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

12/1/1993

ABB ENVIRONMENTAL SERVICES, INC

4

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

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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).

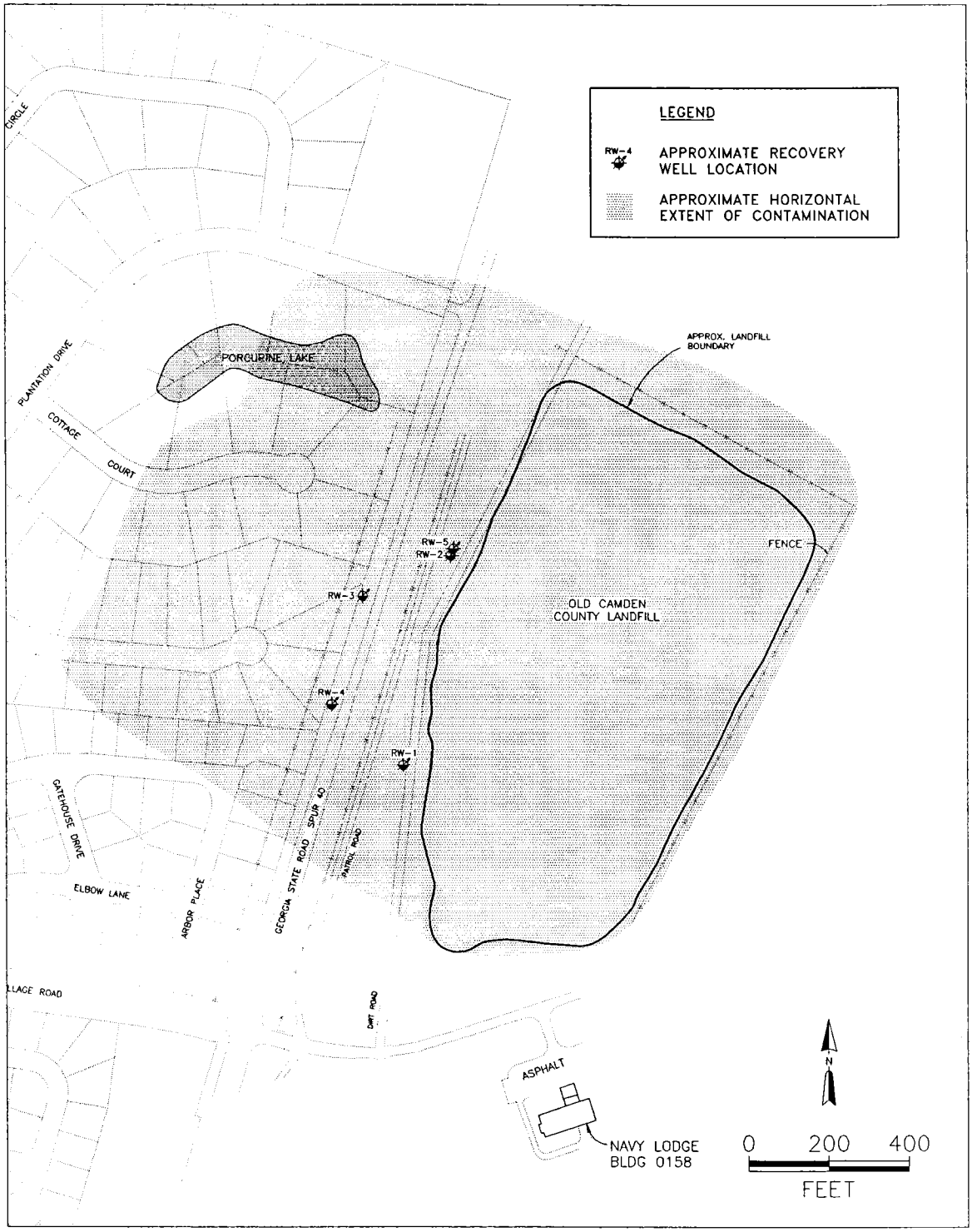
1.1 OBJECTIVE OF INTERIM MEASURE. The overall objective of the Interim Measure (IM) is to hydraulically control movement of the volatile organic compound (VOC) plume within the surficial aquifer. This will be achieved in a phased approach. The first phase will collect site-specific data to support long-term 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.

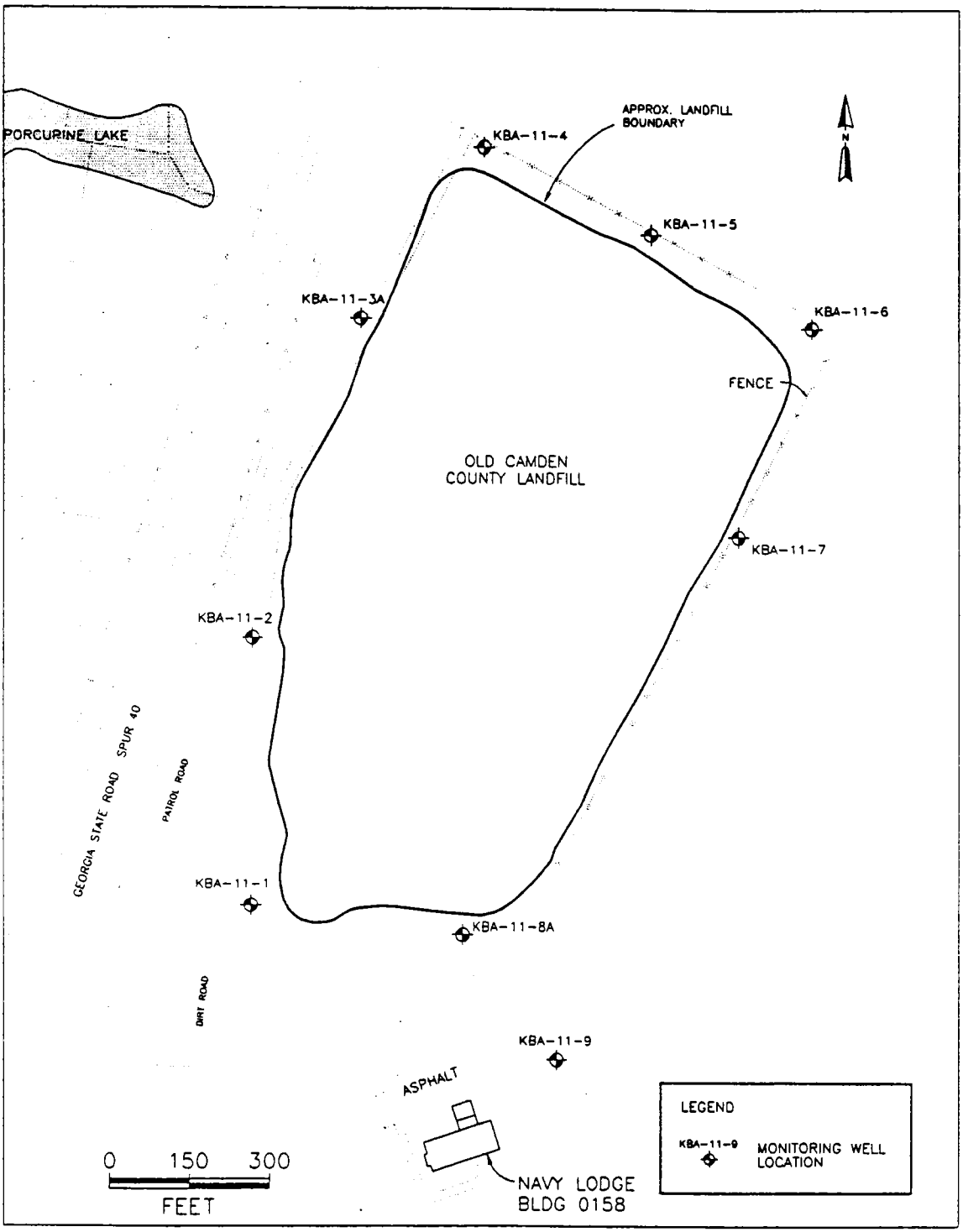
2.1.1 RFI Groundwater Monitoring Program A groundwater monitoring program consisting of six bimonthly sampling events began in February 1992. Nine groundwater monitoring wells, KBA-11-1 through KBA-11-9, were included in the monitoring program (Figure 2-1). These monitoring wells are approximately 13 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			

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

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

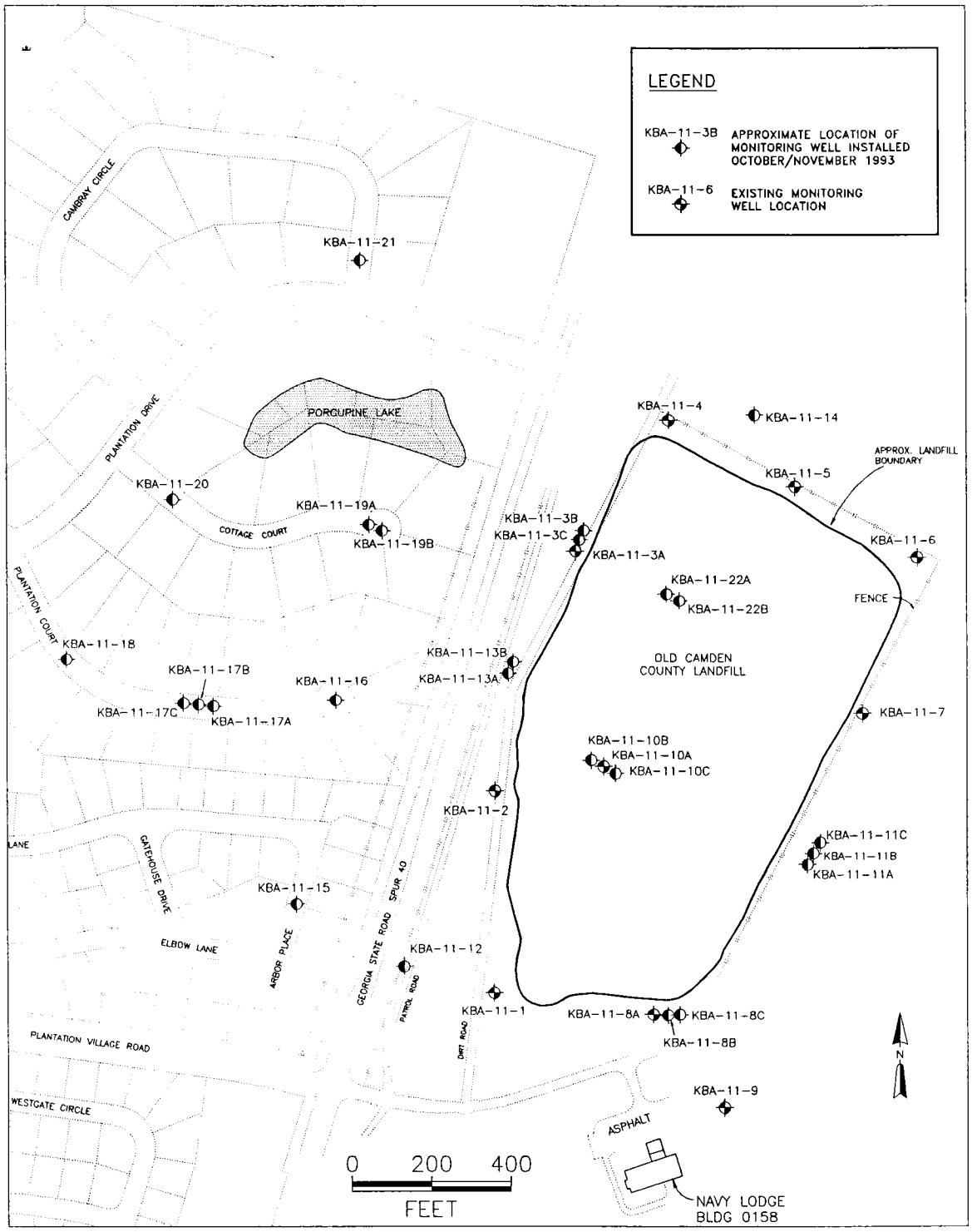
See note at end of table.

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 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.

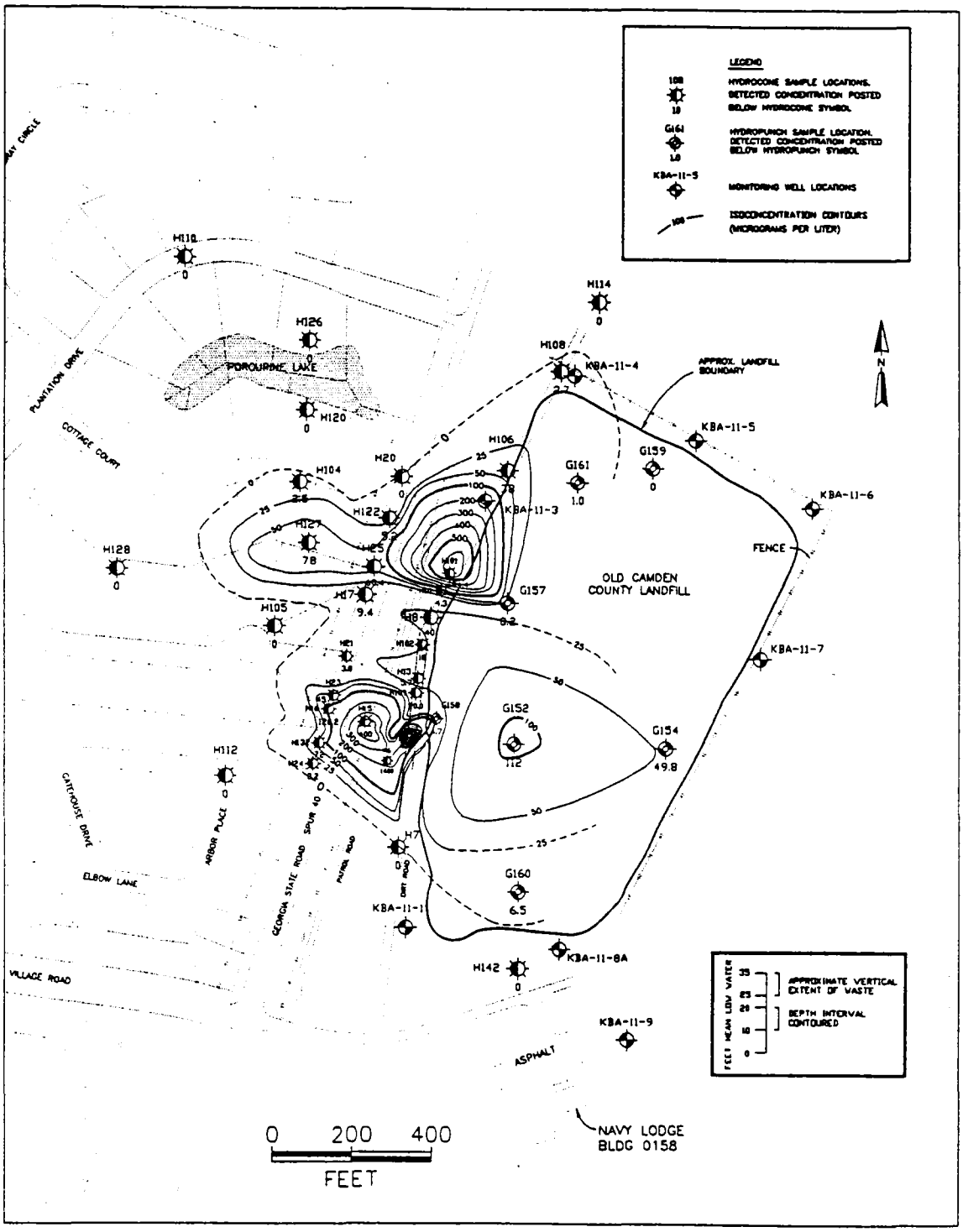
Table 2-6 summarizes VOC analytical data for groundwater samples collected from four recovery wells. Samples collected from the recovery wells contain lower concentrations of VOCs than the samples collected during the Phase I Interim Investigation and ICMSI. The relative difference in VOC concentrations 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.

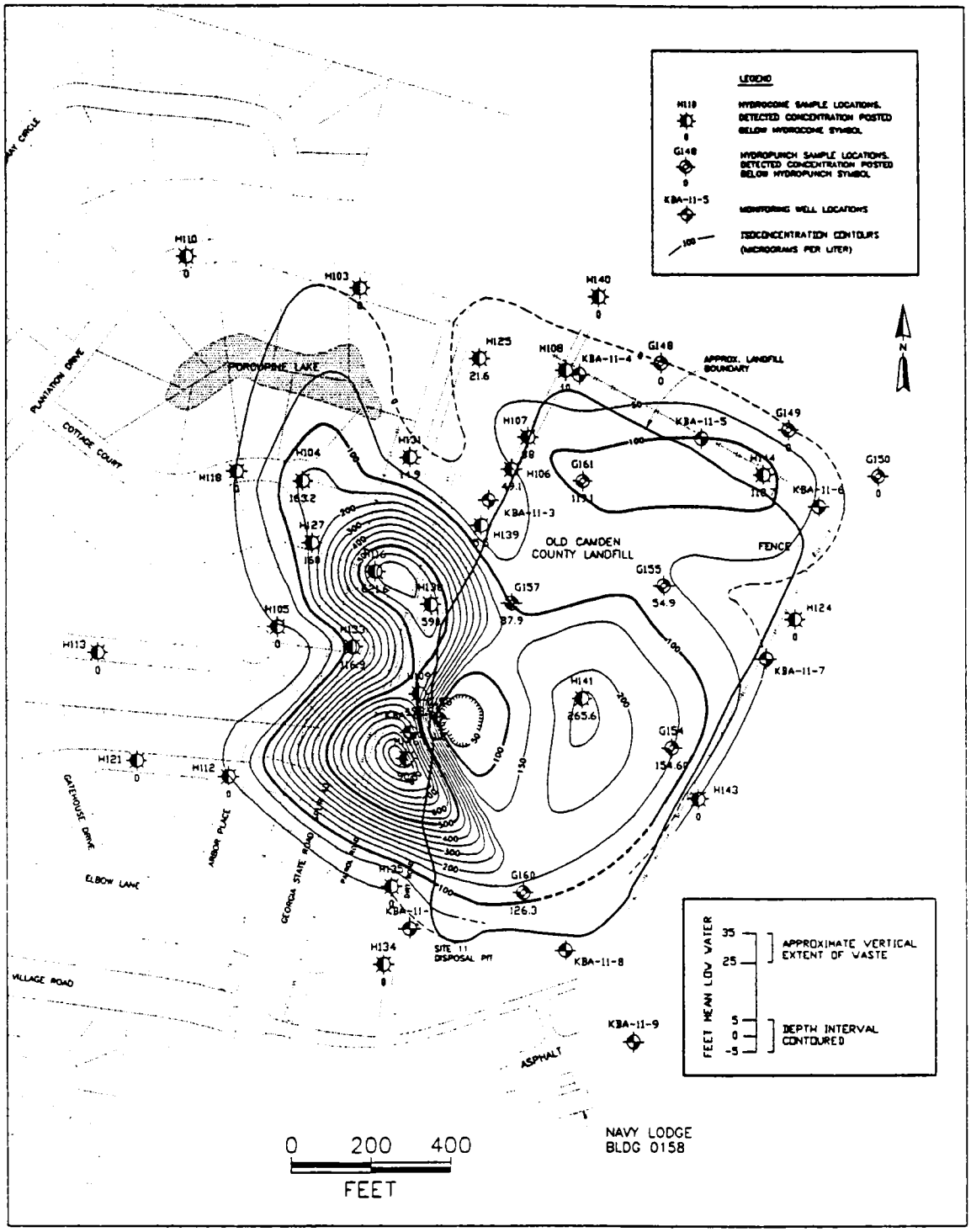
The two groundwater samples collected during the ICMSI and submitted for SVOC analysis contained detectable concentrations of five SVOCs (see Table 2-5). The SVOCs detected include three phenolic compounds, a phthalate, and a polycyclic aromatic. Concentrations ranged from 2 to 280 μg/l. Phenolic compounds 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.

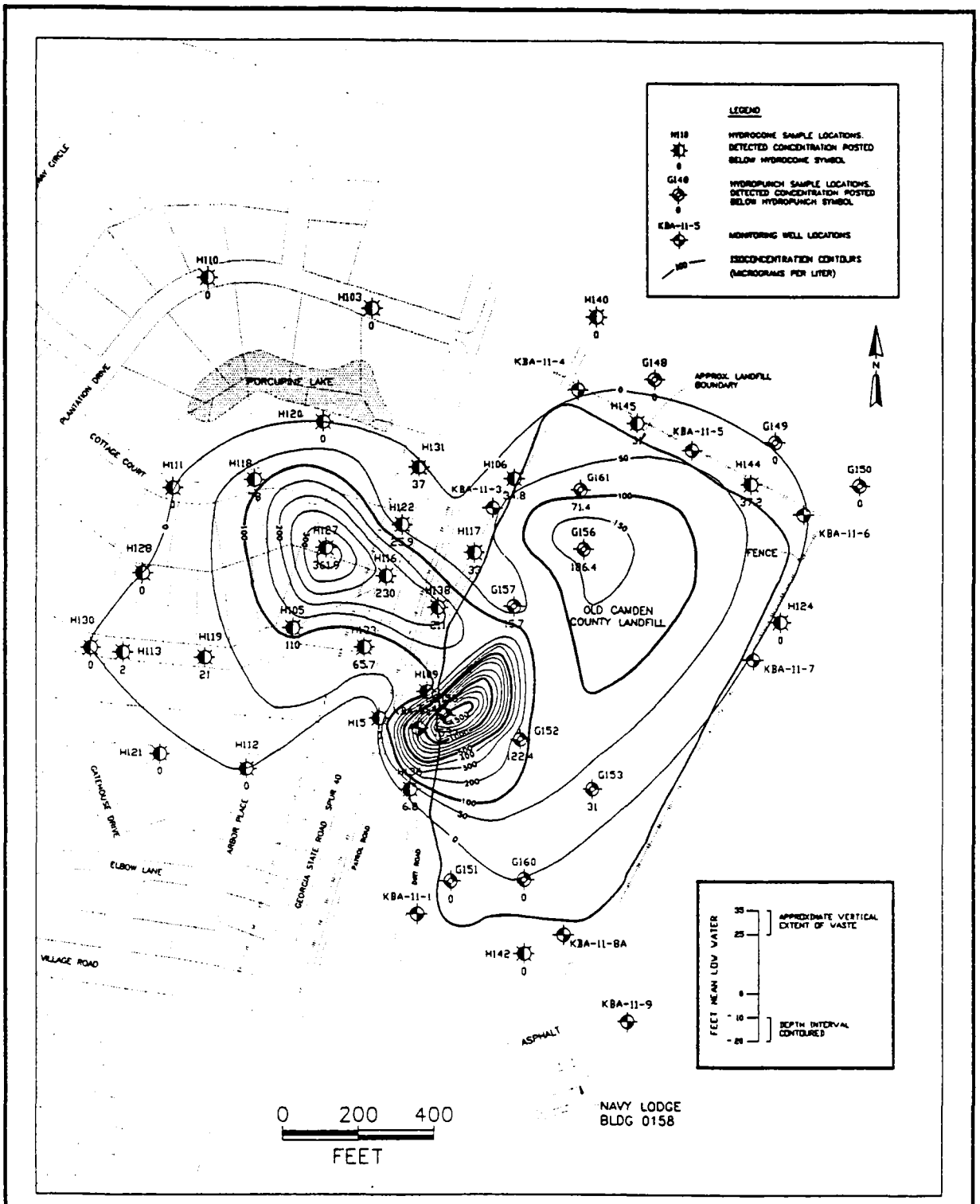
2.2.4 Inorganic Constituents Table 2-7 summarizes inorganic analytical data for the RFI groundwater monitoring program. The first sampling event for the RFI program was conducted approximately 1 week after well installation was completed. The inorganic data associated with the first sampling event are 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	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	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.

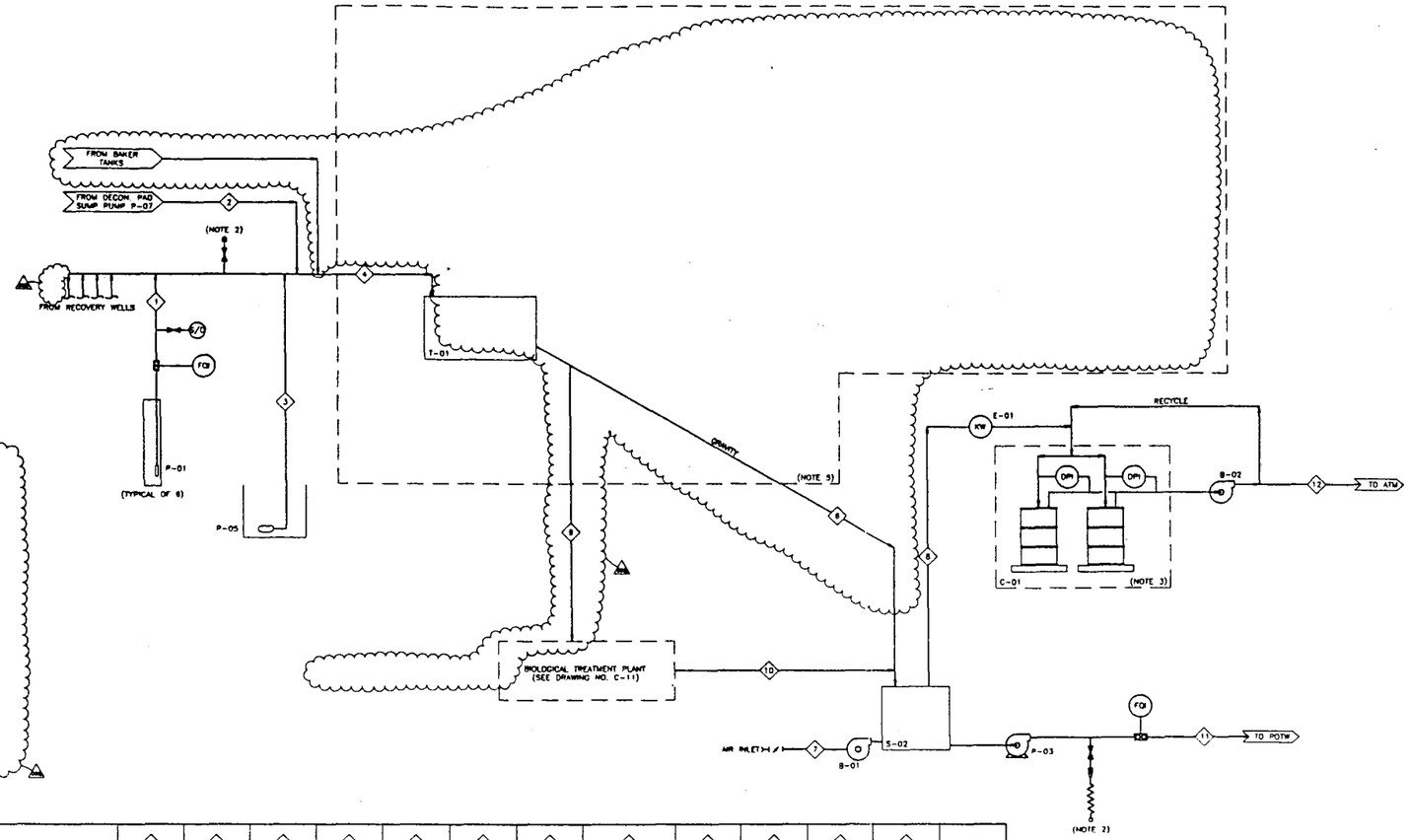
An air sparger will be used to treat the groundwater prior to discharge. The air sparger, an air stripping technology, is a diffused aeration system where a blower directs air into a tank of contaminated water through diffusers that produce coarse bubbles. Water enters the tank through a spray pipe at 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 IO 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
FQIT — FLOW TOTALIZER INDICATOR
DIRECT CONNECTION
DIRECT CONNECTION BLOCK VALVE IN CAP
ELECTRICAL CONNECTION
PACKAGED EQUIPMENT OR INTEGRAL UNITS
FLOW STREAM
KW — 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	50		50		*	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	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		0.81		
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	8			8		8		0.0020 mg/m^3	8		0.34		5
ETHYLBENZENE ug/l	41			41		41		0.0140 mg/m^3	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/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		0.1078 mg/m^3	310		0.40		2

* TO BE DETERMINED BY VENDOR

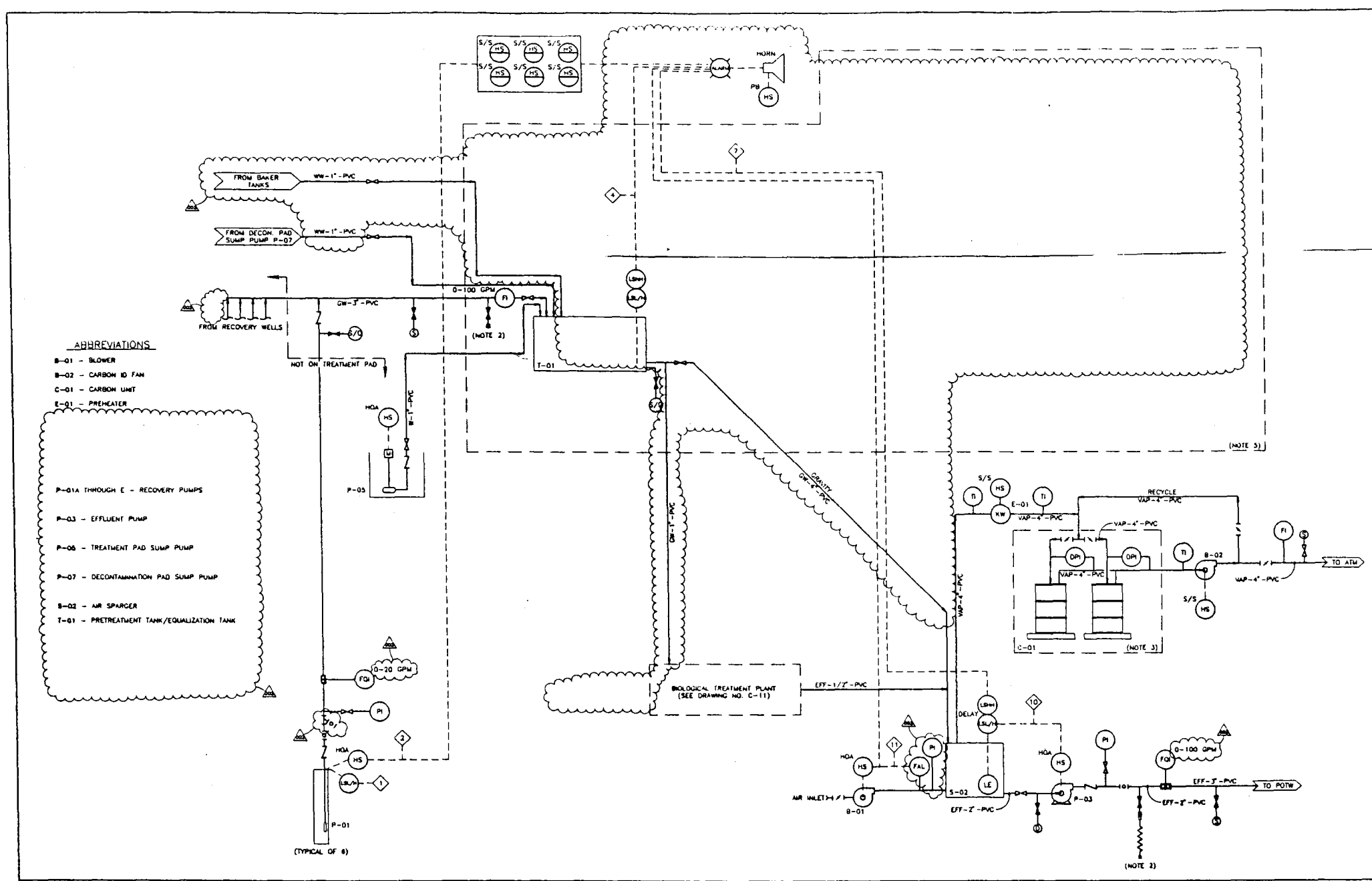
DATE	CHANGE ORDER NO.	BY	DESCRIPTION
11-18-93	002	VAR	PRETREATMENT DELAYED
11-9-93	001	VAR	SIGNED & SEALED

ABB — 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



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-06 - 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
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.
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 "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 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 5)			CONTROLLER (NOTES 3 & 4)			CONTROL VALVE	SELF-ACTUATING VALVE	SWITCH (NOTES 3, 5 & 8)	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: HF	CONTRACT NO.: SE 3-21-037	TITLE: PIPING AND INSTRUMENTATION DIAGRAM AIR SPARGER UNIT
CHKD: KDS	APPD.: GWB	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.

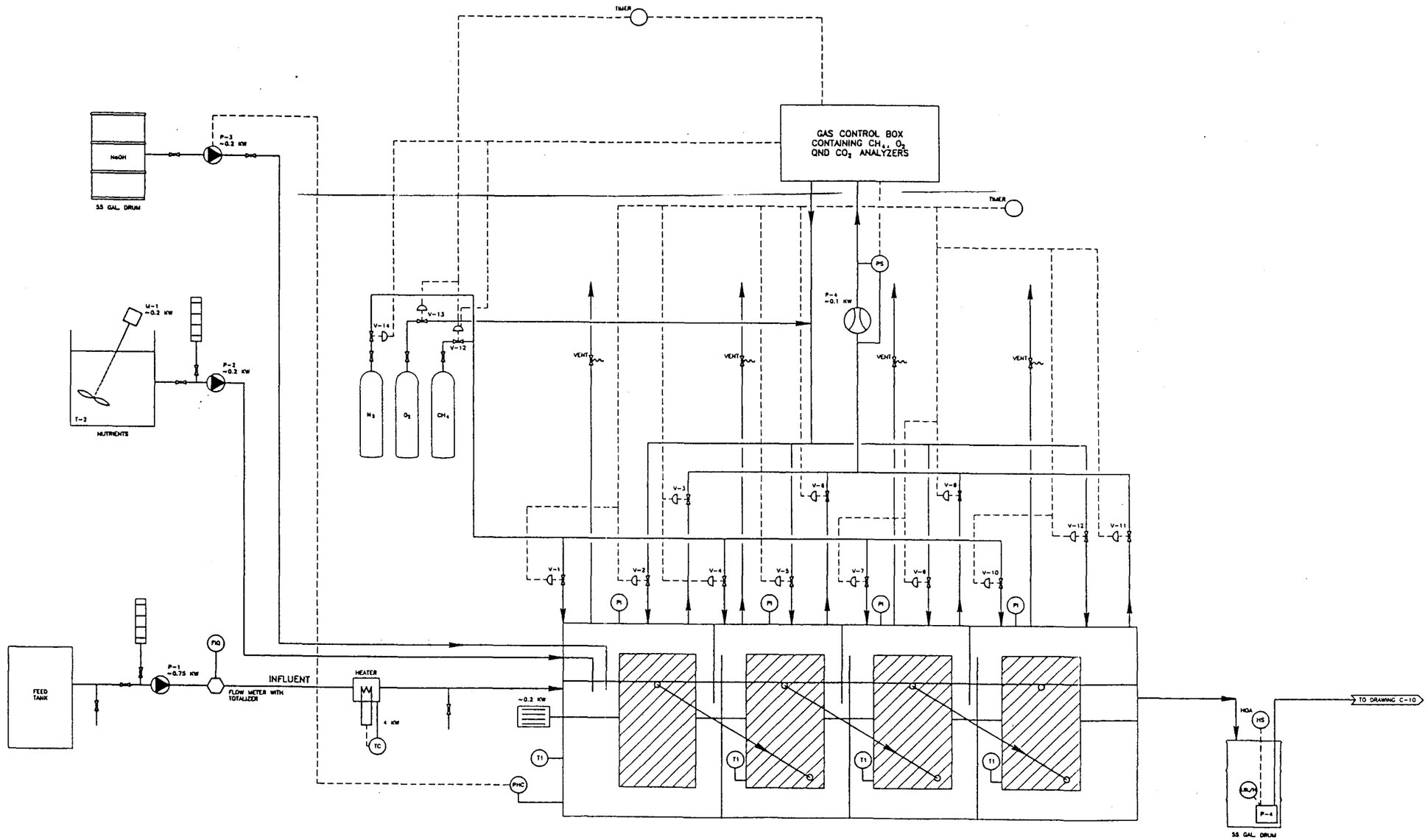


ABB ASEA BROWN BOVERI	ABB Environmental Services Inc.	DWN: DMF	DES: VAR	PROJECT NO.: 08503.02	TITLE: PIPING AND INSTRUMENTATION DIAGRAM ROTATING BIOLOGICAL CONTACTOR UNIT
		CHKD: KDS	APPD.: GMB	SHEET NO.: C-11	
		DATE: 9-24-93	REV.:		

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.

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 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.

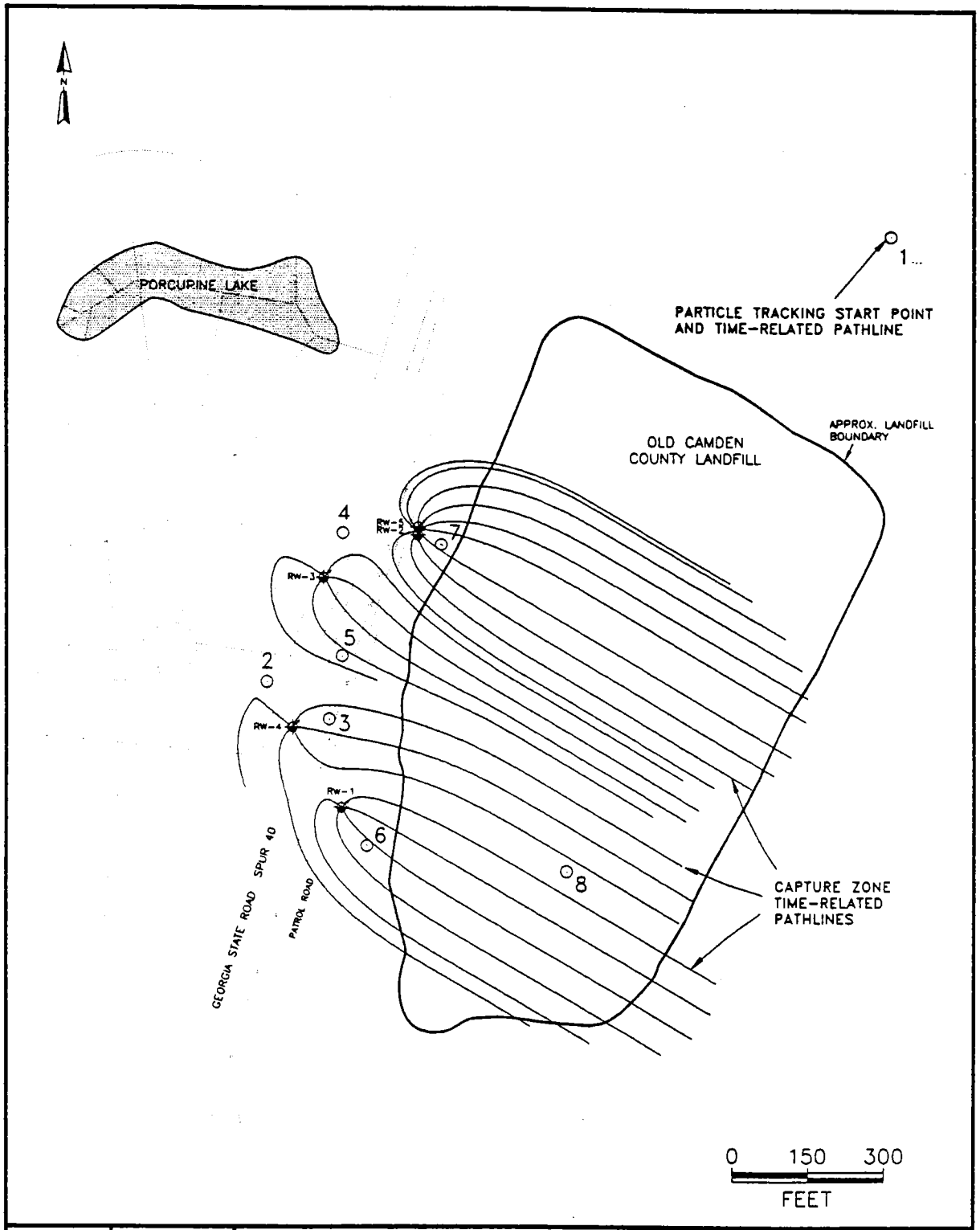
The assumptions and limitations associated with the model are:

- 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.

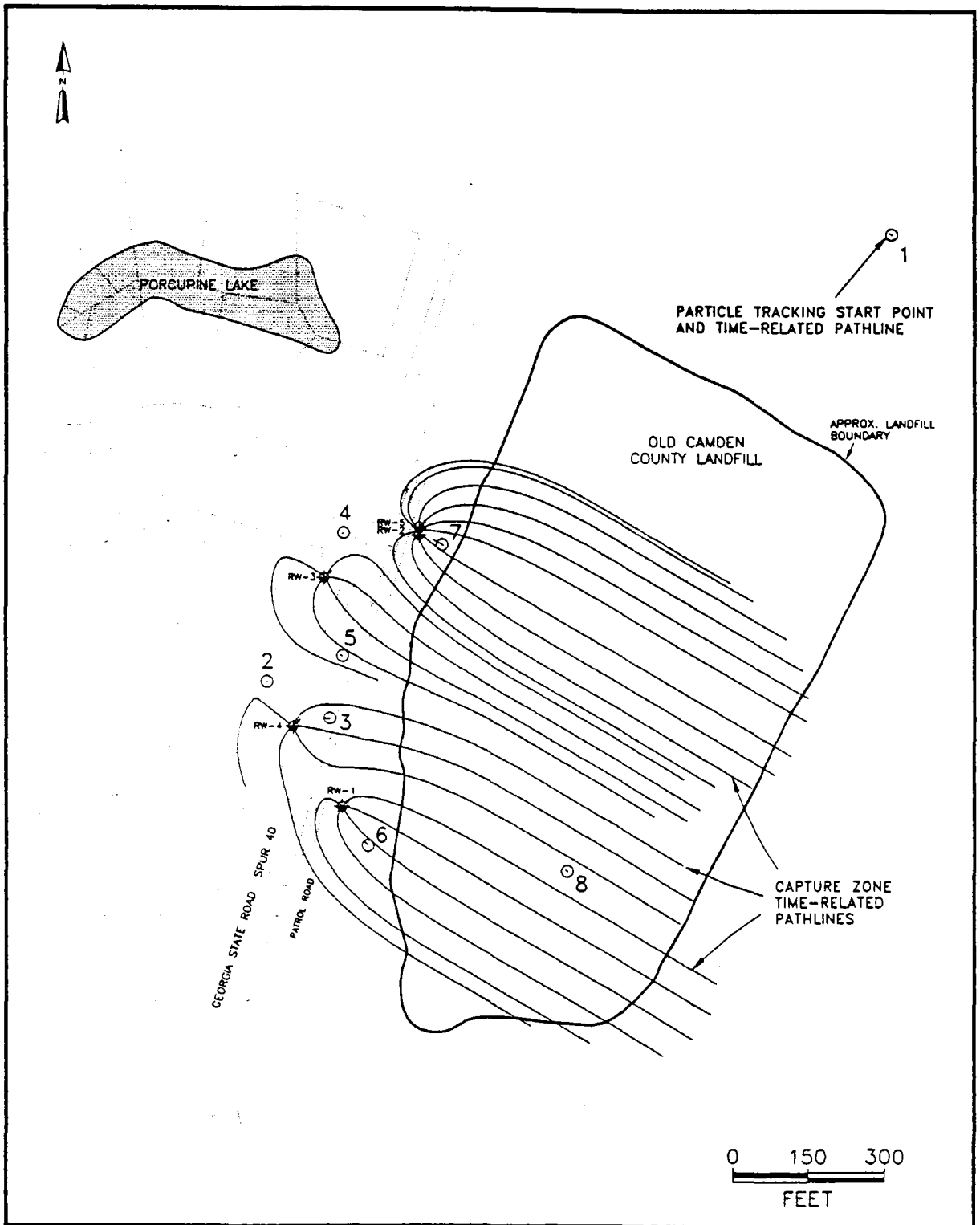
Slugs of contamination or chemical variations of the groundwater can be represented as particles transported by advective movement through the aquifer. GPTRAC models the movement of particle(s) of constituents through the recovery wells' capture zones using analytical velocity computation techniques. 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.

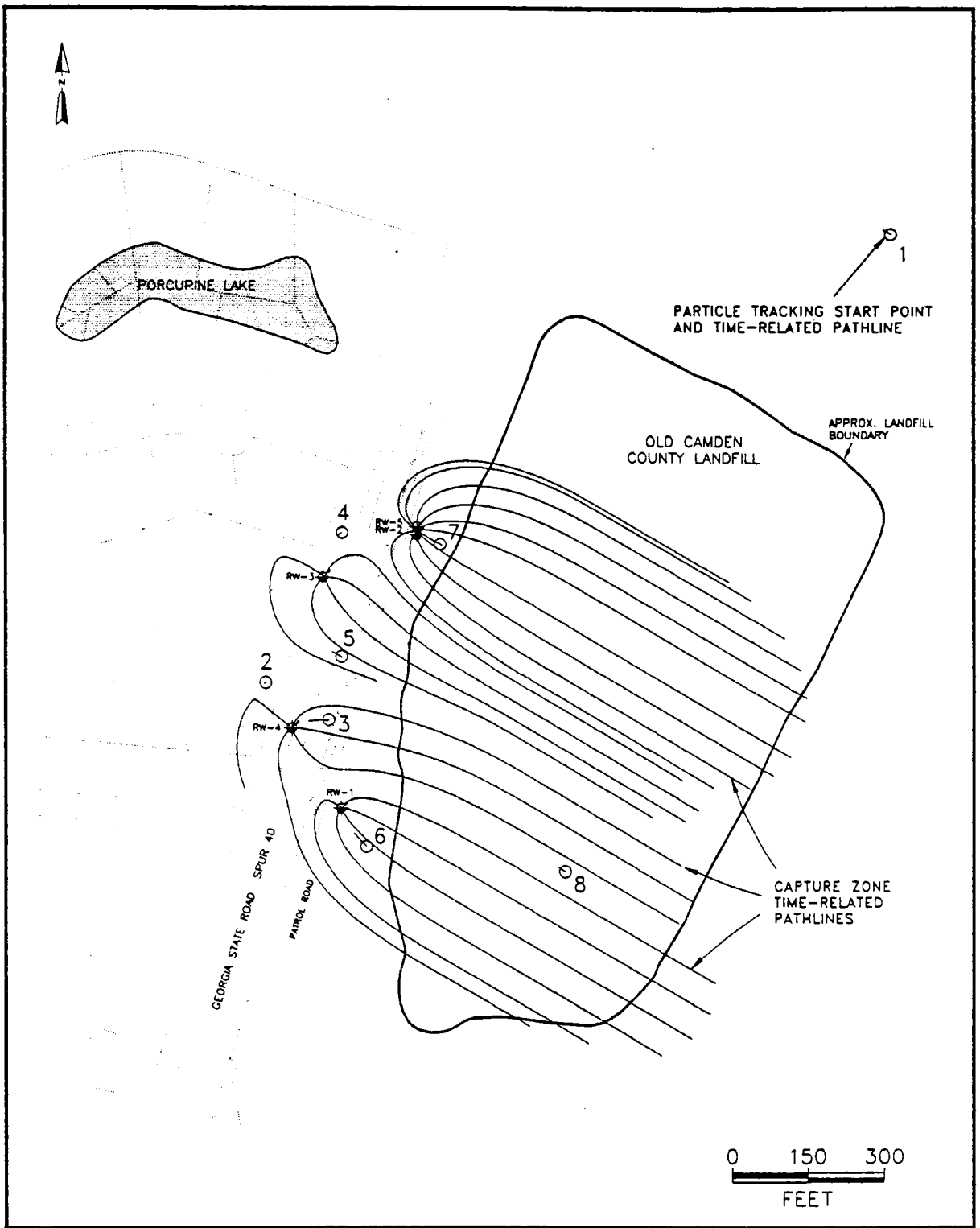
The modeling shows that due to the relatively low seepage velocity within the aquifer, current investigations of the groundwater quality will be representative of groundwater quality for the duration of the initial operations of the IM. Plume characteristics are expected to change slowly; however, the changes during the initial operations of the IM will be gradual enough for weekly monitoring to



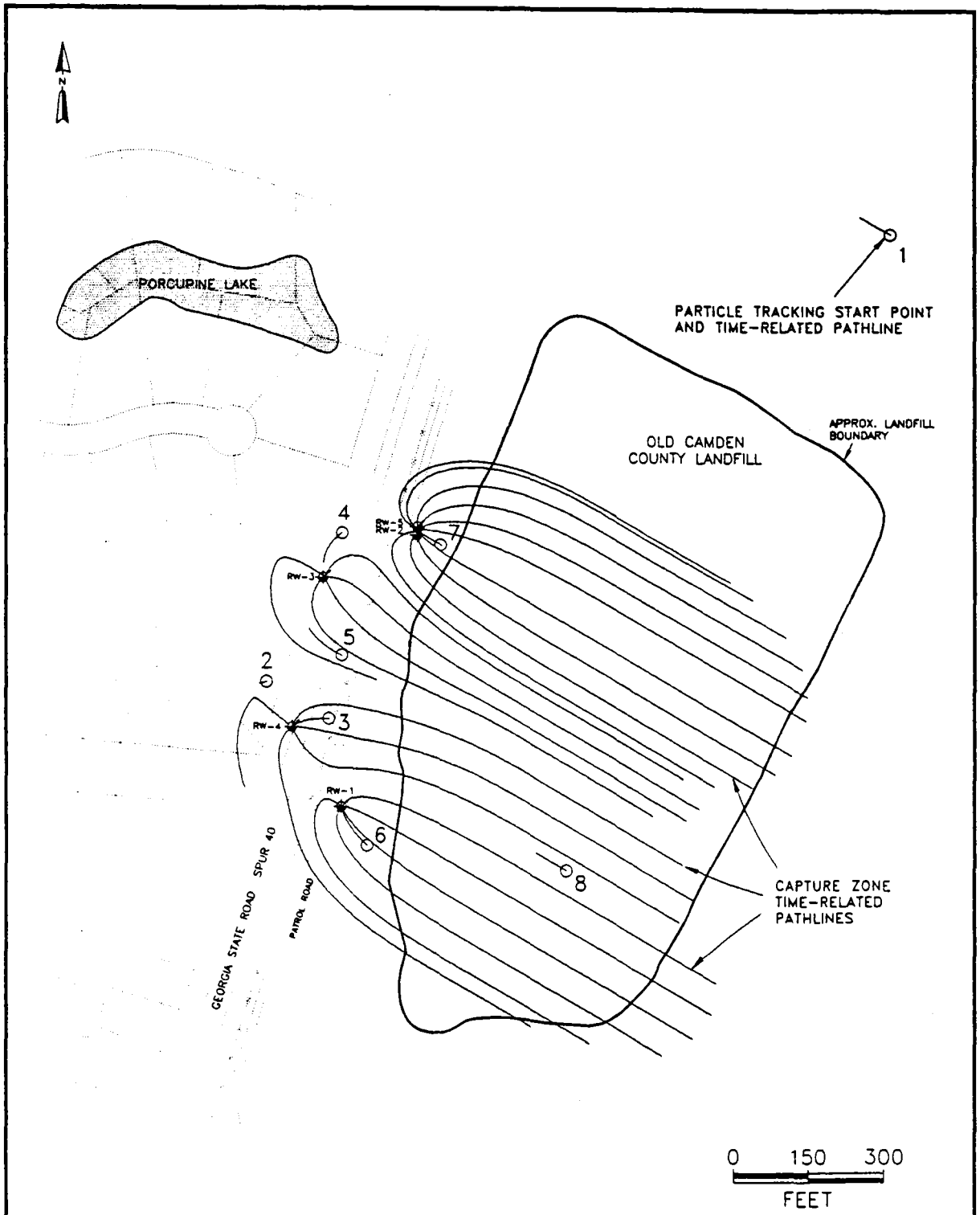
DWN: NLW	PROJECT NO.: 08503	TITLE: PARTICLE TRACKING MODEL 7 DAY SIMULATION	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: KDS	FIGURE NO.: 5-1		
DATE: 12/09/93			



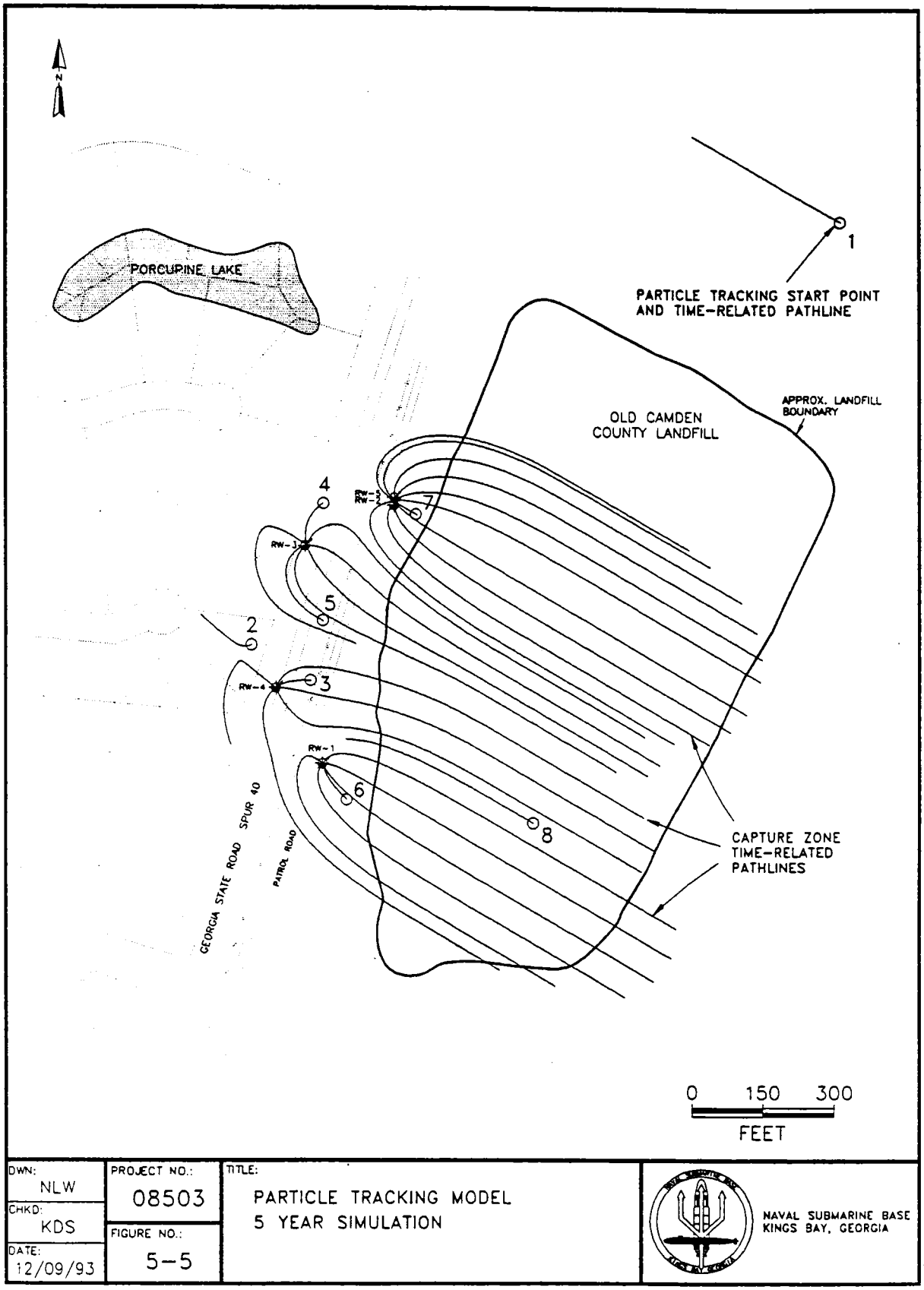
DWN: NLW	PROJECT NO. 08503	TITLE: PARTICLE TRACKING MODEL 30 DAY SIMULATION	NAVAL SUBMARINE BASE KINGS BAY, GEORGIA
CHKD: KDS	FIGURE NO.: 5-2		
DATE: 12/09/93			



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 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			

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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