg/l = micrograms per liter
MCL = Maximum Contaminant Level
NA = Not Applicable

[1] The total number of samples includes those samples that contained at least one or more volatile organic compounds.

Sources:

ABB-ES, 1992.
ABB-ES, 1993c.

The on-site analytical data associated with the Phase I Interim Investigation, ICMSI, and the March 1993 follow-on investigation to the ICMSI were used to create the VOC contour maps presented in Figures 2-3, 2-4, and 2-5. The contour maps were generated using GIS Key™ software. Comparison of Figures 2-3, 2-4, and 2-5 indicates that the majority of VOC contamination is approximately 30 feet bgs, extending from the western margin of the landfill to the right-of-way of Spur 40. The locations and depths of the recovery wells installed during October and November 1993 were selected based on these observations.

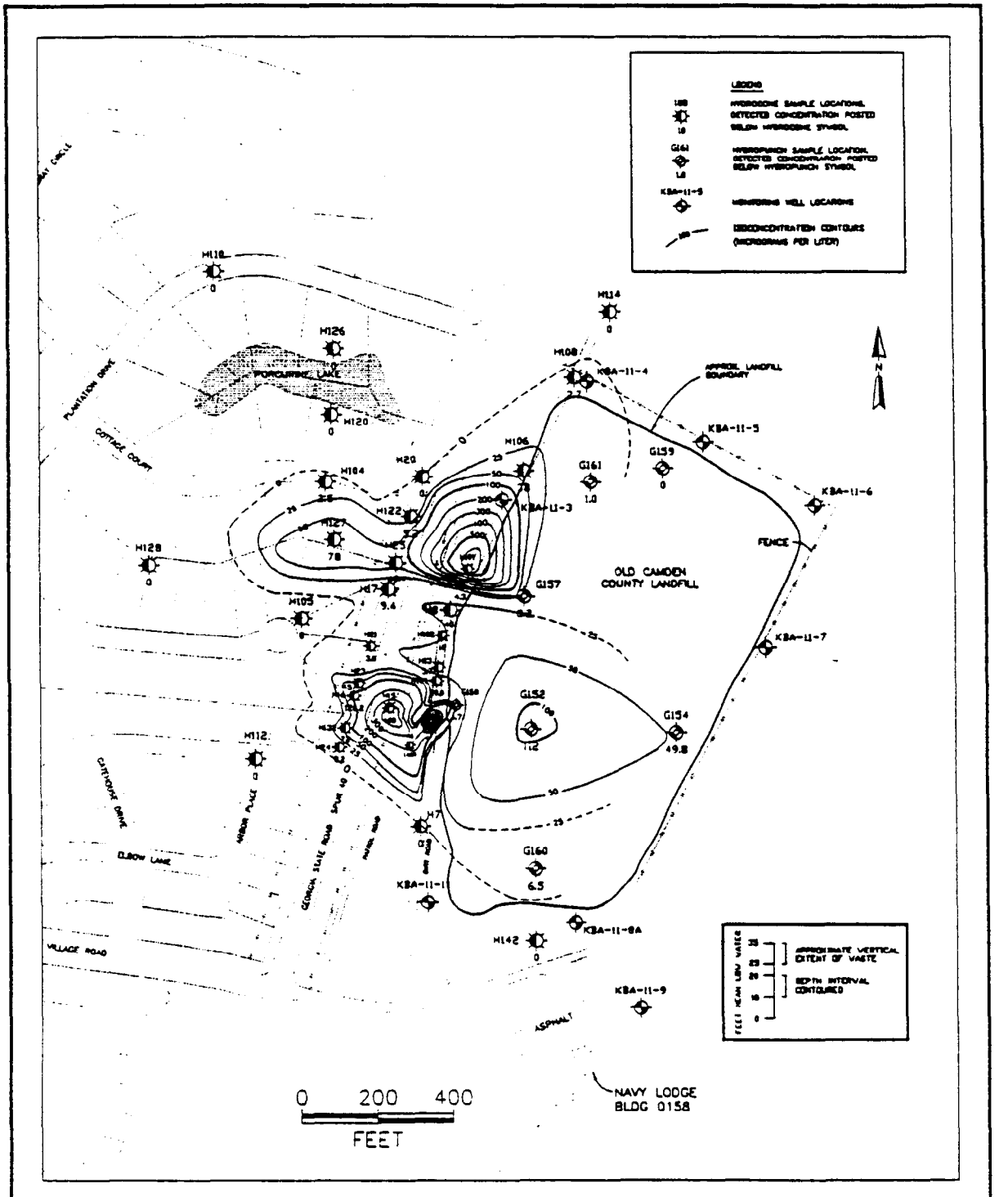
Table 2-6 summarizes VOC analytical data for groundwater samples collected from four recovery wells. Samples collected from the recovery wells contain lower concentrations of VOCs than the samples collected during the Phase I Interim Investigation and ICMSI. The relative difference in VOC concentrations is attributed to differences in sample intervals. The recovery wells have screened intervals of 40 and 50 feet, whereas the sampling devices used during the Phase I Interim Investigation and the ICMSI collect groundwater samples from discrete intervals of 1 foot (hydrocone) and 11 inches (hydropunch). Four VOCs, including 1,2-dichloroethene, methylene chloride, trichlorothene, and vinyl chloride, were detected at concentrations greater than corresponding MCLs promulgated under state and federal drinking water regulations.

2.2.2 Semivolatile Organic Compounds SVOCs detected in groundwater samples during the first two bimonthly sampling events included 1,4-dichlorobenzene and phthalate compounds (see Table 2-3). 1,4-Dichlorobenzene is included as a VOC and an SVOC in Appendix IX analyses. This compound was detected as an SVOC in groundwater samples from monitoring well KBA-11-3 at concentrations ranging from 4 J (estimated concentration) to 13 µg/l. These concentrations do not exceed the MCL of 75 µg/l for 1,4-dichlorobenzene. Two phthalate compounds, diethylphthalate and bis(2-ethylhexyl)phthalate, were detected in groundwater samples. Diethylphthalate was detected at 9 J µg/l in one sample from monitoring well KBA-11-8 during the first sample event. Bis(2-ethylhexyl)phthalate was detected in groundwater samples from four monitoring wells at concentrations ranging from 4 J to 94 µg/l. There are no MCLs for these compounds. Phthalates are common artifacts of sampling and analysis. They can be introduced into sample media through contact with plastic tubing, sample gloves, and sample containers.

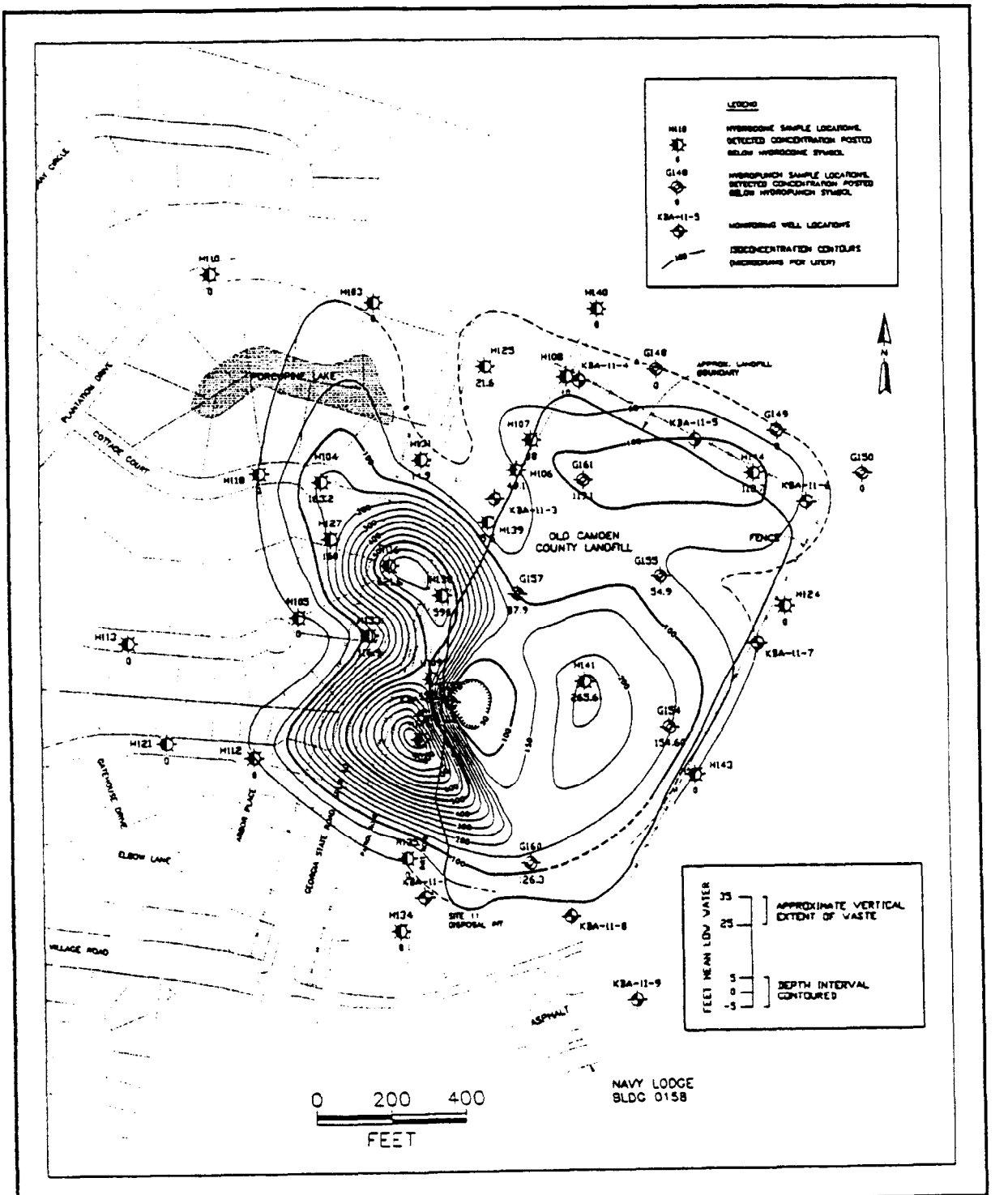
The two groundwater samples collected during the ICMSI and submitted for SVOC analysis contained detectable concentrations of five SVOCs (see Table 2-5). The SVOCs detected include three phenolic compounds, a phthalate, and a polycyclic aromatic. Concentrations ranged from 2 to 280 µg/l. Phenolic compounds and a phthalate compound were also detected at similar concentrations in groundwater samples collected from four recovery wells, as shown in Table 2-6. The SVOCs detected do not have MCLs under state or federal drinking water standards.

2.2.3 Other Organic Compounds VOCs and SVOCs are the only organic compounds detected in groundwater samples from the site. Other organic compounds analyzed in groundwater samples include pesticides, PCBs, herbicides, dioxins, and furans.

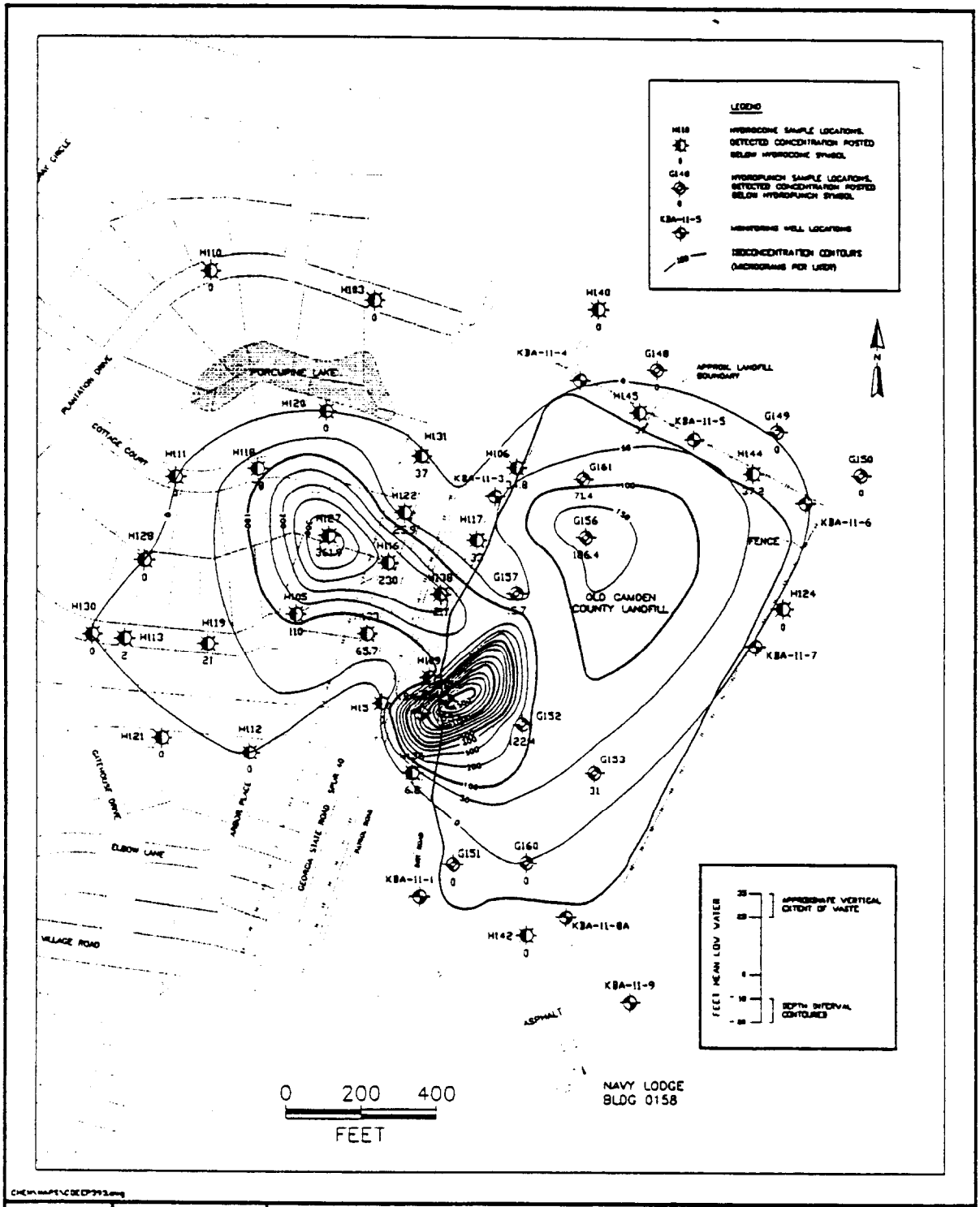
2.2.4 Inorganic Constituents Table 2-7 summarizes inorganic analytical data for the RFI groundwater monitoring program. The first sampling event for the RFI program was conducted approximately 1 week after well installation was completed. The inorganic data associated with the first sampling event are suspected of being influenced by non-equilibrium conditions following well drilling and installation. This non-equilibrium condition is attributed to disturbance of the



DWN: NLW	PROJECT NO.: 08503	TITLE: INTERPRETED PLUME PLAN VIEW 20 TO 10 FT MEAN LOW WATER TOTAL TARGET VOCs	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: LBH	FIGURE NO.: 2-3		
DATE: 12/08/93			



DWN: NLW	PROJECT NO.: 08503	TITLE: INTERPRETED PLUME PLAN VIEW 5 TO -5 FT MEAN LOW WATER TOTAL TARGET VOCs
CHKD: LBH	FIGURE NO.: 2-4	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 12/08/93		



DWN: NLW	PROJECT NO.: 08503	TITLE: INTERPRETED PLUME PLAN VIEW -10 TO -20 FT MEAN LOW WATER TOTAL TARGET VOCs	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: LBH	FIGURE NO.: 2-5		
DATE: 12/08/93			

Table 2-6 Summary of Organic Analysis of Groundwater Samples Collected from Interim Measure Recovery Wells - November 1993

Chemical Detected	MCL (µg/l)	Number of Detections/Number of Samples[1]	Concentration Range (µg/l)	Frequency Above MCL
Volatile Organic Compounds				
Acetone	NA	4/4	10 - 190	NA
Benzene	5	4/4	1 - 4	0/4
2-Butanone (methyl ethyl ketone)	NA	1/4	190	NA
Chlorobenzene	100	2/4	2	0/2
1,1-Dichloroethane	NA	3/4	2 - 31	NA
1,1-Dichloroethene	7	1/4	2	0/1
1,2-Dichloroethene (total)	70	4/4	9 - 1,200	2/4
Ethylbenzene	700	4/4	3 - 65	0/4
2-Hexanone (methyl butyl ketone)	NA	1/4	40	NA
Methylene chloride	5	4/4	2 - 18	2/4
4-Methyl-2-pentanone	NA	2/4	250 - 1,400	NA
Tetrachloroethene	5	1/4	4	0/1
Toluene	1,000	4/4	6 - 95	0/4
Trichloroethene	5	2/4	2 - 44	1/2
Xylenes (total)	10,000	4/4	2 - 61	0/4
Vinyl chloride	2	3/4	2 - 44	3/3
Semivolatile organic compounds .				
Phenol	NA	3/4	2 - 28	NA
2,4-Dimethylphenol	NA	1/4	26	NA
2-Methylphenol	NA	1/4	16	NA
4-Methylphenol	NA	3/4	15 - 340	NA
Diethylphthalate	NA	4/4	4 - 11	NA
Naphthalene	NA	2/4	2 - 15	NA

Notes:

µg/l = micrograms per liter
MCL = Maximum Contaminant Level
NA = Not Applicable

1 The total number of samples includes those samples that contained at least one or more volatile organic compounds.

Table 2-7 Summary of Inorganic Analytical Data for the RFI Groundwater Monitoring Program at Site 11

Analyte	MCL (µg/l)	Non-filtered Groundwater Concentrations (µg/l) Low	High	Frequency Above MCL[2,3]	No. Locations Above MCL[2]	Filtered Groundwater Concentrations (µg/l) Low	High	Frequency Above MCL[3]
Antimony	6	(11.1)	(11.4)	(2/2) 0/0	(2) 0	ND	ND	0/0
Arsenic	50	1.1	(89) 10.3	(1/34) 0/27	(1) 0	0.68	2.5	0/12
Barium	2,000	11.1	(617) 158	(0/54) 0/45	None	4.4	37.9	0/22
Beryllium	4	0.26	(10.2) 4.0	(6/51) 1/42	(6) 1	0.24	0.25	0/2
Cadmium	5	1.3	7.1	(1/8) 1/7	(1) 1	2.8	3.9	0/5
Chromium	100	8.1	(620) 157	(12/45) 4/36	(8) 3	2.6	9.0	0/4
Cobalt	NA	1.6	(16.8) 6.1	NA	None	1.8	2.9	NA
Copper	1,300	3.1	(384) 239	(0/48) 0/42	None	2.6	52.4	0/13
Lead	15	2.9	87.2	(16/53) 8/44	(8) 6	0.98	10.1	0/20
Mercury	2	0.11	4.1	(2/26) 1/18	(2) 1	ND	ND	0/0
Nickel	100	5.7	(107) 89.1	(1/29) 0/20	(1) 0	6.5	11.0	0/4
Selenium	50	0.55	(26.0) 6.4	(0/33) 0/25	None	ND	ND	0/0
Silver	NA	1.5	10.1	NA	None	2.0	2.5	NA
Thallium	2	1.6	1.6	(0/1) 0/1	None	ND	ND	0/0
Vanadium	NA	5.4	(314) 82.5	NA	None	1.4	6.2	NA
Zinc	NA	17.3	555	NA	None	8.4	77.0	NA
Cyanide	200	0.98	26.2	(0/15) 0/12	None	1.1	3.7	0/10
Sulfide	NA	100	(3,400) 2,900	NA	None	100	300	NA
TDS	NA	16	2,110	NA	None		Not Analyzed	
TSS	NA	92	1,090	NA	None		Not Analyzed	

Notes: µg/l = micrograms per liter
MCL = Maximum Contaminant Level
TDS = total dissolved solids
TSS = total suspended solids

1 If the high concentration for the six sampling events occurred in sample event 1, it is shown in parentheses, otherwise the high concentration did not occur during sample event 1.
2 Numbers in parentheses indicate summary of sample events 1 through 6. Numbers without parentheses indicate summary of sample events 2 through 6.
3 Number of detections above MCL/total number of detections.

Source: ABB-ES, 1993a.

aquifer resulting from drilling. The high concentrations shown for unfiltered groundwater samples include the data for the first sampling event in parentheses, if the high concentration was associated with the first sampling event. On Table 2-7, the frequency of detections above an MCL and the number of locations where MCLs were exceeded are summarized by presenting sampling events 1 through 6 in parentheses and sampling events 2 through 6 without parentheses.

The data summarized in Table 2-7 can be evaluated for bias associated with non-equilibrium conditions during the first sample event. Chromium, for instance, was detected at a high concentration of 620 μg/l during the first sampling event, but the high concentration detected during the following five sampling events was 157 μg/l. Additionally, chromium was detected at concentrations above its MCL of 100 μg/l in eight groundwater samples collected during the first sampling event, but only in four groundwater samples collected during the following five sampling events.

Inorganics detected above MCLs during the second through sixth groundwater sampling events include beryllium, cadmium, chromium, lead, and mercury. Beryllium, cadmium, and mercury were each detected above MCLs in one groundwater sample. Lead and chromium were detected above MCLs in eight and four groundwater samples, respectively.

Table 2-8 summarizes inorganic analytical data for groundwater samples collected from monitoring well KBA-11-10A and recovery well KBA-RW-01. Similarly, Table 2-9 summarizes inorganic analytical data for samples collected from four recovery wells, KBA-RW-01 through KBA-RW-04. None of the inorganic concentrations exceed MCLs.

Table 2-8 Summary of Analytical Data for Samples Collected for Pretreatment Evaluation

Analyte	KBA-11-10 Unfiltered 7-1-93 (µg/l)	KBA-11-10 Filtered 7-1-93 (µg/l)	KBA-RW-01 10-26-93 (µg/l)	KBA-RW-01 Duplicate 10-26-93 (µg/l)
Aluminum	32,800	272		
Antimony	20.2 U	20.2 U		
Arsenic	9.2 J	2.9 J		
Barium	87.1 J	53.3 J		
Beryllium	0.61 J	0.41 J		
Cadmium	2.6 U	2.6 U	<5	<5
Calcium	71,800	68,200		
Chromium	24.2	2.5 U	<10	<10
Cobalt	4.8 U	4.8 U		
Copper	8.7 J	2.6 J		
Iron	55,600	47,500	1,610	1,620
Lead	3.9	1.4 J	<3	<3
Magnesium	17,400	17,500		
Manganese	434	405	31	31
Mercury	0.41	0.08 J		
Nickel	11.7 J	9.2 U		
Potassium	16,200	12,700		
Selenium	3.4 J	1.6 U		
Silver	2.4 U	2.9 J		
Sodium	10,600	10,800		
Thallium	1.6 J	1.3 U		
Vanadium	19.0 J	2.0 U		
Zinc	133	20.9		

See notes at end of table.

Table 2-8 (Continued) Summary of Analytical Data for Samples Collected for Pretreatment Evaluation

Parameter	KBA-11-10 Unfiltered 7-1-93 (mg/l)	KBA-11-10 Filtered 7-1-93 (µg/l)	KBA-RW-01 10-26-93 (mg/l)	KBA-RW-01 Duplicate 10-26-93 (mg/l)
Alkalinity (as $CaCO^3$)	296			
Hardness, Total (as $CaCO_3$)	251		38	39
Total Dissolved Solids	319		178	172
Total Suspended Solids	510		2.7	9.8
Volatile Suspended Solids	174			
Total Volatile Solids	619			
Total Solids	830			
Chloride	1.9		65	65
Sulfate	26			
Sulfide	1.1			
Ammonia (as N)	18.0			
Nitrate and Nitrite (as N)	<0.02			
Kjeldahl Nitrogen (as N)	18.9			
BOD (5 day)	14.3			
BOD (20 day)	33			
COD	200			
Grease and Oil Li-Li	18.0			
TOC - Liquid	54.6		22.5	19.6

Notes:

BOD = biochemical oxygen demand
$CaCO_3$ = calcium carbonate
COD = chemical oxygen demand
J = estimated concentration
µg/l = micrograms per liter
mg/l = milligrams per liter
N = nitrogen
TOC = total organic carbon
U = not detected

The list uses a different measurement increment starting with alkalinity.

Table 2-9 Summary of Inorganic Analysis of Groundwater Samples Collected from Interim Measure Recovery Wells - November 1993

Analyte Detected	MCL (µg/l)	Number of Detections/Number of Samples[1]	Concentration Range (µg/l)	Frequency Above MCL
Aluminum	NA	4/4	478 - 10,600	NA
Arsenic	50	4/4	1.2 - 5.5	0/4
Barium	2,000	4/4	32.4 - 94.9	0/4
Beryllium	4	1/4	0.80	0/1
Calcium	NA	4/4	5,680 - 13,500	NA
Chromium	100	4/4	3.4 - 17.4	0/4
Copper	1,300	1/4	4.5	0/1
Iron	NA	4/4	1,110 - 6,780	NA
Lead	15	2/4	0.46 - 5.4	0/2
Magnesium	NA	4/4	2,740 - 6,260	NA
Manganese	NA	4/4	35.4 - 92.1	NA
Nickel	100	3/4	9.5 - 10.7	0/3
Potassium	NA	4/4	3,700 - 24,400	NA
Sodium	NA	4/4	36,900 -47,000	NA
Vanadium	NA	4/4	2.7 - 14.4	NA
Zinc	NA	4/4	13.5 - 823	NA
Cyanide	200	3/4	1.9 - 2.1	0/3
Sulfide	NA	4/4	1.8 - 22.7	NA

Notes:

µg/l = micrograms per liter
MCL = Maximum Contaminant Level
NA = Not Applicable

[1] The total number of samples includes those samples that contained at least one or more inorganic analytes.

3.0 TREATMENT SYSTEM DESCRIPTION

3.1 TREATMENT SYSTEM. The treatment system will collect, treat, and discharge water extracted from the surficial aquifer by the pilot-scale GWE system, as well as other fluids generated during the Phase I installation and operation activities. The streams that will be treated by this system include:

- groundwater from the recovery wells,
- vehicle and equipment decontamination water,
- treatment area spills, leaks, and washdown water,
- process area storm water (if contaminated), and
- water from preliminary aquifer pumping test(s) and well development.

Flow through the treatment system is expected to be approximately 40 gpm. The actual flow rate will depend on optimum flow rates from each of the recovery wells and actual flows from the decontamination pad and treatment pad sumps. The maximum design flow for the pilot-scale treatment system will be 60 gpm, providing additional capacity for additional recovery wells or storm water as needed.

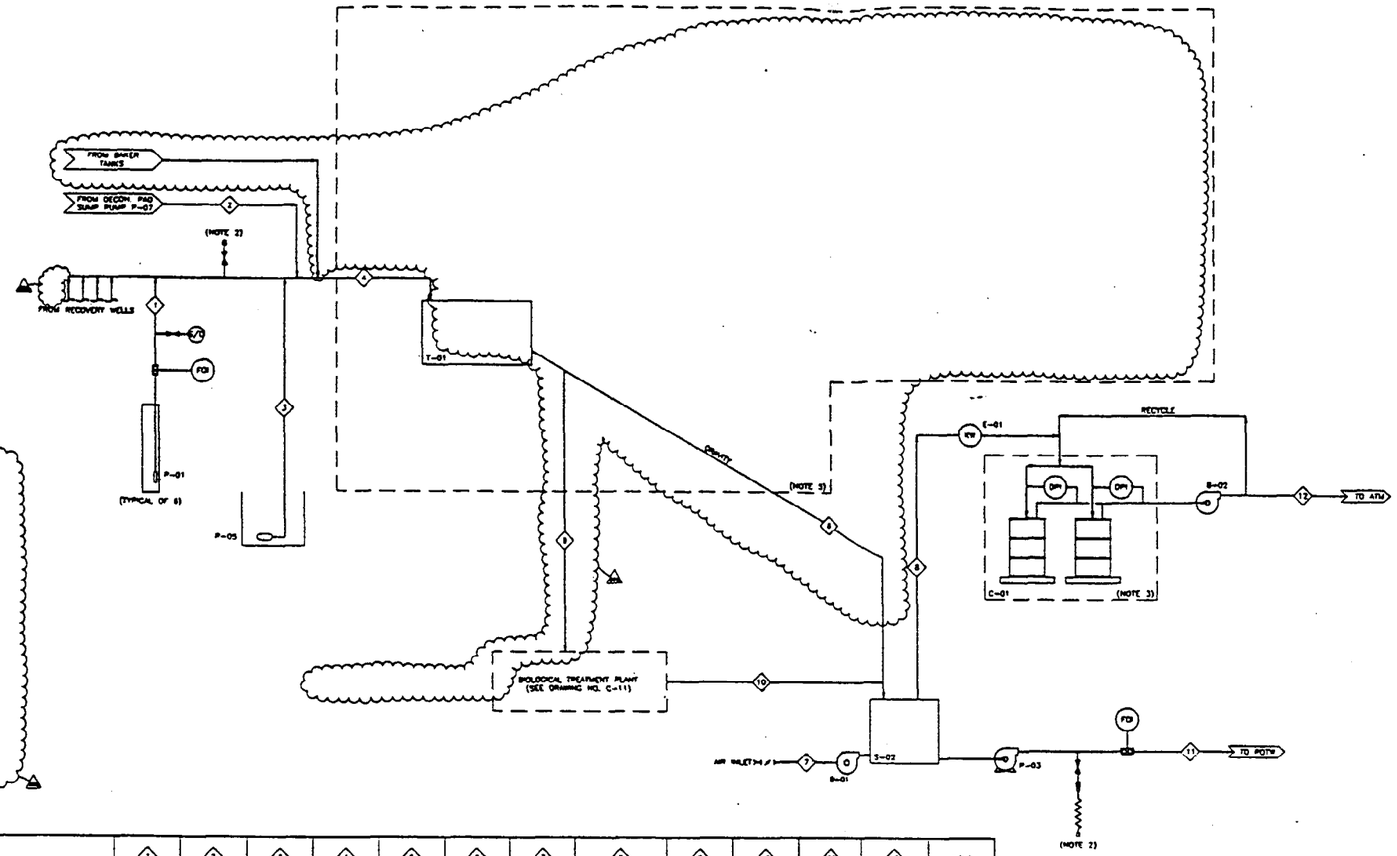
An air sparger will be used to treat the groundwater prior to discharge. The air sparger, an air stripping technology, is a diffused aeration system where a blower directs air into a tank of contaminated water through diffusers that produce coarse bubbles. Water enters the tank through a spray pipe at one side of the unit. As the water is aerated, the contaminants are transferred to the air bubbles. Exhaust air is released through a vent at the top of the tank. For this system, the water will travel through eight consecutive stages of aeration. The exhaust air is collected in a header and is transferred to a carbon adsorption system for treatment before discharge to the atmosphere.

Groundwater extracted by the GWE system will contain VOCs. All the constituents found in the groundwater that are present at concentrations of concern, listed in Table 1-1, are readily volatilized by air sparging and can be reduced to concentrations below MCLs, including 1,2-dichloroethane, cis-1,2-dichloroethene, 1,2-dichloropropane, trichloroethene, methylene chloride, benzene, and vinyl chloride.

A Process Flow Diagram is provided as Figure 3-1.

3.1.1 Pretreatment Tank Groundwater from the recovery wells, system wastewater and storm water will be discharged to the pretreatment tank. The pretreatment tank will provide equalization of the influent streams to minimize possible variations in flow rates or water quality and, therefore, maximize the efficiency of the treatment system. Assuming a process flow rate of 60 gpm, the 1,500-gallon, carbon steel tank provides a 25-minute retention. Retention time will increase with decreases in flow rate. Water from the pretreatment tank will gravity flow to the air sparger. A Piping and Instrumentation Diagram is provided as Figure 3-2.

Liquid level indicators and switches in the pretreatment tank will control the operation of the recovery well pumps. A high liquid level in the pretreatment tank will activate an alarm and shut off the recovery well pumps. The level switch will have a time delay to restart the pumps to avoid excessive cycling of



ABBREVIATIONS

B-01 – BLOWER
B-02 – CARBON ID FAN
C-01 – CARBON UNIT
E-01 – PREHEATER

P-01A THROUGH E – RECOVERY PUMPS
P-03 – EFFLUENT PUMP
P-05 – TREATMENT PAD SUMP PUMP
P-07 – DECONTAMINATION PAD SUMP PUMP
S-02 – AIR SPARGER
T-01 – PRETREATMENT TANK/EQUALIZATION TANK

LEGEND OF SYMBOLS

POSITIVE DISPLACEMENT PUMP
DIAPHRAGM PUMP (ELECTRICAL)
SUBMERGED SUMP PUMP
CENTRIFUGAL PUMP
FLOW TOTALIZER INDICATOR
DIRECT CONNECTION
DIRECT CONNECTION BLOCK VALVE IN CAP
ELECTRICAL CONNECTION
PACKAGED EQUIPMENT OR INTEGRAL UNITS
FLOW STREAM
HEATER
FLEXIBLE HOSE
PIPE ENDED WITH CAP
IN-LINE DEVICE
AGITATOR
DRAIN
SAMPLE TAP
SAMPLE TAP/DRAIN
PRIMARY PROCESS
NOT PIPING
ELECTRICAL
LINE BREAK OR RESUMPTION POINT
QUICK DISCONNECT
GLOBE VALVE
GATE VALVE
CHECK VALVE
BALL VALVE
BUTTERFLY VALVE IN LIQUID LINES, LOUVER IN AIR SERVICE

NOTES

1. FOR LEGEND OF SYMBOLS SEE THIS SHEET.
2. FOR RECYCLE.
3. CARBON TO BE PLACED ON PALLETS.
4. PVC ON TREATMENT PAD IS SCHEDULE 80.
5. PRETREATMENT MAY BE INSTALLED AT A LATER DATE.

	1	2	3	4	5	6	7	8	9	10	11	12	MCLS
FLOW STREAM	RECOVERY WELLS (TYP)	DECON. SUMP	TREATMENT PAD SUMP	INFLUENT		SPARGER FEED	AIR *	VAPOR EFFLUENT	RBC FEED	RBC EFFLUENT	DISCHARGE	VAPOR TO ATM	DISCHARGE CRITERIA
PARAMETER													
AVG. FLOW RATE gpm	8			40		40			1	1	40		
DESIGN													
PUMP FLOW RATE gpm	8	5	5	60		60		*	1	1	60		
DESIGN TOTAL lb/hr	4003.2	2502	2502	30,024		30,024			8.3	8.3	30,024		
SOLIDS lb/hr	2.0			15.3		15.3							
IRON mg/l	3			3		3			53.8				
MANGANESE mg/l	0.434			0.434		0.434			0.434				
ALKALINITY AS $CaCO_3$ mg/l	296			296		296			296				
SULFATE mg/l	28			28		28			28				
HARDNESS AS $CaCO_3$ mg/l	231			231		231			231				
DISSOLVED SOLIDS mg/l	319			319		319			319				
SUSPENDED SOLIDS mg/l	510			510		510			510				
BENZENE ug/l	5			5		5		0.0017 mg/m³	5		0.12		5
2-BUTANONE ug/l	580			580		580			580		580		
CHLOROBENZENE ug/l	10			10		10		0.0034 mg/m³	10		0.33		
1,4-DICHLOROBENZENE ug/l	12			12		12		0.0040 mg/m³	12		0.55		75
1,1-DICHLOROETHANE ug/l	24			24		24		0.0081 mg/m³	24		0.81		
1,2-DICHLOROETHANE ug/l	9			9		9		0.0029 mg/m³	9		0.80		5
CIS-1,2-DICHLOROETHENE ug/l	3800			3800		3800		1.2294 mg/m³	3800		53.28		70
TRANS-1,2-DICHLOROETHENE ug/l	23			23		23		0.0080 mg/m³	23		23		100
1,2-DICHLOROPROPANE ug/l	6			6		6		0.0020 mg/m³	6		0.34		5
ETHYLBENZENE ug/l	41			41		41		0.0140 mg/m³	41		0.85		70
2-HEXANONE ug/l	70			70		70			70		70		
4-METHYL-2-PENTANONE ug/l	110			110		110			110		110		
TETRACHLOROETHENE ug/l	3			3		3		0.0010 mg/m³	3		0.03		5
TOLUENE ug/l	840			840		840		0.2835 mg/m³	840		24.57		1000
TRICHLOROETHENE ug/l	45			45		45		0.0154 mg/m³	45		0.67		3
XYLENES (TOTAL) ug/l	120			120		120		0.0410 mg/m³	120		2.03		10,000
VINYL CHLORIDE ug/l	310			310		310		0.1076 mg/m³	310		0.40		2

* TO BE DETERMINED BY VENDOR

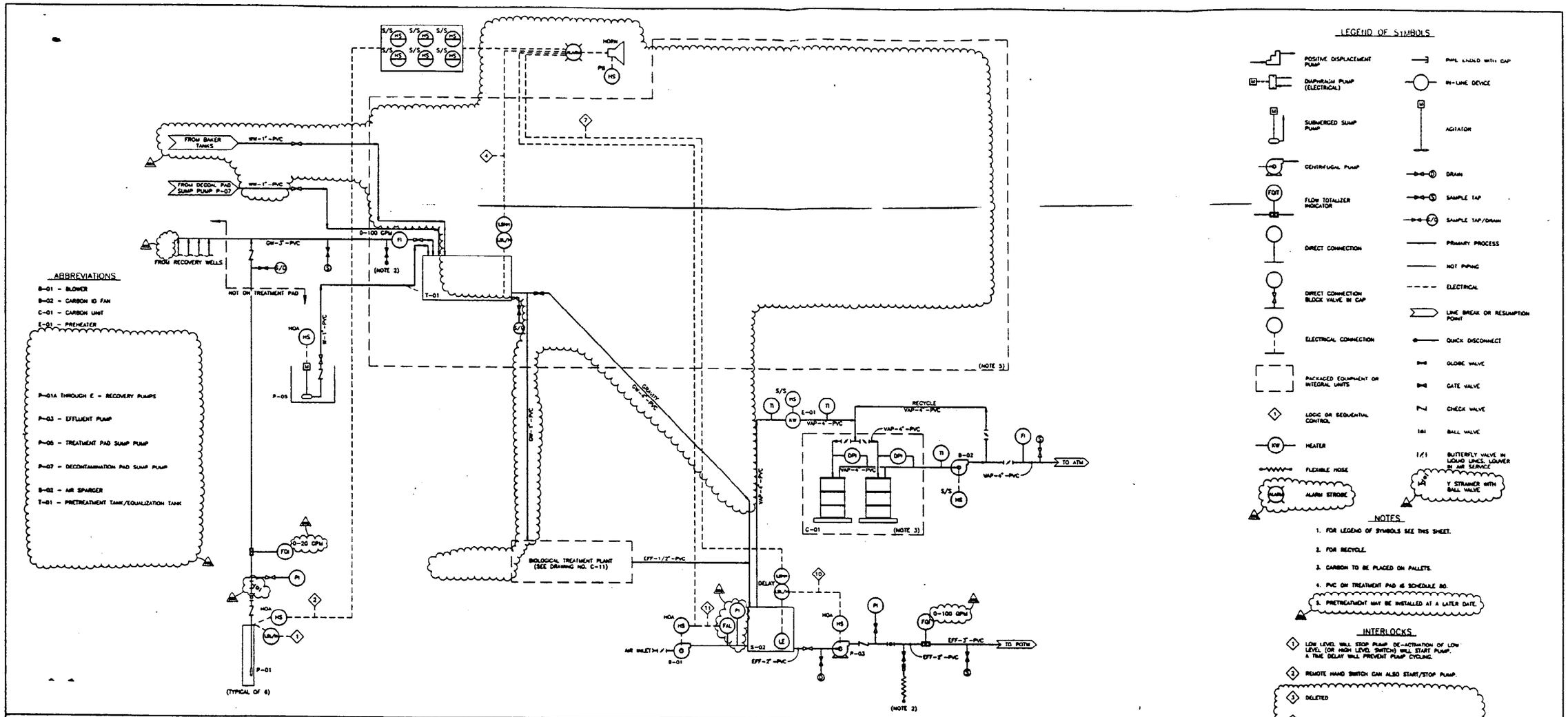
DATE	CHANGE ORDER NO.	BY	DESCRIPTION
11-18-93	002	VAR	PRETREATMENT DELAYED
11-9-93	001	VAR	SIGNED & SEALED

ABB Environmental Services Inc.

DWN: DMF
CHKD: KDS
DATE: 9-24-93
DES: HF
APPD: GMB
REV: VAR
CONTRACT NO: SE 3-21-037
PROJECT NO: 08503 02
SHEET NO: C-10

TITLE: PROCESS FLOW DIAGRAM AIR SPARGER UNIT

FIGURE 3-1



NOTES

1. THE INSTRUMENT LEGEND IS BASED ON ISA STANDARD.
2. THE LETTER "A" IS USED FOR ALL ANALYSIS VARIABLES. TERMS ARE PLACED OUTSIDE THE INSTRUMENT CIRCLE TO DENOTE THE SPECIFIC VARIABLES. SOME EXAMPLES ARE:
   - ORP - OXIDATION REDUCTION POTENTIAL
   - pH - pH
   - TOC - TOTAL ORGANIC CARBON
3. A DEVICE THAT CONNECTS, DISCONNECTS, OR TRANSFERS ONE OR MORE CURRENTS MAY BE EITHER A SWITCH, A RELAY, OR AN ON-OFF CONTROLLER, DEPENDING ON THE APPLICATION.

   A SWITCH, IF IT IS ACTIVATED BY HAND OR DEVICE & USED FOR ALARM, PILOT LIGHT, SELECTION INTERLOCK, OR SAFETY.

   A CONTROLLER, IF THE DEVICE IS USED FOR NORMAL ON-OFF OPERATING CONTROL SUCH AS A SIMPLE HEATING THERMOSTAT.

   A RELAY, IF IT IS AUTOMATIC AND IS NOT THE FIRST SUCH DEVICE IN A LOOP I.E., IT IS ACTIVATED BY A SWITCH OR AN ON-OFF CONTROLLER.
4. A CONTROL OR SENDING DEVICE OR RELAY HAVING A DISPLAY FUNCTION SHOULD HAVE THE APPROPRIATE DISPLAY LETTERS AFTER THE MEASURED VARIABLE DESIGNATION. A-6-AIC DESIGNATES ANALYSIS INDICATING CONTROL STATION.
5. ALARM AND SWITCH DESIGNATIONS SHALL BE FOLLOWED BY A SUFFIX TO INDICATE ACTUATION, I.E., L (LOW), H (HIGH), LL (LOW-LOW SHUTDOWN), HH (HIGH-HIGH SHUTDOWN), HL (HIGH AND LOW).
6. USE OF MODIFYING TERMS HIGH, LOW, AND MIDDLE OR INTERMEDIATE SHALL CORRESPOND TO VALUES OF THE MEASURED VARIABLE, NOT OF THE SIGNAL, UNLESS OTHERWISE NOTED.

GENERAL PIPING AND INSTRUMENTATION DIAGRAM
INSTRUMENTATION IDENTIFICATION

SYMBOL	FIRST LETTER	EXAMPLES															
		SENSING DEVICE			DISPLAY DEVICE								CONTROL DEVICE (NOTE 4)				
			TRANSMITTER					ALARM (NOTE 5)			CONTROLLER (NOTES 3 & 4)						
	MEASURED OR INITIATING VARIABLE	PRIMARY ELEMENT	BLIND	INDICATING	INDICATOR	RECORDER	INTEGRATING INDICATOR	LOW	HIGH	HIGH & LOW	BLIND	INDICATING	RECORDING	CONTROL VALVE	SELF-ACTUATING VALVE	SWITCH (NOTES 3, 5 & 6)	RELAY CONVERTER OR COMPUTING DEVICE (NOTE 3)
A	ANALYSIS (NOTE 2)	AE	AT	AIT	AI	AR		AAL	AAH	AAHL	AC	AIC	AIRC	AV		AS	AY
F	FLOW	FE	FT	FIT	FI	FR	FQI	FAL	FAH	FAHL	FC	FIC	FIRC	FV	FCV	FS	FY
L	LEVEL	LE	LT	LIT	LI	LR		LAL	LAH	LAHL	LC	LIC	LIRC	LV	LCV	LS	LY
P	PRESSURE	PE	PT	PIT	PI	PR		PAL	PAH	PAHL	PC	PIC	PIRC		PCV	PS	PY
T	TEMPERATURE	TE	TT	TIT	TI	TR		TAL	TAH	TAHL	TC	TIC	TIRC	TV	TCV	TS	TY

GENERAL INSTRUMENTS

- INSTRUMENT FOR SINGLE MEASURED VARIABLE AND ANY NUMBER OF FUNCTIONS. INSTRUMENT IS MOUNTED LOCALLY.
- INSTRUMENT IS MOUNTED IN FRONT OF PANEL.

HAND ELECTRIC SWITCH DESIGNATION

S/S = START/STOP

HOA = HAND/OFF/AUTO

PB = PUSH BUTTON

LINE IDENTIFICATION

GW-2"-PVC

- PIPING MATERIAL
- LINE SIZE
- LINE SERVICE

LINE SERVICE DESIGNATION

GW - GROUND WATER

WW - WASTE WATER

S - SLUDGE

EFF - TREATED EFFLUENT

VAP - VAPOR

DATE	CHANGE ORDER NO.	BY	DESCRIPTION
11-18-93	002	VAR	PRETREATMENT DELAYED
11-9-93	001	VAR	SIGNED & SEALED

ABB ASEA BROWN BOVERI — ABB Environmental Services Inc.

DWN: DMF	DES: HF	CONTRACT NO.: SE 3-21-037	TITLE: PIPING AND INSTRUMENTATION DIAGRAM AIR SPARGER UNIT
CHKD: KDS	APPD.: CMB	PROJECT NO.: 08503.02	
DATE: 9-24-93	REV.: VAR	SHEET NO.: C-9	

FIGURE 3-2

the pumps. A high-high level in the air sparger will also shut off the recovery well pumps and activate the alarm.

3.1.2 Air Sparger In the air sparger, air is released in to the water through diffusers that produce coarse air bubbles. The diffusers are made of polyvinyl chloride (PVC) pipe with holes located on the underside of the pipe placed in the water of each of eight (8) aerated compartments. An air to water ratio of between 50 and 100 to 1 can be used by regulating air flow from the blower to the sparger with an inlet damper. The air flow rate must be optimized to provide enough aeration to volatilize the contaminants in the water and minimize vapor phase carbon requirements.

A low level switch in the air sparger sump will shut off the effluent pump. The level switch will have a time delay to restart the pump to avoid excessive cycling of the pump. A high level in the sump will shut off the recovery well pumps and actuate an alarm.

The effluent pump will discharge treated water to the base's sewer system, pending approval. Connection to the system will be made at a manhole located near the IM treatment system. Effluent will be monitored for compliance with the performance standards as outlined in the Monitoring Plan, Section 6.0. Effluent from the air sparger can be diverted to a storage tank for retreatment and recycled through the pilot-scale treatment system if the system is not meeting performance criteria. Recovery well pumps can be turned off until the system is functioning properly.

Air sparger vapors will be collected from each stage in a header system that will divert all vapors to the vapor carbon system.

3.1.3 Vapor Treatment Based on maximum concentrations of VOCs found within the groundwater during previous studies and assuming 100 percent volatilization, the total organic maximum emission rate from the air sparger will be less than 0.19 pounds per hour. A carbon adsorption unit will be installed for treatment of VOCs in the vapor effluent before emission to the atmosphere. Air monitoring of the air sparger and stack emissions will be performed and recorded throughout the operation of the pilot-scale test as outlined in Section 6.0.

3.1.4 *Ex Situ* Biological Treatment The pilot-scale mRBC reactor and ancillary equipment will consist of an equalization tank, the mRBC unit, a methane/oxygen monitoring and control unit, a nutrient delivery system, and a pH control system. A piping and instrumentation diagram for the pilot-scale mRBC is provided as Figure 3-3.

The pretreatment tank will be used as a feed tank (T-1) to supply groundwater to the mBRC. A metering pump (P-1) will transfer the contaminated groundwater at a set flow rate (24 hours per day, seven days per week). A totalizing flow meter will be used to monitor flow rate.

The pilot-scale mRBC unit will consist of a 80-inch by 30-inch by 25-inch (length by weight by height) aluminum tank with internal baffles separating the reactor into four compartments. Contaminated groundwater will enter the first compartment and pass through each compartment via external orifices or internal openings in the compartment walls.

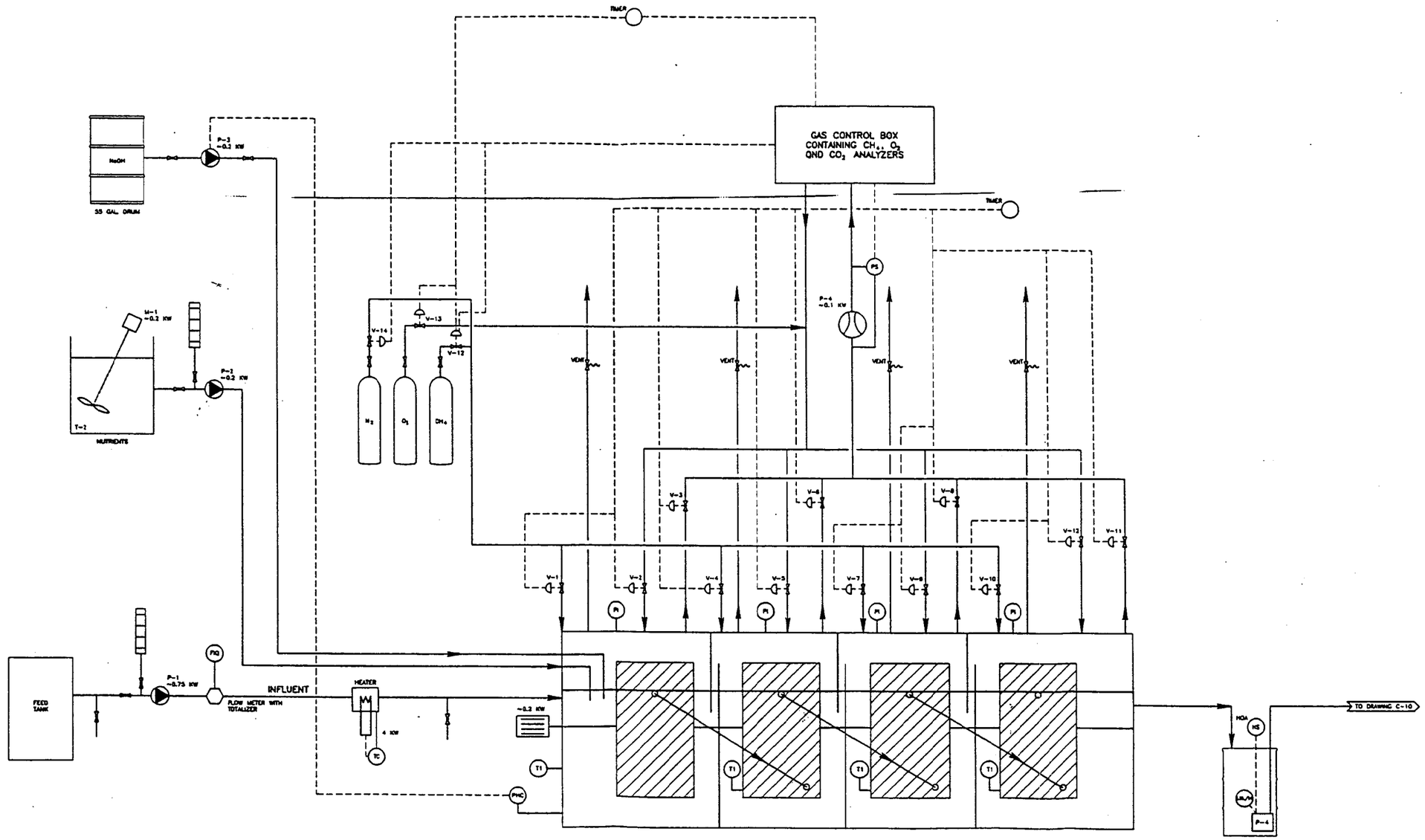


ABB ASEA BROWN BOVERI — ABB Environmental Services Inc.	DWN: DMF	DES: VAR	PROJECT NO.: 08503.02	TITLE: PIPING AND INSTRUMENTATION DIAGRAM ROTATING BIOLOGICAL CONTACTOR UNIT	
	CHKD: KDS	APPD.: GMB	SHEET NO.: C-11		
	DATE: 9-24-93	REV.:			

FIGURE 3-3

A central shaft supporting corrugated plastic media on which microorganisms attach and form a biological film will be rotated. The rotating shaft and plastic media will be partially submerged in the liquid phase of the reactor, which allows contact between the microorganisms, methane, oxygen, contaminants, and nutrients.

To protect the reactor from excessive pressure, each reactor compartment is equipped with a pressure relief valve venting to the atmosphere.

The metering pump (P-2) will transfer nutrients from a 250-gallon nutrient tank equipped with a mixer (M-1). The nutrient solution will be prepared periodically by mixing weighed amounts of dry nutrients and water.

The pH of the reactor contents will be adjusted when necessary to maintain a pH in the range of 6 to 8. A metering pump (P-3) will receive a signal from the pH controller and pump sodium hydroxide from a 55-gallon drum to the first compartment of the reactor as required.

The effluent from the mRBC will gravity flow to an open top drum and then transfer to the air sparger by a submersible pump equipped with a float switch.

3.2 DISCHARGE. Liquid effluent from the air sparger will be collected in the air sparger sump. A totalizing flow meter will be placed at the air sparger effluent. Instantaneous and daily flow rates will be recorded throughout the operation of the system. The effluent pump will discharge the pilot-scale system effluent to a manhole for the base's LAS, pending approval from the city. Conveyance of the fluids will be through 3-inch PVC pipe. One hand-operated gate valve will be installed in the effluent line to isolate the system when necessary.

4.0 PILOT-SCALE OPERATION

4.1 GROUNDWATER EXTRACTION. The pilot-scale test operations include three stages of aquifer pumping from first one recovery well, then two wells, and finally all five wells. Discharge from the recovery wells will be maintained at a constant flow rate during each of the three phases. Flow rates will be measured for each well using the respective totalizing flow meters to record successive cumulative flow readings over a set interval.

The first stage of the pilot-scale test operations will be conducted by pumping from a single recovery well for seven days. Preliminary estimates of flow are expected to be approximately 10 gpm. This pumping test will provide hydraulic data for the evaluation of aquifer parameters, boundary conditions and anisotropic effects, and the effective capture zone.

At completion of the first pumping stage, a recovery phase test will be conducted to allow the surficial aquifer to reach equilibrium. No groundwater will be extracted during this phase. Water from previous pump tests that has been stored may be treated during this time.

The second stage of the pilot-scale test operations will be conducted by pumping from two recovery wells for a period of seven days following the single well test recovery phase. Preliminary estimates of flow are approximately 17 gpm. The third stage of the pilot-scale test operations will be conducted by pumping from all five recovery wells. Starting of the pumps will be staggered at timed intervals and synchronized with the hydrologic data logger unit(s) and set at constant flow rates. Preliminary estimates of flow are expected to be approximately 7 to 12 gpm from each well.

This pumping test will provide hydraulic data for evaluation of the effectiveness of multiple recovery wells for the extraction of VOC-contaminated groundwater and the actual capture zone caused by five discharging wells.

4.2 AIR SPARGER TREATMENT SYSTEM.

4.2.1 Start-Up Following installation of the equipment, the recovery wells will discharge to the pretreatment tank. Initially, only one or two recovery well pumps will be started. Also, a hose will be connected to the recycle taps, and the effluent valve will be closed to allow recycle of the process stream until verification is received that discharge criteria can be met.

The pretreatment tank will fill to the height of the discharge nozzle, which will allow the feed stream to fill the air sparger via gravity flow.

As water enters the air sparger, the blower will force air through the air sparger and the carbon induced draft (ID) fan will pull the air sparger effluent vapors through the carbon adsorbers.

Once steady state has been reached in the recycle mode, samples will be collected to determine the quality of the effluent. If the effluent meets the discharge criteria, the discharge valve will be opened to allow the water to discharge to the treatment works. The treated effluent will be analyzed hourly for performance criteria (Subsection 1.3) until steady state is reached.

Feed from the recovery well pumps will be slowly increased until steady state is reached. If the process pumps are cycling too often at steady state, the ball valves at the discharge of the process pumps can be closed slightly to induce a pressure drop and to reduce flow where needed.

4.2.2 Operation and Process Control During Phase I, a minimum of one operator per shift will be on-site to operate and monitor the treatment system 24 hours per day. The operator will also be responsible for operating the GWE system and various other on-site duties. The system may be retrofitted to minimize operator requirements during the continued operation of the system (Phase I Continuance).

Pumps During normal operation, the recovery well pumps and process pumps will be on automatic operation. Each pump will shut down at low level and restart either with deactivation of the low level switch or with a high level switch. Each pump is operated with a Hand/Off/Auto switch that enables the operator to operate the pump in each mode.

Air Sparger The process water enters the air sparger through a spray pipe at one side of the unit that disperses the water evenly across the first stage of the unit. The water travels through eight separate stages of aeration before discharge from the unit. Air is released from the blower into the bottom of each stage through detachable perforated PVC piping. Exhaust air exits the stages and is pulled by an induced draft to the carbon unit. The water is discharged to a sump that is an integral part of the sparger and the effluent pump transfers the water to the discharge point.

The air sparger sump is equipped with a high and low level switch. Low level in the sump will shut off the effluent pump. The pump will restart either with deactivation of the low level switch or with a high level switch. High-high level will shut off the recovery well pumps and activate the alarm horn.

The blower is equipped with a low flow switch to shut off the blower and to activate the horn on low flow conditions.

Carbon Unit Before reaching the carbon adsorber, the vapor stream will be heated by the preheater to reduce the humidity of the stream. The vapors from the air sparger will be pulled through the preheater and carbon adsorber by the carbon ID fan. VOCs transferred from the groundwater to the vapor stream in the air sparger will be adsorbed by the carbon before discharge to the atmosphere. To ensure that particulate is not entrained in the vapor effluent, the adsorber will be operated in the downflow configuration.

The carbon adsorber(s) will be connected with flexible hoses to simplify changeout procedures. The carbon treatment unit will include eight canisters of carbon, each canister being 55 gallons in volume. The eight canisters will be arranged such that four canisters are in parallel and are primary treatment units. The other four units are connected in series and act as backup to the primary units. The life expectancy of the primary units will be calculated based on 100 percent volatization of VOCs detected in groundwater samples from the pretreatment tank. Air samples will be collected from the discharge of the primary carbon units once per week and will be analyzed for VOCs in the on-site laboratory. The data for each sample event will be evaluated to determine if the primary carbon unit is saturated. The primary carbon canisters will be removed when saturation is indicated by air sample analytical data or no later than the

end of the calculated life expectancy. The backup carbon canisters will be moved to the primary position and new canisters placed in the backup position.

After the Phase I treatment operations and prior to the Phase I continuance, a schedule will be established for replacement of the primary carbon canisters. The schedule for replacement will be based on the results of the air samples discussed in the paragraph above or will be the calculated life expectancy.

4.2.3 Discharge If approval is granted by the base, the effluent pump will transfer treated water to the LAS via a manhole located near the IM treatment system.

Effluent from the system will be sampled daily for the duration of the Phase I operations and analyzed on-site as detailed in the Monitoring Plan (Table 6-1). If at any time effluent does not meet discharge criteria, effluent can be diverted temporarily to the 20,000-gallon storage tanks. If the storage tanks are full, then the recovery well pumps can be shut off, and the system can be placed in recycle mode until the treatment system adequately treats the groundwater for discharge. After the initial pilot-scale testing stage (Phase I) and development of a strong database of groundwater and system effluent quality, sampling will be reduced to weekly off-site analysis of VOCs, metals, and selected engineering treatability parameters.

4.2.4 Alarm Conditions Each pump will shut down at low level and restarted either with deactivation of the low level switch or with a high level switch. High-high level switches will activate the horn to alarm the operator to check the system. Tankage is not totally enclosed and the operator must correct the downstream problem that is causing a system backup, or must adjust pumping rates to prevent overflow conditions. Containment is provided around the entire process system.

If the air sparger blower is shut off on low flow, the horn will be activated. A scale buildup around the air sparger diffuser piping can cause a low flow condition.

4.3 ROTATING BIOLOGICAL CONTACTOR. An mRBC reactor designed to promote biological degradation of organic compounds in groundwater will be used to evaluate full-scale treatment potential. The mRBC will be monitored continuously and chemical addition functions will be manually adjusted as needed.

Groundwater will be continuously pumped from the pretreatment tank through the mRBC reactor. Mineral nutrients will be added to the passing groundwater from the nutrient delivery system. Methane, the carbon source for the methanotrophic bacteria, will be continuously monitored and supplied to the mRBC system using the methane/oxygen analyzer and control system. Oxygen required for biological degradation of VOCs will also be monitored and regulated in the mRBC reactor using the methane/oxygen analyzer and control system. Groundwater pH will be monitored and controlled using a pH control system. The biologically treated water will be discharged to the air sparger before discharge to the sewer system.

4.4 STORM WATER MANAGEMENT. Process area and decontamination pad storm water will be collected in the respective sump and processed through the treatment system. If there are no activities being conducted that require use of the decontamination pad (i.e., well drilling, excavation) and the decontamination pad has been cleaned since its last use, storm water will be discharged to the ground

surface. Containment for the tanks and process equipment has been designed in accordance with 40 CFR 264 Subpart J and I. The containment has sufficient excess capacity to contain run-on or infiltration from a 25-year, 24-hour rainfall event. The floor of the containment area will be sloped to the treatment pad sump.

All rainfall events will be recorded. Excessive rainfalls will be transferred from the sumps to a storage tank. The storage tank will be sampled and analyzed on-site to determine if treatment is needed or if direct discharge is possible.

4.5 ENGINEERING EVALUATION PLAN. An evaluation of the hydraulic and chemical data collected during the IM installation and start-up activities will be performed following the initial 45-day pilot-scale testing period. The evaluation will be of the components of the GWE and treatment system including: the groundwater extraction system, the conveyance system, the air sparger treatment system, the mRBC system, and the discharge permit and options. These systems will be evaluated for their ease of implementation, effectiveness in meeting remediation objectives, cost effectiveness, and schedule constraints. Additionally, other technologies and discharge options will be evaluated, as appropriate, for meeting remediation objectives. These evaluations will be compiled into an Evaluation and Recommendations Report. Further definition of the Engineering Evaluation Plan is provided in the Interim Measure Work Plan for Site 11, Old Camden County Landfill Phase I Activities (ABB-ES,1993b).

4.5.1 Groundwater Extraction System Evaluation Evaluation of the GWE system includes the interpretation and assessment of hydraulic and chemical data collected during the initial aquifer pumping test, pilot-scale start-up activities, and pilot-scale test operations. These data will be used to evaluate aquifer parameters, well performance characteristics, and optimum extraction methodologies for the full-scale GWE/Treatment system IM. Evaluation of the pilot-scale test start-up activities includes analysis of the well performance tests from each of the recovery wells and interpretation of background monitoring data from within the surficial aquifer. Evaluation of hydraulic data from the three pumping stages and recovery phase of the pilot-scale test operations includes: (1) analysis and interpretation of the hydraulic head data that support delineation of the actual capture zone, and (2) analysis of the variations in the waste-stream flow for treatment process performance monitoring.

A computer-based analytical flow model will be used to assess additional GWE wells linked to the pilot-scale GWE system for the purpose of full-scale system recommendations. This will allow evaluation of the impact and effectiveness of additional wells in the system, by adding recovery wells at other locations within the plume or adding horizontal collector wells to control VOC plume movement. During the modeling and the continued operation of the GWE system, additional operational data will be collected to confirm Phase I results.

4.5.2 Conveyance System Evaluation The conveyance system, including piping layout, materials of construction, fittings, valves, flow meters, well headers, and well vaults will be evaluated for long-term effectiveness and cost.

4.5.3 Treatment System Evaluation Treatment system influent and effluent concentrations, removal efficiencies for the constituents of concern, flow rates, and vapor emissions will be monitored throughout the pilot-scale test (Phase I activities). These parameters will be evaluated against performance criteria for the treatment system. The ability of the treatment system to meet performance

criteria at higher full-scale operation flow rates and modification requirements will be evaluated. The evaluation will include an evaluation of applicable technologies and cost estimates for long-term full-scale (Phase II) operation. The influent VOC concentrations will be evaluated and the possibility of discharging without treatment during the full-scale IM will be considered. Full-scale metals and carbonate removal, vapor treatment, and overall operating and maintenance requirements will be evaluated.

The parameters to be monitored for the IM treatment system evaluation include:

1) Air Sparger -
   - Efficiency (influent and effluent VOC concentrations)
   - Corrosion and/or scaling problems, especially at diffusers
   - Blower operation
   - Capacity for additional flow

2) Vapor Treatment -
   - Efficiency (influent and effluent VOC concentrations)
   - Blower operation
   - Capacity for additional flow
   - Carbon usage rates
   - Carbon costs and disposal costs
   - Change-out frequency and method

3) Pumps -
   - Discharge pressure
   - Cycling due to level switch placement
   - Capacity for additional flow or head loss

The Rotating Biological Reactor will be evaluated for applicability as a full-scale (Phase II) remediation technology. Parameters to be monitored (with respect to controlled hydraulic loading rates) for this evaluation include:

- VOC degradation rates,
- methane utilization rates, and
- sludge production rates.

<u>4.5.4 Instrumentation and Controls</u> In addition to the instrumentation and controls evaluated as part of the system performance evaluation, extraction well instrumentation and controls will be evaluated for accessibility and value of information received. Requirements for additional control, indication, or recording abilities will be evaluated for full-scale implementation requirements.

<u>4.5.5 Discharge Permit/Options</u> Estimated full-scale system flow rates and constituent concentrations will be evaluated for long-term discharge to the LAS. The USEPA Fate and Treatability Estimator for Discharge to POTWs (USEPA, 1990) (USEPA Fate Model) will be used to evaluate whether discharge to the LAS will adversely affect the facility's operation or effluent quality. Alternatives such as discharging through a National Pollutant Discharge Elimination System (NPDES) permit will be evaluated.

4.5.6 Evaluation and Recommendations Report The Evaluation and Recommendations Report will incorporate results of the evaluations discussed above and will recommend a full-scale system (Phase II) for implementation as an IM. The final report will be submitted to Georgia Environmental Protection Division for approval.

5.0 CAPTURE ZONE MODELING

A two-dimensional semi-analytical model, the General Particle Tracking Module (GPTRAC) of the USEPA's Well Head Protection Area (WHPA) delineation code, has been used to illustrate the movement of a "slug" of contamination within or around the capture zone of the groundwater extraction wells. WHPAs are defined as the surface and subsurface area surrounding a water well or wellfield through which contaminants are reasonably likely to move toward and reach such water well or wellfield.

The WHPA model delineates capture zones of pumping wells using the particle tracking technique. The term "particle" is used only for conceptual purposes. A particle may be viewed as an individual water molecule or an individual molecule of a conservative tracer that moves through the aquifer coincident with the bulk movement of groundwater flow; dispersion and diffusion do not affect the particle location.

Time-related capture zones are obtained by tracing the pathlines formed by a series of particles placed around the well bore of the pumping well. The particle tracking method requires knowledge of the groundwater flow velocity at any point within the aquifer. Once velocities have been determined, pathlines may be delineated using particle tracking. Forward tracking is performed to determine if particles that are released upgradient of a well will be captured by the well.

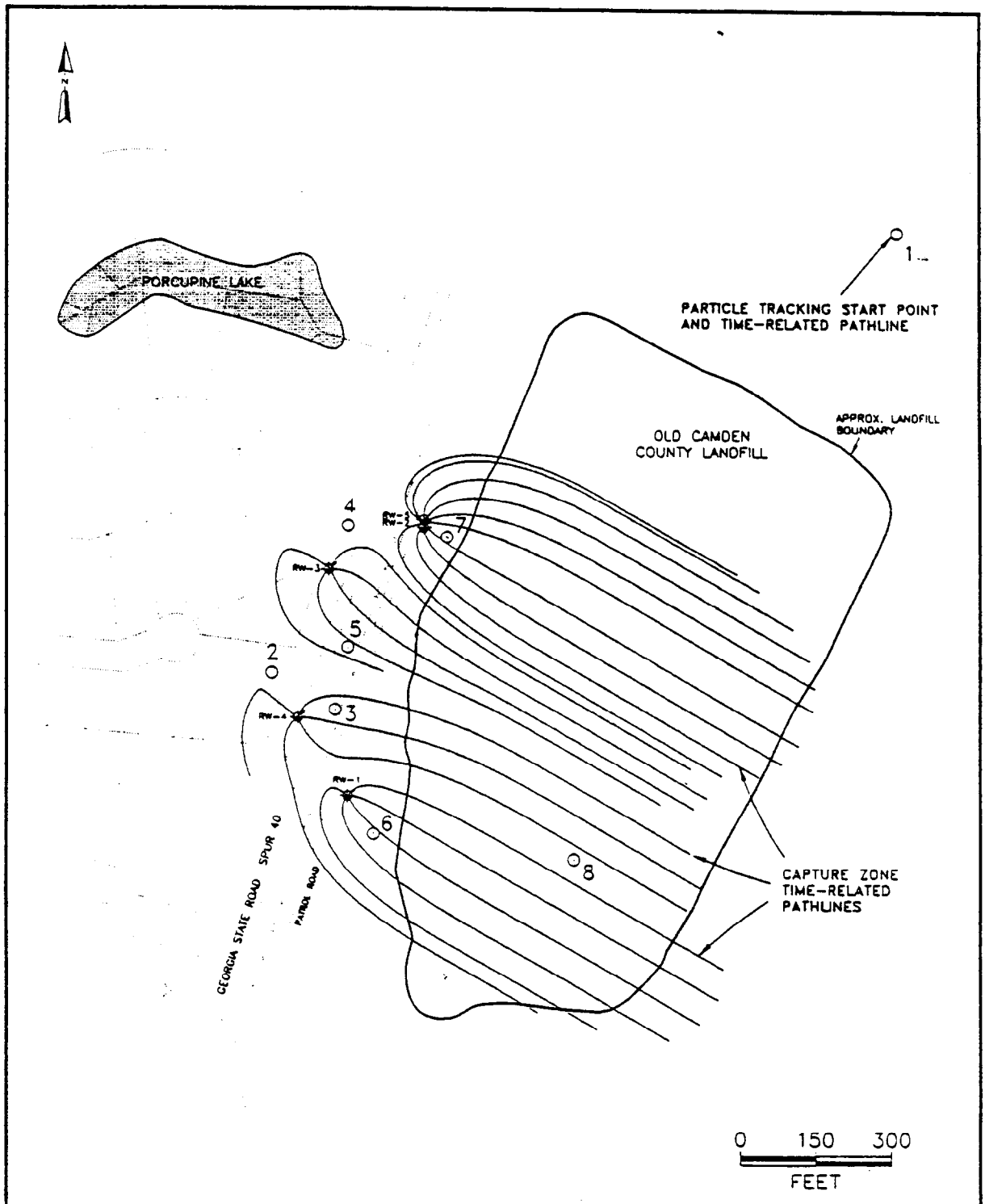
The assumptions and limitations associated with the model are:

- the groundwater flow field is at equilibrium (steady state), and
- the flow in the aquifer must be two-dimensional in the horizontal plane; vertical flow components are neglected.

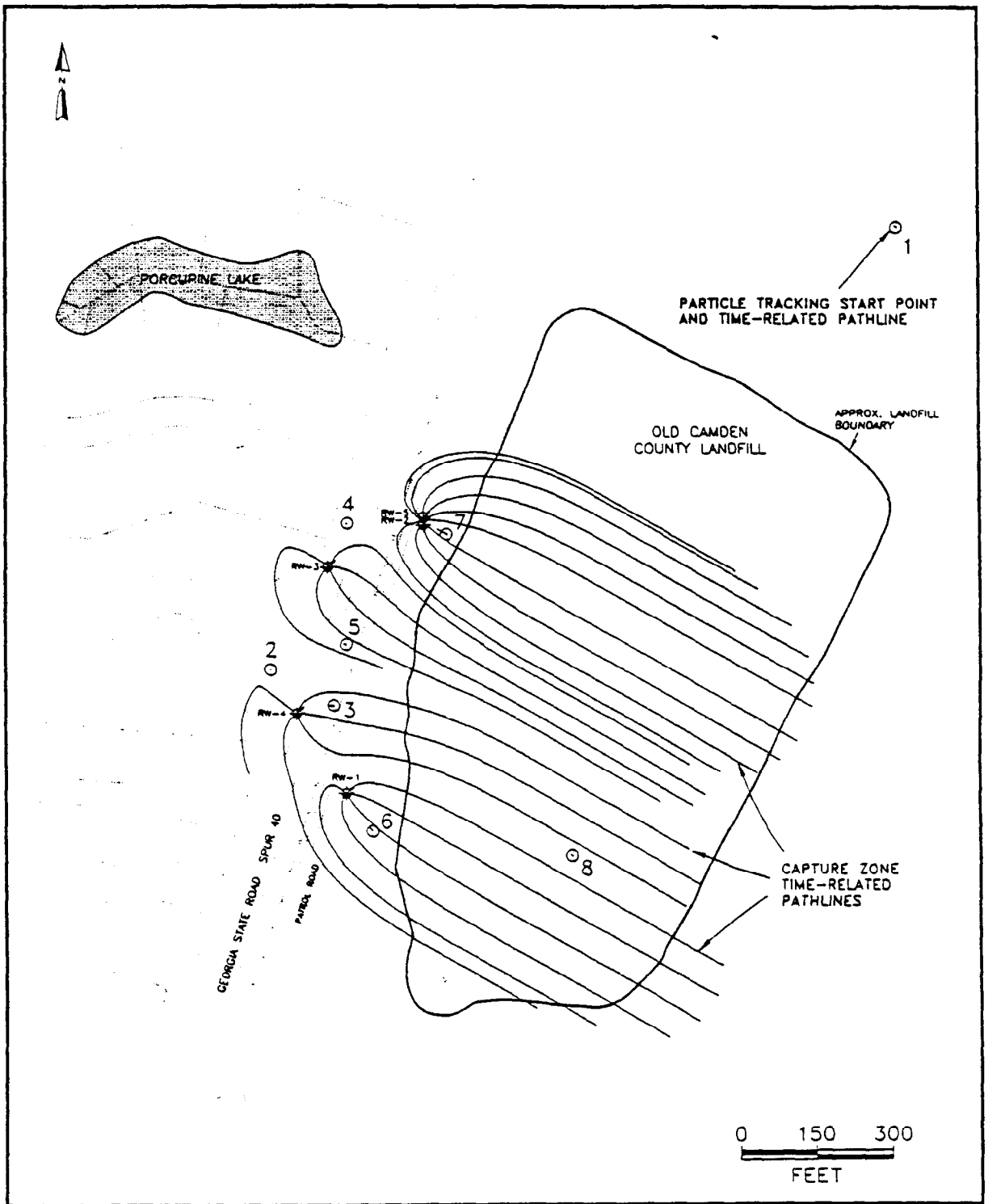
Slugs of contamination or chemical variations of the groundwater can be represented as particles transported by advective movement through the aquifer. GPTRAC models the movement of particle(s) of constituents through the recovery wells' capture zones using analytical velocity computation techniques. Distance traveled, therefore, is time-dependent.

Several plots of the five-well recovery system and its effective capture zone are provided as Figures 5-1 through 5-5. These show the movement of "slugs" of constituents from seven arbitrarily selected locations within the plume. Particle #1 in each figure represents a particle within the zone unaffected by the groundwater extraction system or the baseline particle movement. The projected particle pathway for each model duration (7 days, 30 days, 90 days, 1 year, and 5 years) is shown to begin at the indicated circles. The pathways which appear as dots in the shorter durations are actually lines indicating travel distances.

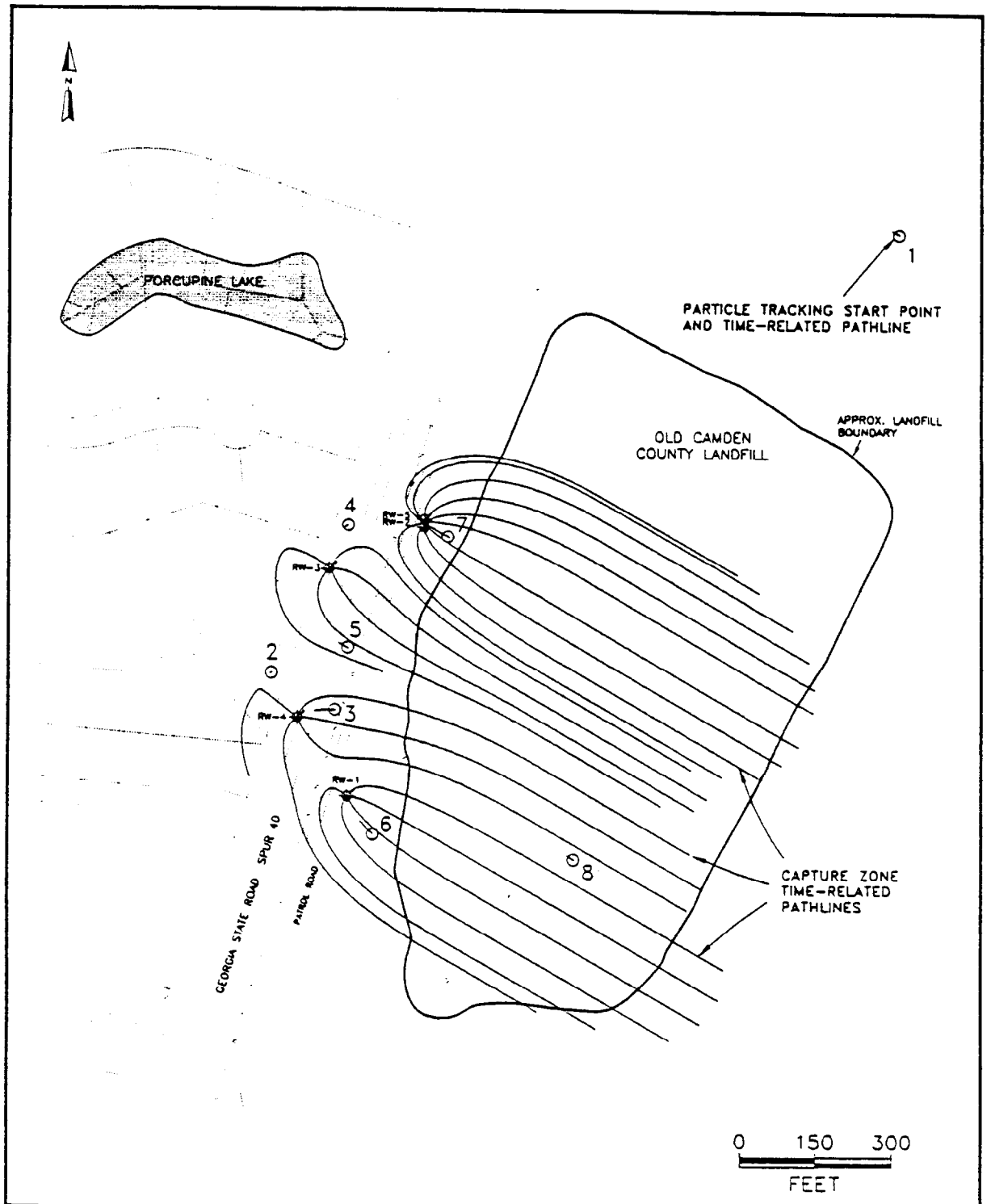
The modeling shows that due to the relatively low seepage velocity within the aquifer, current investigations of the groundwater quality will be representative of groundwater quality for the duration of the initial operations of the IM. Plume characteristics are expected to change slowly; however, the changes during the initial operations of the IM will be gradual enough for weekly monitoring to



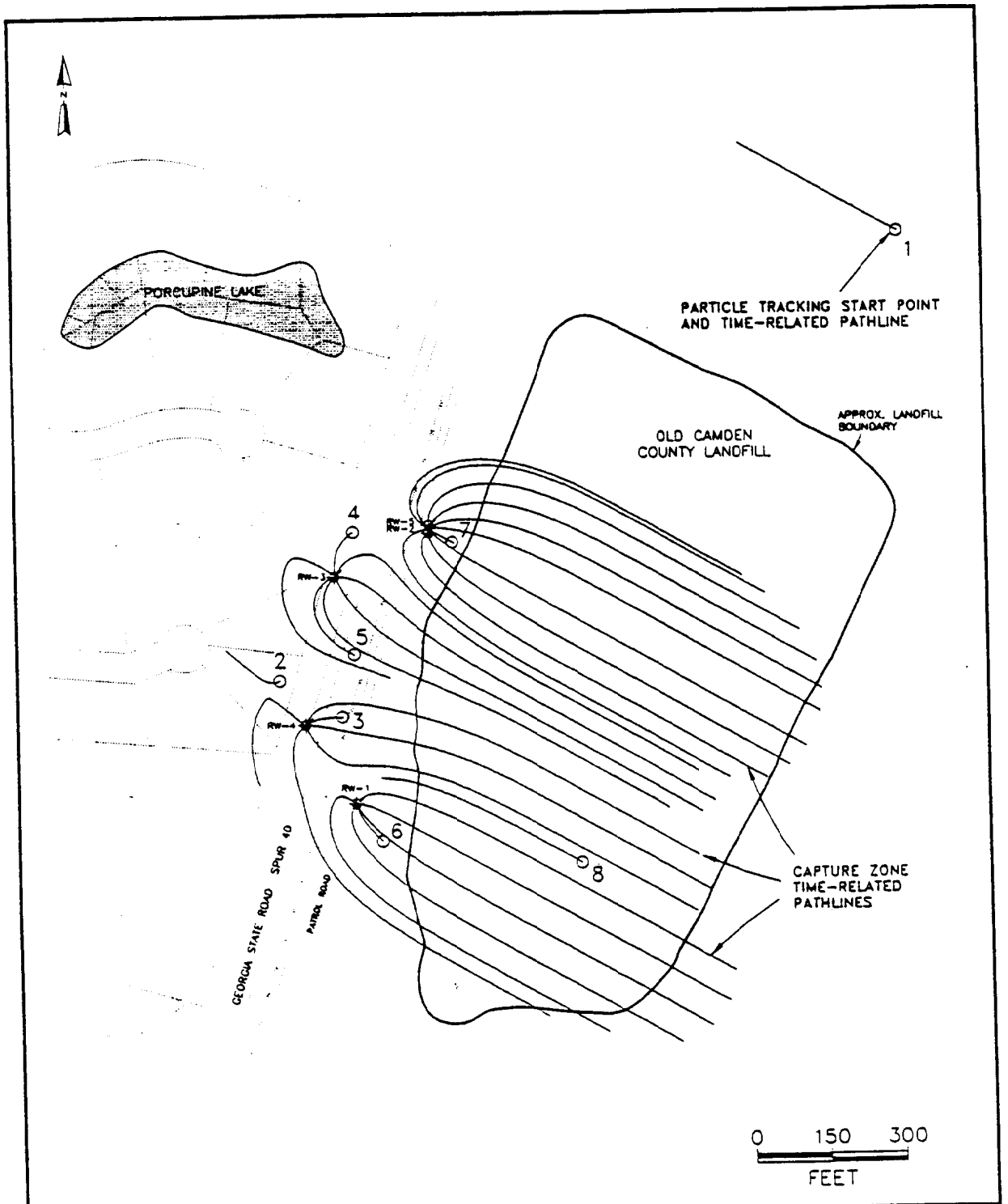
DWN: NLW	PROJECT NO.: 08503	TITLE: PARTICLE TRACKING MODEL 7 DAY SIMULATION	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: KDS	FIGURE NO.: 5-1		
DATE: 12/09/93			



DWN: NLW	PROJECT NO.: 08503	TITLE: PARTICLE TRACKING MODEL 30 DAY SIMULATION	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: KDS	FIGURE NO.: 5-2		
DATE: 12/09/93			

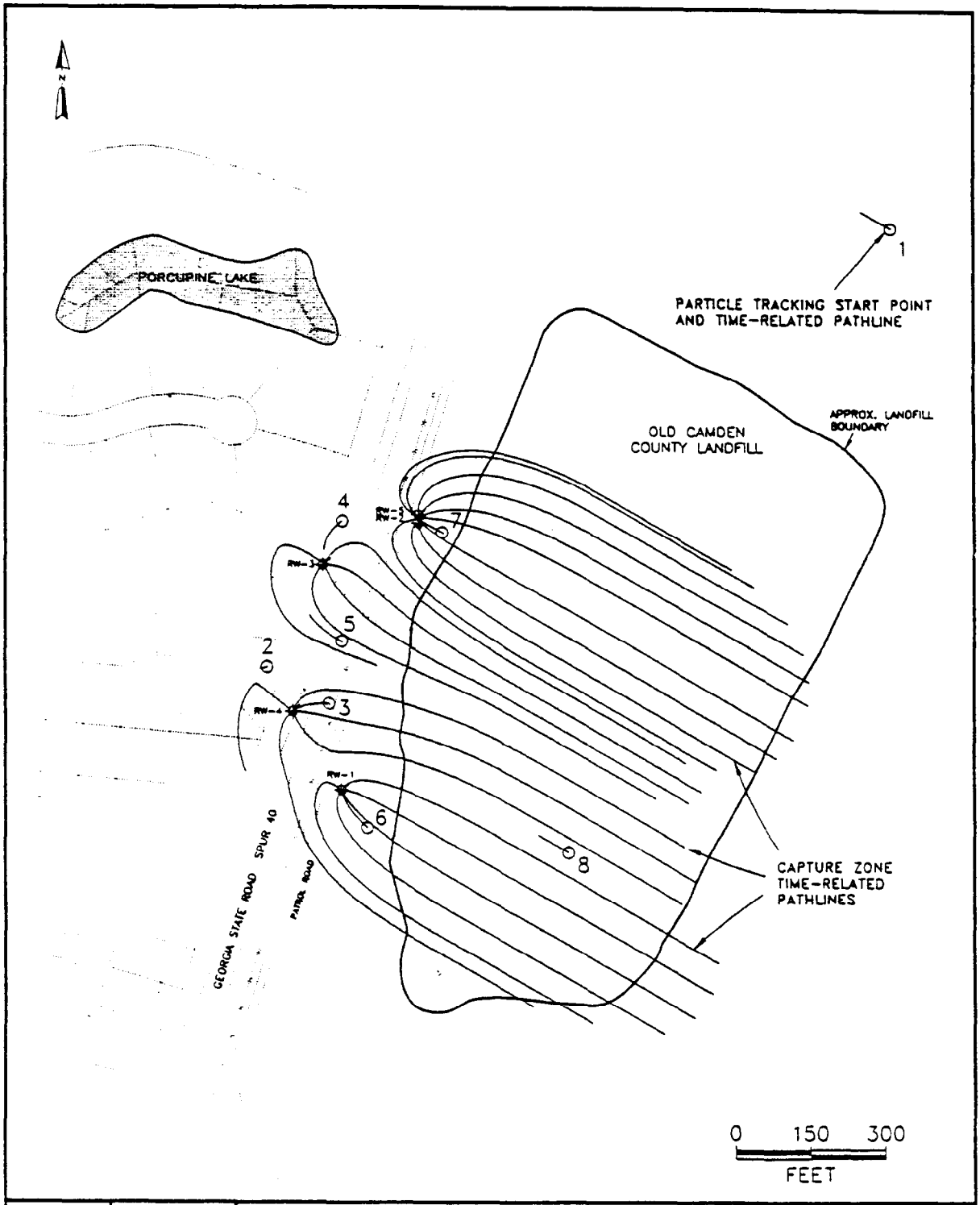


DWN: NLW	PROJECT NO.: 08503	TITLE: PARTICLE TRACKING MODEL 90 DAY SIMULATION	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: KDS	FIGURE NO.: 5-3		
DATE: 12/09/93			



DWN: NLW	PROJECT NO.: 08503	TITLE: PARTICLE TRACKING MODEL 5 YEAR SIMULATION	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: KDS	FIGURE NO.: 5-5		
DATE: 12/09/93			

KB NSB [LAS 8503.004]#030/93.mlv



DWN: NLW	PROJECT NO.: 08503	TITLE: PARTICLE TRACKING MODEL 1 YEAR SIMULATION	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: KDS	FIGURE NO.: 5-4		
DATE: 12/09/93			

be sufficient to detect and respond to the changes. Due to the low groundwater velocity as depicted by the short distance traveled by a particle in the 7-day and the 30-day models, sufficient time will be available to respond to any indication of change in plume characteristics. Vinyl chloride will be the greatest indicator of change in plume characteristics since it is a degradation product for many organics.

Drastic changes in groundwater chemistry or contaminant concentrations due to pumping that would require rapid operational monitoring or retention are not expected.

6.0 MONITORING PLAN

6.1 DATA COLLECTION STRATEGY. The intended uses for the data obtained during IM activities are: (1) to evaluate the use of groundwater extraction as a means to hydraulically control VOC plume movement; (2) to measure the efficiency of air sparging as a viable option to remediate VOCs from the groundwater while ensuring that treatment performance standards and discharge criteria are being met; and, (3) to measure the efficiency of *ex situ* biological treatment technology as an alternative option to remediate VOCs from the groundwater. Further definition of the Monitoring Plan is provided in the Interim Measure Work Plan for Site 11, Old Camden County Landfill Phase I Activities (ABB-ES, 1993b).

6.2 SAMPLING AND FIELD MEASUREMENTS.

6.2.1 Hydraulic Monitoring During the operation of the treatment facility, specific hydraulic data will be collected and monitored. Periodic measurements of flow rates and total flow, in gpm, will be taken from each recovery well. Precipitation events will be monitored using rain gauges indicating when the event occurred, duration of event, and the quantity of rainfall that fell. Barometric pressures during the tests will be recorded by a gauge linked to one of the data loggers.

6.2.2 Operations Monitoring During the pilot-scale operation, specified locations will be sampled to observe the concentrations of constituents coming into and out of the treatment facility. In addition, samples of process water from specific pieces of equipment will be sampled periodically to monitor the efficiency of the system components. Locations to be sampled are listed below.

- Pretreatment tank (system influent)
- Air sparger effluent (water)
- Air sparger effluent (vapor)
- Primary carbon unit effluent (vapor)
- Stage I (single well GWE test) - sample tap at manifold of recovery well
- Stage II (two well GWE test) - sample tap at manifold of each recovery well
- Stage III (five well GWE test) - sample from pretreatment tank
- Phase I Continuance (Stage III continued) - sample from pretreatment tank

Refer to Tables 6-1 and 6-2 for operations monitoring schedule.

Table 6-1 Phase I and Phase I Continuance Operations Monitoring Schedule

Sampling Location	Frequency	Analysis	On site/ Off site[1,2]
Phase I			
Pretreatment Tank	1/day	Volatiles	On site
Pretreatment Tank	1 every other week	Metals, ETPs	Off site
Air Stripper Effluent (water)	1/day	Volatiles, pH	On site
Air Stripper Effluent (Water)	1/week	TSS, BOD	Off site
Air Stripper Effluent (vapor)	1/week	Volatiles	On site
Stack Effluent (vapor)	1/day	Volatiles	On site
Primary Carbon Unit Effluent (vapor)	1/week	Volatiles	On site
Initial Pumping Test	1/event	Volatiles, Metals, ETPs	Off site
Stage I P-OIA, drawdown	1/day	Volatiles	On site
Stage I P-OIA, drawdown	1/event (day 5)	TCL, TAL, ETPs	Off site
Stage I P-OIA, single well pumping test	1/day	Volatiles	On site
Stage I P-OIA, single well pumping test	1/event	Metals, ETPs	Off site
Stage I P-OIA, single well pumping test	2/event	TCL, TAL	Off site
Stage II P-OIA & B, two well pumping test	1/day	Volatiles	On site
Stage II P-OIA & B, two well pumping test	1/week/well	TCL, TAL	Off site
Stage III, five well pumping test	1 every other day	Volatiles	On site
Stage III, five well pumping test	1/week	TCL, TAL	Off site
Phase I Continuance			
Air Stripper Effluent (water)	1/week	Volatiles	Off site
Pretreatment Tank	1 every other week	Metals, Selected ETPs	Off site

Notes:

BOD = biochemical oxygen demand
ETP = engineering treatability parameters, as indicated in Table 6-3.
SVOC = semivolatile organic compound
TAL = target analyte list
TCL = target compound list - VOCs, SVOCs, pesticides, and polychlorinated biphenyl compounds
TSS = total suspended solids
VOC = volatile organic compound

[1] Methods of analysis by off-site analytical laboratory and on-site laboratory is listed on Table 6-3.
[2] Five percent of samples analyzed in the on-site laboratory will be submitted for off-site VOC analysis.

Table 6-2 Sample Collection Frequency For Methanotrophic Rotating Biological Contactor

Parameter	Influent	Stage #1	Stage #2	Stage #3	Effluent	Headspace
VOCs	daily	daily	daily	daily	daily	as needed
pH	continuous	continuous	continuous	continuous	continuous	-----
Nitrate	2/week	2/week	2/week	2/week	2/week	-----
Phosphate	2/week	2/week	2/week	2/week	2/week	-----
Total Suspended Solids	1/week	-----	-----	-----	1/week	-----
Total Volatile Suspended Solids	1/week	-----	-----	-----	1/week	-----
Methane	-----	-----	-----	-----	-----	continuous
Oxygen	-----	-----	-----	-----	-----	continuous
Carbon Dioxide	-----	-----	-----	-----	-----	continuous

Note:

VOC = volatile organic compound

The following associated data will be recorded when collecting samples:

- ambient temperature,
- daily amount of precipitation,
- time sample was collected, and
- unusual events (i.e., samples were collected during rain event).

Vapor sample collection will be performed using Tedlar bags, following Method 18, Section 7 of 40 CFR Part 60, Appendix A.

6.3 ANALYTICAL PROGRAM.

6.3.1 Analytical Parameters Laboratory analyses for monitoring the pilot-scale operations include physical and chemical parameters. As indicated in Subsection 6.2.2, analyses will be conducted on air and water samples. Parameters for analysis during operations monitoring are summarized in Table 6-3. All vapor samples collected from the air sparger and carbon absorption units will be analyzed in the on-site laboratory for the 10 VOCs listed in Table 6-3.

The analytical program for aqueous samples (groundwater influent and effluent) includes on-site and off-site analysis of chemical and physical parameters. VOC analysis of aqueous samples will be done on site and off site as indicated on Table 6-1. Parameters for on-site analysis are listed on Table 6-3. Off-site analysis of aqueous samples will include the TCL and TAL analytes listed in Table 2-2. Other parameters for analysis in aqueous samples include a select list of metals and engineering and treatability parameters (Table 6-3).

Several parameters will be monitored in association with operation of the mRBC unit. The parameters include nitrate and nitrite, phosphate, total volatile suspended solids, oxygen, and methane (see Table 6-3).

6.3.2 On-Site Analytical Procedures On-site analytical procedures include physical and chemical measurements of vapor and aqueous samples. Table 6-3 includes information regarding the methods of analysis associated with monitoring the IM operations. These methods include the use of colorimetric test kits, field GC, and real time measurements.

Colorimetric test kits will be used for measurements of nitrate, nitrite, and phosphate. Each test kit employs the use of an indicator solution which reacts with the analyte to produce a color change. The intensity of the resulting color is directly related to the concentration of the analyte in the sample.

Samples collected for on-site VOC analysis will be analyzed using a Hewlett Packard 5890 GC or equivalent. The GC will be equipped with a purge-and-trap unit for use in analysis of aqueous samples. Air samples will be injected directly into the GC. The GC will also be equipped with two detectors, a photometric ionization detector (PID) and electrolytic conductivity (Hall) detector. The Hall detector will be calibrated to measure concentrations of benzene, toluene, xylenes, and ethylbenzene. The PID will be calibrated to measure concentrations of 1,2-dichloroethane, cis-1,2-dichloroethene, trans-1,2-dichloroethene, tetrachloroethene, trichloroethene, and vinyl chloride.

Table 6-3 Analytical Requirements for Phase I IM Activities

Parameter	Analytical Method	Constituent	Reference
VOCs (on site)	USEPA Method 5030/8010 & 5030/8020 (Modified)	Benzene 1,2-Dichloroethane cis-1,2-Dichloroethene trans-1,2-Dichloroethene Ethylbenzene Tetrachloroethene Toluene Trichloroethene Xylenes (total) Vinyl Chloride	(1) (2)
VOCs (off site)	1990 CLP SOW	TCL (Table 2-2)	(3)
SVOCs	1990 CLP SOW	TCL (Table 2-2)	(3)
Pesticides and PCBs	1990 CLP SOW	TCL (Table 2-2)	(3)
Metals	USEPA Method 6010	Cadmium Chromium Iron Manganese	(2)
	USEPA Method 7421	Lead	
	1991 CLP SOW	TAL (Table 2-2)	(4)
mRBC Parameters			
* Nitrate and Nitrite	Field Test Kit		
* Phosphate (total)	Field Test Kit		
* TSS	USEPA Method 160.2		(5)
* Total Volatile Suspended Solids	USEPA Method 160.2M		(5)
* Oxygen/Methane/Carbon Dioxide	Field Method		

See notes at end of table.

Table 6-3 (Continued) Analytical Requirements for Phase I IM Activities

Parameter	Analytical Method	Constituent	Reference
Engineering Treatability (ETPs)			
* pH	Field Method		
* Chloride	USEPA Method 325.2		(5)
* TOC	USEPA Method 415.1		(5)
* TSS	USEPA Method 160.2		(5)
* TDS	USEPA Method 160.1		(5)
* Hardness, total (as $CaCO_3$)	USEPA Method 130.2		(5)
* BOD (5-day)	USEPA Method 405.1		(5)

Notes:

BOD = biochemical oxygen demand
mRBC = methanotrophic Rotating Biological Contactor
SVOCs = semivolatile organic compounds
TAL = target analyte list
TCL = target compound list
TOC = total organic carbon
TSS = total suspended solids
TDS = total dissolved solids
USEPA = U.S. Environmental Protection Agency
VOCs = volatile organic compounds

References:

(1) Test Methods for Evaluating Solid Waste, Physical Chemical Methods, SW-846, 3rd Edition, USEPA 1986.
(2) ABB-ES' Treatability Laboratory Standard Operating Procedures.
(3) Contract Laboratory Program (CLP) Statement of Work (SOW) for Organic Analysis.
(4) CLP SOW for Inorganic Analysis.
(5) Methods for Chemical Analysis of Water and Wastes, USEPA-600/4-79-020, revised March 1983.

Quality assurance and quality control (QA/QC) procedures for the on-site laboratory are discussed in this paragraph. Duplicate samples will be collected and analyzed at a frequency of 10 percent of the total number of samples. A method blank will be analyzed at the beginning of each day. Cleaning blanks will be analyzed, as necessary, to check for carryover of contaminants from a previous analysis. Matrix spike and matrix spike duplicate analyses will be done at a frequency of 5 percent of the total number of samples. A known concentration of bromofluorobenzene surrogate will be added to each sample and the percentage of recovery calculated and recorded.

Real time measurements of carbon dioxide, oxygen, and methane will be done using various electronic analyzers. The mRBC unit employs three gas analyzers that continuously measure headspace gases in the unit. The measurements are recorded on a strip chart.

6.3.3 Off-Site Analytical Procedures The off-site laboratory program for IM operations monitoring includes analysis of physical and chemical parameters. All off-site analyses will be conducted according to USEPA-approved methods. Table 6-3 summarizes analytical methods to be used for the off-site analyses. The subcontract laboratory will be qualified to perform CLP analyses, will have an active QA/QC program, and will be NEESA-approved. QA/QC procedures are specified in the various analytical methods to be used for the IM off-site laboratory program. Details of QA/QC procedures for individual analyses can be found in the references cited in Table 6-3.

The off-site laboratory program includes analysis of a minimum of 5 percent of all samples analyzed in the on-site laboratory. Off-site analysis of air and aqueous samples, analyzed in the on-site laboratory for the target VOCs, will include TCL VOCs. All SVOC, pesticide, PCB, metals, and engineering treatability parameter analyses (excluding pH) conducted as part of IM operations monitoring will be done by the off-site laboratory. Table 6-1 provides information on the location and frequency of sample collection for off-site analyses.

6.3.4 Turnaround Times With the exception of TCL and TAL analyses, data from off-site laboratory samples should be submitted to IM personnel within 30 days of receiving the sample. TCL and TAL analyses will be conducted on a 7-day turnaround schedule. Analysis on field samples will be complete within 24 hours from the time the sample is collected. On-site analysis of treated water effluent will be completed within 2 hours from the time the sample is collected.

6.4 SUPPLEMENTAL RFI GROUNDWATER MONITORING. Twenty-five (25) groundwater monitoring wells have been installed in and around the landfill and Crooked River Plantation Subdivision to be used for groundwater monitoring for the site RFI. The monitoring wells range in depth from 20 to 95 feet bgs. These wells will be sampled in January and April 1994. Sample analysis will include all TCL and TAL analytes, plus sulfide. A subset of groundwater samples will be analyzed for Appendix IX constituents.

The IM GWE operations will not be started until analytical results from the January sampling event are available and reviewed to confirm that no additional constituents are present at concentrations of concern.

REFERENCES

ABB Environmental Services, Inc. (ABB-ES), 1993a. Draft Final Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Interim Report, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay, Georgia. Contract Task Order No. 041, Navy CLEAN District 1, Contract No. N62467-89-D-0317. August.

ABB Environmental Services, Inc. (ABB-ES), 1993b. Draft Final Interim Measure Work Plan for Site 11, Old Camden County Landfill Phase I Activities. Contract Task Order No. 041, Navy CLEAN District 1, Contract No. N62467-89-D-0317. December.

ABB Environmental Services, Inc. (ABB-ES), 1993c. Interim Corrective Measure Screening Investigation Report, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay, Georgia. Contract Task Order No. 041, Navy CLEAN District 1, Contract No. N62467-89-D-0317. August.

ABB Environmental Services, Inc. (ABB-ES), 1992. Phase I Interim Investigation Memorandum, Site 11, Naval Installation Restoration Program, Naval Submarine Base, Kings Bay, Georgia. Contract No. N62467-89-D-0317. September.

American Public Health Association (APHA), American Water Works Association, and the Water Pollution Control Federation, 1992. Standard Methods for the Examination of Water and Wastewater. 18th Edition.

Bureau of National Affairs, 1993. EPA Pretreatment Standards, The Bureau of National Affairs, Inc.. August.

Bureau of National Affairs, 1993. Measurement of Gaseous Organic Compound Emissions by Gas Chromatography. The Bureau of National Affairs, Inc. August.

Bureau of National Affairs, 1993. EPA Regulations for Owners and Operators of Permitted Hazardous Waste Facilities. The Bureau of National Affairs, Inc. September.

U.S. Environmental Protection Agency (USEPA), 1993. Drinking Water Regulations and Health Advisories. Office of Water, Washington, D.C. May.

U.S. Environmental Protection Agency (USEPA), 1990. USEPA Fate and Treatability Estimator for Discharge to POTWs, Document No. 540/2-90-007. August.

U.S. Environmental Protection Agency (USEPA), 1986. Test Methods for Evaluating Solid Waste, Physical Chemical Methods, SW-846, 3rd Edition.

U.S. Environmental Protection Agency (USEPA), 1983. Methods for Chemical Analysis of Water and Wastes, USEPA-600/4-79-020, revised March 1993.

APPENDIX C

REQUEST FOR AUTHORIZATION FOR GROUNDWATER DISHCARGE INTO THE ST. MARYS' POINT PETER SEWAGE TREATMENT FACILITY

5090
Ser N56/0021

03 JAN 1994

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Georgia Department of Natural Resources
Attn: Mr. Jim Sommerville, Manager
Municipal Permitting Program
4244 International Parkway, Suite 110
Atlanta, GA 30354

Dear Mr. Sommerville:

This is to formally request your authorization to allow discharge of treated groundwater to the City of St. Marys Point Peter sewage treatment facility (POTW).

For your information, we are providing two copies of Request For Authorization For Groundwater Discharge into the St. Marys Point Peter Sewage Treatment Facility, enclosure (1), and one copy of Draft Final RFI Interim Report for Site 11, Volumes I & II, enclosure (2). The RFI Interim Report has been reviewed and accepted by the Environmental Protection Division. Mr. Bruce Khaleghi and Ms. Madeleine Kellam are our contacts in EPD's Hazardous Waste Department.

As part of our Interim Measure pilot remediation, groundwater will be extracted from five recovery wells installed near the Old County Landfill (Site 11) on SUBASE property. The water will be treated on-site to meet State and Federal drinking water standards and will then be discharged to the Point Peter facility. Connection to the sewer system will be made at a manhole located at the Crooked River Elementary School.

Currently, the Point Peter facility operates at approximately 79 percent of its permitted capacity of 800,000 gallons per day (gpd). The proposed maximum treatment system discharge flow of 86,400 gpd (60 gpm, 24 hours per day) would represent approximately 11 percent additional flow. The Point Peter facility has the ability, if needed, to divert flow to the City's Weed Street facility, which operates well below rated capacity. The Point Peter plant is an activated sludge process which operates under a land application permit and has discharge limitations of 50mg/l BOD and 50 mg/l TS. The discharge of the treated groundwater to the facility will not adversely affect these parameters.

The intended duration for discharge to the Point Peter facility is up to ten months. This includes six weeks of pilot scale testing to begin February 10, 1994 and eight months of continued

operation of the treatment system during the design and implementation of a full-scale Interim Measure.

We are working closely with the St. Mary's City Manager, Mr. Mike Mahaney, and the City's consulting engineers in all aspects of this project. Currently, we are sharing extensive technical information with the consulting firm, to enable the City to complete a full technical evaluation of the proposed discharge concurrently with this request for authorization.

As ABB Environmental Services is the operator of the pilot-scale test we request that you provide a copy of your authorization to them at ABB Environmental Systems, Inc., Attn: Mr. Frank Cater, 1400 Centerpoint Blvd., Suite 158, Knoxville, TN 37922.

We thank you for your consideration of this request and the continuing assistance you are providing to us and to ABB-ES. If you have questions regarding this request or the enclosed documents please contact Mr. John Garner at (912)673-8845. Please address all correspondence to "Commanding Officer, Naval Submarine Base, 1063 USS Tennessee Avenue, Kings Bay, GA 31547-2606."

Sincerely,

L.P. SCULLION
CAPTAIN, CEC, USN
PUBLIC WORKS OFFICER
BY DIRECTION OF THE
COMMANDING OFFICER

Encl:
(1) Request For Authorization For Groundwater Discharge
(2) Draft Final RFI Interim Report, Volumes I & II

Copy to:
City of St. Marys, Mike Mahaney (w/1 copy encl (1))
GaDNR (EPD), Bruce Khaleghi (w/1 copy encl (1))
ABB-ES (Frank Cater) (w/o encls)
Mayes, Sudderth, and Etheredge, Tom Bailey (w/1 copy encl (1))

Blind Copy to:
SOUTHNAVFACENGCOM (Dave Dregger)

ASEA BROWN BOVERI

3 March 1994

Georgia Department of Natural Resources
Georgia Environmental Protection Division
Atlanta Tradeport
4244 International Parkway
Suite 110
Atlanta, Georgia 30354

Attention: Mr. Winthrop Brown

Subject: **Request for Authorization for Groundwater Discharge into the St. Marys' Point Peter Sewage Treatment Facility by Naval Submarine Base Kings Bay, Georgia.**
Naval Submarine Base Kings Bay, Georgia - Interim Measure
Contract Task Order 094
Prime Contract No. N62467-89-D-0317

Dear Mr. Brown:

ABB Environmental Services, Inc. (ABB-ES) is pleased to provide you with the additional information you requested of Mr. Kurt Sichelstiel of ABB-ES Knoxville Tennessee office. This conversation took place on 10 February 1994. We apologize in the delay for forwarding this information to you. We understand that you had requested that the Interim Measure Treatment System effluent concentrations be calculated based on the efficiencies of the manufacturer's supplied system. Using the manufacturer's system performance model and the estimated concentration levels of the 17 constituents of concern, we have provided a table of the system efficiencies and system effluent concentrations.

The table provides the estimated influent concentration, the percent efficient removal, and the system effluent estimated concentrations. We hope this provides the information you need to evaluate the Naval Submarine Base request to discharge to the City of St. Marys' Point Peter Sewage Treatment Facility. This table is in addition to the information provided in the document prepared by ABB-ES in conjunction with the request for discharge.

If you have any further questions, or need any additional information, please feel free to call me at (615) 531-1922, or contact Mr. John Garner of Naval Submarine Base Kings Bay at (912) 673-8845.

Sincerely,

ABB ENVIRONMENTAL SERVICES, INC.

Frank B. Cater, P.E.
Task Order Manager

pc: John Garner - Subase
David Driggers - Southern Division
CTO 094 Files

ABB Environmental Services Inc.

1400 Centerpoint Blvd
Suite 158
Knoxville, Tennessee 37932-1968

Phone
531-1922

Fax
(615) 531-8225

Proposed Treatment System, Efficiencies and Estimated Effluent Concentrations For Treatment of Volatile Organic Compounds (VOCs)

Constituent of Concern	Estimated influent Concentration (µg/l)	Percent Efficient Removal	System Effluent Estimated Concentrations (µg/l)
Benzene	28	99.9	<1
2-Butanone	580	7	541
Chlorobenzene	10	99.8	<1
1,4-Dichlorobenzene	12	99.7	<1
1,1-Dichloroethane	100	99.9	<1
1,2-Dichloroethane	9	95.3	<1
cis-1,2-Dichloroethene	3,600	98.9	40
trans-1,2,-Dichloroethene	23	99.9	<1
1,2-Dichloropropane	6	99.0	<1
Ethylbenzene	200	99.9	<1
2-Hexanone	70	3	68
4-Methyl-2-pentanone	1,400	25.8	1,039
Tetrachloroethene	24	99.9	<1
Toluene	840	99.9	<1
Trichloroethene	45	99.9	<1
Xylenes (total)	155	99.9	<1
Vinyl Chloride	1,400	100	0

Notes:

µg/l = micrograms per liter
mg/l = milligrams per liter
VOC = volatile organic compounds

REQUEST FOR AUTHORIZATION FOR GROUNDWATER DISCHARGE INTO THE ST. MARYS' POINT PETER SEWAGE TREATMENT FACILITY

NAVAL INSTALLATION RESTORATION PROGRAM
NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

CONTRACT NO. N62467-89-D-0317

DECEMBER 1993

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA
29419-9010

REQUEST FOR AUTHORIZATION FOR GROUNDWATER DISCHARGE INTO THE ST. MARYS' POINT PETER SEWAGE TREATMENT FACILITY

CONTRACT TASK ORDER NO. 94
CONTRACT NO. N62467-89-D-0317

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

Prepared for:

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December 1993

Request for Authorization for Groundwater Discharge into the St. Marys' Point Peter Sewage Treatment Facility

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ACRONYMS

ABB-ES	ABB Environmental Services, Inc.
BOD	biochemical oxygen demand
bgs	below ground surface
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
DQOs	Data Quality Objectives
ETP	engineering treatability parameters
GC	gas chromatograph
gpm	gallons per minute
GPTRAC	General Particle Tracking Module
GWE	groundwater extraction
ICMSI	Interim Corrective Measure Screening Investigation
ID	Induced Draft
IM	Interim Measure
µg/l	micrograms per liter
mg/l	milligrams per liter
MCLs	Maximum Contaminant Levels
mRBC	methanotrophic Rotating Biological Contactor
MS/MSD	matrix spike and matrix spike duplicate
NPDES	National Pollutant Discharge Elimination System
NSB	Naval Submarine Base
PCBs	polychlorinated biphzenyls
PID	photoionization detector
POTW	Publicly Owned Treatment Works
PVC	polyvinyl chloride
QC	quality control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
s.u.	standard units
SOUTHDIV	Southern Division
SVOCs	semivolatile organic compounds

ACRONYMS (Continued)

TCL	Target Compound List
TDS	total dissolved solids
TSS	total suspended solids
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WHPA	Well Head Protection Area

1.0 INTRODUCTION

The purpose of this document is to provide the information needed for the Georgia Department of Natural Resources to evaluate the request to discharge treated groundwater to the City of St. Marys Point Peter sewage treatment facility. The following sections provide current and historic groundwater quality data, modeling of groundwater extraction system capture zones, a description of the groundwater treatment system, and a treatment system operation and discharge monitoring plan.

Additional information and backup data on groundwater quality is available in the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Interim Report (ABB-ES, 1993a). More detailed treatment system design information is available in the Interim Measure Work Plan for Site 11, Old Camden County Landfill Phase I Activities (ABB-ES, 1993b).

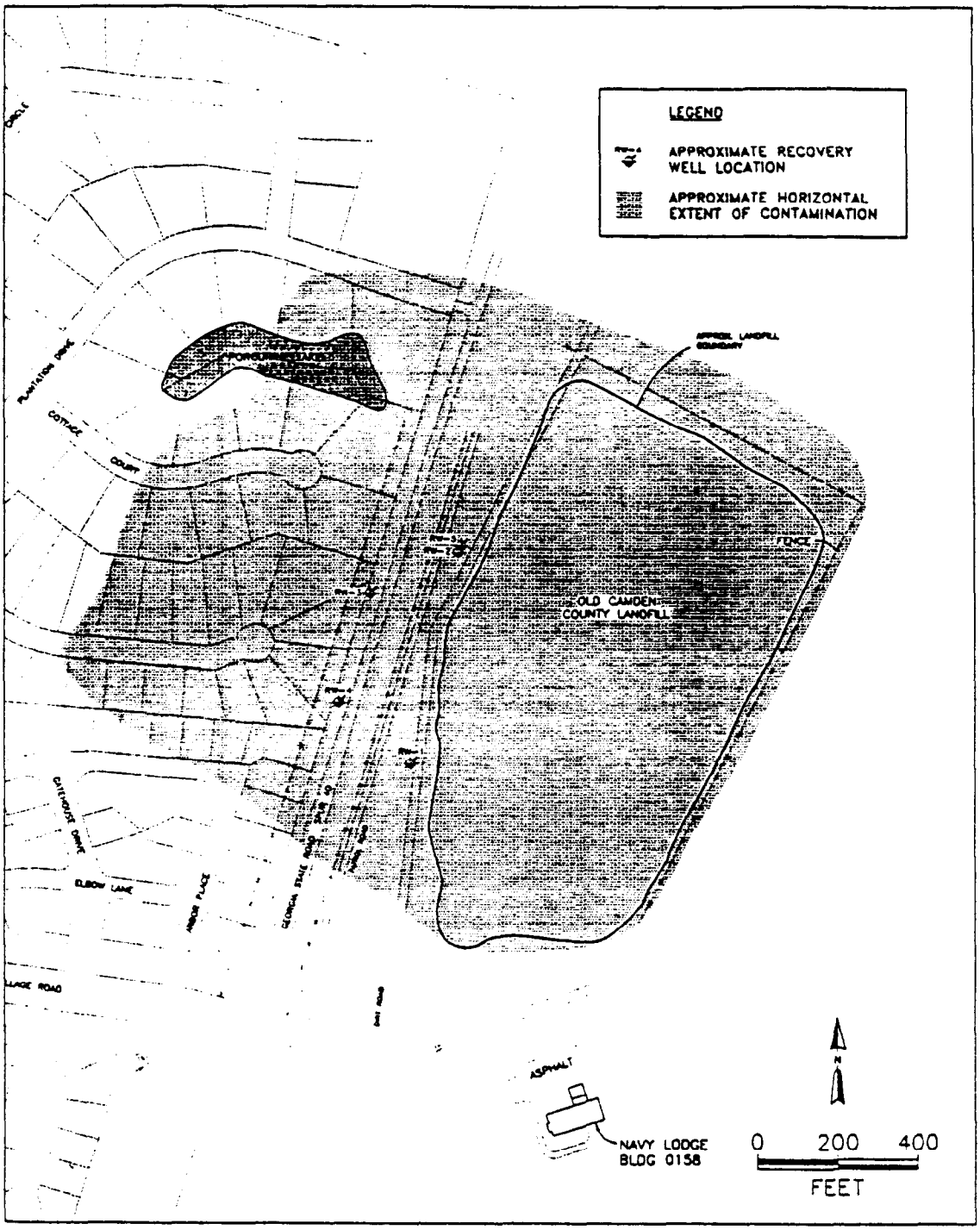
1.1 OBJECTIVE OF INTERIM MEASURE. The overall objective of the Interim Measure (IM) is to hydraulically control movement of the volatile organic compound (VOC) plume within the surficial aquifer. This will be achieved in a phased approach. The first phase will collect site-specific data to support long-term corrective measures, while in the process focus on collection of VOC-contaminated groundwater from known areas of highest contamination. This first phase will continue while design activities are conducted for a full-scale IM system. The second phase, or full-scale IM, will be designed to meet the overall IM objective of stabilization of VOC-contaminated groundwater within the surficial aquifer.

1.2 TREATMENT SYSTEM OVERVIEW.

1.2.1 Plume Definition Groundwater sampling results from the Interim Corrective Measure Screening Investigation (ICMSI) at the Old Camden County Landfill, Site 11, at Naval Submarine Base (NSB) Kings Bay indicated that VOCs are present within the surficial aquifer. VOCs detected include vinyl chloride, cis-1,2-dichloroethene, and other fuel-related VOC contaminants. The VOC contamination is present beneath the site and extends into the Crooked River Plantation Subdivision. The spatial distribution of the VOCs appears to be limited to the upper 60 feet of the surficial aquifer in the subdivision and along the western boundary of the landfill. Beneath the landfill, VOC contaminants were detected at depths of 85 feet below ground surface (bgs). The overall hydraulic gradient in the vicinity of the landfill is approximately 0.003 foot per foot towards the west-northwest. The VOCs appear to have migrated within the groundwater laterally toward the subdivision through advective transport and dispersion.

Section 2.0 of this document provides a more detailed discussion of groundwater contamination characteristics. Plume plan view contour maps are included in Subsection 2.2.1 of this document.

1.2.2 Groundwater Extraction Controlling the contaminant plume will be accomplished by use of a groundwater extraction (GWE) system to withdraw groundwater contaminated with VOCs from the surficial aquifer. The pilot-scale GWE system will include five recovery wells at four locations. Four wells (RW-1, RW-2, RW-3, and RW-4) are screened between approximately 20 to 70 feet bgs. One location includes a recovery well screened from 6 to 26 feet bgs and nested with well RW-2. The recovery wells, shown in Figure 1-1, are positioned along the



DWN: NLW	PROJECT NO.: 08503	TITLE: APPROXIMATE RECOVERY WELL LOCATIONS AND HORIZONTAL EXTENT OF CONTAMINATION	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: LBH	FIGURE NO.: 1-1		
DATE: 12/15/93			

western side of the landfill and on the western right-of-way of Spur 40 in areas where the highest concentrations of VOCs were detected.

1.2.3 Groundwater Treatment The treatment system will collect, treat, and discharge water extracted from the surficial aquifer by the pilot-scale GWE system. The system will have the capacity to reduce contaminant concentrations in the groundwater to United States Environmental Protection Agency (USEPA)-established Maximum Contaminant Levels (MCLs). MCLs are concentrations that are generally accepted as drinking water standards. Further discussion of these performance standards is provided in Subsection 1.3.

Two pilot-scale treatment systems will be evaluated for suitability as a treatment method for full-scale IM implementation. Most of the water will be treated using air stripping technology for removal of the VOCs. The second pilot-scale treatment system, a methanotrophic Rotating Biological Contactor (mRBC), will accept a small stream (1 gallon per minute) which will be biologically treated for removal of the VOCs. Both systems will be evaluated for effectiveness and efficiency as a long-term IM treatment approach.

During an initial pumping test conducted in October 1993, groundwater samples were collected and analyzed for heavy metals, iron, and carbonate concentrations to determine requirements for metals and carbonate removal prior to air stripping. Analytical results are presented in Subsection 2.1.5. Based on the analytical results, metals and carbonate removal will not be needed at this time.

1.3 PERFORMANCE STANDARDS. The IM groundwater treatment system operations and effluent will be operated and monitored to:

1) achieve MCLs for constituents of concern at the system discharge,
2) achieve efficient and effective operation of the air sparger, and
3) collect data to design a full-scale treatment system, if needed.

The USEPA considers a discharge to a Publicly Owned Treatment Works (POTW) an "indirect discharge." The General Pretreatment Regulations (40 Code of Federal Regulations (CFR) 403) apply to the site discharge and will be adhered to during the operation of the IM groundwater treatment system. The purpose of the pretreatment regulations and standards is to prevent the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the POTW.

The prohibitions of the pretreatment regulations (40 CFR 403.5.a) are applicable to nondomestic uses and control the introduction of contaminants into POTWs to accomplish the following:

1) prevent interference with the operation (including sludge management) of a POTW, and

2) prevent pass through of contaminants through the POTW.

The term "interference" means a discharge that inhibits or disrupts a POTW, its treatment processes or operations, or its sludge processes, use, or disposal, causing a violation of its discharge permit or other requirements. "Pass through" is any discharge to a POTW in quantities or concentrations that causes a violation of any requirement of the POTW's discharge permit.

The effluent from the IM treatment systems will meet federal, state, and local pretreatment requirements, as applicable, for discharge to the City of St. Marys' Point Peter Plant. During the pilot-scale testing, the concentrations of constituents of concern to the POTW influent will meet the federal drinking water criteria MCLs listed in Table 1-1. Groundwater meeting this criteria will not cause any biological interference, or be toxic, to the POTW system. Nor will the constituents pass through the POTW at any concentrations of concern.

During pilot-scale operation, untreated groundwater analytical data will be collected to evaluate treatment and performance standards required for full-scale IM operation. Currently, available groundwater data does not sufficiently support a no-treatment alternative for the groundwater extracted during pilot-scale testing. Treatment and monitoring of the groundwater extracted during pilot-scale testing will be performed to prevent the receiving treatment facility from being adversely affected by the IM discharge stream. If approved, the treatment system effluent will be discharged to the Point Peter Plant which is equipped with an aeration and activated sludge process.

The proposed performance standards for the treatment system, or MCLs, for the constituents of concern are listed in Table 1-1.

1.4 PROPOSED SCHEDULE. The IM Treatment System is tentatively scheduled to start-up in February 1994. The pilot-scale test operations will take approximately 6 weeks to complete (Phase I). The testing operations will progress as follows:

- Start-up of one recovery well (approximately 10 gpm) and operation for one week.
- Recovery phase for one week - some well development water that has been stored will be treated.
- Start-up of two recovery wells (approximately 17 gpm) and operation for one week.
- Start-up of remaining three recovery wells and operation of all wells for 4 weeks (60 gpm maximum).

Evaluation of the pilot-scale test results and design of a full-scale IM system is expected to require a minimum of 8 months. During this time (Phase I Continuance), the pilot-scale system will continue to operate to maintain the control of migration of constituents that was achieved during the pilot-scale test operations. Discharge to the Point Peter facility is requested for the duration of the Phase I and Phase I Continuance activities (approximately 10 months). Treatment system discharge during full-scale IM (Phase II) activities will be evaluated and resolved during design of the full-scale system.

Table 1-1 Proposed Treatment System Performance Criteria

Constituent of Concern	Estimated Influent Concentration[1]	Performance Criteria[2] (µg/l)
Benzene	28 µg/l	5
2-Butanone	580 µg/l	No limit[3]
Chlorobenzene	10 µg/l	100
1,4-Dichlorobenzene	12 µg/l	75
1,1-Dichloroethane	100 µg/l	No limit[3]
1,2-Dichloroethane	9 µg/l	5
cis-1,2-Dichloroethene	3,600 µg/l	70
trans-1,2-Dichloroethene	23 µg/l	100
1,2-Dichloropropane	6 µg/l	5
Ethylbenzene	200 µg/l	700
2-Hexanone	70 µg/l	No limit[3]
Methylene Chloride	41 µg/l	5
4-Methyl-2-pentanone	1,400 µg/l	No limit[3]
Tetrachloroethene	24 µg/l	5
Toluene	840 µg/l	1,000
Trichloroethene	45 µg/l	5
Xylenes (total)	155 µg/l	10,000
Vinyl Chloride	1,400 µg/l	2
BOD (5-day)	14.3 mg/l	*
TSS	9.8 mg/l	*
pH	4 - 6 s.u.	*

Notes:

* = to be set by Publicly Owned Treatment Works
BOD = biochemical oxygen demand
mg/l = milligrams per liter
µg/l = micrograms per liter
TSS = total suspended solids
s.u. = standard units

1 Maximum concentration detected from previous studies.
2 Performance criteria are the maximum contaminant levels for constituents of concern as established by the State of Georgia (1993) and USEPA (1993).
3 No MCL or health-based advisory established.

2.0 GROUNDWATER CHARACTERIZATION

2.1 GROUNDWATER INVESTIGATIONS. Previous investigation activities to characterize the nature and extent of groundwater contamination associated with Site 11 include a RFI groundwater monitoring program and three phases of contamination characterization. The first characterization effort was a Phase I Interim Investigation. The second and third phases of contamination characterization are included in the ICMSI. A Supplemental RFI and IM has been planned for the site and the initial implementation began in October 1993. The scope of the RFI groundwater monitoring program, Supplemental RFI, IM, and phases of contamination characterization are briefly described in the following paragraphs. Subsection 2.2 discusses the results of the investigation activities conducted at Site 11.

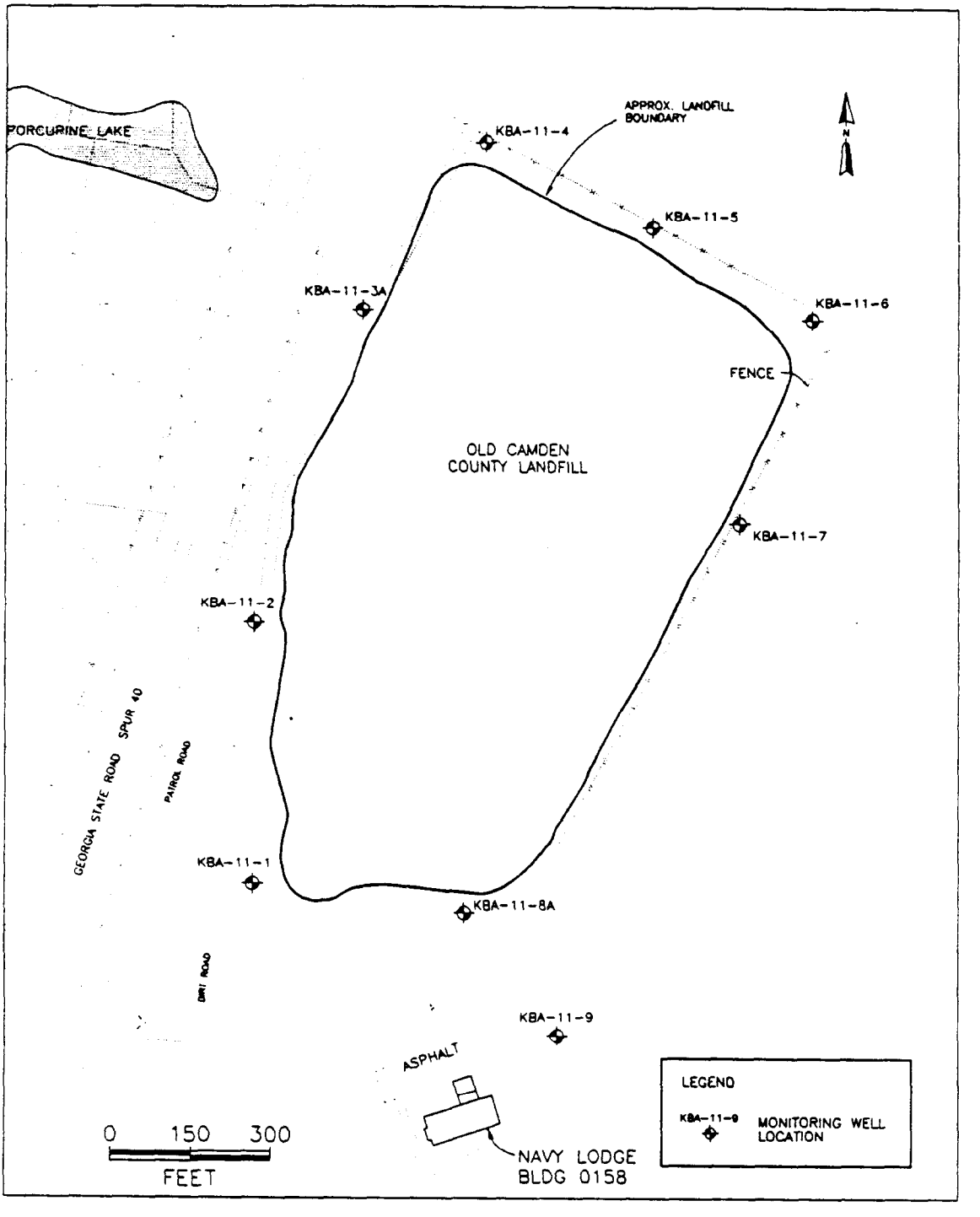
2.1.1 RFI Groundwater Monitoring Program A groundwater monitoring program consisting of six bimonthly sampling events began in February 1992. Nine groundwater monitoring wells, KBA-11-1 through KBA-11-9, were included in the monitoring program (Figure 2-1). These monitoring wells are approximately 13 feet bgs and have 10-foot well screens that intercept the surface of the water table.

Samples from the first two sampling events were analyzed for Appendix IX VOCs, semivolatile organic compounds (SVOCs), organochlorine pesticides and polychlorinated biphenyls (PCBs), dioxins and furans, herbicides, organophosphorus pesticides, and inorganics (including cyanide and sulfide) (Table 2-1). No pesticides, PCBs, herbicides, dioxins, or furans, were detected in the groundwater samples, and the SVOCs detected were attributed to incidental contamination during sampling and/or analysis. The analytical program was reduced after the second sampling event to include Appendix IX VOCs, inorganics (including cyanide and sulfide), total dissolved solids (TDS), and total suspended solids (TSS).

2.1.2 Phase I Interim Investigation The Phase I Interim Investigation was implemented in August 1992 (ABB-ES, 1992). The objective of this investigation was to determine whether VOCs detected in the RFI groundwater monitoring wells had migrated off NSB property. The investigation included collection of 36 groundwater samples using a hydrocone groundwater sampler advanced by direct push technology. These groundwater samples were collected from 25 locations along the western margin of the landfill and on the western right-of-way of Spur 40. Sample depths ranged from 7 to 20 feet bgs, with the exception that one penetration was advanced to a depth of 78 ft bgs. The groundwater samples were analyzed in an on-site laboratory for five target VOCs listed below:

- vinyl chloride,
- chloroethane,
- trans-1,2-dichloroethene,
- trichloroethene, and
- tetrachloroethene.

Five duplicate groundwater samples were sent to an off-site analytical laboratory for confirmatory analysis. These analyses were conducted using SW-846 Methods 8010 and 8020. The analytes for these analyses include the VOCs listed for Appendix IX constituents in Table 2-1.



DWN: NLW	PROJECT NO.: 08503	TITLE: LOCATIONS OF MONITORING WELLS INSTALLED DURING THE RFI - FEBRUARY 1992	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: VAR	FIGURE NO.: 2-1		
DATE: 12/08/93			

Table 2-1 Appendix IX, Groundwater Monitoring List

Volatile Organic Compounds (58 total)
SW-846 Method 8240

Chloromethane
Bromomethane
Vinyl Chloride
Chloroethane
Methylene Chloride
Acetone
Carbon Disulfide
Trichlorofluoromethane
1,1-Dichloroethene
1,1-Dichloroethane
1,2-Dichloroethene (total)
Chloroform
1,2-Dichloroethane
2-Butanone
1,1,1-Trichloroethane
Carbon Tetrachloride
Vinyl Acetate
Bromodichloromethane
1,2-Dichloropropane
cis-1,3-Dichloropropene
Trichloroethene
Dibromochloromethane
1,1,2-Trichloroethane
Benzene
trans-1,3-Dichloropropene
2-Chloroethylvinylether
Bromoform
2-Hexanone
4-Methyl-2-Pentanone
Tetrachloroethene
1,1,2,2-Tetrachloroethane
Toluene
Chlorobenzene
Ethylbenzene
Styrene
Xylene (total)
1,3-Dichlorobenzene
1,4-Dichlorobenzene
1,2-Dichlorobenzene
Acrolein
Iodomethane
Acrylonitrile
Dibromomethane
Ethyl Methacrylate
1,2,3-Trichloropropane
trans-1,4-Dichloro-2-Butene
Acetonitrile
3-Chloropropene
Propionitrile
Methacrylonitrile
1,4-Dioxane
Methyl Methacrylate
1,2-Dibromoethane
1,1,1,2-Tetrachloroethane
1,2-Dibromo-3-Chloropropane
Pentachloroethane
Isobutyl alcohol
Chloroprene

Semivolatile Organic Compounds (acid fraction)
SW-846 Method 8270 (18 total)

Phenol
2,6-Dichlorophenol
2-Chlorophenol
2-Methylphenol
2,3,4,6-Tetrachlorophenol
3-Methylphenol
4-Methylphenol
2-Nitrophenol
Benzoic Acid
2,4-Dichlorophenol
4-Chloro-3-Methylphenol
2,4,6-Trichlorophenol
2,4,5-Trichlorophenol
2,4-Dinitrophenol
4-Nitrophenol
4,6-Dinitro-2-Methylphenol
2,4-Dimethylphenol
Pentachlorophenol

Table 2-1 (Continued) Appendix IX, Groundwater Monitoring List

Semivolatile Organic Compounds (base/neutral fraction)
SW-846 Method 8270 (93 total)

N-Nitrosodimethylamine	Di-n-Octyl Phthalate
Aniline	Benzo(b)Fluoranthene
bis(2-Chloroethyl)Ether	Benzo(k)Fluoranthene
1,3-Dichlorobenzene	Benzo(a)Pyrene
1,4-Dichlorobenzene	Indeno(1,2,3-cd)Pyrene
Benzyl Alcohol	Dibenz(a,h)Anthracene
1,2-Dichlorobenzene	Benzo(g,h,i)Perylene
bis(2-Chloroisopropyl)Ether	2-Picoline
N-Nitroso-Di-n-Propylamine	Methyl methanesulfonate
Hexachloroethane	Ethyl methanesulfonate
Nitrobenzene	Acetophenone
Isophorone	N-Nitrosopiperidine
bis(2-Chloroethoxy)Methane	Phenyl-tert-butylamine
1,2,4-Trichlorobenzene	N-Nitroso-di-n-butylamine
Naphthalene	N-Nitrosodiethylamine
4-Chloroaniline	N-Nitrosopyrrolidine
Hexachlorobutadiene	Benzidine
2-Methylnaphthalene	1,2,4,5-Tetrachlorobenzene
Hexachlorocyclopentadiene	Pentachlorobenzene
2-Chloronaphthalene	1-Naphthylamine
2-Nitroaniline	2-Naphthylamine
Dimethylphthalate	Diphenylamine
Acenaphthylene	Phenacetine
2,6-Dinitrotoluene	4-Aminobiphenyl
3-Nitroaniline	Pentachloronitrobenzene
Acenaphthene	Pronamide
Dibenzofuran	p-Dimethylaminoazobenzene
2,4-Dinitrotoluene	3-Methylcholanthrene
Diethylphthalate	7,12-Dimethylbenz(a)Anthracene
4-Chlorophenyl-phenylether	Pyridine
Fluorene	N-Nitrosomethylethylamine
4-Nitroaniline	N-Nitrosomorpholine
N-Nitrosodiphenylamine	o-Toluidine
1,2-Diphenylhydrazine	Hexachloropropene
4-Bromophenyl-phenylether	p-Phenylenediamine
Hexachlorobenzene	Safrole
Aramite	Isosafrole
Phenanthrene	1,4-Napthoquinone
Anthracene	1,3-Dinitrobenzene
Di-n-Butylphthalate	5-Nitro-o-toluidine
Fluoranthene	1,3,5-Trinitrobenzene
Pyrene	4-Nitroquinoline-1-oxide

Table 2-1 (Continued) Appendix IX, Groundwater Monitoring List

Semivolatile Organic Compounds (base/neutral fraction) (Continued)
SW-846 Method 8270 (93 total)

Butylbenzylphthalate
3,3'-Dichlorobenzidine
Benzo(a)Anthracene
Chrysene
bis(2-Ethylhexyl)Phthalate
Methapyrilene
3,3'Dimethylbenzidine
2-Acetamidofluorene
Hexachlorophene

Chlorinated Dibenzofurans and Dibenzo-p-dioxins
SW-846 Method 8280 (7 total)

Tetrachlorodibenzo-p-dioxins (TCDDs) (total)
2,3,7,8- TCDD (total)
Pentachlorodibenzo-p-dioxins (PeCDDs) (total)
Hexachlorodibenzo-p-dioxins (HeCDDs) (total)
Tetrachlorodibenzofurans (TCDFs) (total)
Pentachlorodibenzofurans (PeCDFs) (total)
Hexachlorodebenzofurans (HeCDFs) (total)

Organochlorine Pesticide and PCB Compounds (30 total)
SW-846 Method 8080

alpha-BHC
beta-BHC
delta-BHC
gamma-BHC (Lindane)
Heptachlor
Aldrin
Heptachlor epoxide
Endosulfan I
Dieldrin
4,4'-DDE
Endrin
Endosulfan II
4,4'-DDD
Endrin aldehyde
Endosulfan Sulfate
4,4'-DDT
Methoxychlor
Chlordane
Toxaphene
Aroclor-1016
Aroclor-1221
Aroclor-1232
Aroclor-1242
Aroclor-1248
Aroclor-1254
Aroclor-1260
Kepone
Chlorobenzilate
Diallate
Isodrin

Organophosphorous Pesticide Compounds (9 total)
SW-846 Method 8140

Triethylphosphorothioate
Thionazin
Sulfotepp
Phorate
Dimethoate
Disulfoton
Methyl Parathion
Ethyl Parathion
Famphur

Table 2-1 (Continued) Appendix IX, Groundwater Monitoring List

Chlorinated Herbicide Compounds (4 total) SW-846 Method 8150			
2,4-D	Silvex	2,4,5-T	Dinoseb

Inorganic Analytes (19 total) SW-846 Methods		
Antimony	Copper	Thallium
Arsenic	Lead	Vanadium
Barium	Mercury	Zinc
Beryllium	Nickel	Tin
Cadmium	Selenium	Cyanide
Chromium	Silver	Sulfide
	Cobalt	

2.1.3 Interim Corrective Measure Screening Investigation The ICMSI was conducted in October and November 1992, with follow-on work conducted in March 1993 (ABB-ES, 1993c). The initial ICMSI conducted in 1992 included collection of 144 groundwater samples from 46 locations in and around the landfill, on the right-of-way of Spur 40, and in Crooked River Plantation Subdivision. Sample depths ranged from 5 to 72 feet bgs. All of the groundwater samples were analyzed in an on-site laboratory for 10 target VOCs listed below:

vinyl chloride	trans-1,2-dichloroethene
trichloroethene	cis-1,2-dichloroethene
tetrachloroethene	benzene
toluene	ethylbenzene
m/p-xylene	o-xylene

Seventeen duplicate groundwater samples were submitted to an off-site laboratory for confirmatory analysis. These analyses were performed according to Contract Laboratory Program (CLP) methods and included Target Compound List (TCL) VOCs (Table 2-2). Two groundwater samples were collected and submitted to the off-site laboratory for analysis of TCL SVOCs.

During the ICMSI field effort, two problems were encountered that necessitated follow-on work. First, the direct push instruments had difficulty with the stratigraphy and frequently met refusal at depths as shallow as 10 feet bgs in the area of the landfill. Second, in the landfill the objective was to penetrate the undisturbed soil between burial trenches, but waste was consistently encountered during penetrations.

The follow-on work for the ICMSI was conducted in March 1993 and included collection of groundwater samples from 16 locations within and to the north of the landfill. Sample depths ranged from 12 to 90 feet bgs. Fifty-four groundwater samples were collected and analyzed in an on-site laboratory for the 10 target VOCs listed for the ICMSI. Five groundwater samples were submitted to an off-site laboratory for analysis of TCL VOCs using CLP methods.

A monitoring well, KBA-11-10, was also installed during the March 1993 field effort. This monitoring well was installed at one of the Hydropunch™ locations in the landfill and is 20 feet deep with a 10-foot well screen.

2.1.4 Supplemental RFI In October and November 1993, groundwater monitoring wells were installed in and around the landfill and in Crooked River Plantation Subdivision. Twenty-five monitoring wells were installed at 15 locations (Figure 2-2). The monitoring wells range in depth from 20 to 95 feet bgs. Results of previous investigations were used to select screened intervals for the monitoring wells. The monitoring wells will be sampled during two groundwater sampling events in January and March 1994. Sample analysis will include all TCL and Target Analyte List (TAL) analytes, plus sulfide, which is not a TAL parameter. A subset of groundwater samples collected during the first groundwater sampling event will be analyzed for Appendix IX constituents.

2.1.5 Interim Measure Groundwater contamination characterization activities associated with the IM include collection of groundwater samples from four recovery wells installed in October and November 1993. These samples were submitted to an off-site laboratory for analysis of TCL and TAL parameters (plus sulfide) using CLP methods.

Table 2-2 Target Compound List and Target Analyte List

Parameter: **Volatile Organic Compounds**
Method: **Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration.**

Chloromethane	cis-1,3-Dichloropropene
Bromomethane	Trichloroethene
Vinyl Chloride	Dibromochloromethane
Chloroethane	1,1,2-Trichloroethane
Methylene Chloride	trans-1,3-Dichloropropene
Acetone	Bromoform
Carbon Disulfide	2-Hexanone
1,1-Dichloroethene	4-Methyl-2-Pentanone
1,1-Dichloroethane	Tetrachloroethene
1,2-Dichloroethene (total)	1,1,2,2-Tetrachloroethane
Chloroform	Toluene
1,2-Dichloroethane	Benzene
2-Butanone	Chlorobenzene
1,1,1-Trichloroethane	Ethylbenzene
Carbon Tetrachloride	Styrene
Bromodichloromethane	Xylene (total)
1,2-Dichloropropane	

Parameter: **Semivolatile Organic Compounds**
Method: **Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration.**

Phenol	Acenaphthene
bis(2-Chloroethyl)ether	2,4-Dinitrophenol
2-Chlorophenol	4-Nitrophenol
1,3-Dichlorobenzene	Dibenzofuran
1,4-Dichlorobenzene	2,4-Dinitrotoluene
1,2-Dichlorobenzene	Diethylphthalate
2-Methylphenol	4-Chlorophenyl-phenylether
2,2'-oxybis(1-Chloropropane)	Fluorene
4-Methylphenol	4-Nitroaniline
N-Nitroso-di-n-propylamine	4,6-Dinitro-2-methylphenol
Hexachloroethane	N-Nitrosodiphenylamine
Nitrobenzene	4-Bromophenyl-phenylether
Isophorone	Hexachlorobenzene
2-Nitrophenol	Pentachlorophenol
2,4-Dimethylphenol	Phenanthrene
bis(2-Chloroethoxy)methane	Anthracene
2,4-Dichlorophenol	Carbazole
1,2,4-Trichlorobenzene	Di-n-butylphthalate
Naphthalene	Fluoranthene

See note at end of table.

Table 2-2 (continued) Target Compound List and Target Analyte List

Parameter: Semivolatile Organic Compounds (Continued)

4-Chloroaniline	Pyrene
Hexachlorobutadiene	Butylbenzylphthalate
4-Chloro-3-methylphenol	3,3'-Dichlorobenzidine
2-Methylnaphthalene	Benzo(a)anthracene
Hexachlorocyclopentadiene	Chrysene

Parameter: Semivolatile Organic Compounds - continued
Method: Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration.

2,4,6-Trichlorophenol	bis(2-Ethylhexyl)phthalate
2,4,5-Trichlorophenol	Di-n-octyl phthalate
2-Chloronaphthalene	Benzo(b)fluoranthene
2-Nitroaniline	Benzo(k)fluoranthene
Dimethylphthalate	Benzo(a)pyrene
Acenaphthylene	Indeno(1,2,3-cd)pyrene
2,5-Dinitrotoluene	Dibenz(a,h)anthracene
3-Nitroaniline	Benzo(g,h,i)perylene

Parameter: Organochlorine Pesticide and PCB Compounds
Method: Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration.

alpha-BHC	Endosulfan sulfate
beta-BHC	4,4'-DDT
delta-BHC	Methoxychlor
gamma-BHC (Lindane)	gamma-Chlordane
Heptachlor	alpha-Chlordane
Aldrin	Toxaphene
Heptachlor epoxide	Aroclor-1016
Endosulfan I	Aroclor-1221
Dieldrin	Aroclor-1232
4,4'-DDE	Aroclor-1242
Endrin	Aroclor-1248
Endosulfan II	Aroclor-1254
4,4'-DDD	Aroclor-1260
Endrin aldehyde	

Parameter: Inorganic Analytes
Method: Contract Laboratory Program Statement of Work for Inorganic Analysis

Aluminum	Cobalt	Potassium
Antimony	Copper	Selenium
Arsenic	Iron	Silver
Barium	Lead	Sodium
Beryllium	Magnesium	Thallium

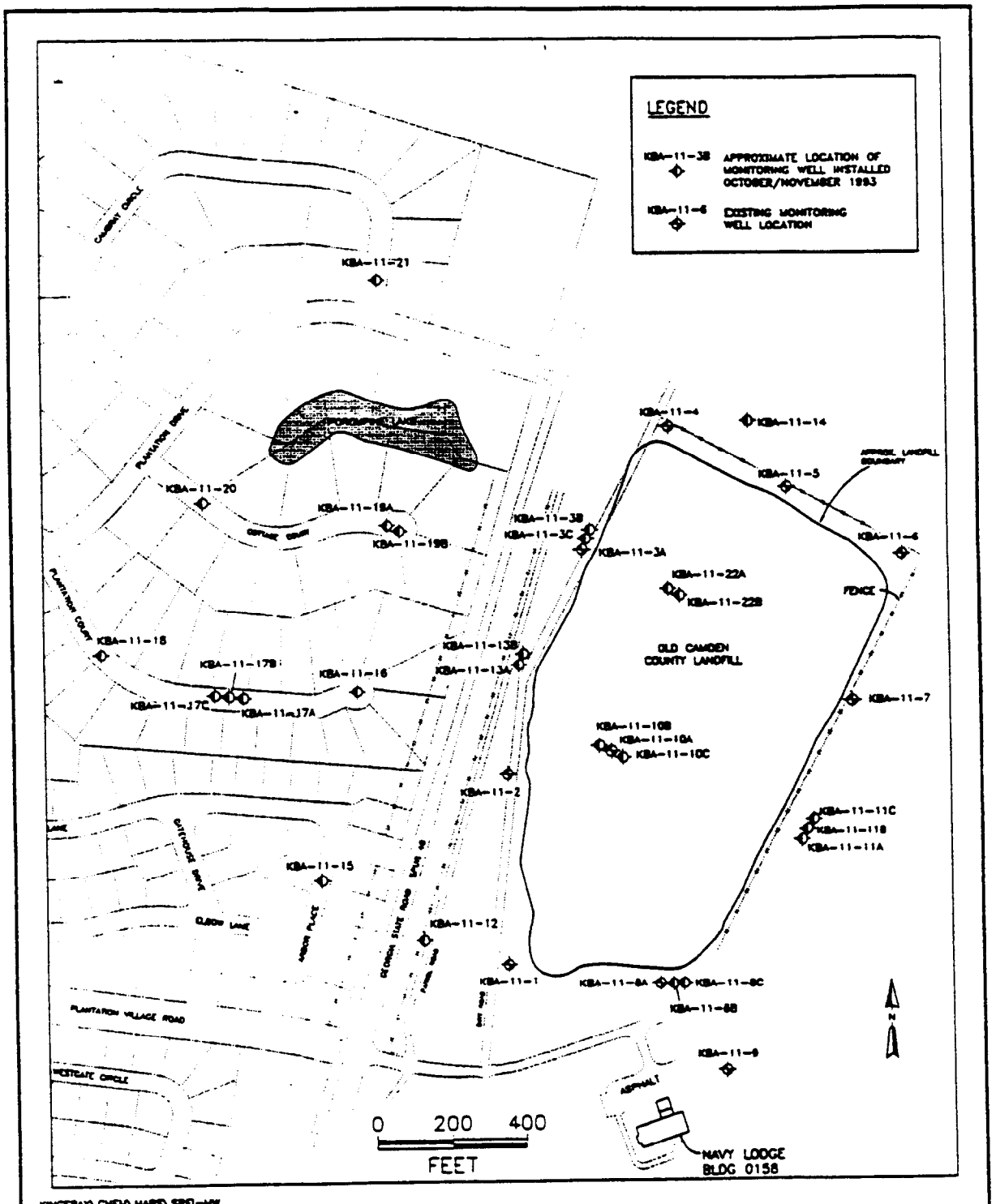
See note at end of table.

Table 2-2 (continued) Target Compound List and Target Analyte List

Parameter: Inorganic Analytes (Continued)		
Cadmium	Manganese	Vanadium
Chromium	Mercury	Zinc
Calcium	Nickel	Cyanide

Note:

PCBs = polychlorinated biphenyls



KINGSBAY\CHEM\MAPS\SRFI-MW

DWN: NLW	PROJECT NO.: 08503	TITLE: LOCATIONS OF MONITORING WELLS INSTALLED DURING THE SUPPLEMENTAL RFI - OCTOBER\NOVEMBER 1993	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: LBH	FIGURE NO.: 2-2		
DATE: 12/08/93			

Additionally, groundwater samples were collected from monitoring well KBA-11-10 (July 1993) and KBA-RW-01 (October 1993). The purpose of analyzing samples from KBA-11-10 and KBA-RW-01 was to evaluate the treatability of the groundwater with respect to the need for pretreatment. The data are included herein for use in evaluating the wastestream to be treated under this request. The groundwater samples from KBA-11-10 were analyzed by an off-site laboratory for the constituents listed below:

TAL inorganics	Alkalinity (as $CaCO_3$)
Hardness, Total (as $CaCO_3$)	TDS
Volatile Suspended Solids	TSS
Total Volatile Solids	Total Solids
Chloride	Sulfate
Sulfide	Ammonia (as N)
Nitrate and Nitrite (as N)	Kjeldahl Nitrogen (as N)
Biological Oxygen Demand (5 and 20 day)	Chemical Oxygen Demand
Grease and Oil	Total Organic Carbon

The samples from KBA-RW-01, collected in October 1993, were analyzed by an off-site laboratory for select metals (cadmium, chromium, lead, iron, and manganese), total hardness (as $CaCO_3$), TDS, TSS, chloride, and total organic carbon (TOC).

2.2 GROUNDWATER CONTAMINATION. The following subsections summarize available information on contaminants in the groundwater to be treated under the IM. The discussion is organized according to groups of compounds.

2.2.1 Volatile Organic Compounds Table 2-3 summarizes VOC data for the RFI groundwater samples. Eleven chlorinated and nonchlorinated solvents and fuel-related VOCs were detected in groundwater samples from monitoring well KBA-11-2 during the RFI bimonthly sampling events. Vinyl chloride was the only VOC detected above its MCL of 2 μg/l. In the remaining four wells containing detectable VOCs, one to four VOCs were detected, but none of the VOC concentrations exceeded MCLs. Detection of vinyl chloride in samples from monitoring well KBA-11-2 prompted the Navy to initiate an aggressive investigation of potential VOC contamination of groundwater.

The results of the Phase I Interim Investigation and ICMSI confirmed that VOCs had migrated, via the groundwater, beyond the boundary of the landfill and underneath Crooked River Plantation Subdivision. These chemicals included solvent-related VOCs such as the dichloroethene and vinyl chloride, as well as fuel-related VOCs such as benzene, ethylbenzene, toluene, and xylenes.

Tables 2-4 and 2-5 summarize on-site and off-site analytical data, respectively, for the groundwater samples collected during the Phase I Interim Investigation and the ICMSI. A total of 25 VOCs have been detected in 27 groundwater samples from the plume. Based on off-site laboratory analysis, seven VOCs were detected at concentrations greater than corresponding MCLs promulgated under state and federal drinking water regulations (Table 2-5). The seven VOCs include benzene, 1,2-dichloroethane, cis-1,2-dichloroethene, 1,2-dichloropropane, methylene chloride, trichloroethene, and vinyl chloride. The on-site analytical data (Table 2-4) indicate that tetrachloroethene is also present in groundwater at concentrations that exceed its MCL of 5 μg/l.

Table 2-3 Summary of Volatile Organic Compound and Semivolatile Organic Compound Analytical Data for the RFI Groundwater Monitoring Program at Site 11

Monitoring Well I.D.	SVOCs Detected	VOCs Detected	Concentration Range (µg/l)	Associated Sample Events
KBA-11-1	None	None		
KBA-11-2	None	vinyl chloride	18 - 160	1,2,3,4,5,6
		1,2-dichloroethene	4.8 - 22	1,2,3,4,5,6
		ethylbenzene	1 J	5
		toluene	1 J - 3 J	2,4,5,6
		xylenes (total)	2 J - 4 J	2,3,5,6
		1,4-dichlorobenzene	1 J	5
		chloroethane	3 J - 5 J	3,5
		methylene chloride	3.3	4
		trichloroethene	1 J	2
		tetrachloroethene	1 J	2
		chloroform	4 J	1
KBA-11-3		chlorobenzene	3 J - 6	1,2,3,4,5,6
	1,4-dichlorobenzene	1,4-dichlorobenzene	4 - 28	1,2,4,5,6
		1,3-dichlorobenzene	15	2,3
	bis(2-ethylhexyl) phthalate		31	2
KBA-11-4		None		
KBA-11-5		xylenes (total)	2	1
		1,4-dichlorobenzene	1 J - 2 J	1,2,3,4
	bis(2-ethylhexyl) phthalate		4 J	2
KBA-11-6		xylenes (total)	2	1
		1,4-dichlorobenzene	1 J - 2 J	1,2,3,4,6
	bis(2-ethylhexyl) phthalate		5 J	2
KBA-11-7	bis(2-ethylhexyl) phthalate	None	94	1

See notes at end of table.

Table 2-3 (Continued) Summary of Volatile Organic Compound and Semivolatile Organic Compound Analytical Data for the RFI Groundwater Monitoring Program at Site 11

Monitoring Well I.D.	SVOCs Detected	VOCs Detected	Concentration Range (µg/l)	Associated Sample Events
KBA-11-8		vinyl chloride	2 J	1
		ethylbenzene	1 J	1
		xylenes (total)	5	1
		chloroethane	2 J	2
	diethylphthalate		9 J	1
KBA-11-9		xylenes	3 J	1

Notes:

µg/l = micrograms per liter
J = estimated concentration
VOC = volatile organic compound
SVOC = semivolatile organic compound

Source:

ABB-ES, 1993a.

Table 2-4 Summary of On-site Analytical Data for Groundwater Samples Collected during the Phase I Interim Investigation and the Interim Corrective Measure Screening Investigation

Chemical Detected	MCL (µg/l)	Number of Detections/Number of Samples[1]	Concentration Range (µg/l)	Frequency Above MCL
Volatile Organic Compounds				
Benzene	5	24/102	1.0 - 28	17/24
cis-1,2-Dichloroethene	70	56/125	1.3 - 1,100	10/56
trans-1,2-Dichloroethene	100	9/125	5.0 - 21	0/9
Ethyl benzene	700	24/102	2.7 - 200	0/24
Tetrachloroethene	5	8/125	3.2 - 24	7/8
Toluene	1,000	42/102	4.0 - 430	0/42
Trichloroethene	5	4/125	5.9 - 45	4/4
Xylenes (total)	10,000	31/102	2.1 - 155	0/31
Vinyl chloride	2	113/125	1.1 - 1,400	112/113
Total Volatile Organic Compounds	NA	NA	1.0 - 1537	NA

Notes:

µg/l = micrograms per liter
MCL = Maximum Contaminant Level
NA = Not Applicable

[1] The total number of samples includes those samples that contained at least one or more volatile organic compounds.

Sources:

ABB-ES, 1992.
ABB-ES, 1993c.

Table 2-5 Summary of Off-site Analytical Data for Groundwater Samples Collected during the Phase I Interim Investigation and the Interim Corrective Measure Screening Investigation

Chemical Detected	MCL (µg/l)	Number of Detections/Number of Samples[1]	Concentration Range (µg/l)	Frequency Above MCL
Volatile Organic Compounds				
Acetone	NA	11/49	6 - 800	NA
Benzene	5	7/49	1.7 - 5	2/7
Bromomethane	NA	1/49	1.5	NA
2-Butanone (methyl ethyl ketone)	NA	6/49	24 - 580	NA
Chlorobenzene	100	2/49	2.3 - 10	0/2
Chloroform	NA	1/49	3	NA
Carbon Disulfide	NA	6/49	1 - 250	NA
1,2-Dichlorobenzene	600	1/49	6.4	0/1
1,4-Dichlorobenzene	75	4/49	1.8 - 12	0/4
Dichlorodifluoromethane	NA	1/49	5.3	NA
1,1-Dichloroethane	NA	8/49	2 - 100	NA
1,1-Dichloroethene	7	1/49	3.9	0/1
1,2-Dichloroethane	5	1/49	9	1/1
cis-1,2-Dichloroethene	70	13/49	1 - 3,600	3/13
trans-1,2-Dichloroethene	100	2/49	1 - 23	0/2
1,2-Dichloropropane	5	2/49	1 - 6	1/2
Ethylbenzene	700	10/49	2 - 41	0/10
2-Hexanone (methyl butyl ketone)	NA	4/49	16 - 70	NA
Methylene chloride	5	3/49	3 - 41	2/3
4-Methyl-2-pentanone	NA	7/49	12 - 110	NA
Tetrachloroethene	5	1/49	3	0/1
Toluene	1,000	9/49	2 - 840	0/9
Trichloroethene	5	6/49	3 - 45	2/6
Xylenes (total)	10,000	9/49	1 - 120	0/9
Vinyl chloride	2	7/49	1.4 - 310	6/7
Semivolatile organic compounds				
2,4-Dimethylphenol	NA	1/2	280	NA
2-Methylphenol	NA	1/2	7	NA
4-Methylphenol	NA	1/2	120	NA

See notes at end of table.

Table 2-5 (Continued) Summary of Off-site Analytical Data for Groundwater Samples Collected during the Phase I Interim Investigation and the Interim Corrective Measure Screening Investigation

Chemical Detected	MCL (µg/l)	Number of Detections/Number of Samples[1]	Concentration Range (µg/l)	Frequency Above MCL
Diethylphthalate	NA	2/2	2 - 50	NA
Naphthalene	NA	1/2	20	NA

Notes:

µg/l = micrograms per liter
MCL = Maximum Contaminant Level
NA = Not Applicable

[1] The total number of samples includes those samples that contained at least one or more volatile organic compounds.

Sources:

ABB-ES, 1992.
ABB-ES, 1993c.

The on-site analytical data associated with the Phase I Interim Investigation, ICMSI, and the March 1993 follow-on investigation to the ICMSI were used to create the VOC contour maps presented in Figures 2-3, 2-4, and 2-5. The contour maps were generated using GIS Key™ software. Comparison of Figures 2-3, 2-4, and 2-5 indicates that the majority of VOC contamination is approximately 30 feet bgs, extending from the western margin of the landfill to the right-of-way of Spur 40. The locations and depths of the recovery wells installed during October and November 1993 were selected based on these observations.

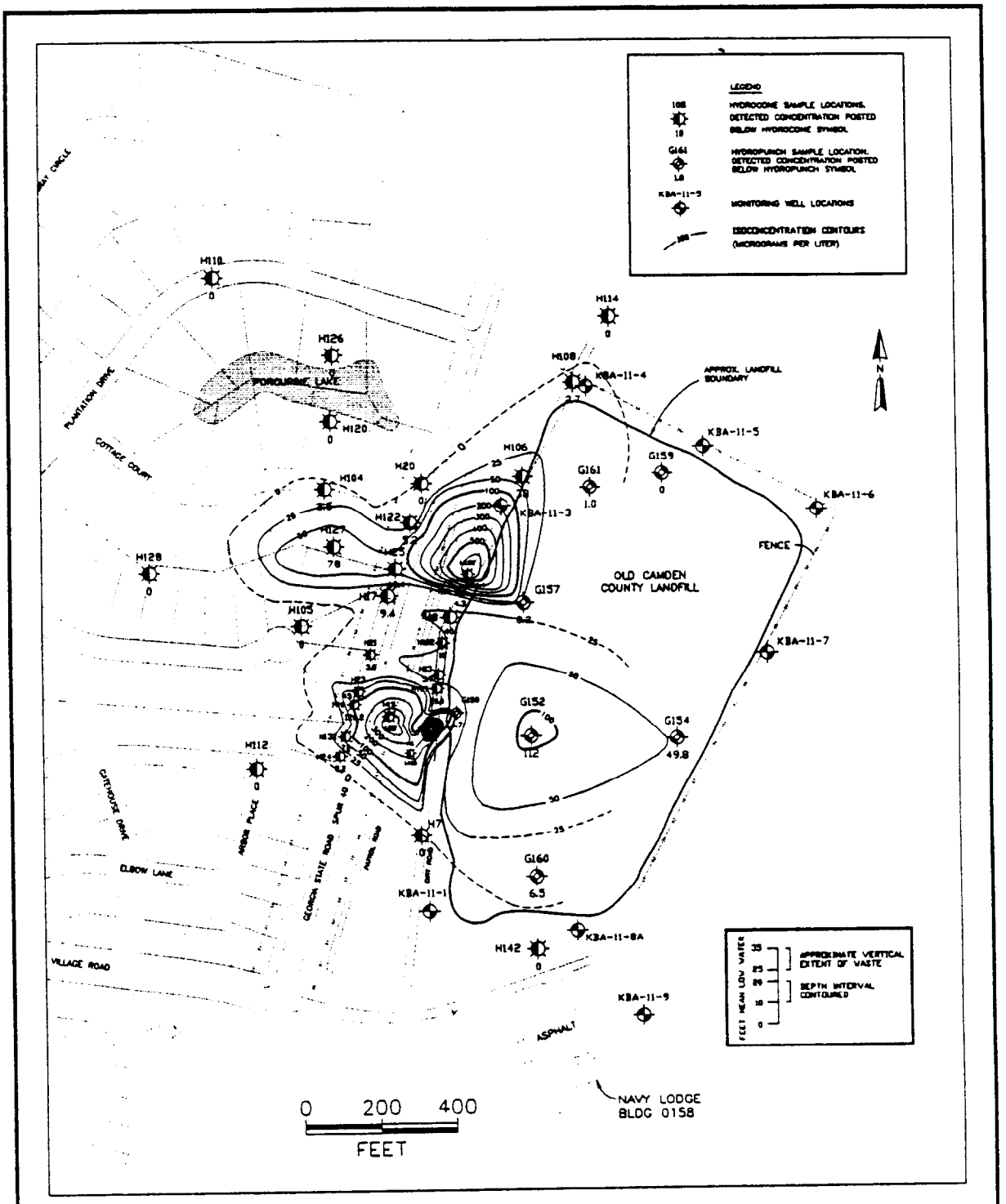
Table 2-6 summarizes VOC analytical data for groundwater samples collected from four recovery wells. Samples collected from the recovery wells contain lower concentrations of VOCs than the samples collected during the Phase I Interim Investigation and ICMSI. The relative difference in VOC concentrations is attributed to differences in sample intervals. The recovery wells have screened intervals of 40 and 50 feet, whereas the sampling devices used during the Phase I Interim Investigation and the ICMSI collect groundwater samples from discrete intervals of 1 foot (hydrocone) and 11 inches (Hydropunch™). Four VOCs, including 1,2-dichloroethene, methylene chloride, trichlorothene, and vinyl chloride, were detected at concentrations greater than corresponding MCLs promulgated under state and federal drinking water regulations.

2.2.2 Semivolatile Organic Compounds SVOCs detected in groundwater samples during the first two bimonthly sampling events included 1,4-dichlorobenzene and phthalate compounds (see Table 2-3). 1,4-Dichlorobenzene is included as a VOC and an SVOC in Appendix IX analyses. This compound was detected as an SVOC in groundwater samples from monitoring well KBA-11-3 at concentrations ranging from 4 J (estimated concentration) to 13 µg/l. These concentrations do not exceed the MCL of 75 µg/l for 1,4-dichlorobenzene. Two phthalate compounds, diethylphthalate and bis(2-ethylhexyl)phthalate, were detected in groundwater samples. Diethylphthalate was detected at 9 J µg/l in one sample from monitoring well KBA-11-8 during the first sample event. Bis(2-ethylhexyl)phthalate was detected in groundwater samples from four monitoring wells at concentrations ranging from 4 J to 94 µg/l. There are no MCLs for these compounds. Phthalates are common artifacts of sampling and analysis. They can be introduced into sample media through contact with plastic tubing, sample gloves, and sample containers.

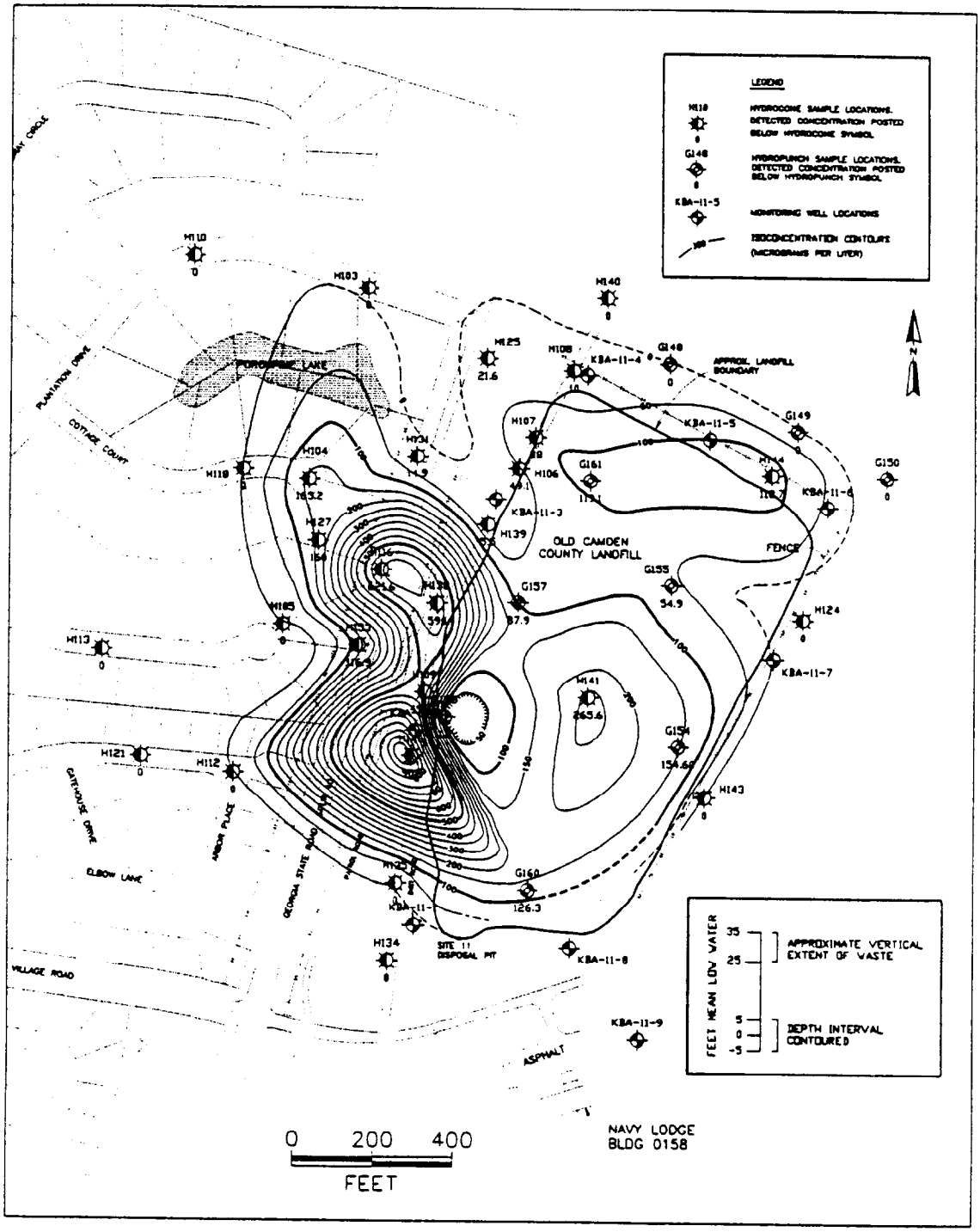
The two groundwater samples collected during the ICMSI and submitted for SVOC analysis contained detectable concentrations of five SVOCs (see Table 2-5). The SVOCs detected include three phenolic compounds, a phthalate, and a polycyclic aromatic. Concentrations ranged from 2 to 280 µg/l. Phenolic compounds and a phthalate compound were also detected at similar concentrations in groundwater samples collected from four recovery wells, as shown in Table 2-6. The SVOCs detected do not have MCLs under state or federal drinking water standards.

2.2.3 Other Organic Compounds VOCs and SVOCs are the only organic compounds detected in groundwater samples from the site. Other organic compounds analyzed in groundwater samples include pesticides, PCBs, herbicides, dioxins, and furans.

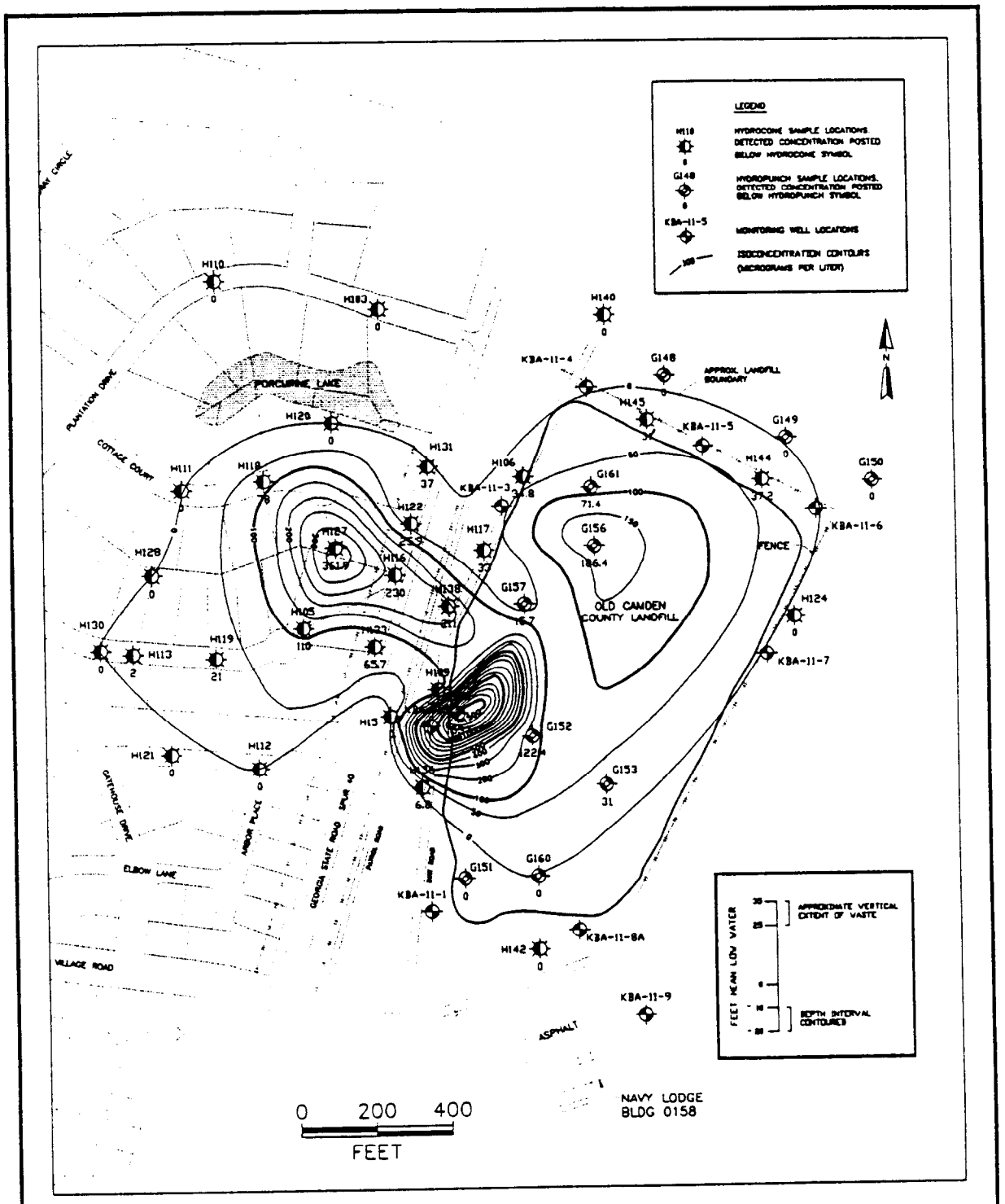
2.2.4 Inorganic Constituents Table 2-7 summarizes inorganic analytical data for the RFI groundwater monitoring program. The first sampling event for the RFI program was conducted approximately 1 week after well installation was completed. The inorganic data associated with the first sampling event are suspected of being influenced by non-equilibrium conditions following well drilling and installation. This non-equilibrium condition is attributed to disturbance of the



DWN: NLW	PROJECT NO.: 08503	TITLE: INTERPRETED PLUME PLAN VIEW 20 TO 10 FT MEAN LOW WATER TOTAL TARGET VOCs
CHKD: LBH	FIGURE NO.: 2-3	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 12/08/93		



DWN: NLW	PROJECT NO.: 08503	TITLE: INTERPRETED PLUME PLAN VIEW 5 TO -5 FT MEAN LOW WATER TOTAL TARGET VOCs	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: LBH	FIGURE NO.: 2-4		
DATE: 12/08/93			



DWN: NLW	PROJECT NO.: 08503	TITLE: INTERPRETED PLUME PLAN VIEW -10 TO -20 FT MEAN LOW WATER TOTAL TARGET VOCs
CHKD: LBH	FIGURE NO.: 2-5	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
DATE: 12/08/93		

Table 2-6 Summary of Organic Analysis of Groundwater Samples Collected from Interim Measure Recovery Wells - November 1993

Chemical Detected	MCL (µg/l)	Number of Detections/Number of Samples[1]	Concentration Range (µg/l)	Frequency Above MCL
Volatile Organic Compounds				
Acetone	NA	4/4	10 - 190	NA
Benzene	5	4/4	1 - 4	0/4
2-Butanone (methyl ethyl ketone)	NA	1/4	190	NA
Chlorobenzene	100	2/4	2	0/2
1,1-Dichloroethane	NA	3/4	2 - 31	NA
1,1-Dichloroethene	7	1/4	2	0/1
1,2-Dichloroethene (total)	70	4/4	9 - 1,200	2/4
Ethylbenzene	700	4/4	3 - 65	0/4
2-Hexanone (methyl butyl ketone)	NA	1/4	40	NA
Methylene chloride	5	4/4	2 - 18	2/4
4-Methyl-2-pentanone	NA	2/4	250 - 1,400	NA
Tetrachloroethene	5	1/4	4	0/1
Toluene	1,000	4/4	6 - 95	0/4
Trichloroethene	5	2/4	2 - 44	1/2
Xylenes (total)	10,000	4/4	2 - 61	0/4
Vinyl chloride	2	3/4	2 - 44	3/3
Semivolatile organic compounds				
Phenol	NA	3/4	2 - 28	NA
2,4-Dimethylphenol	NA	1/4	26	NA
2-Methylphenol	NA	1/4	16	NA
4-Methylphenol	NA	3/4	15 - 340	NA
Diethylphthalate	NA	4/4	4 - 11	NA
Naphthalene	NA	2/4	2 - 15	NA

Notes:

µg/l = micrograms per liter
MCL = Maximum Contaminant Level
NA = Not Applicable

[1] The total number of samples includes those samples that contained at least one or more volatile organic compounds.

Table 2-7 Summary of Inorganic Analytical Data for the RFI Groundwater Monitoring Program at Site 11

Analyte	MCL (µg/l)	Non-filtered Groundwater Concentrations (µg/l) Low	High[1]	Frequency Above MCL[2,3]	No. Locations Above MCL[2]	Filtered Groundwater Concentrations (µg/l) Low	High	Frequency Above MCL[3]
Antimony	6	(11.1)	(11.4)	(2/2) 0/0	(2) 0	ND	ND	0/0
Arsenic	50	1.1	(89) 10.3	(1/34) 0/27	(1) 0	0.68	2.5	0/12
Barium	2,000	11.1	(617) 158	(0/54) 0/45	None	4.4	37.9	0/22
Beryllium	4	0.26	(10.2) 4.0	(6/51) 1/42	(6) 1	0.24	0.25	0/2
Cadmium	5	1.3	7.1	(1/8) 1/7	(1) 1	2.8	3.9	0/5
Chromium	100	8.1	(620) 157	(12/45) 4/36	(8) 3	2.6	9.0	0/4
Cobalt	NA	1.6	(16.8) 6.1	NA	None	1.8	2.9	NA
Copper	1,300	3.1	(384) 239	(0/48) 0/42	None	2.6	52.4	0/13
Lead	15	2.9	87.2	(16/53) 8/44	(8) 6	0.98	10.1	0/20
Mercury	2	0.11	4.1	(2/26) 1/18	(2) 1	ND	ND	0/0
Nickel	100	5.7	(107) 89.1	(1/29) 0/20	(1) 0	6.5	11.0	0/4
Selenium	50	0.55	(26.0) 6.4	(0/33) 0/25	None	ND	ND	0/0
Silver	NA	1.5	10.1	NA	None	2.0	2.5	NA
Thallium	2	1.6	1.6	(0/1) 0/1	None	ND	ND	0/0
Vanadium	NA	5.4	(314) 82.5	NA	None	1.4	6.2	NA
Zinc	NA	17.3	555	NA	None	8.4	77.0	NA
Cyanide	200	0.98	26.2	(0/15) 0/12	None	1.1	3.7	0/10
Sulfide	NA	100	(3,400) 2,900	NA	None	100	300	NA
TDS	NA	16	2,110	NA	None		Not Analyzed	
TSS	NA	92	1,090	NA	None		Not Analyzed	

Notes: µg/l = micrograms per liter
MCL = Maximum Contaminant Level
TDS = total dissolved solids
TSS = total suspended solids

Source: ABB-ES, 1993a.

1 If the high concentration for the six sampling events occurred in sample event 1, it is shown in parentheses, otherwise the high concentration did not occur during sample event 1.
2 Numbers in parentheses indicate summary of sample events 1 through 6. Numbers without parentheses indicate summary of sample events 2 through 6.
3 Number of detections above MCL/total number of detections.

aquifer resulting from drilling. The high concentrations shown for unfiltered groundwater samples include the data for the first sampling event in parentheses, if the high concentration was associated with the first sampling event. On Table 2-7, the frequency of detections above an MCL and the number of locations where MCLs were exceeded are summarized by presenting sampling events 1 through 6 in parentheses and sampling events 2 through 6 without parentheses.

The data summarized in Table 2-7 can be evaluated for bias associated with non-equilibrium conditions during the first sample event. Chromium, for instance, was detected at a high concentration of 620 μg/l during the first sampling event, but the high concentration detected during the following five sampling events was 157 μg/l. Additionally, chromium was detected at concentrations above its MCL of 100 μg/l in eight groundwater samples collected during the first sampling event, but only in four groundwater samples collected during the following five sampling events.

Inorganics detected above MCLs during the second through sixth groundwater sampling events include beryllium, cadmium, chromium, lead, and mercury. Beryllium, cadmium, and mercury were each detected above MCLs in one groundwater sample. Lead and chromium were detected above MCLs in eight and four groundwater samples, respectively.

Table 2-8 summarizes inorganic analytical data for groundwater samples collected from monitoring well KBA-11-10A and recovery well KBA-RW-01. Similarly, Table 2-9 summarizes inorganic analytical data for samples collected from four recovery wells, KBA-RW-01 through KBA-RW-04. None of the inorganic concentrations exceed MCLs.

Table 2-8 Summary of Analytical Data for Samples Collected for Pretreatment Evaluation

Analyte	KBA-11-10 Unfiltered 7-1-93 (µg/l)	KBA-11-10 Filtered 7-1-93 (µg/l)	KBA-RW-01 10-26-93 (µg/l)	KBA-RW-01 Duplicate 10-26-93 (µg/l)
Aluminum	32,800	272		
Antimony	20.2 U	20.2 U		
Arsenic	9.2 J	2.9 J		
Barium	87.1 J	53.3 J		
Beryllium	0.61 J	0.41 J		
Cadmium	2.6 U	2.6 U	<5	<5
Calcium	71,800	68,200		
Chromium	24.2	2.5 U	<10	<10
Cobalt	4.8 U	4.8 U		
Copper	8.7 J	2.6 J		
Iron	55,600	47,500	1,610	1,620
Lead	3.9	1.4 J	<3	<3
Magnesium	17,400	17,500		
Manganese	434	405	31	31
Mercury	0.41	0.08 J		
Nickel	11.7 J	9.2 U		
Potassium	16,200	12,700		
Selenium	3.4 J	1.6 U		
Silver	2.4 U	2.9 J		
Sodium	10,600	10,800		
Thallium	1.6 J	1.3 U		
Vanadium	19.0 J	2.0 U		
Zinc	133	20.9		

See notes at end of table.

Table 2-8 (Continued) Summary of Analytical Data for Samples Collected for Pretreatment Evaluation

Parameter	KBA-11-10 Unfiltered 7-1-93 (mg/l)	KBA-11-10 Filtered 7-1-93 (µg/l)	KBA-RW-01 10-26-93 (mg/l)	KBA-RW-01 Duplicate 10-26-93 (mg/l)
Alkalinity (as $CaCO^3$)	296			
Hardness, Total (as $CaCO_3$)	251		38	39
Total Dissolved Solids	319		178	172
Total Suspended Solids	510		2.7	9.8
Volatile Suspended Solids	174			
Total Volatile Solids	619			
Total Solids	830			
Chloride	1.9		65	65
Sulfate	26			
Sulfide	1.1			
Ammonia (as N)	18.0			
Nitrate and Nitrite (as N)	<0.02			
Kjeldahl Nitrogen (as N)	18.9			
BOD (5 day)	14.3			
BOD (20 day)	33			
COD	200			
Grease and Oil Li-Li	18.0			
TOC - Liquid	54.6		22.5	19.6

Notes:

BOD = biochemical oxygen demand
$CaCO_3$ = calcium carbonate
COD = chemical oxygen demand
J = estimated concentration
µg/l = micrograms per liter
mg/l = milligrams per liter
N = nitrogen
TOC = total organic carbon
U = not detected

The list uses a different measurement increment starting with alkalinity.

Table 2-9 Summary of Inorganic Analysis of Groundwater Samples Collected from Interim Measure Recovery Wells - November 1993

Analyte Detected	MCL (µg/l)	Number of Detections/Number of Samples[1]	Concentration Range (µg/l)	Frequency Above MCL
Aluminum	NA	4/4	478 - 10,600	NA
Arsenic	50	4/4	1.2 - 5.5	0/4
Barium	2,000	4/4	32.4 - 94.9	0/4
Beryllium	4	1/4	0.80	0/1
Calcium	NA	4/4	5,680 - 13,500	NA
Chromium	100	4/4	3.4 - 17.4	0/4
Copper	1,300	1/4	4.5	0/1
Iron	NA	4/4	1,110 - 6,780	NA
Lead	15	2/4	0.46 - 5.4	0/2
Magnesium	NA	4/4	2,740 - 6,260	NA
Manganese	NA	4/4	35.4 - 92.1	NA
Nickel	100	3/4	9.5 - 10.7	0/3
Potassium	NA	4/4	3,700 - 24,400	NA
Sodium	NA	4/4	36,900 -47,000	NA
Vanadium	NA	4/4	2.7 - 14.4	NA
Zinc	NA	4/4	13.5 - 823	NA
Cyanide	200	3/4	1.9 - 2.1	0/3
Sulfide	NA	4/4	1.8 - 22.7	NA

Notes:

µg/l = *micrograms per liter*
MCL = Maximum Contaminant Level
NA = Not Applicable

[1] The total number of samples includes those samples that contained at least one or more inorganic analytes.

3.0 TREATMENT SYSTEM DESCRIPTION

3.1 TREATMENT SYSTEM. The treatment system will collect, treat, and discharge water extracted from the surficial aquifer by the pilot-scale GWE system, as well as other fluids generated during the Phase I installation and operation activities. The streams that will be treated by this system include:

- groundwater from the recovery wells,
- vehicle and equipment decontamination water,
- treatment area spills, leaks, and washdown water,
- process area storm water (if contaminated), and
- water from preliminary aquifer pumping test(s) and well development.

Flow through the treatment system is expected to be approximately 40 gpm. The actual flow rate will depend on optimum flow rates from each of the recovery wells and actual flows from the decontamination pad and treatment pad sumps. The maximum design flow for the pilot-scale treatment system will be 60 gpm, providing additional capacity for additional recovery wells or storm water as needed.

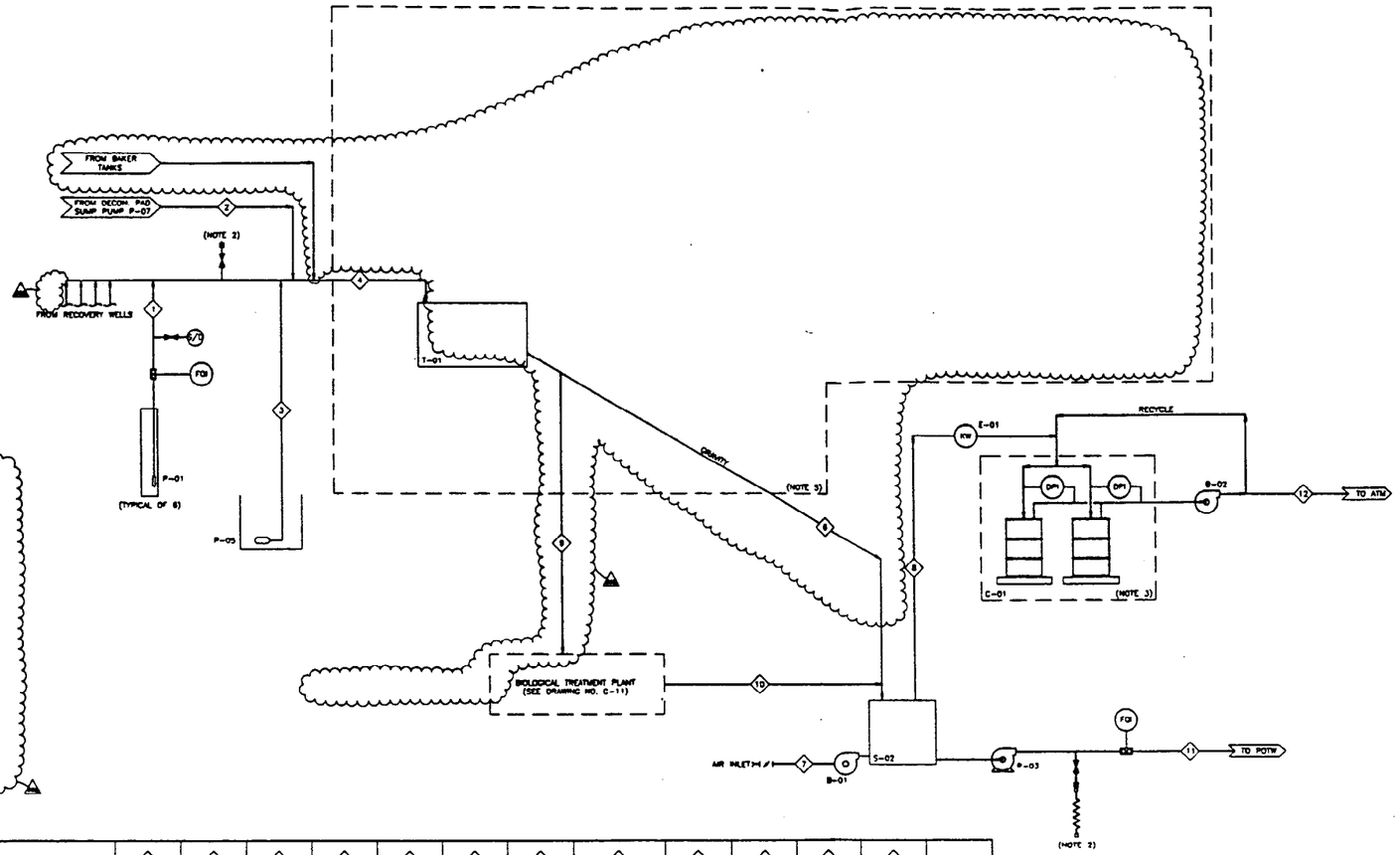
An air sparger will be used to treat groundwater prior to discharge to the POTW. The air sparger, an air stripping technology, is a diffused aeration system where a blower directs air into a tank of contaminated water through diffusers that produce coarse bubbles. Water enters the tank through a spray pipe at one side of the unit. As the water is aerated, the contaminants are transferred to the air bubbles. Exhaust air is released through a vent at the top of the tank. For this system, the water will travel through eight consecutive stages of aeration. The exhaust air is collected in a header and is transferred to a carbon adsorption system for treatment before discharge to the atmosphere.

Groundwater extracted by the GWE system will contain VOCs. All the constituents found in the groundwater that are present at concentrations of concern, listed in Table 1-1, are readily volatilized by air sparging and can be reduced to concentrations below MCLs, including 1,2-dichloroethane, cis-1,2-dichloroethene, 1,2-dichloropropane, trichloroethene, methylene chloride, benzene, and vinyl chloride.

A Process Flow Diagram is provided as Figure 3-1.

3.1.1 Pretreatment Tank Groundwater from the recovery wells, system wastewater and storm water will be discharged to the pretreatment tank. The pretreatment tank will provide equalization of the influent streams to minimize possible variations in flow rates or water quality and, therefore, maximize the efficiency of the treatment system. Assuming a process flow rate of 60 gpm, the 1,500-gallon, carbon steel tank provides a 25-minute retention. Retention time will increase with decreases in flow rate. Water from the pretreatment tank will gravity flow to the air sparger. A Piping and Instrumentation Diagram is provided as Figure 3-2.

Liquid level indicators and switches in the pretreatment tank will control the operation of the recovery well pumps. A high liquid level in the pretreatment tank will activate an alarm and shut off the recovery well pumps. The level switch will have a time delay to restart the pumps to avoid excessive cycling of



ABBREVIATIONS

B-01 - BLOWER
B-02 - CARBON ID FAN
C-01 - CARBON UNIT
E-01 - PREHEATER

P-01A THROUGH E - RECOVERY PUMPS

P-03 - EFFLUENT PUMP

P-05 - TREATMENT PAD SUMP PUMP

P-07 - DECONTAMINATION PAD SUMP PUMP

S-02 - AIR SPARGER
T-01 - PRETREATMENT TANK/EQUALIZATION TANK

LEGEND OF SYMBOLS

POSITIVE DISPLACEMENT PUMP
DIAPHRAGM PUMP (ELECTRICAL)
SUBMERGED SUMP PUMP
CENTRIFUGAL PUMP
FLOW TOTALIZER INDICATOR
DIRECT CONNECTION
DIRECT CONNECTION BLOCK VALVE IN CAP
ELECTRICAL CONNECTION
PACKAGED EQUIPMENT OR INTEGRAL UNITS
FLOW STREAM
HEATER
FLEXIBLE HOSE
PIPE ENDED WITH CAP
IN-LINE DEVICE
AGITATOR
DRAIN
SAMPLE TAP
SAMPLE TAP/DRAIN
PRIMARY PROCESS
HOT PIPING
ELECTRICAL
LINE BREAK OR RESUMPTION POINT
QUICK DISCONNECT
GLOBE VALVE
GATE VALVE
CHECK VALVE
BALL VALVE
BUTTERFLY VALVE IN LIQUID LINES, LOUVER IN AIR SERVICE

NOTES

1. FOR LEGEND OF SYMBOLS SEE THIS SHEET.
2. FOR RECYCLE.
3. CARBON TO BE PLACED ON PALLETS.
4. PVC ON TREATMENT PAD IS SCHEDULE 80.
5. PRETREATMENT MAY BE INSTALLED AT A LATER DATE.

	1	2	3	4	5	6	7	8	9	10	11	12	MCLS
FLOW STREAM	RECOVERY WELLS (TYP.)	DECON. SUMP	TREATMENT PAD SUMP	INFLUENT		SPARGER FEED	AIR *	VAPOR EFFLUENT	RBC FEED	RBC EFFLUENT	DISCHARGE	VAPOR TO ATM	DISCHARGE CRITERIA
PARAMETER													
AVG. FLOW RATE gpm	8			40		40			1	1	40		
DESIGN													
PUMP FLOW RATE gpm	8	5	5	80		80		*	1	1	80		
DESIGN TOTAL lb/hr	4003.2	2502	2502	30,024		30,024			8.3	8.3	30,024		
SOLIDS lb/hr	2.0			15.3		15.3							
IRON mg/l	3			3		3			33.8				
MANGANESE mg/l	0.434			0.434		0.434			0.434				
ALKALINITY AS $CaCO_3$ mg/l	296			296		296			296				
SULFATE mg/l	26			26		26			26				
HARDNESS AS $CaCO_3$ mg/l	251			251		251			251				
DISSOLVED SOLIDS mg/l	319			319		319			319				
SUSPENDED SOLIDS mg/l	510			510		510			510				
BENZENE ug/l	5			5		5		0.0017 mg/m³	5		0.12		5
2-BUTANONE ug/l	580			580		580			580		580		
CHLOROBENZENE ug/l	10			10		10		0.0034 mg/m³	10		0.35		
1,4-DICHLOROBENZENE ug/l	12			12		12		0.0040 mg/m³	12		0.55		75
1,1-DICHLOROETHANE ug/l	24			24		24		0.0081 mg/m³	24		0.61		
1,2-DICHLOROETHANE ug/l	9			9		9		0.0029 mg/m³	9		0.80		5
CIS-1,2-DICHLOROETHENE ug/l	3600			3600		3600		1.2294 mg/m³	3600		63.28		70
TRANS-1,2-DICHLOROETHENE ug/l	23			23		23		0.0080 mg/m³	23		23		100
1,2-DICHLOROPROPANE ug/l	8			8		8		0.0020 mg/m³	8		0.34		5
ETHYLBENZENE ug/l	41			41		41		0.0140 mg/m³	41		0.85		70
2-HEXANONE ug/l	70			70		70			70		70		
4-METHYL-2-PENTANONE ug/l	110			110		110			110		110		
TETRACHLOROETHENE ug/l	3			3		3		0.0010 mg/m³	3		0.03		5
TOLUENE ug/l	840			840		840		0.2835 mg/m³	840		24.57		1000
TRICHLOROETHENE ug/l	45			45		45		0.0154 mg/m³	45		0.67		5
XYLENES (TOTAL) ug/l	120			120		120		0.0410 mg/m³	120		2.05		10,000
VINYL CHLORIDE ug/l	310			310		310		0.1078 mg/m³	310		0.49		2

* TO BE DETERMINED BY VENDOR

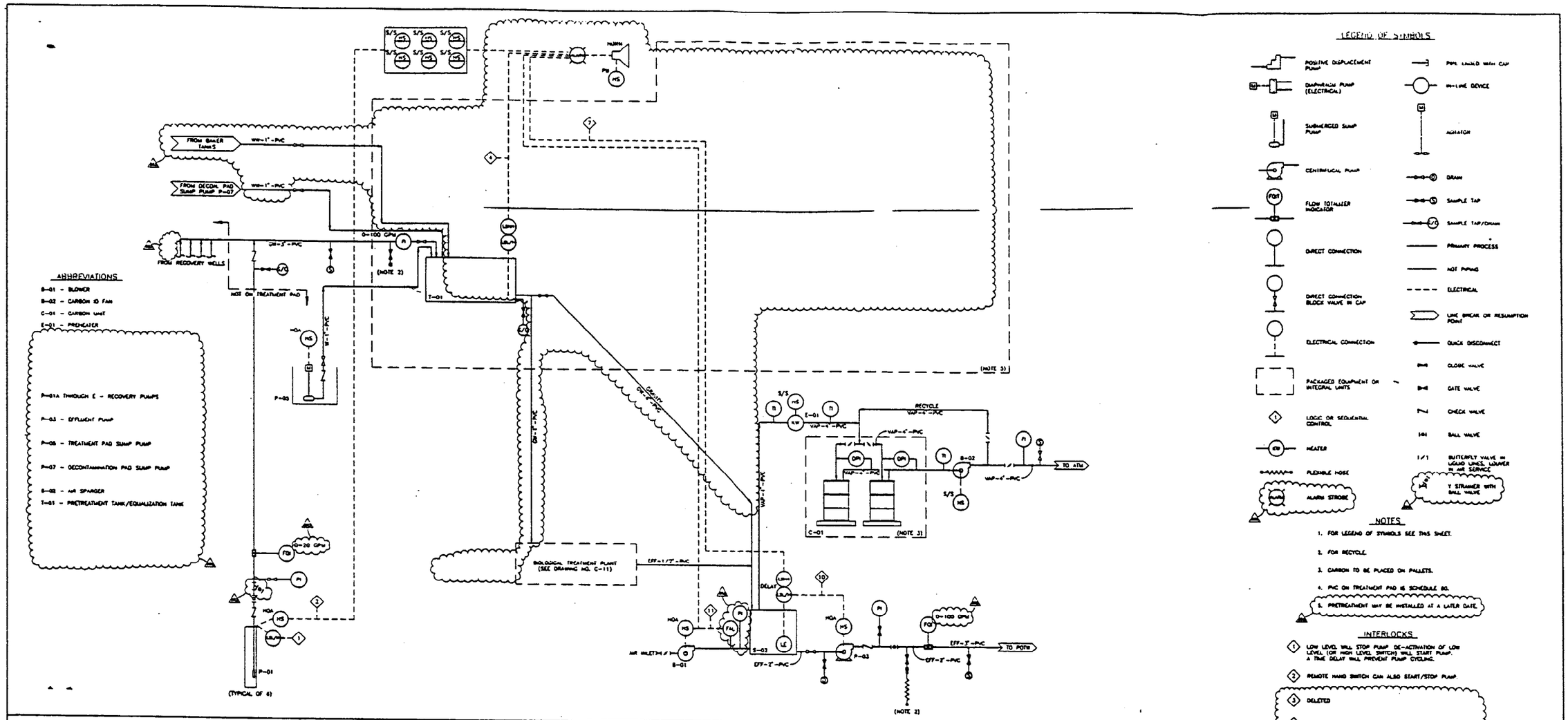
DATE	CHANGE ORDER NO.	BY	DESCRIPTION
11-18-93	002	VAR	PRETREATMENT DELAYED
11-9-93	001	VAR	SIGNED & SEALED

ABB Environmental Services Inc.

DWN: DMF	DES: HF	CONTRACT NO.: SE 3-21-037	TITLE: PROCESS FLOW DIAGRAM AIR SPARGER UNIT
CHKD: KDS	APPD.: CMB	PROJECT NO.: 08503.02	
DATE: 9-24-93	REV: VAR	SHEET NO.: C-10	

KB NSB [SMPPF 8503.003]#030/93.mlv

FIGURE 3-1



LEGEND OF SYMBOLS

- POSITIVE DISPLACEMENT PUMP
- DIAPHRAGM PUMP (ELECTRICAL)
- SUBMERGED SUMP PUMP
- CENTRIFUGAL PUMP
- FLOW TOTALIZER INDICATOR
- DIRECT CONNECTION
- DIRECT CONNECTION BLOCK VALVE IN CAP
- ELECTRICAL CONNECTION
- PACKAGED EQUIPMENT OR INTEGRAL UNITS
- LOGIC OR SEQUENTIAL CONTROL
- HEATER
- FLEXIBLE HOSE
- ALARM STROBE
- PIPE CAPPED WITH CAP
- IN-LINE DEVICE
- AGITATOR
- DRAIN
- SAMPLE TAP
- SAMPLE TAP/DRAIN
- PRIMARY PROCESS
- HOT PIPING
- ELECTRICAL
- LINE BREAK OR RESUMPTION POINT
- QUICK DISCONNECT
- GLOBE VALVE
- GATE VALVE
- CHECK VALVE
- BALL VALVE
- BUTTERFLY VALVE IN LIQUID LINES, LOUVER IN AIR SERVICE
- Y STRAINER WITH BALL VALVE

NOTES

1. FOR LEGEND OF SYMBOLS SEE THIS SHEET.
2. FOR RECYCLE.
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4. PVC ON TREATMENT PAD IS SCHEDULE 80.
5. PRETREATMENT MAY BE INSTALLED AT A LATER DATE.

INTERLOCKS

1. LOW LEVEL WILL STOP PUMP DE-ACTIVATION OF LOW LEVEL (OR HIGH LEVEL SWITCH) WILL START PUMP. A TIME DELAY WILL PREVENT PUMP CYCLING.
2. REMOTE HAND SWITCH CAN ALSO START/STOP PUMP.
3. DELETED
4. HIGH LEVEL IN EQUALIZATION TANK WILL SHUT OFF RECOVERY WELL PUMPS. LOW LEVEL SWITCH WILL START PUMP. HIGH-HIGH LEVEL WILL ACTIVATE HORN.
5. DELETED
6. DELETED
7. HIGH-HIGH LEVEL IN AIR SPARGER WILL SHUT OFF RECOVERY WELL PUMPS AND ACTIVATE HORN.
8. DELETED
9. DELETED
10. LOW LEVEL IN AIR SPARGER SUMP WILL SHUT OFF EFFLUENT PUMP DE-ACTIVATION OF LOW LEVEL (OR HIGH LEVEL SWITCH) WILL START PUMP. A TIME DELAY WILL PREVENT PUMP CYCLING.
11. LOW FLOW WILL SHUT OFF BLOWER AND ACTIVATE HORN.

NOTES

1. THE INSTRUMENT LEGEND IS BASED ON ISA STANDARD.
2. THE LETTER "X" IS USED FOR ALL ANALYSIS VARIABLES. TERMS ARE PLACED OUTSIDE THE INSTRUMENT CIRCLE TO DENOTE THE SPECIFIC VARIABLES. SOME EXAMPLES ARE:
   - ORP - OXIDATION REDUCTION POTENTIAL
   - pH - pH
   - TOC - TOTAL ORGANIC CARBON
3. A DEVICE THAT CONNECTS, DISCONNECTS, OR TRANSFERS ONE OR MORE CURRENTS MAY BE EITHER A SWITCH, A RELAY, OR AN ON-OFF CONTROLLER, DEPENDING ON THE APPLICATION.

   A SWITCH, IF IT IS ACTIVATED BY HAND OR DEVICE IS USED FOR ALARM, PILOT LIGHT, SELECTION INTERLOCK, OR SAFETY.

   A CONTROLLER, IF THE DEVICE IS USED FOR NORMAL ON-OFF OPERATING CONTROL SUCH AS A SIMPLE HEATING THERMOSTAT.

   A RELAY, IF IT IS AUTOMATIC AND IS NOT THE FIRST SUCH DEVICE IN A LOOP I.E., IT IS ACTIVATED BY A SWITCH OR AN ON-OFF CONTROLLER.
4. A CONTROL OR SENSING DEVICE OR RELAY HAVING A DISPLAY FUNCTION SHOULD HAVE THE APPROPRIATE DISPLAY LETTERS AFTER THE MEASURED VARIABLE DESIGNATION, e.g. AIC DESIGNATES ANALYSIS INDICATING CONTROL STATION.
5. ALARM AND SWITCH DESIGNATIONS SHALL BE FOLLOWED BY A SUFFIX TO INDICATE ACTUATION, I.E., L (LOW), H (HIGH), LL (LOW-LOW SHUTDOWN), HH (HIGH-HIGH SHUTDOWN), HL (HIGH AND LOW).
6. USE OF MODIFYING TERMS HIGH, LOW, AND MIDDLE OR INTERMEDIATE SHALL CORRESPOND TO VALUES OF THE MEASURED VARIABLE, NOT OF THE SIGNAL, UNLESS OTHERWISE NOTED.

GENERAL PIPING AND INSTRUMENTATION DIAGRAM
INSTRUMENTATION IDENTIFICATION

SYMBOL	FIRST LETTER	EXAMPLES															
		SENSING DEVICE			DISPLAY DEVICE						CONTROL DEVICE (NOTE 4)						
	MEASURED OR INITIATING VARIABLE	PRIMARY ELEMENT	TRANSMITTER		INDICATOR	RECORDER	INTEGRATING INDICATOR	ALARM (NOTE 3)			CONTROLLER (NOTES 3 & 4)			CONTROL VALVE	SELF-ACTUATING VALVE	SWITCH (NOTES 3, 5 & 6)	RELAY CONVERTER OR COMPUTING DEVICE (NOTE 3)
			BLIND	INDICATING				LOW	HIGH	HIGH & LOW	BLIND	INDICATING	RECORDING				
A	ANALYSIS (NOTE 2)	AE	AT	AIT	AI	AR		AAL	AAH	AAHL	AC	AIC	ARC	AV		AS	AY
F	FLOW	FE	FT	FIT	FI	FR	FQI	FAL	FAH	FAHL	FC	FIC	FRC	FV	FCV	FS	FY
L	LEVEL	LE	LT	LIT	LI	LR		LAL	LAH	LAHL	LC	LIC	LRC	LV	LCV	LS	LY
P	PRESSURE	PE	PT	PIT	PI	PR		PAL	PAH	PAHL	PC	PIC	PRC		PCV	PS	PY
T	TEMPERATURE	TE	TT	TIT	TI	TR		TAL	TAH	TAHL	TC	TIC	TRC	TV	TCV	TS	TY

GENERAL INSTRUMENTS

- INSTRUMENT FOR SINGLE MEASURED VARIABLE AND ANY NUMBER OF FUNCTIONS. INSTRUMENT IS MOUNTED LOCALLY.
- INSTRUMENT IS MOUNTED IN FRONT OF PANEL.

HAND ELECTRIC SWITCH DESIGNATION

S/S - START/STOP

HOA - HAND/OFF/AUTO

PB - PUSH BUTTON

LINE IDENTIFICATION

GW-2"-PVC

- PIPING MATERIAL
- LINE SIZE
- LINE SERVICE

LINE SERVICE DESIGNATION

GW - GROUND WATER
WW - WASTE WATER
S - SLUDGE
EFF - TREATED EFFLUENT
VAP - VAPOR

DATE	CHANGE ORDER NO.	BY	DESCRIPTION
11-18-93	002	VAR	PRETREATMENT DELAYED
11-9-93	001	VAR	SIGNED & SEALED

ABB ASEA BROWN BOVERI — ABB Environmental Services Inc.

DWN: DMF	DES: MF	CONTRACT NO.: SE 3-21-037	TITLE: PIPING AND INSTRUMENTATION DIAGRAM AIR SPARGER UNIT
CHKD: KOS	APPD.: GMB	PROJECT NO.: 08503.02	
DATE: 9-24-93	REV.: VAR	SHEET NO.: C-8	

FIGURE 3-2

the pumps. A high-high level in the air sparger will also shut off the recovery well pumps and activate the alarm.

3.1.2 Air Sparger In the air sparger, air is released in to the water through diffusers that produce coarse air bubbles. The diffusers are made of polyvinyl chloride (PVC) pipe with holes located on the underside of the pipe placed in the water of each of eight (8) aerated compartments. An air to water ratio of between 50 and 100 to 1 can be used by regulating air flow from the blower to the sparger with an inlet damper. The air flow rate must be optimized to provide enough aeration to volatilize the contaminants in the water and minimize carbon vapor phase requirements.

A low level switch in the air sparger sump will shut off the effluent pump. The level switch will have a time delay to restart the pump to avoid excessive cycling of the pump. A high level in the sump will shut off the recovery well pumps and actuate an alarm.

The effluent pump will discharge treated water to the City of St. Marys' sewer system, pending approval. Connection to the system will be made at a manhole located at the Crooked River Elementary School. Effluent will be monitored for compliance with the performance standards as outlined in the Monitoring Plan, Section 6.0. Effluent from the air sparger can be diverted to a storage tank for retreatment and recycled through the pilot-scale treatment system if the system is not meeting performance criteria. Recovery well pumps can be turned off until the system is functioning properly.

Air sparger vapors will be collected from each stage in a header system that will divert all vapors to the vapor phase carbon system.

3.1.3 Vapor Treatment Based on maximum concentrations of VOCs found within the groundwater during previous studies and assuming 100 percent volatilization, the maximum total organic emission rate from the air sparger will be less than 0.19 pounds per hour. A carbon adsorption unit will be installed for treatment of VOCs in the vapor effluent before emission to the atmosphere. Air monitoring of the air sparger and stack emissions will be performed and recorded throughout the operation of the pilot-scale test as outlined in Section 6.0.

3.1.4 *Ex Situ* Biological Treatment The pilot-scale mRBC reactor and ancillary equipment will consist of an equalization tank, the mRBC unit, a methane/oxygen monitoring and control unit, a nutrient delivery system, and a pH control system. A piping and instrumentation diagram for the pilot-scale mRBC is provided as Figure 3-3.

The pretreatment tank will be used as a feed tank (T-1) to supply groundwater to the mBRC. A metering pump (P-1) will transfer the contaminated groundwater at a set flow rate (24 hours per day, seven days per week). A totalizing flow meter will be used to monitor flow rate.

The pilot-scale mRBC unit will consist of a 80-inch by 30-inch by 25-inch (length by width by height) aluminum tank with internal baffles separating the reactor into four compartments. Contaminated groundwater will enter the first compartment and pass through each compartment via external orifices or internal openings in the compartment walls.

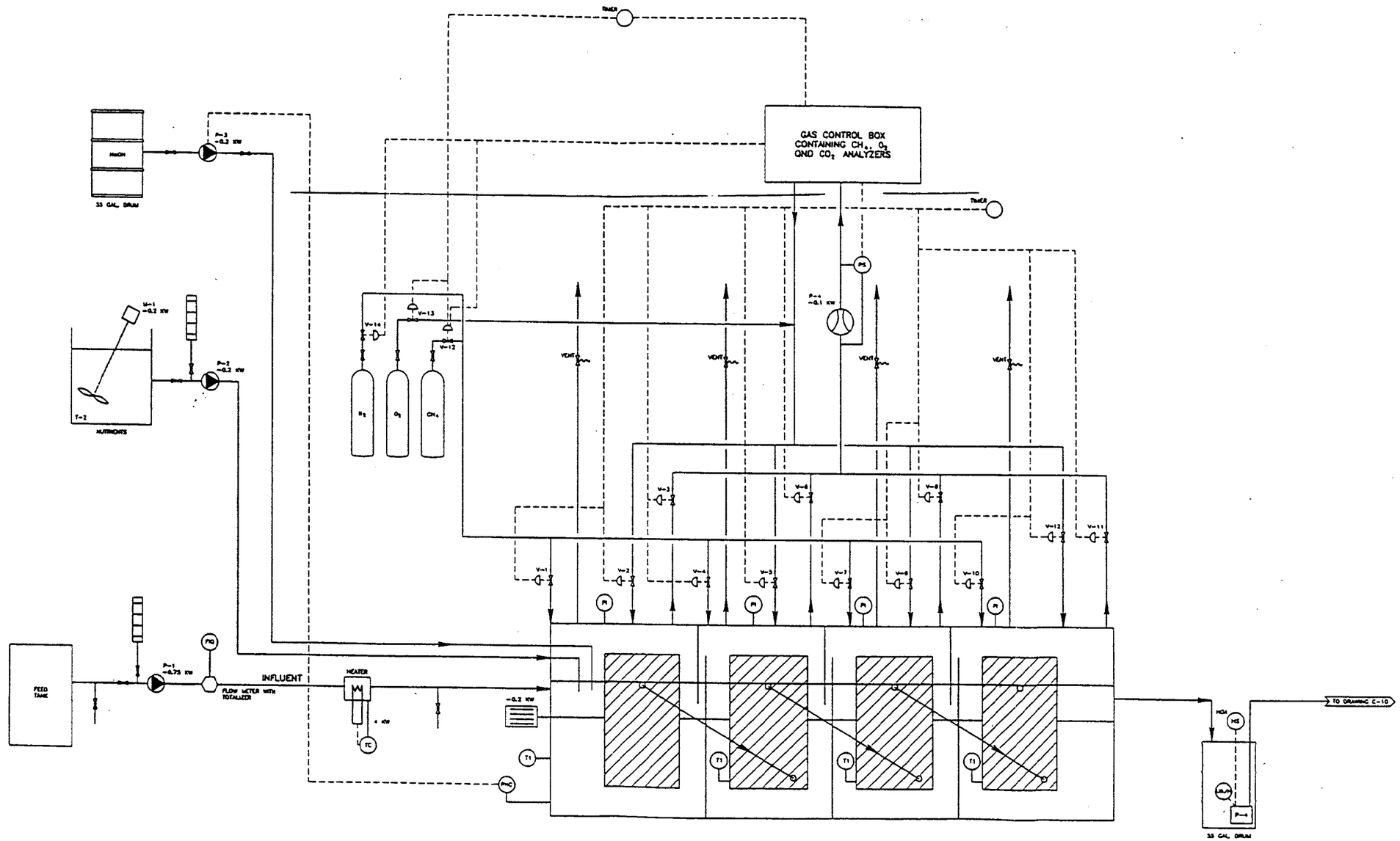

ABB ASEA BROWN BOVERI	ABB Environmental Services Inc.	DWN: DMF	DES: VAR	PROJECT NO.: 08503.02	TITLE: PIPING AND INSTRUMENTATION DIAGRAM ROTATING BIOLOGICAL CONTACTOR UNIT
		CHKD: KDS	APPD: GMB	SHEET NO.: C-11	
		DATE: 9-24-93	REV.:		

KB NSB [LAS 8503.004]#030/93.mlv

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FIGURE 3-3

A central shaft supporting corrugated plastic media on which microorganisms attach and form a biological film will be rotated. The rotating shaft and plastic media will be partially submerged in the liquid phase of the reactor, which allows contact between the microorganisms, methane, oxygen, contaminants, and nutrients.

To protect the reactor from excessive pressure, each reactor compartment is equipped with a pressure relief valve venting to the atmosphere.

The metering pump (P-2) will transfer nutrients from a 250-gallon nutrient tank equipped with a mixer (M-1). The nutrient solution will be prepared periodically by mixing weighed amounts of dry nutrients and water.

The pH of the reactor contents will be adjusted when necessary to maintain a pH in the range of 6 to 8. A metering pump (P-3) will receive a signal from the pH controller and pump sodium hydroxide from a 55-gallon drum to the first compartment of the reactor as required.

The effluent from the mRBC will gravity flow to an open top drum and then transfer to the air sparger by a submersible pump equipped with a float switch.

3.2 DISCHARGE. Liquid effluent from the air sparger will be collected in the air sparger sump. A totalizing flow meter will be placed at the air sparger effluent. Instantaneous and daily flow rates will be recorded throughout the operation of the system. The effluent pump will discharge the pilot-scale system effluent to a manhole for the City of St. Marys' sanitary sewer system, pending approval from the city. Conveyance of the fluids will be through 3-inch PVC pipe. One hand-operated gate valve will be installed in the effluent line to isolate the system when necessary.

4.0 PILOT-SCALE OPERATION

4.1 GROUNDWATER EXTRACTION. The pilot-scale test operations include three stages of aquifer pumping from first one recovery well, then two wells, and finally all five wells. Discharge from the recovery wells will be maintained at a constant flow rate during each of the three phases. Flow rates will be measured for each well using the respective totalizing flow meters to record successive cumulative flow readings over a set interval.

The first stage of the pilot-scale test operations will be conducted by pumping from a single recovery well for seven days. Preliminary estimates of flow are expected to be approximately 10 gpm. This pumping test will provide hydraulic data for the evaluation of aquifer parameters, boundary conditions and anisotropic effects, and the effective capture zone.

At completion of the first pumping stage, a recovery phase test will be conducted to allow the surficial aquifer to reach equilibrium. No groundwater will be extracted during this phase. Water from previous pump tests that has been stored may be treated during this time.

The second stage of the pilot-scale test operations will be conducted by pumping from two recovery wells for a period of seven days following the single well test recovery phase. Preliminary estimates of flow are approximately 17 gpm. The third stage of the pilot-scale test operations will be conducted by pumping from all five recovery wells. Starting of the pumps will be staggered at timed intervals and synchronized with the hydrologic data logger unit(s) and set at constant flow rates. Preliminary estimates of flow are expected to be approximately 7 to 12 gpm from each well.

This pumping test will provide hydraulic data for evaluation of the effectiveness of multiple recovery wells for the extraction of VOC-contaminated groundwater and the actual capture zone caused by five discharging wells.

4.2 AIR SPARGER TREATMENT SYSTEM.

4.2.1 Start-Up Following installation of the equipment, the recovery wells will discharge to the pretreatment tank. Initially, only one or two recovery well pumps will be started. Also, a hose will be connected to the recycle taps, and the effluent valve will be closed to allow recycle of the process stream until verification is received that discharge criteria can be met.

The pretreatment tank will fill to the height of the discharge nozzle, which will allow the feed stream to fill the air sparger via gravity flow.

As water enters the air sparger, the blower will force air through the air sparger and the carbon induced draft (ID) fan will pull the air sparger effluent vapors through the carbon adsorbers.

Once steady state has been reached in the recycle mode, samples will be collected to determine the quality of the effluent. If the effluent meets the discharge criteria, the discharge valve will be opened to allow the water to discharge to the treatment works. The treated effluent will be analyzed hourly for performance criteria (Subsection 1.3) until steady state is reached.

Feed from the recovery well pumps will be slowly increased until steady state is reached. If the process pumps are cycling too often at steady state, the ball valves at the discharge of the process pumps can be closed slightly to induce a pressure drop and reduce flow where needed.

4.2.2 Operation and Process Control During Phase I, a minimum of one operator per shift will be on-site to operate and monitor the treatment system 24 hours per day. The operator will also be responsible for operating the GWE system and various other on-site duties. The system may be retrofitted to minimize operator requirements during the continued operation of the system (Phase I Continuance).

Pumps During normal operation, the recovery well pumps and process pumps will be on automatic operation. Each pump will shut down at low level and restart either with deactivation of the low level switch or with a high level switch. Each pump is operated with a Hand/Off/Auto switch that enables the operator to operate the pump in each mode.

Air Sparger The process water enters the air sparger through a spray pipe at one side of the unit that disperses the water evenly across the first stage of the unit. The water travels through eight separate stages of aeration before discharge from the unit. Air is released from the blower into the bottom of each stage through detachable perforated PVC piping. Exhaust air exits the stages and is pulled by an induced draft to the carbon unit. The water is discharged to a sump that is an integral part of the sparger and the effluent pump transfers the water to the discharge point.

The air sparger sump is equipped with a high and low level switch. Low level in the sump will shut off the effluent pump. The pump will restart either with deactivation of the low level switch or with a high level switch. High-high level will shut off the recovery well pumps and activate the alarm horn.

The blower is equipped with a low flow switch to shut off the blower and to activate the horn on low flow conditions.

Carbon Unit Before reaching the carbon adsorber, the vapor stream will be heated by the preheater to reduce the humidity of the stream. The vapors from the air sparger will be pulled through the preheater and carbon adsorber by the carbon ID fan. VOCs transferred from the groundwater to the vapor stream in the air sparger will be adsorbed by the carbon before discharge to the atmosphere. To ensure that particulate is not entrained in the vapor effluent, the adsorber will be operated in the downflow configuration.

The carbon adsorber(s) will be connected with flexible hoses to simplify changeout procedures. The carbon treatment unit will include eight canisters of carbon, each canister being 55 gallons in volume. The eight canisters will be arranged such that four canisters are in parallel and are primary treatment units. The other four units are connected in series and act as backup to the primary units. The life expectancy of the primary units will be calculated based on 100 percent volatization of VOCs detected in groundwater samples from the pretreatment tank. Air samples will be collected from the discharge of the primary carbon units once per week and will be analyzed for VOCs in the on-site laboratory. The data for each sample event will be evaluated to determine if the primary carbon unit is saturated. The primary carbon canisters will be removed when saturation is indicated by air sample analytical data or no later than the

end of the calculated life expectancy. The backup carbon canisters will be moved to the primary position and new canisters placed in the backup position.

After the Phase I treatment operations and prior to the Phase I continuance, a schedule will be established for replacement of the primary carbon canisters. The schedule for replacement will be based on the results of the air samples discussed in the paragraph above or will be the calculated life expectancy.

4.2.3 Discharge If approval is granted by the City of St. Marys, the effluent pump will transfer treated water to the POTW via a manhole located at the Crooked River Elementary School, which is located on Georgia Spur 40.

Effluent from the system will be sampled daily for the duration of the Phase I operations and analyzed on-site as detailed in the Monitoring Plan (Table 6-1). If at any time effluent does not meet discharge criteria, effluent can be diverted temporarily to the 20,000-gallon storage tanks. If the storage tanks are full, then the recovery well pumps can be shut off, and the system can be placed in recycle mode until the treatment system adequately treats the groundwater for discharge. After the initial pilot-scale testing stage (Phase I) and development of a strong database of groundwater and system effluent quality, sampling will be reduced to weekly off-site analysis of VOCS, metals, and selected engineering treatability parameters.

4.2.4 Alarm Conditions Each pump will shut down at low level and restarted either with deactivation of the low level switch or with a high level switch. High-high level switches will activate the horn to alarm the operator to check the system. Tankage is not totally enclosed and the operator must correct the downstream problem that is causing a system backup, or must adjust pumping rates to prevent overflow conditions. Containment is provided around the entire process system.

If the air sparger blower is shut off on low flow, the horn will be activated. A scale buildup around the air sparger diffuser piping can cause a low flow condition.

4.3 ROTATING BIOLOGICAL CONTACTOR. An mRBC reactor designed to promote biological degradation of organic compounds in groundwater will be used to evaluate full-scale treatment potential. The mRBC will be monitored continuously and chemical addition functions will be manually adjusted as needed.

Groundwater will be continuously pumped from the pretreatment tank through the mRBC reactor. Mineral nutrients will be added to the passing groundwater from the nutrient delivery system. Methane, the carbon source for the methanotrophic bacteria, will be continuously monitored and supplied to the mRBC system using the methane/oxygen analyzer and control system. Oxygen required for biological degradation of VOCs will also be monitored and regulated in the mRBC reactor using the methane/oxygen analyzer and control system. Groundwater pH will be monitored and controlled using a pH control system. The biologically treated water will be discharged to the air sparger before discharge to the sewer system.

4.4 STORM WATER MANAGEMENT. Process area and Decontamination Pad storm water will be collected in the respective sump and processed through the treatment system. If there are no activities being conducted that require use of the decontamination pad (i.e., well drilling and excavation) and the decontamination pad has been cleaned since its last use, storm water will be discharged to the

ground surface. Containment for the tanks and process equipment has been designed in accordance with 40 CFR 264 Subpart J and I. The containment has sufficient excess capacity to contain run-on or infiltration from a 25-year, 24-hour rainfall event. The floor of the containment area will be sloped to the treatment pad sump.

All rainfall events will be recorded. Excessive rainfalls will be transferred from the sumps to a storage tank. The storage tank will be sampled and analyzed on-site to determine if treatment is needed or if direct discharge is possible.

4.5 ENGINEERING EVALUATION PLAN. An evaluation of the hydraulic and chemical data collected during the IM installation and start-up activities will be performed following the initial 45-day pilot-scale testing period. The evaluation will be of the components of the GWE and treatment system including: the groundwater extraction system, the conveyance system, the air sparger treatment system, the mRBC system, and the discharge permit and options. These systems will be evaluated for their ease of implementation, effectiveness in meeting remediation objectives, cost effectiveness, and schedule constraints. Additionally, other technologies and discharge options will be evaluated, as appropriate, for meeting remediation objectives. These evaluations will be compiled into an Evaluation and Recommendations Report. Further definition of the Engineering Evaluation Plan is provided in the Interim Measure Work Plan for Site 11, Old Camden County Landfill Phase I Activities (ABB-ES, 1993b).

4.5.1 Groundwater Extraction System Evaluation Evaluation of the GWE system includes the interpretation and assessment of hydraulic and chemical data collected during the initial aquifer pumping test, pilot-scale start-up activities, and pilot-scale test operations. These data will be used to evaluate aquifer parameters, well performance characteristics, and optimum extraction methodologies for the full-scale GWE/Treatment system IM. Evaluation of the pilot-scale test start-up activities includes analysis of the well performance tests from each of the recovery wells and interpretation of background monitoring data from within the surficial aquifer. Evaluation of hydraulic data from the three pumping stages and recovery phase of the pilot-scale test operations includes: (1) analysis and interpretation of the hydraulic head data that support delineation of the actual capture zone, and (2) analysis of the variations in the waste-stream flow for treatment process performance monitoring.

A computer-based analytical flow model will be used to assess additional GWE wells linked to the pilot-scale GWE system for the purpose of full-scale system recommendations. This will allow evaluation of the impact and effectiveness of additional wells in the system, by adding recovery wells at other locations within the plume or adding horizontal collector wells to control VOC plume movement. During the modeling and the continued operation of the GWE system, additional operational data will be collected to confirm Phase I results.

4.5.2 Conveyance System Evaluation The conveyance system, including piping layout, materials of construction, fittings, valves, flow meters, well headers, and well vaults will be evaluated for long-term effectiveness and cost.

4.5.3 Treatment System Evaluation Treatment system influent and effluent concentrations, removal efficiencies for the constituents of concern, flow rates, and vapor emissions will be monitored throughout the pilot-scale test (Phase I activities). These parameters will be evaluated against performance criteria for the treatment system. The ability of the treatment system to meet performance

criteria at higher full-scale operation flow rates and modification requirements will be evaluated. The evaluation will include an evaluation of applicable technologies and cost estimates for long-term full-scale (Phase II) operation. The influent VOC concentrations will be evaluated and the possibility of discharging without treatment during the full-scale IM will be considered. Full-scale metals and carbonate removal, vapor treatment, and overall operating and maintenance requirements will be evaluated.

The parameters to be monitored for the IM treatment system evaluation include:

1) Air Sparger -
   - Efficiency (influent and effluent VOC concentrations)
   - Corrosion and/or scaling problems, especially at diffusers
   - Blower operation
   - Capacity for additional flow

2) Vapor Treatment -
   - Efficiency (influent and effluent VOC concentrations)
   - Blower operation
   - Capacity for additional flow
   - Carbon usage rates
   - Carbon costs and disposal costs
   - Change-out frequency and method

3) Pumps -
   - Discharge pressure
   - Cycling due to level switch placement
   - Capacity for additional flow or head loss

The Rotating Biological Reactor will be evaluated for applicability as a full-scale (Phase II) remediation technology. Parameters to be monitored (with respect to controlled hydraulic loading rates) for this evaluation include:

- VOC degradation rates,
- methane utilization rates, and
- sludge production rates.

4.5.4 Instrumentation and Controls In addition to the instrumentation and controls evaluated as part of the system performance evaluation, extraction well instrumentation and controls will be evaluated for accessibility and value of information received. Requirements for additional control, indication, or recording abilities will be evaluated for full-scale implementation requirements.

4.5.5 Discharge Permit/Options Estimated full-scale system flow rates and constituent concentrations will be evaluated for long-term discharge to the POTW. The USEPA Fate and Treatability Estimator for Discharge to POTWs (USEPA, 1990) (USEPA Fate Model) will be used to evaluate whether discharge to the POTW will adversely affect the facility's operation or effluent quality. Alternatives such as discharging through a National Pollutant Discharge Elimination System (NPDES) permit will be evaluated.

4.5.6 Evaluation and Recommendations Report The Evaluation and Recommendations Report will incorporate results of the evaluations discussed above and will recommend a full-scale system (Phase II) for implementation as an IM. The final report will be submitted to Georgia Environmental Protection Division for approval.

5.0 CAPTURE ZONE MODELING

A two-dimensional semi-analytical model, the General Particle Tracking Module (GPTRAC) of the USEPA's Well Head Protection Area (WHPA) delineation code, has been used to illustrate the movement of a "slug" of contamination within or around the capture zone of the groundwater extraction wells. WHPAs are defined as the surface and subsurface area surrounding a water well or wellfield through which contaminants are reasonably likely to move toward and reach such water well or wellfield.

The WHPA model delineates capture zones of pumping wells using the particle tracking technique. The term "particle" is used only for conceptual purposes. A particle may be viewed as an individual water molecule or an individual molecule of a conservative tracer that moves through the aquifer coincident with the bulk movement of groundwater flow; dispersion and diffusion do not affect the particle location.

Time-related capture zones are obtained by tracing the pathlines formed by a series of particles placed around the well bore of the pumping well. The particle tracking method requires knowledge of the groundwater flow velocity at any point within the aquifer. Once velocities have been determined, pathlines may be delineated using particle tracking. Forward tracking is performed to determine if particles that are released upgradient of a well will be captured by the well.

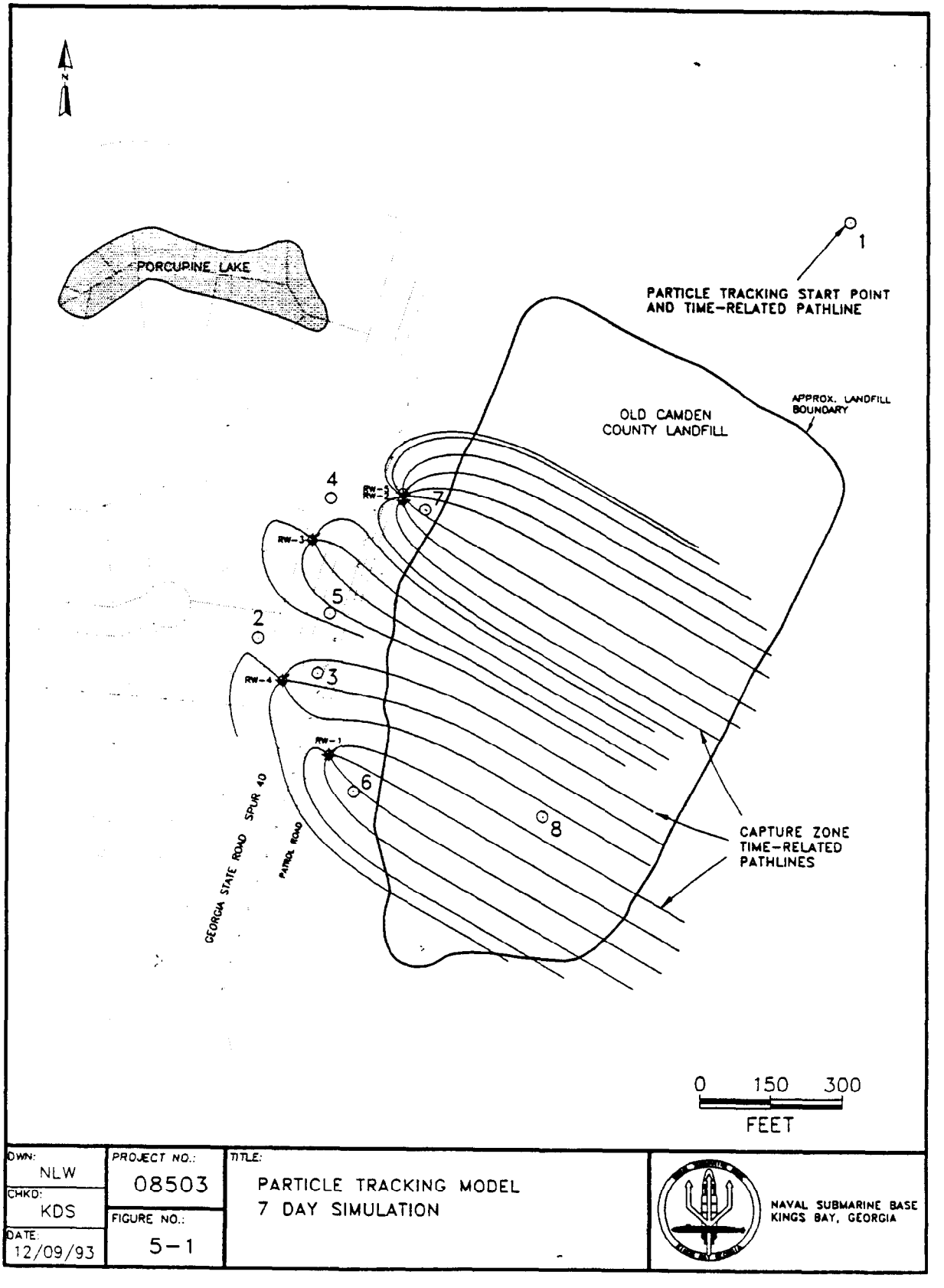
The assumptions and limitations associated with the model are:

- the groundwater flow field is at equilibrium (steady state), and
- the flow in the aquifer must be two-dimensional in the horizontal plane; vertical flow components are neglected.

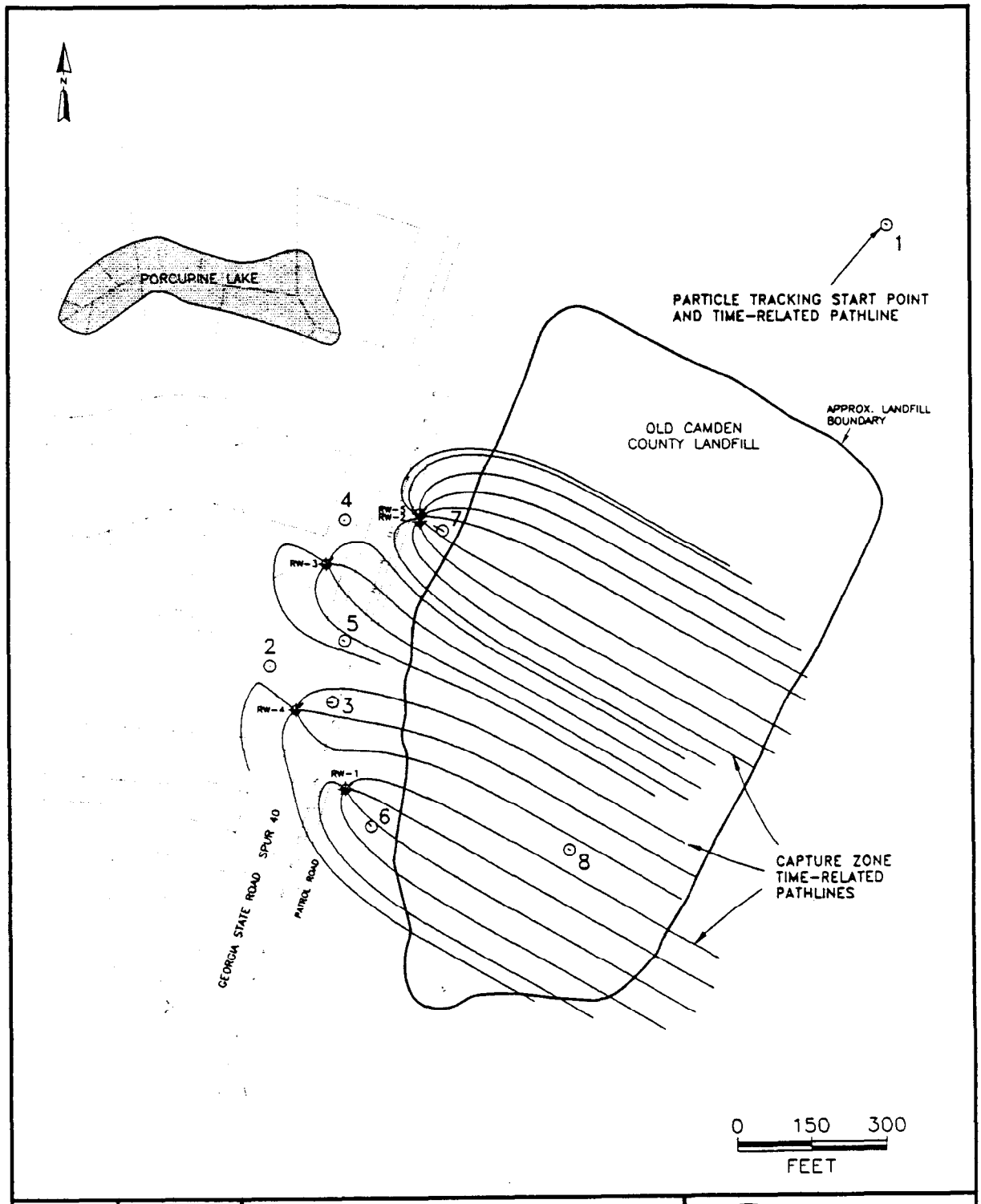
Slugs of contamination or chemical variations of the groundwater can be represented as particles transported by advective movement through the aquifer. GPTRAC models the movement of particle(s) of constituents through the recovery wells' capture zones using analytical velocity computation techniques. Distance traveled, therefore, is time-dependent.

Several plots of the five-well recovery system and its effective capture zone are provided as Figures 5-1 through 5-5. These show the movement of "slugs" of constituents from seven arbitrarily selected locations within the plume. Particle #1 in each figure represents a particle within the zone unaffected by the groundwater extraction system or the baseline particle movement. The projected particle pathway for each model duration (7 days, 30 days, 90 days, 1 year, and 5 years) is shown to begin at the indicated circles. The pathways which appear as dots in the shorter durations are actually lines indicating travel distances.

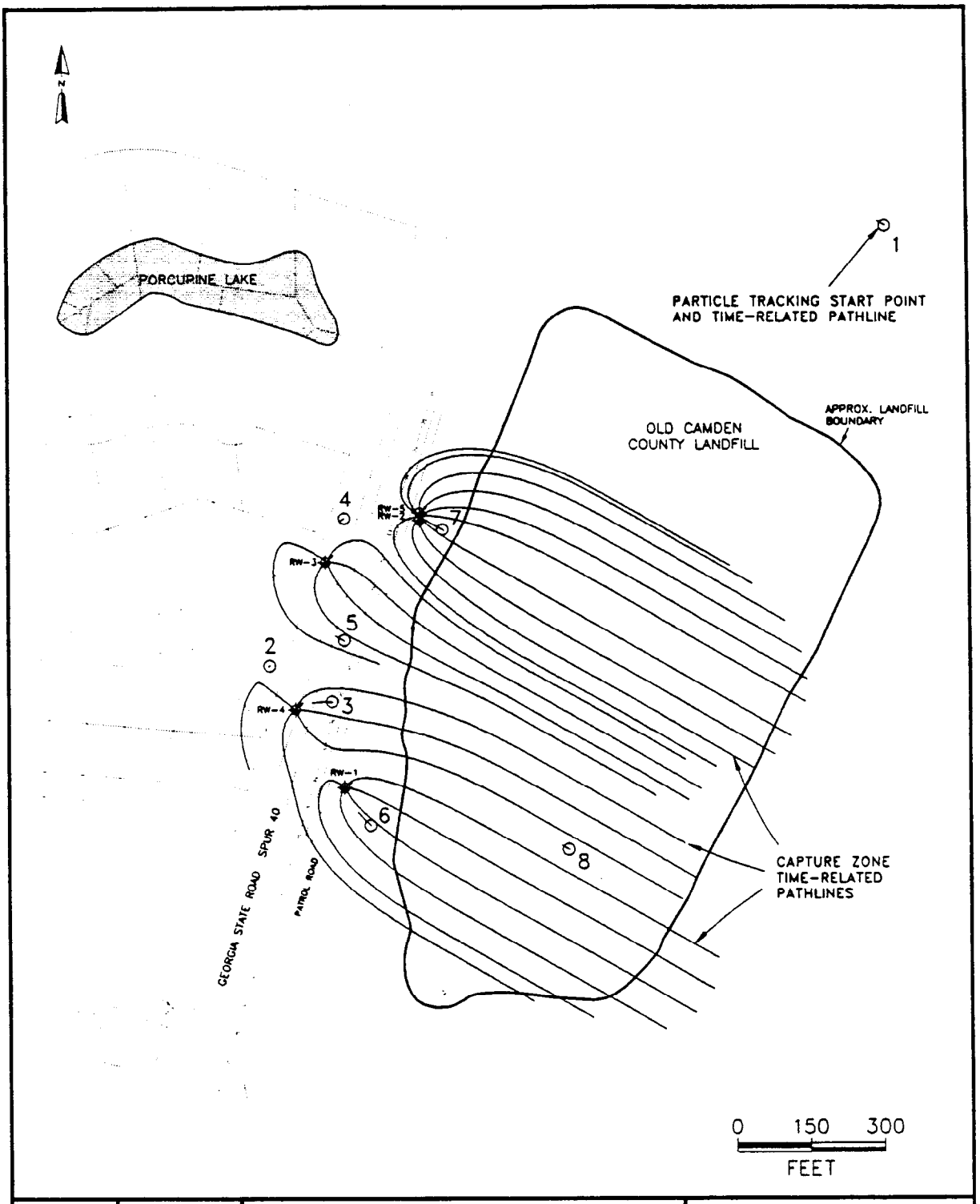
The modeling shows that due to the relatively low seepage velocity within the aquifer, current investigations of the groundwater quality will be representative of groundwater quality for the duration of the initial operations of the IM.



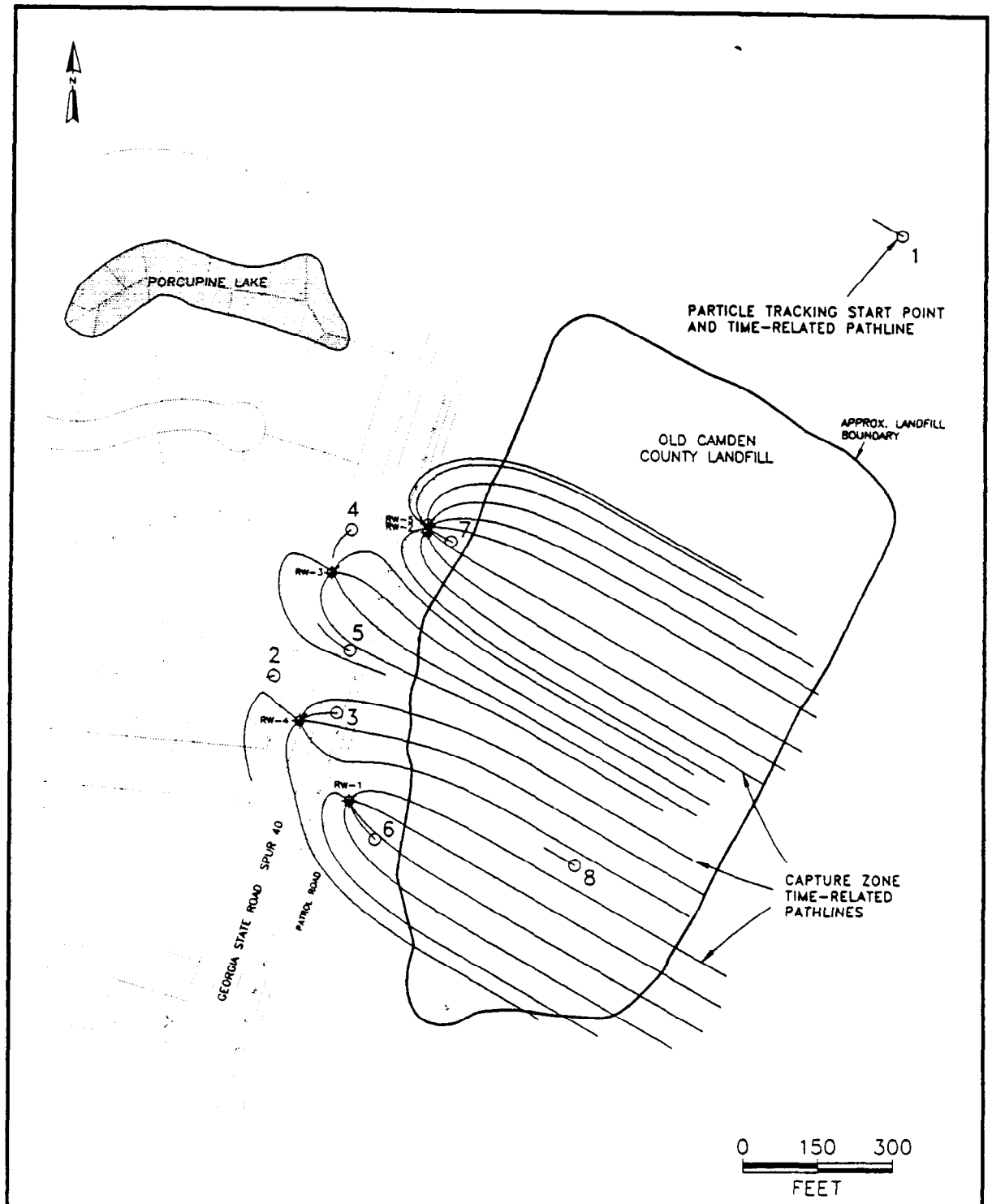
DWN: NLW	PROJECT NO.: 08503	TITLE: PARTICLE TRACKING MODEL 7 DAY SIMULATION	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: KDS	FIGURE NO.: 5-1		
DATE: 12/09/93			



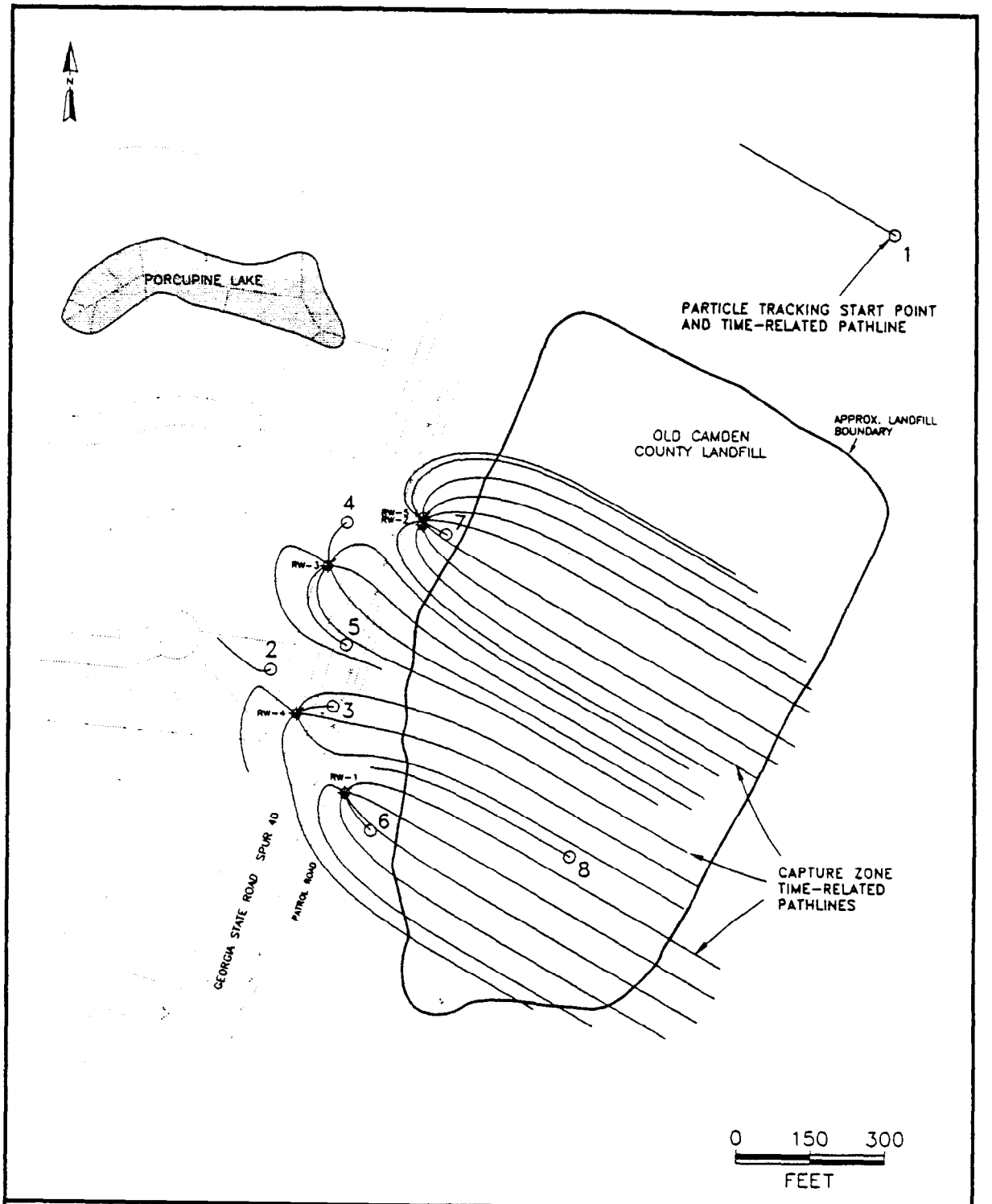
DWN: NLW	PROJECT NO.: 08503	TITLE: PARTICLE TRACKING MODEL 30 DAY SIMULATION	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: KDS	FIGURE NO.: 5-2		
DATE: 12/09/93			



DWN: NLW	PROJECT NO.: 08503	TITLE: PARTICLE TRACKING MODEL 90 DAY SIMULATION	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: KDS	FIGURE NO.: 5-3		
DATE: 12/09/93			



DWN: NLW	PROJECT NO.: 08503	TITLE: PARTICLE TRACKING MODEL 1 YEAR SIMULATION	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: KDS	FIGURE NO.: 5-4		
DATE: 12/09/93			



DWN: NLW	PROJECT NO.: 08503	TITLE: PARTICLE TRACKING MODEL 5 YEAR SIMULATION	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: KDS	FIGURE NO.: 5-5		
DATE: 12/09/93			

Plume characteristics are expected to change slowly; however, the changes during the initial operations of the IM will be gradual enough for weekly monitoring to be sufficient to detect and respond to the changes. Due to the low groundwater velocity as depicted by the short distance traveled by a particle in the 7-day and the 30-day models, sufficient time will be available to respond to any indication of change in plume characteristics. Vinyl chloride will be the greatest indicator of change in plume characteristics since it is a degradation product for many organics.

Drastic changes in groundwater chemistry or contaminant concentrations due to pumping that would require rapid operational monitoring or retention are not expected.

6.0 MONITORING PLAN

6.1 DATA COLLECTION STRATEGY. The intended uses for the data obtained during IM activities are: (1) to evaluate the use of groundwater extraction as a means to hydraulically control VOC plume movement; (2) to measure the efficiency of air sparging as a viable option to remediate VOCs from the groundwater while ensuring that treatment performance standards and discharge criteria are being met; and, (3) to measure the efficiency of *ex situ* biological treatment technology as an alternative option to remediate VOCs from the groundwater. Further definition of the Monitoring Plan is provided in the Interim Measure Work Plan for Site 11, Old Camden County Landfill Phase I Activities (ABB-ES, 1993b).

6.2 SAMPLING AND FIELD MEASUREMENTS.

6.2.1 Hydraulic Monitoring During the operation of the treatment facility, specific hydraulic data will be collected and monitored. Periodic measurements of flow rates and total flow, in gpm, will be taken from each recovery well. Precipitation events will be monitored using rain gauges indicating when the event occurred, duration of event, and the quantity of rainfall that fell. Barometric pressures during the tests will be recorded by a gauge linked to one of the data loggers.

6.2.2 Operations Monitoring During the pilot-scale operation, specified locations will be sampled to observe the concentrations of constituents coming into and out of the treatment facility. In addition, samples of process water from specific pieces of equipment will be sampled periodically to monitor the efficiency of the system components. Locations to be sampled are listed below.

- Pretreatment tank (system influent)
- Air sparger effluent (water)
- Air sparger effluent (vapor)
- Primary carbon unit effluent (vapor)
- Stage I (single well GWE test) - sample tap at manifold of recovery well
- Stage II (two well GWE test) - sample tap at manifold of each recovery well
- Stage III (five well GWE test) - sample from pretreatment tank
- Phase I Continuance (Stage III continued) - sample from pretreatment tank

Refer to Tables 6-1 and 6-2 for operations monitoring schedule.

Table 6-1 Phase I and Phase I Continuance Operations Monitoring Schedule

Sampling Location	Frequency	Analysis	On site/ Off site[1,2]
Phase I			
Pretreatment Tank	1/day	Volatiles	On site
Pretreatment Tank	1 every other week	Metals, ETPs	Off site
Air Stripper Effluent (water)	1/day	Volatiles, pH	On site
Air Stripper Effluent (Water)	1/week	TSS, BOD	Off site
Air Stripper Effluent (vapor)	1/week	Volatiles	On site
Stack Effluent (vapor)	1/day	Volatiles	On site
Primary Carbon Unit Effluent (vapor)	1/week	Volatiles	On site
Initial Pumping Test	1/event	Volatiles, Metals, ETPs	Off site
Stage I P-OIA, drawdown	1/day	Volatiles	On site
Stage I P-OIA, drawdown	1/event (day 5)	TCL, TAL, ETPs	Off site
Stage I P-OIA, single well pumping test	1/day	Volatiles	On site
Stage I P-OIA, single well pumping test	1/event	Metals, ETPs	Off site
Stage I P-OIA, single well pumping test	2/event	TCL, TAL	Off site
Stage II P-OIA & B, two well pumping test	1/day	Volatiles	On site
Stage II P-OIA & B, two well pumping test	1/week/well	TCL, TAL	Off site
Stage III, five well pumping test	1 every other day	Volatiles	On site
Stage III, five well pumping test	1/week	TCL, TAL	Off site
Phase I Continuance			
Air Stripper Effluent (water)	1/week	Volatiles	Off site
Pretreatment Tank	1 every other week	Metals, Selected ETPs	Off site

Notes:

BOD = biochemical oxygen demand
ETP = engineering treatability parameters, as indicated in Table 6-3.
SVOC = semivolatile organic compound
TAL = target analyte list
TCL = target compound list - VOCs, SVOCs, pesticides, and polychlorinated biphenyl compounds
TSS = total suspended solids
VOC = volatile organic compound

[1] Methods of analysis by off-site analytical laboratory and on-site laboratory is listed on Table 6-3.
[2] Five percent of samples analyzed in the on-site laboratory will be submitted for off-site VOC analysis.

Table 6-2 Sample Collection Frequency For Methanotrophic Rotating Biological Contactor

Parameter	Influent	Stage #1	Stage #2	Stage #3	Effluent	Headspace
VOCs	daily	daily	daily	daily	daily	as needed
pH	continuous	continuous	continuous	continuous	continuous	-----
Nitrate	2/week	2/week	2/week	2/week	2/week	-----
Phosphate	2/week	2/week	2/week	2/week	2/week	-----
Total Suspended Solids	1/week	-----	-----	-----	1/week	-----
Total Volatile Suspended Solids	1/week	-----	-----	-----	1/week	-----
Methane	-----	-----	-----	-----	-----	continuous
Oxygen	-----	-----	-----	-----	-----	continuous
Carbon Dioxide	-----	-----	-----	-----	-----	continuous

Note:

VOC = volatile organic compound

The following associated data will be recorded when collecting samples:

- ambient temperature,
- daily amount of precipitation,
- time sample was collected, and
- unusual events (i.e., samples were collected during rain event).

Vapor sample collection will be performed using Tedlar bags, following Method 18, Section 7 of 40 CFR Part 60, Appendix A.

6.3 ANALYTICAL PROGRAM.

6.3.1 Analytical Parameters Laboratory analyses for monitoring the pilot-scale operations include physical and chemical parameters. As indicated in Subsection 6.2.2, analyses will be conducted on air and water samples. Parameters for analysis during operations monitoring are summarized in Table 6-3. All vapor samples collected from the air sparger and carbon absorption units will be analyzed in the on-site laboratory for the 10 VOCs listed in Table 6-3.

The analytical program for aqueous samples (groundwater influent and effluent) includes on-site and off-site analysis of chemical and physical parameters. VOC analysis of aqueous samples will be done on site and off site as indicated on Table 6-1. Parameters for on-site analysis are listed on Table 6-3. Off-site analysis of aqueous samples will include the TCL and TAL analytes listed in Table 2-2. Other parameters for analysis in aqueous samples include a select list of metals and engineering and treatability parameters (Table 6-3).

Several parameters will be monitored in association with operation of the mRBC unit. The parameters include nitrate and nitrite, phosphate, total volatile suspended solids, oxygen, and methane (see Table 6-3).

6.3.2 On-Site Analytical Procedures On-site analytical procedures include physical and chemical measurements of vapor and aqueous samples. Table 6-3 includes information regarding the methods of analysis associated with monitoring the IM operations. These methods include the use of colorimetric test kits, field GC, and real time measurements.

Colorimetric test kits will be used for measurements of nitrate, nitrite, and phosphate. Each test kit employs the use of an indicator solution which reacts with the analyte to produce a color change. The intensity of the resulting color is directly related to the concentration of the analyte in the sample.

Samples collected for on-site VOC analysis will be analyzed using a Hewlett Packard 5890 GC or equivalent. The GC will be equipped with a purge-and-trap unit for use in analysis of aqueous samples. Air samples will be injected directly into the GC. The GC will also be equipped with two detectors, a photometric ionization detector (PID) and electrolytic conductivity (Hall) detector. The Hall detector will be calibrated to measure concentrations of benzene, toluene, xylenes, and ethylbenzene. The PID will be calibrated to measure concentrations of 1,2-dichloroethane, cis-1,2-dichloroethene, trans-1,2-dichloroethene, tetrachloroethene, trichloroethene, and vinyl chloride.

Table 6-3 Analytical Requirements for Phase I IM Activities

Parameter	Analytical Method	Constituent	Reference
VOCs (on site)	USEPA Method 5030/8010 & 5030/8020 (Modified)	Benzene 1,2-Dichloroethane cis-1,2-Dichloroethene trans-1,2-Dichloroethene Ethylbenzene Tetrachloroethene Toluene Trichloroethene Xylenes (total) Vinyl Chloride	(1) (2)
VOCs (off site)	1990 CLP SOW	TCL (Table 2-2)	(3)
SVOCs	1990 CLP SOW	TCL (Table 2-2)	(3)
Pesticides and PCBs	1990 CLP SOW	TCL (Table 2-2)	(3)
Metals	USEPA Method 6010	Cadmium Chromium Iron Manganese	(2)
	USEPA Method 7421	Lead	
	1991 CLP SOW	TAL (Table 2-2)	(4)
mRBC Parameters			
* Nitrate and Nitrite	Field Test Kit		
* Phosphate (total)	Field Test Kit		
* TSS	USEPA Method 160.2		(5)
* Total Volatile Suspended Solids	USEPA Method 160.2M		(5)
* Oxygen/Methane/Carbon Dioxide	Field Method		

See notes at end of table.

Table 6-3 (Continued) Analytical Requirements for Phase I IM Activities

Parameter	Analytical Method	Constituent	Reference
Engineering Treatability (ETPs)			
* pH	Field Method		
* Chloride	USEPA Method 325.2		(5)
* TOC	USEPA Method 415.1		(5)
* TSS	USEPA Method 160.2		(5)
* TDS	USEPA Method 160.1		(5)
* Hardness, total (as $CaCO_3$)	USEPA Method 130.2		(5)
* BOD (5-day)	USEPA Method 405.1		(5)

Notes:

BOD = biochemical oxygen demand
mRBC = methanotrophic Rotating Biological Contactor
SVOCs = semivolatile organic compounds
TAL = target analyte list
TCL = target compound list
TOC = total organic carbon
TSS = total suspended solids
TDS = total dissolved solids
USEPA = U.S. Environmental Protection Agency
VOCs = volatile organic compounds

References:

(1) Test Methods for Evaluating Solid Waste, Physical Chemical Methods, SW-846, 3rd Edition, USEPA 1986.
(2) ABB-ES' Treatability Laboratory Standard Operating Procedures.
(3) Contract Laboratory Program (CLP) Statement of Work (SOW) for Organic Analysis.
(4) CLP SOW for Inorganic Analysis.
(5) Methods for Chemical Analysis of Water and Wastes, USEPA-600/4-79-020, revised March 1983.

Quality assurance and quality control (QA/QC) procedures for the on-site laboratory are discussed in this paragraph. Duplicate samples will be collected and analyzed at a frequency of 10 percent of the total number of samples. A method blank will be analyzed at the beginning of each day. Cleaning blanks will be analyzed, as necessary, to check for carryover of contaminants from a previous analysis. Matrix spike and matrix spike duplicate analyses will be done at a frequency of 5 percent of the total number of samples. A known concentration of bromofluorobenzene surrogate will be added to each sample and the percentage of recovery calculated and recorded.

Real time measurements of carbon dioxide, oxygen, and methane will be done using various electronic analyzers. The mRBC unit employs three gas analyzers that continuously measure headspace gases in the unit. The measurements are recorded on a strip chart.

6.3.3 Off-Site Analytical Procedures The off-site laboratory program for IM operations monitoring includes analysis of physical and chemical parameters. All off-site analyses will be conducted according to USEPA-approved methods. Table 6-3 summarizes analytical methods to be used for the off-site analyses. The subcontract laboratory will be qualified to perform CLP analyses, will have an active QA/QC program, and will be NEESA-approved. QA/QC procedures are specified in the various analytical methods to be used for the IM off-site laboratory program. Details of QA/QC procedures for individual analyses can be found in the references cited in Table 6-3.

The off-site laboratory program includes analysis of a minimum of 5 percent of all samples analyzed in the on-site laboratory. Off-site analysis of air and aqueous samples, analyzed in the on-site laboratory for the target VOCs, will include TCL VOCs. All SVOC, pesticide, PCB, metals, and engineering treatability parameter analyses (excluding pH) conducted as part of IM operations monitoring will be done by the off-site laboratory. Table 6-1 provides information on the location and frequency of sample collection for off-site analyses.

6.3.4 Turnaround Times With the exception of TCL and TAL analyses, data from off-site laboratory samples should be submitted to IM personnel within 30 days of receiving the sample. TCL and TAL analyses will be conducted on a 7-day turnaround schedule. Analysis on field samples will be complete within 24 hours from the time the sample is collected. On-site analysis of treated water effluent will be completed within 2 hours from the time the sample is collected.

6.4 SUPPLEMENTAL RFI GROUNDWATER MONITORING. Twenty-five (25) groundwater monitoring wells have been installed in and around the landfill and Crooked River Plantation Subdivision to be used for groundwater monitoring for the site RFI. The monitoring wells range in depth from 20 to 95 feet bgs. These wells will be sampled in January and April 1994. Sample analysis will include all TCL and TAL analytes, plus sulfide. A subset of groundwater samples will be analyzed for Appendix IX constituents.

The IM GWE operations will not be started until analytical results from the January sampling event are available and reviewed to confirm that no additional constituents are present at concentrations of concern.

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APPENDIX D

RESPONSE TO GEORGIA ENVIRONMENTAL PROTECTION DIVISION COMMENTS

Response to Comments by Georgia Environmental Protection Division (EPD) on
Final Draft Interim Measure Work Plan for
Site 11 - Old Camden County Landfill
NSB Kings Bay, Georgia

Comment No./ Section/Para.	Comment	Response
Comment 1 Section 2.2	This section should state why other treatment options, such as reverse osmosis and ozonation, were not considered. It should contain a brief description of the rationale for choosing the relative sizes of the waste streams being treated during the pilot-scale test by air-stripping versus biological treatment.	The constituents detected in the groundwater can be treated effectively by air stripping and biological technologies during the Interim Measure (IM). Either of these two are considerably less costly to implement than other technologies. This section will be revised to clarify the IM treatment technology selection. The one (1) gallon per minute stream to be used in the biological process is sufficient to collect data needed to evaluate biological treatment of the groundwater. Higher flows of extracted groundwater are more easily handled by the air-stripping technology apparatus; therefore, the bulk of the waste stream will be routed through the air stripping treatment system. The rationale for the split in the flow stream will be clarified further in the final Work Plan.
Comment 2 Section 2.3 and associated Table 2-1	The State of Georgia requires cleanup to Maximum Contaminant Levels (MCL) where these have been established, and to site-specific background concentrations for compounds with no established MCLs. Therefore, Table 2-1 should list "Site-specific background" as the performance criteria for 1,1-Dichloroethane. It should be noted that because 1,1-Dichloroethane is not a naturally occurring compound, "background" for this compound will effectively be zero.	Table 2-1 lists treatment system performance goals for treated discharge and does not reflect cleanup goals for the aquifer. Cleanup standards for the groundwater have not been addressed in the Interim Measure. Cleanup goals for the final remedial action effort(s) will be addressed in the Corrective Measure Study and the Corrective Action Plan.

Comment No./ Section/Para.	Comment	Response
Comment 3 Section 3.0	This section should contain a map showing the proposed monitoring well locations. Also, Figures 9.1 and 9.2, which show recovery well locations and treatment pad design, should be included in this section, rather than in the Health and Safety section of the Plan.	A figure that shows locations of proposed recovery wells, observation wells/piezometers, the treatment pad and the RFI monitoring wells will be included in Section 3 of the Final IM Work Plan.
Comment 4 Section 3.1	U.S. Environmental Protection Agency guidance for monitoring well construction calls for the use of stainless steel casing. Use of alternate materials (PVC) for monitoring well construction is not recommended. EPD will not prohibit the use of PVC, however, any contaminants detected in groundwater from these wells will be attributed to contamination emanating from the landfill, and will never be considered to have resulted from degradation of the PVC well casing material. The Work Plan should include a statement to this effect.	The observation wells/piezometers, constructed of PVC, will be used for water level measurements to monitor drawdown caused by the recovery well discharge. No water quality samples will be collected from these ten observation wells/piezometers. Monitoring wells to be installed as part of the RFI will be constructed with stainless steel casing.
Comment 5 Section 3.1	This section should discuss the methods for providing security for all monitoring and recovery wells, not just those wells which lie off base.	All observation wells/piezometers will be equipped with lockable, expandable-seal caps. Off-site observation wells will also be installed with flush-mounted vaults that have latchable covers. All recovery wells will be installed and secured with lockable covers.

Comment No./ Section/Para.	Comment	Response
Comment 6 Section 3.3	This section also states that the decision to use either an air stripper or an air sparger will be made during the initial pumping tests. This section should state that an addendum to the .Work Plan, describing selection criteria and providing the system design, will be prepared at that time.	An initial pumping test has been performed and a recovery well discharge sample has been collected for analyses of engineering treatability parameters. Results have been obtained and the air sparger has been selected. An addendum to the Work Plan will be issued providing the selection process and the final system design. This section will be revised to address the addendum to be issued.

Comment No./ Section/Para.	Comment	Response
Comment 7 Section 3.3.3	This section must identify a target range or other performance standards for organic vapor air emissions. Vinyl Chloride is a known human carcinogen and has been identified as a hazardous air pollutant; vapor emissions testing should therefore include analyses specifically for Vinyl Chloride as the monomer. Attainment of the Lowest Achievable Emission Rate (LAER) is required.	Pre-operational estimates of vapor emissions for the vapor treatment system will be provided in a letter to Georgia EPD by mid-December 1993. These pre-operational estimates of vapor emissions will be generated by modeling highest concentrations of specific constituents in the waste stream and using equipment performance parameters of the selected air sparger and carbon treatment units. These performance standards will be calculated using guidance from Georgia's "Guideline for Ambient Impact Assessment of Toxic Air Pollutant Emissions" on the calculation of Acceptable Ambient Pollutant Concentration. The Threshold Limit Value (TLV) for each constituent will be adjusted for full-time operation and for the safety factors recommended for toxic/lethal effects. Vapor emissions testing will be performed by the on-site laboratory for the constituents of concern, including vinyl chloride. The Lowest Achievable Emission Rate will be maintained through the use of granular activated carbon. Preliminary estimates of the granular activated carbon indicates a removal efficiency of approximately 99% of the vinyl chloride.

Response to Comments from GA EPD on
the RFI Report for Sites 5 and 16, and Site History
and File Information for Site 12
NSB Kings Bay, Georgia

Comment No.	Section	Comment	Response
10	Section 3.2	This section should define the limits of the waste disposal area and describe how the area was delineated. This has not been done adequately. It is not clear how the "approximate landfill boundary" shown on Figure 2-6 was determined. It is also not clear how the nature of the waste and the waste disposal practices at the site were determined. This section must be revised to provide this information.	The limits of the disposal area shown in Figure 2-6 were taken from the RFI Work Plan. The work plan and the Initial Assessment Study do not agree on the location of Site 16 relative to Woodrow Wilson Rd. A ground penetrating radar (GPR) survey will be recommended as a means to possibly reconcile this discrepancy. The nature of wastes disposed at Site 16 and disposal practices described in the RFI Report are from the Initial Assessment Study. Section 6.2 of the RFI Report will be revised to reflect the uncertainty of the location of the site and the recommendation for a GPR survey.
11	Section 3.2	The terrain conductivity data for Site 16 should be presented.	The terrain conductivity survey was performed as part of groundwater characterization, which is addressed in subsection 6.2.1. A subsection within 6.2.1 will be created to address the conductivity survey at Site 16. Graphics will be used to present the terrain conductivity data for the site. The stations where measurements were taken will be added to an existing site diagram in the text. A reference will be added to the text to direct the reader to the diagram where stations are shown. Discussion will be included to explain the results of the survey.

Comment No./ Section/Para.	Comment	Response
Comment 11 Section 6.3	The first paragraph of this section states that the possibility of discharging the influent without treatment will be considered. In the event of a discharge to the city of St. Marys' POTW, proof of the ability of St. Marys to treat and dispose of the wastewater under its NPDES permit will be required.	Extracted groundwater will be treated before discharge to either of the treatment works during Phase I of the IM activities at Site 11. Extracted groundwater **may** be discharged, without prior treatment, to the selected treatment works (on-base or City of St. Marys POTW) after Phase I of the IM activities if the POTW has the capability to treat and dispose the wastewater under its discharge permit. Appropriate documentation will be supplied to Georgia EPD and the City of St. Marys. No change will be made to the treatment operations affecting the discharge to the POTW without the approval of Georgia EPD or the City of St. Marys.

Response to Comment No. 7 on Interim Measure Work Plan
By Georgia EPD
Naval Submarine Base, Kings Bay, Georgia

Comment No. 7

Reference: Section 3.3.3 of the Final Draft Interim Measure Work Plan of Site 11 - Old Camden County Landfill.

Comment: This section must identify a target range or other performance standards for organic vapor air emissions. Vinyl Chloride is a known human carcinogen and has been identified as a hazardous air pollutant; vapor emission testing should therefore include analyses specifically for Vinyl Chloride as the monomer. Attainment of the Lowest Achievable Emission Rate (LAER) is required.

Response:

1. Please refer also to the Response to Comments Table submitted to Georgia Environmental Protection Division (EPD) on 17 November 1993.

2. This portion of the response contains information on expected air emissions and air quality impacts from the air sparging operation. This information is also being sent to Mr. Gene Drew of the Air Protection Branch of the Department of Natural Resources for review and approval.

   We have attempted to supply all the information you need to evaluate the air quality aspects of this project. Target ranges for each constituent are presented as Acceptable Ambient Criteria (AAC) in Table 1. The performance standard for vinyl chloride has been calculated and is discussed on pages 4 and 5. The modeling for determining the performance standard for vinyl chloride is presented in Table 8. Attainment of the Lowest Achievable Emission Rate will be achieved through the proposed system.

<u>Description of Air Sparging Pilot Study</u>

Groundwater will be extracted from the area beneath the Old Camden County Landfill to prevent further migration of contaminants in the aquifer. The groundwater is known to contain volatile organic compounds (VOCs) as listed in Table 1. The VOCs will be removed from the groundwater utilizing an air stripping technology before discharge of the water to a treatment works.

The Air Sparger is a diffused aeration system where air is released into the water through diffusers that produce coarse bubbles. Mass transfer occurs across the air-water interface of the bubbles. Exhaust air exits the unit and is directed to a series of activated carbon adsorbers before being discharged through a single PVC stack to be released to the atmosphere at a minimum height of 16 feet.

Design air flow through the Air Sparger is 800 cubic feet per minute for an air to water ratio of 100 to 1 at a water feed rate of 60 gallons per minute.

The pilot study will operate up to 24 hours per day, 7 days per week, for a total of 45 days.

Figure 1 shows the approximate location of the Air Sparger, carbon adsorbers and stack.

Air Emissions

Seventeen chemicals have been identified in the groundwater which may be emitted into the air during the air sparging. These chemicals are listed in Table 1. Tables 2 and 3 provide the estimated emission rates for each chemical following vapor phase carbon adsorption (Column 3). Emission rates were calculated using the maximum groundwater concentration detected at any point in the constituent plume (Table 1, Column 1) and modeling for the Air Sparger and carbon adsorbers using the following equations:

$$C_1/C_0 = [1/(1+kt)]^N$$

Where:
C_0 = initial concentration
C_1 = effluent concentration from the Air Sparger
k = Henry's Law Constant
t = residence time
N = number of stages

And: $R/AW \times 1.203$ = vapor effluent in mg/m^3

Where:
R = concentration transferred to the vapor stream in micrograms per liter
AW = air to water ratio of Air Sparger

These equations have been documented to be a conservative calculation based on actual operating data of the Air Sparger unit to be used at the site.

The vapor phase activated carbon has been documented to remove a minimum of 99 percent of each constituent of concern with a retention time of 1.7 to 2 seconds. Four parallel streams of carbon adsorbers will be used to provide a retention time of 1.8 seconds in each adsorber. Two units will be placed in series to provide a polishing stage and a sample point will be placed between the two units to monitor for breakthrough.

The maximum emission rate from the carbon adsorbers was calculated based on a 99 percent removal efficiency.

Ambient Air Quality Impacts

To estimate expected ambient air quality concentrations during the pilot test, air dispersion modeling was conducted. Maximum predicted impacts were then compared with calculated acceptable ambient concentrations to ensure public health would not be threatened during the system operation.

The United States Environmental Protection Agency (USEPA) SCREEN model was used to predict air quality impacts for each chemical of concern. SCREEN uses a number of conservative assumptions and provides conservative estimates of ambient air concentrations. This model is recommended by the USEPA for conducting dispersion modeling for air pathway analyses. Based upon discussions with staff at the Georgia Air Protection Branch, the SCREEN model is the preferred screening model for estimating air quality impacts.

The point source algorithm in SCREEN was used in the analysis. Flat terrain and rural dispersion were assumed. Concentrations were calculated for the full range of meteorological conditions available in the model. Automated receptor distances from one meter to 50 kilometers were selected for a single wind direction. One additional receptor, 200 feet from the stack, was calculated to represent the nearest public property. Because stack gas temperature is expected to be close to ambient temperature, the default ambient temperature assumed by the model, 293 Kelvin, was also used as the stack gas temperature. The stack gas velocity is based on the blower capacity (800 cubic feet per minute) and stack diameter (4 inches). To reduce the number of model runs and for ease of calculating air quality impacts for each of the chemicals, the model was conducted using a unit emission rate of one pound per hour (lb/hr).

The emission rates and modeled maximum ground level concentrations for each chemical of concern are provided in Tables 2 and 3. Table 4 presents the SCREEN model documentation for calculating the maximum ground level concentrations. Stack parameters used as input to the model are shown in Table 5.

Dimensions of the Air Sparger to be installed are approximately 14 feet long by 8 feet wide by 26 inches high. The unit on a skid will be a height of approximately 3 feet. Due to its size and the height of the stack, the Air Sparger is not expected to affect dispersion of air emissions. The tallest nearby structure to the stack is the Equalization Tank (7 feet high with a 6 foot diameter). The stack height of 16 feet follows Good Engineering Practice (GEP) for stack heights, defined as the height of a nearby structure plus 1.5 times the lesser of the height or width of the nearby structure. Because the stack height is equivalent to the GEP stack height, building downwash is not expected to occur. The Equalization Tank dimensions were input to the model to confirm that emissions will not be subject to downwash effects.

Table 3 represents the maximum one-hour concentrations that will occur during various dispersion situations following vapor treatment. Table 4 represents the maximum concentrations for a 24-hour averaging time. The maximum predicted one-hour concentration for a 1 lb/hr emission rate was 90.37 $\mu g/m^3$ (Table 4). The maximum impact for a 1 lb/hr emission rate occurred at 421 meters for F stability and a 1 meter per second wind speed. Using a factor of 0.4 to convert this one-hour impact to a 24-hour concentration, the maximum 24-hour impact for a 1 lb/hr emission rate is 36.15 $\mu g/m^3$. The USEPA recommends this 0.4 factor to be applied to one-hour results from the SCREEN model to estimate 24-hour impacts. The 24-hour concentration was multiplied by the emission rate for each chemical to obtain the maximum ambient air concentrations as presented in the tables.

Modeling of the dispersion following the Air Sparger without vapor treatment was also performed to estimate the confidence of emissions not exceeding Acceptable Ambient Concentrations (defined below). Table 6 represents the maximum one-hour concentrations that will occur during various dispersion situations following the Air Sparger without vapor treatment. Table 7 represents the maximum concentrations for a 24-hour averaging time following the Air Sparger without vapor treatment.

Acceptable Ambient Concentrations

In the telephone conversation with Ms. Gordon, Mr. Ron Methier indicated that no more recent guidance was available than the July 1984 guidance document followed in determining the Acceptable Ambient Concentrations (AAC). The basis for the calculation of the AAC comes from the toxicity data priority schedule provided in Part III, paragraph 1 of the guidance document. The American Conference of Governmental and Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) recommendations were converted to units of mg/m^3 for each constituent of concern. These values are included in the tables. The TLV values were adjusted for operation 24 hours a day, 7 days a week by multiplying by 40 hours per week and dividing by 168 hours per week. This is required by paragraph 2, Part III of the guidance document. The values were then adjusted by a safety factor that accounts for pollutant exposure to members of the public who may be more sensitive to pollutant effects than the average citizen, as required by paragraph 3. Table 1 indicates known carcinogens as category A, and all other pollutants as category B.

As indicated on Tables 2, 3, 6 and 7, the maximum ground level concentration calculated by the SCREEN model are well below the resulting AACs. The analysis reaffirms that air emissions will result in a negligible impact on air quality during the air sparging pilot test.

Response to Comment No. 7
Interim Measure Work Plan
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Page 5

Proposed Monitoring

Daily stack monitoring for vinyl chloride will be conducted during the pilot study to collect actual air emission data. The modeling shows that a concentration of 37 mg/m^3 of vinyl chloride at the stack should not exceed a maximum ground level concentration of 0.01004 mg/m^3 (Table 8) for worst case meteorological conditions. This is less than the required AAC. ABB-ES proposes to monitor the stack and to initiate corrective action if the stack concentration exceeds 3.7 mg/m^3, providing a minimum safety factor of 10 times the AAC. If a stack concentration of 3.7 mg/m^3 of vinyl chloride is exceeded, corrective measures to reduce emissions will be initiated. Corrective measures will be defined in an Operations and Maintenance Plan. The on-site laboratory that will be used initially for this stack monitoring will use a maximum detection limit of 0.1 mg/m^3. When analytical functions are transferred to an off-site laboratory, this maximum detection limit will continue to be used.