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REMEDIAL ACTION PLAN FOR BUILDING 271 TANKS UL/R/SUL/D NAS CECIL FIELD FL
9/27/2002
TETRA TECH NUS INC

Remedial Action Plan
for
Building 271 Tanks UL/R/SUL/D
FDEP Facility ID No. 168507293

at

Naval Air Station Cecil Field
Jacksonville, Florida

Southern Division
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888

Contract Task Order 0248

September 2002

Rev. 0
09/27/02

REMEDIAL ACTION PLAN
FOR
BUILDING 271 TANKS UL/R/SUL/D
FDEP FACILITY ID NO. 168507293

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Tetra Tech NUS, Inc.
Foster Plaza 7
661 Andersen Drive
Pittsburgh, PA 15220-2745

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0248

SEPTEMBER 2002

PREPARED UNDER THE SUPERVISION OF:

PAUL CALLIGAN, P.G.
TASK ORDER MANAGER
TETRA TECH NUS, INC.
FLORIDA LICENSE NO. PG-0001864
TAMPA, FLORIDA

APPROVED FOR SUBMITTAL BY:

DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS, INC.
PITTSBURGH, PENNSYLVANIA

EXECUTIVE SUMMARY
of
REMEDIAL ACTION PLAN
for
NAVAL AIR STATION CECIL FIELD
BUILDING 271 TANKS UL/R/SUL/D
JACKSONVILLE, FLORIDA

Tetra Tech NUS, Inc. (TtNUS) has completed a Remedial Action Plan (RAP) at Building 271 Tanks UL/R/SUL/D in accordance with the requirements of Chapter 62-770, Florida Administrative Code (FAC). This RAP is being submitted to the Florida Department of Environmental Protection (FDEP) for approval.

TtNUS performed the following tasks during the preparation of this RAP:

- Reviewed past pilot-scale treatability studies and remedial systems for relevant technologies from sites at Naval Air Station (NAS) Cecil Field.
- Summarized the Site Assessment Report (TtNUS, May 2002).
- Evaluated remedial alternatives to address the groundwater contamination.
- Prepared a Remedial Action Plan to remediate the contaminated groundwater and provide remedial equipment specifications.
- Specified a sampling plan to track the remediation status of the site.
- Specified a system start-up and an operations and maintenance plan to operate the system.

This RAP recommends air sparging (AS) as the selected remedial alternative to clean up the site. The system was designed based on pilot studies from other sites at the Base. In accordance with conversations amongst the NAS Cecil Field partnering Team Petroleum Subcommittee, previous AS systems implemented at NAS Cecil Field exhibit acceptable feasible remediating results. If implemented in accordance with this document, it is expected to require approximately 36 months to remediate the groundwater to below groundwater cleanup target levels. During this time, operation and maintenance requirements will include maintaining the system in a proper operating mode and collection of groundwater data to verify that the system is operational.

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ACRONYMS

AAL	Accura Analytical Laboratory
bls	Below Land Surface
BTEX	Benzene, Toluene, Ethylbenzene, Total Xylenes
CCI	CH2M Hill Constructors, Inc.
CSR	Confirmatory Sampling Report
CTO	Contract Task Order
DPT	Direct Push Technology
DRO	Diesel Range Organics
EDB	1,2-dibromoethane
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FL-PRO	Florida – Petroleum Range Organics
GCTL	Groundwater Cleanup Target Level
gpd	Gallons Per Day
gpm	Gallons Per Minute
K	Hydraulic Conductivity
HLA	Harding Lawson Associates
KAG	Kerosene Analytical Group
LCAR	Limited Closure Assessment Reports
mg/L	Milligram per liter
mg/kg	Milligram per kilogram
MTBE	Methy-tert-butyl Ether
OD	Outside Diameter
OVA-FID	Organic Vapor Analyzer-Flame Ionization Detector
OWS	Oil-water Separator
NADSC	Natural Attenuation Default Source Concentration
NAS	Naval Air Station
PAH	Polycyclic Aromatic Hydrocarbon
ppm	Parts Per Million
PVC	Polyvinyl Chloride
RAC	Remedial Action Contractor
SA	Site Assessment
SAP	Site Assessment Plan
SAR	Site Assessment Report

ACRONYMS (CONTINUED)

SCTL	Soil Cleanup Target Level
Sec	Seconds
SOUTHNAVFACENGCOM	Southern Division, Naval Facilities Engineering Command
SPECAP	Specific Capacity
SRR	Source Removal Report
S_y	Specific Yield
T	Transmissivity
TRPH	Total Recoverable Petroleum Hydrocarbons
TtNUS	Tetra Tech NUS, Inc.
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compounds
μg/kg	Micrograms Per Kilogram
μg/L	Micrograms Per Liter

The professional opinions rendered in this decision document identified as Remedial Action Plan for Building 271 Tanks UL/R/SUL/D, Naval Air Station Cecil Field, Jacksonville, Florida were developed in accordance with commonly accepted procedures consistent with applicable standards of practice. Decision documents were prepared under the supervision of the signing engineer and are based on information obtained from others. If conditions are determined to exist differently than those described in this document, then the undersigned professional engineer should be notified to evaluate the effects of any additional information on the project described in this document.

Steven L Brashers

09-18-2002

Steven L. Brashers, P.E.
Professional Engineering Number FL 47151
Tetra Tech NUS, Inc. Engineering Number 7988

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

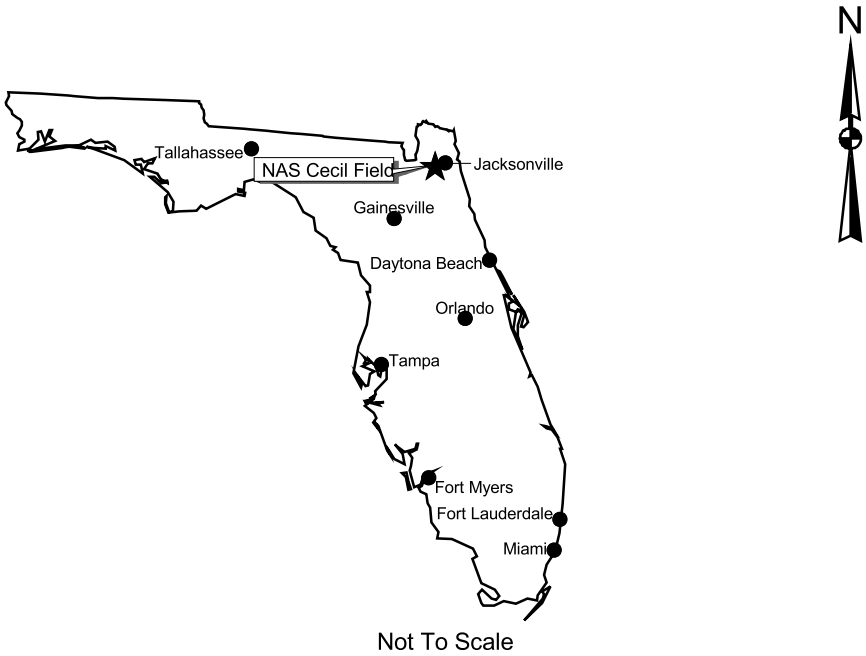
This Remedial Action Plan (RAP) was prepared by Tetra Tech NUS (TtNUS) for the U.S. Navy (Navy) Southern Division Naval Facilities Engineering Command (SOUTHDIV) under Contract Task Order 0248, for the Comprehensive Long-term Environmental Action Navy (CLEAN III), Contract Number N62467-94-D-0888. The RAP was prepared to recommend treatment options for the contaminated groundwater at Building 271 on Naval Air Station (NAS) Cecil Field in Jacksonville, Florida (FDEP Facility ID No. 168507293). Figure 1-1 indicates the location of Cecil Field on a portion of a United States Geologic Survey Map. Figure 1-2 shows the location of Building 271 within the confines of Cecil Field.

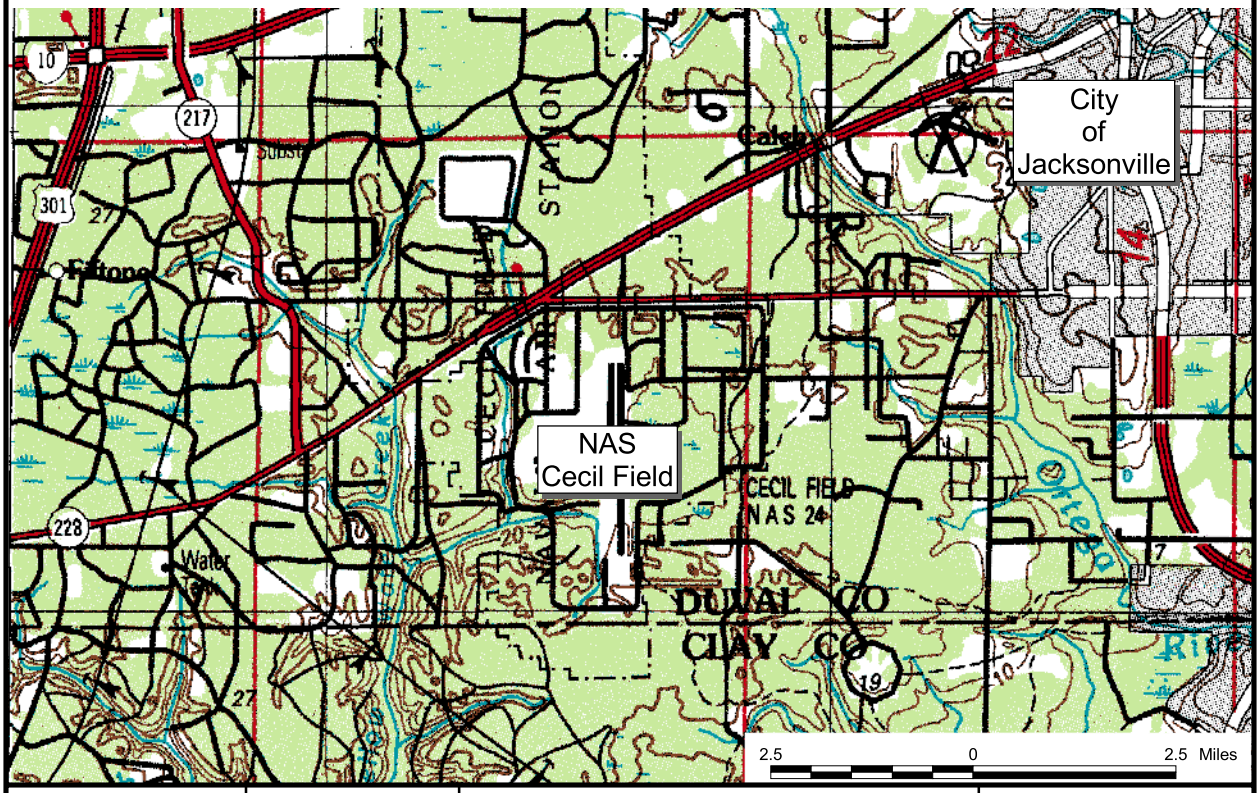
Building 271 was previously investigated under the Installation Restoration (IR) Program. More specifically, the areas investigated included Underground Storage Tanks (USTs) 271 UL (unleaded gasoline), 271 R (regular gasoline), 271 SUL (super unleaded gasoline), and 271 D (diesel).

The purpose of this RAP is to propose a remedial alternative that would serve to remediate the impacted groundwater in accordance with the requirements of Chapter 62-770 of the Florida Administrative Code (FAC). This RAP will address impacted groundwater for the area of concern by evaluating applicable alternatives that protect human health and the environment, reduce hydrocarbon constituent concentrations within impacted groundwater, and retard further migration of hydrocarbon constituents. The RAP will also provide a design for the selected remedial alternative that will offer the best assurance of remediating the site in a cost-effective and timely manner.

1.2 SITE DESCRIPTION

As shown on Figure 1-3, several buildings surround Building 271. There are three dormitories to the north of the site that are currently not in use. These are not shown on the figure, but they are adjacent to parking lot shown north of Building 271. Building 201 to the northwest is currently being used by TtNUS to store drummed investigative wastes from various sites until





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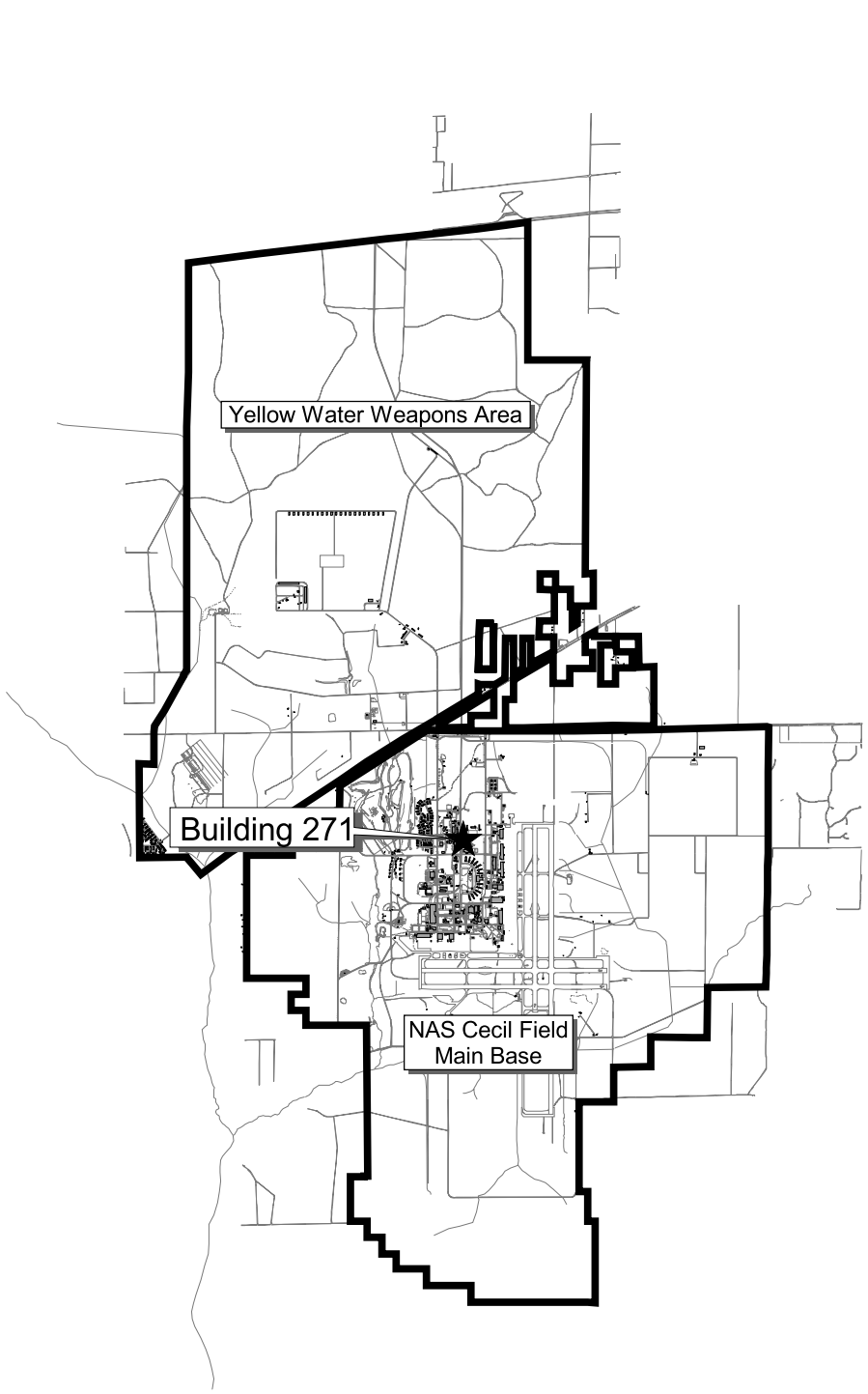

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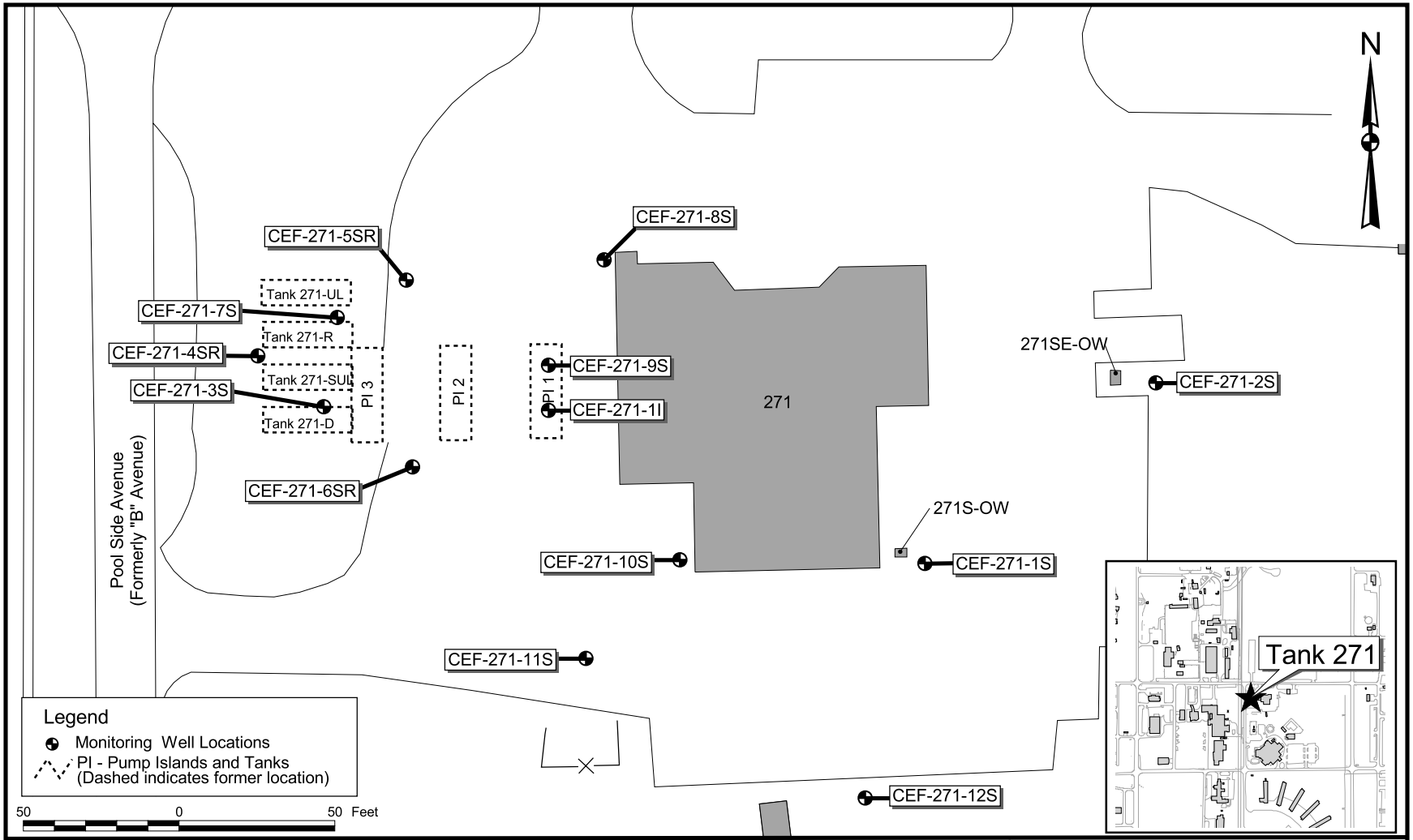

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SCALE: AS NOTED			DRAWING NO.: FIGURE 1-3 / REV: 0

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characterized for disposal. Building 81, further west of Building 201, is not in use. Building 907 is the local Jacksonville Economic Development Commission (JEDC) office. Building 906 is now a local branch of the Jacksonville Navy Federal Credit Union. Facility 356 is being temporarily used by the Jacksonville Electric Authority (Roberts, 2002). Building 905 is partially occupied, but it will be demolished in November 2002 (Roberts, 2002). The JEDC plans to retain Building 498 as a gymnasium (Roberts, 2002). Buildings 220, 280, and 282 are not in use, and the JEDC plans to have them demolished (Roberts, 2002). The water tower (Facility 16D, south of Building 271) is still in use.

1.3 SITE HISTORY

Building 271 is a former retail gasoline facility that maintained four USTs and two oil-water separators (OWSs). The USTs were grouped in a tank pit located on the west side of Building 271, while the OWSs were located on the east side of the building. Three of the USTs (UL, R and SUL) each had an approximate capacity of 10,000 gallons. The fourth UST (D) had an approximate capacity of 6,000 gallons. The locations of the USTs and OWSs, (known as 271-SE-OW and 271-S-OW) at the site are shown in Figure 1-3.

According to UST closure records, Tank 271-D was removed on March 5, 1996. The closure report indicates that no soil or groundwater contamination was detected relative to Tank 271 D. The report also indicates that the tank and associated piping were removed from the site.

In July 1999, Harding and Lawson Associates (HLA) compiled the Confirmatory Sampling Report (CSR) for the tank site and the two OWSs. The CSR indicated that petroleum-impacted soil was encountered at two locations relative to the tank site. The CSR also reported that no Kerosene Analytical Group (KAG), as defined by Chapter 62-770, FAC, constituents were detected in the groundwater sample from the monitoring well CEF-271-3S (Figure 1-3) installed for the tank investigation. HLA reported no soil or groundwater contamination relative to the OWSs. Based on their finding of soil contamination, a Site Assessment (SA) was recommended for the UST site. A Site Assessment Plan (SAP) for the assessment of soil and groundwater at the UST site was prepared by TtNUS (2000) under Contract Task Order (CTO) 0121.

Following completion of the planned investigation in the SAP, the Remedial Action Contractor (RAC) removed the remaining three USTs and associated piping and distribution systems. The RAC's work on site addressed the soil contamination issues and indicated the existence of groundwater contamination. TtNUS proceeded to plan and execute a second investigation in a SAP Addendum (2001) to address the remaining site contamination in the groundwater.

The RAC also removed both OWSs, and submitted separate Limited Closure Assessment Reports (LCAR) for each OWS site in April 2001 to the Florida Department of Environmental Protection (FDEP). Both LCARs for the OWSs indicated that no petroleum contamination of the soil or groundwater existed relative to the OWSs. On May 23, 2001, the FDEP issued separate letters agreeing with the RAC's findings.

1.4 REPORT ORGANIZATION

This report is organized into eight (8) sections. Below is a list of the sections and a brief description of their purpose:

Section 1	Introduction	Supplies the report's purpose, scope, site information, and report organization.
Section 2	Site Assessment Report Findings and Conclusions	Reviews the approved SAR, and summarizes the SAR's findings and conclusions.
Section 3	Remedial Action Plan Goals	Sets the groundwater treatment objectives for the remedial system / plan.
Section 4	Contaminant Distribution	Estimates the mass of contaminants in the soil and groundwater.
Section 5	Remedial Alternative Technology Screening	Presents the alternatives for remediation, determines the suitability for the site, and develops budgetary costs for each.
Section 6	Remedial System Design	Presents all of the assumptions made and provides the detailed design of the preferred remedial alternative.
Section 7	Operation & Maintenance and Monitoring	Establishes start-up and O&M procedures and provides a monitoring plan for the remediation system and sampling frequencies to evaluate the system's effectiveness.
Section 8	References	Lists all references used.

2.0 SITE ASSESSMENT REPORT FINDINGS AND CONCLUSIONS

Since March 1996, various environmental investigations have been conducted at Building 271. Tank D was removed in 1996, and the remaining three tanks, UL, R, and SUL were removed in 1999. Phase 1 of the SA occurred prior to the removal of the three tanks and indicated soil contamination. Phase 2 conducted soil and groundwater sampling after the removal of the three tanks and additional contaminated soil. Phase 3 addressed groundwater contamination. The following is a summary of the SAR submitted to the FDEP in May 2002.

2.1 FIELD ACTIVITIES

A work plan that described the investigation was developed and presented to the FDEP for concurrence prior to starting field activities. The investigation consisted of direct push technology (DPT) groundwater sampling, permanent monitoring well installation and sampling, and synoptic groundwater level measurements. These activities were conducted in general accordance with the applicable guidance in FAC 62-770 and the TtNUS standard operating procedures and quality assurance protocols.

2.2 GROUNDWATER FLOW DIRECTION

The depth to groundwater ranged from approximately 4 to 6.5 feet below land surface (bls). The groundwater flow direction is generally to the southeast. Table 2-1 presents the monitoring well construction data and groundwater elevations from October 31, 2001. Figure 2-1 presents the groundwater potentiometric surface map from October 2001.

2.3 CONTAMINATED SOIL ASSESSMENT

Phase 1

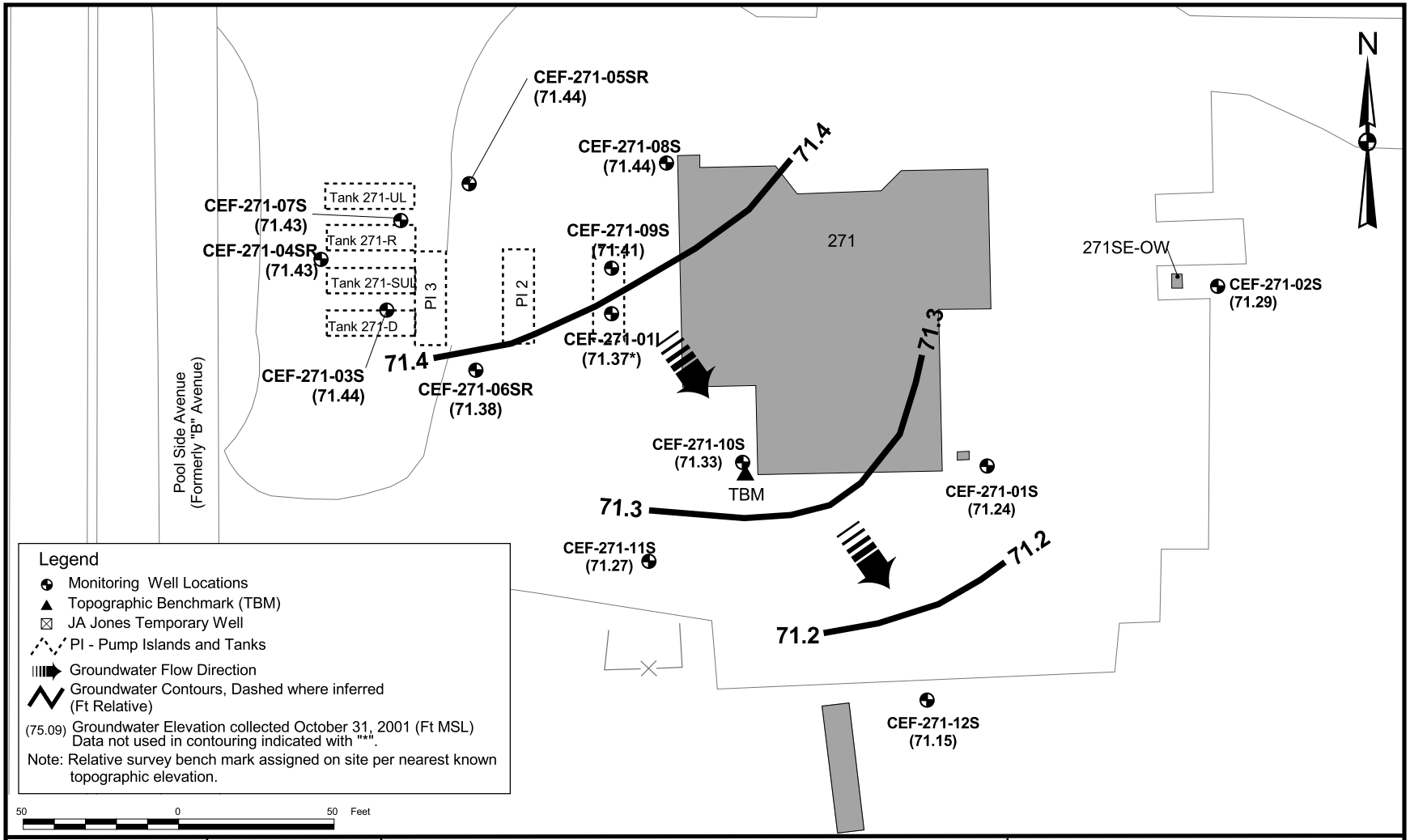
In June 2000, eight confirmatory soil borings (CEF-B271-SB-001 through CEF-B271-SB-008) were advanced to the water table to delineate soils around HLA's soil borings CEF-271-SB-1 and CEF-271-SB-2 where soil contamination was found. The water table was encountered at approximately 5 feet bls. The soil lithology encountered in these borings and during well installation was predominantly fine silty sand. Of the eight sample locations, the screened samples from soil boring CEF-B271-SB-003 exceeded FDEP's diesel range action level of

Table 2-1
Monitoring Well Construction and Water Elevation Data

Site Assessment Report
Building 271, Tanks 271 UL/R/SUL/D
Naval Air Station Cecil Field
Jacksonville, Florida

Monitoring Well Identification	Well Depth (feet, btoc)	Top-of-Casing Elevation (feet, msl)	October 25, 2000		May 7, 2001		October 31, 2001	
			Depth to Water (feet, btoc)	Water-Level Elevation (feet, msl)	Depth to Water (feet, btoc)	Water-Level Elevation (feet, msl)	Depth to Water (feet, btoc)	Water-Level Elevation (feet, msl)
CEF-271-1S	16.80	77.65	5.98	71.67	8.91	68.74	6.41	71.24
CEF-271-2S	16.50	76.93	5.21	71.72	8.20	68.73	5.64	71.29
CEF-271-3S	12.85	76.37	4.48	71.89	7.45	68.92	4.93	71.44
CEF-271-4SR	14.95	75.72	4.81	70.91	6.73	68.99	4.29	71.43
CEF-271-5SR	14.66	76.41	4.50	71.91	7.44	68.97	4.97	71.44
CEF-271-6S	15.85	77.07	5.24	71.83	8.15	68.92	5.69	71.38
CEF-271-7S	13.65	76.54	NM	NM	NM	NM	5.11	71.43
CEF-271-8S	13.05	77.39	NM	NM	NM	NM	5.95	71.44
CEF-271-9S	13.00	77.09	NM	NM	NM	NM	5.68	71.41
CEF-271-10S	13.15	77.76	NM	NM	NM	NM	6.43	71.33
CEF-271-11S	13.30	76.87	NM	NM	NM	NM	5.60	71.27
CEF-271-12S	13.40	76.75	NM	NM	NM	NM	5.60	71.15
CEF-271-1I	38.00	77.14	NM	NM	NM	NM	5.77	71.37

Notes:
msl = mean sea level
btoc = below top of casing
NM = not measured
TOC Elevations measured during a relative survey based on an assumed benchmark of 78.00 feet msl.
The benchmark elevation (shown on Figure 2-1) was interpolated from the nearest contour on the USGS 7.5 minute Topographic Quandrangle Map, Fiftone, Florida.



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GROUNDWATER FLOW MAP, 10/31/01
BUILDING 271, TANKS 271 UL/R/SUL/D
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NUMBER	
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50 parts per million (ppm) for excessively contaminated soil. The soil boring locations are shown on Figure 2-2.

During the months of August and September 2000, the RAC conducted a source removal of the remaining gasoline USTs, three dispensers, the associated piping, and a total of 511.54 tons of petroleum-impacted soil. This field effort was documented in the Source Removal Report (SRR) [CH2M Hill Constructors (CCI), 2001]. The soil removal included the contaminated soil previously identified by HLA and TtNUS at soil borings CEF-271-SB-2 and CEF-B271-SB-003, respectively. The SRR indicated that the soil excavation continued in the UST area and pump island areas until OVA-FID readings less than 10 ppm were encountered, and vertically to a maximum depth of 10.5 feet to extricate the USTs. The RAC also collected confirmatory soil samples from the walls of the excavation. The results for those confirmatory samples were reported below applicable SCTLs (CCI, 2001).

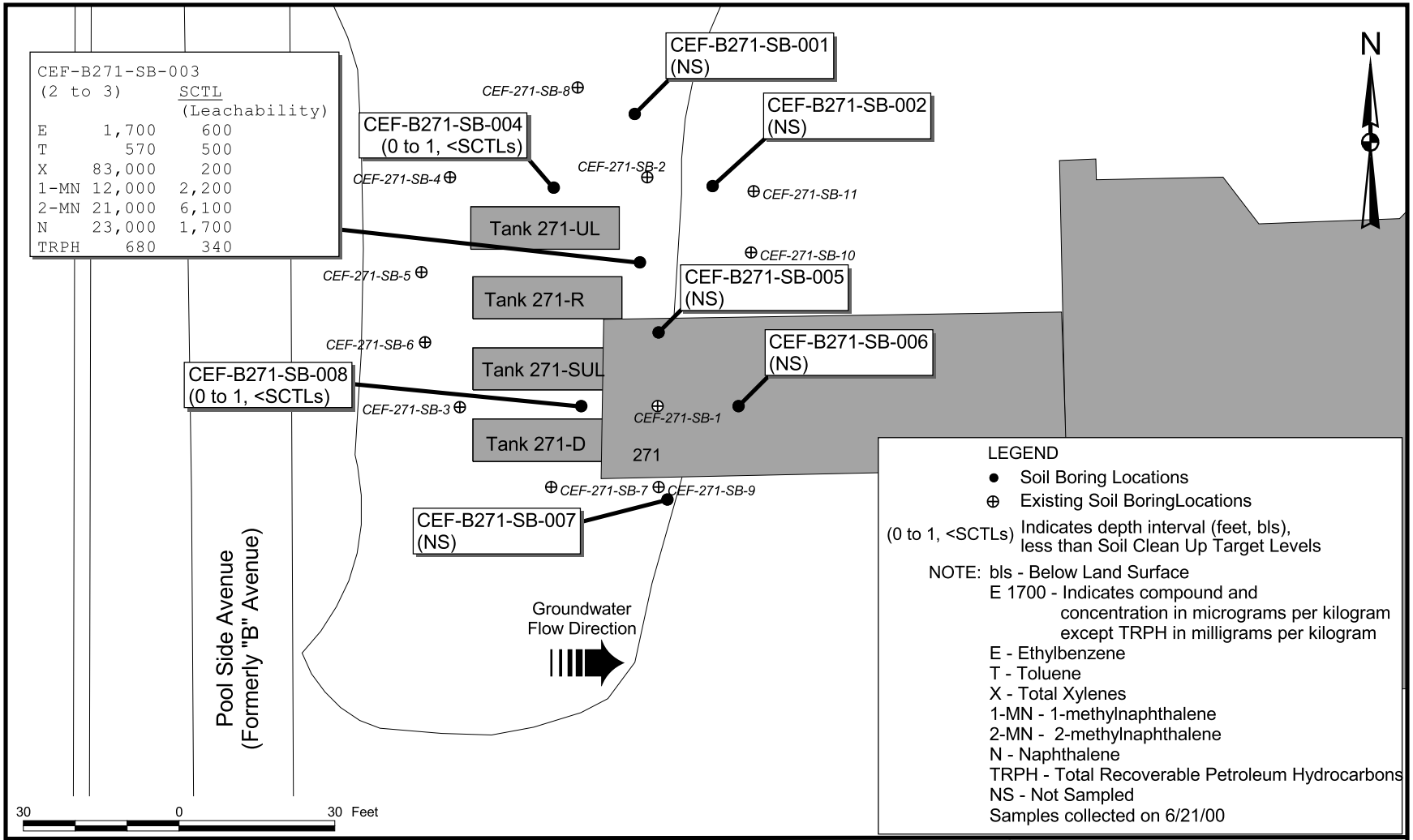
Phase 2

On May 7 and 8, 2001, a DPT investigation of the vadose zone soils at Building 271 was conducted. The soil collection points were outside the RAC's excavation area. The soils encountered during this phase consisted of fine silty sands to a depth of about 4.5 feet bls followed by a discontinuous fine clayey sand to about 8 feet bls. The water table was encountered at about 7 to 7.5 feet bls in these borings. Initial screening was accomplished using standard head-space vapor analysis. None of the vapor measurements exceeded the 50 ppm action level for OVA-FID screening. In addition, seven soil samples were collected and screened by the mobile laboratory for BTEX, MTBE, naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, and DRO. Results of the mobile laboratory analyses indicate that none of the compounds that were detected exceeded the FDEP SCTLs. This completed the soil investigation for the site and supported the RAC's conclusion that the contaminated soil at the site had been removed, and no further action is warranted at the site with regard to soils (CCI, 2001).

2.4 CONTAMINATED GROUNDWATER ASSESSMENT

Phase 1

On July 17, 2000, TtNUS personnel collected groundwater samples from three monitoring wells, CEF-271-4S, CEF-271-5S, and CEF-271-6S, which were analyzed for KAG compounds. The analytical results for the groundwater samples indicated that none of the Groundwater Cleanup Target Levels (GCTLs) for the KAG compounds were exceeded, and only two compounds (total xylenes and TRPH) were detected.



DRAWN BY MJJ	DATE 15Sept00	PHASE 1 SOIL ANALYTICAL DATA BUILDING 271, TANKS 271 UL/R/SUL/D NAVAL AIR STATION CECIL FIELD JACKSONVILLE, FLORIDA	CONTRACT NUMBER 121
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During the UST removal in August and September 2002, the RAC had to remove two of the permanent monitoring wells, CEF-271-4S and CEF-271-5S. The wells were properly abandoned and replaced as documented by CCI (2001). The replacement wells, CEF-271-4SR and CEF-271-5SR were installed in approximately the same location and to the same specifications as the original wells.

On October 25, 2000, water levels were collected from wells CEF-271-1S through CEF-271-6S. This data, shown on Table 2-1, was used to calculate groundwater elevations and estimate groundwater flow direction. The data indicated that groundwater flow was to the southeast.

Phase 2

Groundwater levels were measured on May 7, 2001 at wells CEF-271-1S through CEF-271-6S. Average depth-to-water in the wells was about 7.5 feet. Groundwater elevation measurements were calculated from the field data (Table 2-1) and indicated that groundwater flow continues to be toward the southeast.

Based on southeasterly groundwater flow, TtNUS personnel collected 17 DPT groundwater samples in that general direction to evaluate the extent of petroleum impacted groundwater and aid in the placement of permanent monitoring wells. The samples were screened for BTEX, MTBE, naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, and DRO. Seven of the groundwater samples (CEF-271-DP-GW-A1, CEF-271-DP-GW-A2, CEF-271-DP-GW-A3, CEF-271-DP-GW-A6, CEF-271-DP-GW-A7, CEF-271-DP-GW-A8 and CEF-271-DP-GW-14) exceeded the FDEP GCTLs. The vertical depth sample, CEF-271-DP-GW-A4, was reported with minor detections of VOCs and PAHs, but none of them exceeded a GCTL.

Phase 3

On August 20 and 21, 2001, TtNUS supervised the installation of new wells CEF-271-7S through CEF-271-12S and CEF-271-1I. The lithology encountered in the borings consisted of very fine to medium sands to a depth of about 37 feet bls. Occasionally, a sand with some clay was encountered at approximately 3 to 5 feet bls. The soil lithology, encountered in Phases 1 through 3, is predominantly sand with no confining units between the land surface and 37 feet bls. Due to the uniform lithology encountered at the site, a geologic cross section was not prepared for this site. The General Information Report (ABB Environmental Services, 1998) contains a generalized stratigraphic column and descriptions of the geology and hydrogeology for NAS Cecil Field.

During August 23 and 24, 2001, TtNUS personnel collected groundwater samples from existing wells CEF-271-1S, CEF-271-3S, CEF-271-4SR, CEF-271-5SR, and CEF-271-6S; and from new wells CEF-271-7S through CEF-271-12S and CEF-271-1I. The groundwater samples were analyzed for KAG compounds. BTEX, naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, and MTBE were detected at concentrations greater than GCTLs. Monitoring wells with groundwater concentrations in excess of one or more GCTLs included CEF-271-GW-7S, CEF-271-GW-9S, and CEF-271-GW-10S. The groundwater sample collected from monitoring well CEF-271-7S exceeded the NADSC for several VOCs and naphthalene, and the sample from well CEF-271-9S exceeded the NADSC for total xylenes. A summary of positive detections in those samples is provided in Table 2-2. An estimated outline of the benzene plume in groundwater is presented in Figure 2-3.

On October 31, 2001, groundwater levels were measured at wells CEF-271-1S through CEF-271-12S and CEF-271-1I. Average depth to water on site at this time was about 5.5 feet bls. Groundwater elevation measurements were calculated from the field data (Table 2-1) and plotted on Figure 2-3. The figure indicates that groundwater flow for the water table zone of the shallow aquifer continues to be toward the southeast.

2.5 SITE ASSESSMENT REPORT CONCLUSIONS

The SAR concluded that petroleum constituents have impacted groundwater and that all of the contaminated soil was removed from the vicinity of the former USTs at the site. Benzene, ethylbenzene, toluene, xylenes, naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, and MTBE were detected above target levels in the groundwater. In accordance with Chapter 62-770 FAC, TtNUS recommended the preparation and implementation of a RAP to remediate groundwater at the site.

Table 2-2
Summary of Positive Detections in Groundwater

Remedial Action Plan
Building 271, Tanks 271 UL/R/SUL/D
Naval Air Station Cecil Field
Jacksonville, Florida

Well ID	GCTLs	CEF-271-1I	CEF-271-1S	CEF-271-3S	CEF-271-4S	CEF-271-4SR	CEF-271-5S	NADSC
Sample Date		8/24/2001	8/23/2001	8/23/2001	7/17/2000	8/23/2001	7/17/2000	
Well Depth in Feet		38	16.8	12.85	15.55	14.95	15.55	
Volatile Organic Compounds (USEPA Method 8260B)(µg/L)								
Benzene	1	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	100
Chloromethane	2.7	1.0 U	0.51 J	1.0 U	1.0 U	1.0 U	1.0 U	270
Ethylbenzene	30	0.77 J	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	300
MTBE	50	10 U	5.0 U	5.0 U	10 U	5.0 U	10 U	500
Toluene	40	3.1	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	400
Xylenes, Total	20	5.5	2.0 U	2.0 U	0.50J	2.0 U	5.7	200
EDB (USEPA Method 504.1)								
EDB	0.02	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	2
Polynuclear Aromatic Hydrocarbons (USEPA Method 8270C)(µg/L)								
1-Methylnaphthalene	20	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	200
2-Methylnaphthalene	20	0.25 J	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	200
Acenaphthene	20	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	200
Anthracene	2100	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	21000
Benzo (a) anthracene	4.8	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	20
Fluoranthene	280	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	2800
Fluorene	280	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	2800
Naphthalene	20	0.71 J	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	200
Phenanthrene	210	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	2100
Pyrene	210	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	2100
Metal (USEPA Method 6010B) (mg/L)								
Total Lead	.015	0.01 U	0.05 U	0.05 U	0.01 U	0.05 U	0.01 U	0.15
FLORIDA-PRO (mg/L)								
TPH (C8-C40)	5	1.0 U *	1.0 U *	1.0 U *	0.14JB	1.0 U *	5.7	50

See notes at end of table.

Table 2-2 (Continued)
Summary of Positive Detections in Groundwater

Remedial Action Plan
Building 271, Tanks 271 UL/R/SUL/D
Naval Air Station Cecil Field
Jacksonville, Florida

Well ID	GCTLs	CEF-271-5SR	CEF-271-6S	CEF-271-6S	CEF-271-7S	CEF-271-8S	CEF-271-9S	NADSC
Sample Date		8/23/2001	7/17/2000	8/23/2001	8/24/2001	8/24/2001	8/24/2001	
Well Depth in Feet		14.66	15.85	15.85	13.65	13.05	13	
Volatile Organic Compounds (USEPA Method 8260B)(µg/L)								
Benzene	1	1.0 U	1.0 U	1.0 U	**89**	1.0 U	**9.8**	100
Chloromethane	2.7	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	270
Ethylbenzene	30	1.0 U	1.0 U	1.0 U	**520**	1.0 U	**36**	300
MTBE	50	5.0 U	10 U	5.0 U	**11**	10 U	10 U	500
Toluene	40	1.0 U	1.0 U	1.0 U	**2900**	1.0 U	**270**	400
Xylenes, Total	20	2.0 U	5.5	2.0 U	**3300**	2.0 U	**1600**	200
EDB (USEPA Method 504.1)								
EDB	0.02	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	2
Polynuclear Aromatic Hydrocarbons (USEPA Method 8270C)(µg/L)								
1-Methylnaphthalene	20	1.0 U	1.0 U	1.0 U	**35**	1.0 U	8.2	200
2-Methylnaphthalene	20	1.0 U	1.0 U	1.0 U	**55**	1.0 U	7.3	200
Acenaphthene	20	1.0 U	1.0 U	1.0 U	4.5	1.0 U	1.0 U	200
Anthracene	2100	1.0 U	1.0 U	1.0 U	1.0	1.0 U	1.0 U	21000
Benzo (a) anthracene	4.8	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	20
Fluoranthene	280	1.0 U	1.0 U	1.0 U	1.8	1.0 U	1.0 U	2800
Fluorene	280	1.0 U	1.0 U	1.0 U	4.1	1.0 U	0.43 J	2800
Naphthalene	20	1.0 U	1.0 U	1.0 U	**230**	1.0 U	7.4	200
Phenanthrene	210	1.0 U	1.0 U	1.0 U	7.0	1.0 U	1.0 U	2100
Pyrene	210	1.0 U	1.0 U	1.0 U	1.2	1.0 U	1.0 U	2100
Metal (USEPA Method 6010B) (mg/L)								
Total Lead	.015	0.05 U	0.01 U	0.05 U	0.01 U	0.01 U	0.01 U	0.15
FLORIDA-PRO (mg/L)								
TPH (C8-C40)	5	1.0 U *	5.5	1.0 U *	4.1 *	1.0 U *	1.6 *	50

See notes at end of table.

Table 2-2 (Continued)
Summary of Positive Detections in Groundwater

Remedial Action Plan
Building 271, Tanks 271 UL/R/SUL/D
Naval Air Station Cecil Field
Jacksonville, Florida

Well ID	GCTLs	CEF-271-10S	CEF-271-11S	CEF-271-12S	NADSC
Sample Date		8/24/2001	8/24/2001	8/23/2001	
Well Depth in Feet		13.15	13.3	13.4	
Volatile Organic Compounds (USEPA Method 8260B)(µg/L)					
Benzene	1	**1.8**	1.0 U	0.44 J	100
Chloromethane	2.7	1.0 U	1.0 U	0.53 J	270
Ethylbenzene	30	1.2	1.0 U	1.0 U	300
MTBE	50	10 U	10 U	10 U	500
Toluene	40	6.2	1.0 U	0.35 J	400
Xylenes, Total	20	8.0	2.0 U	2.0 U	200
EDB (USEPA Method 504.1)					
EDB	0.02	0.05 U	0.05 U	0.05 U	2
Polynuclear Aromatic Hydrocarbons (USEPA Method 8270C)(µg/L)					
1-Methylnaphthalene	20	1.0 U	1.0 U	1.0 U	200
2-Methylnaphthalene	20	1.0 U	1.0 U	1.0 U	200
Acenaphthene	20	1.0 U	1.0 U	1.0 U	200
Anthracene	2100	1.0 U	1.0 U	1.0 U	21000
Benzo (a) anthracene	4.8	1.0 U	1.0 U	1.0 U	20
Fluoranthene	280	1.0 U	1.0 U	1.0 U	2800
Fluorene	280	1.0 U	1.0 U	1.0 U	2800
Naphthalene	20	0.47 J	1.0 U	1.0 U	200
Phenanthrene	210	1.0 U	1.0 U	1.0 U	2100
Pyrene	210	1.0 U	1.0 U	1.0 U	2100
Metal (USEPA Method 6010B) (mg/L)					
Total Lead	.015	0.01 U	0.01 U	0.05 U	0.15
FLORIDA-PRO (mg/L)					
TPH (C8-C40)	5	1.0 U *	1.0 U *	1.0 U *	50

See notes at end of table.

Table 2-2 (Continued)
Summary of Positive Detections in Groundwater

Remedial Action Plan
Building 271, Tanks 271 UL/R/SUL/D
Naval Air Station Cecil Field
Jacksonville, Florida

NOTES:
EDB = 1,2 Dibromoethane
GCTLs = Groundwater Cleanup Target Levels
MTBE = Methyl-Tert-Butyl Ether
NADSC = Natural Attenuation Default Source Concentrations
PRO = Petroleum Range Organics
TPH = Total Petroleum Hydrocarbons
USEPA = United States Environmental Protection Agency
µg/L = micrograms per liter
mg/L = milligrams per liter
U = Indicates the constituent was not detected in excess of its method detection limit (represented by the value).
B = Indicates compounds present in method blank.
J = Estimated.
* = Estimated value due to elapsed holding time.
Bold denotes levels equaling or exceeding Floridal Department of Environmental Protection GCTLs.

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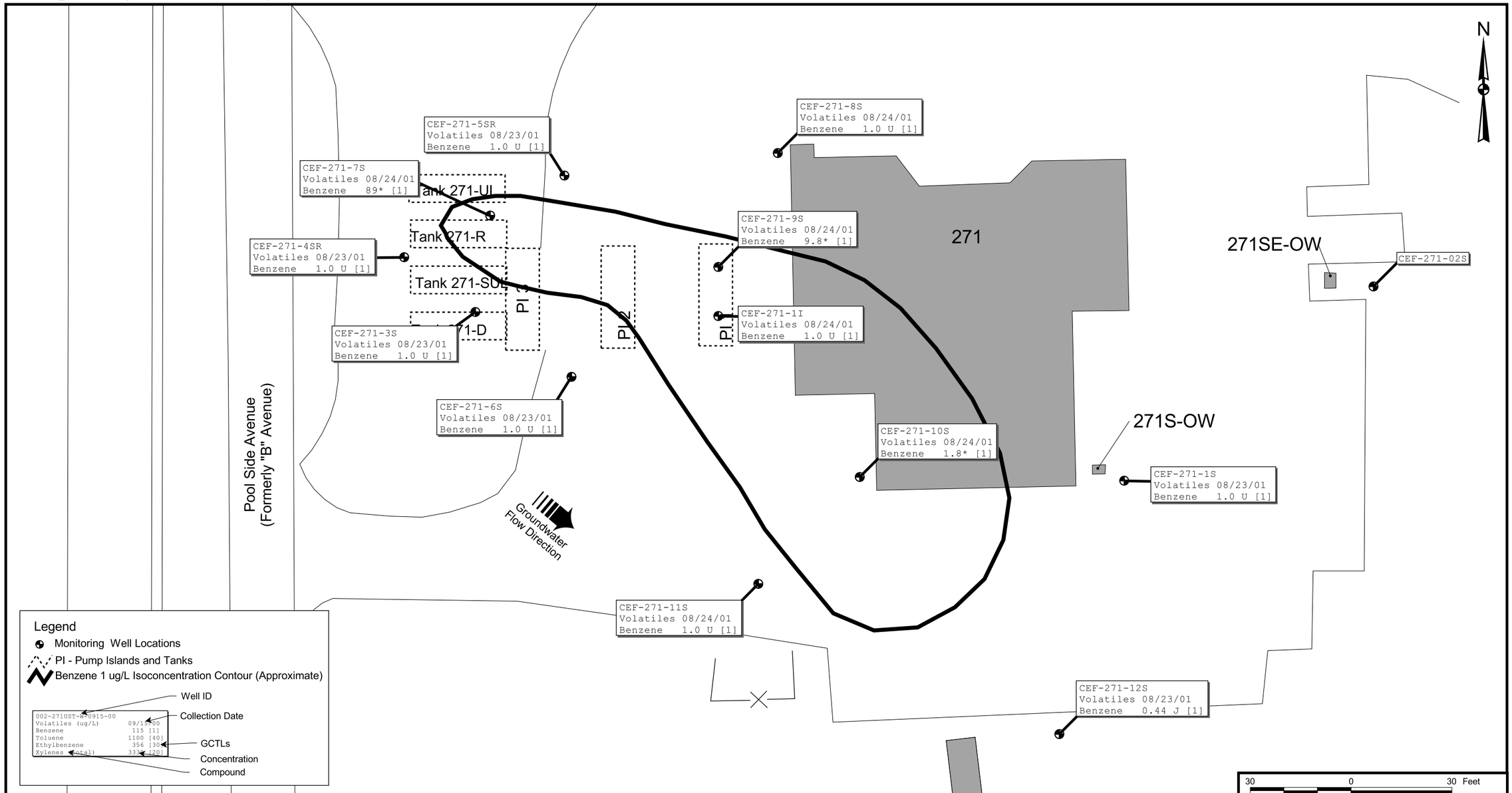

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MJJ	DATE 03Sept02
CHECKED BY	DATE
COST/SCHED-AREA	
SCALE AS NOTED	

BENZENE GROUNDWATER ANALYTICAL RESULTS
BUILDING 271, TANKS 271 UL/R/SUL/D
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO. N4248	
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3.0 REMEDIAL ACTION PLAN GOALS

3.1 SOIL REMEDIAL ACTION GOALS

Analytical data acquired during Phase 2 of the site assessment indicate that excavation activities successfully remedied petroleum-impacted soil at the site, and no further remedial action is planned.

3.2 GROUNDWATER REMEDIAL ACTION GOALS

The objective of this RAP is to recommend a technology relevant to and cost-effective for:

- Retarding plume migration at the site
- Protecting human health and the environment by reducing the concentrations of hydrocarbons detected at the site to target cleanup levels.

The goals and expected accomplishments of the RAP include:

- Identifying a method to reduce the petroleum-impacted groundwater at the Building 271 site
- Selecting a remedial alternative that will result in a reduction of the dissolved fraction of hydrocarbon constituents within the groundwater matrix
- Selecting a remedial alternative that is protective of human health and the environment.

The target cleanup concentrations for groundwater at the subject site are based on analytes detected in the soil and groundwater in exceedance of Chapter 62-770, FAC. Based on the Groundwater Cleanup Target Levels (GCTLs) listed in Table I of Chapter 62-777, FAC, Table 3-1 presents the soil remediation goals for the site-specific COCs.

Table 3-1
Chemicals of Concern and Associated Selected Groundwater Cleanup Target Levels

Site-Specific COCs	Concentrations (μg/L)
Benzene	1
Ethylbenzene	30
Toluene	40
Total Xylenes	20
MTBE	50
Naphthalene	20
1-Methylnaphthalene	20
2-Methylnaphthalene	20

Note: Concentrations from GCTLs Table I, 62-777, FAC.

4.0 CONTAMINANT DISTRIBUTION

4.1 ESTIMATED MASS OF CONTAMINANTS IN SOIL

Data acquired during Phase 2 of the site assessment indicate that soil removal was complete.

4.2 ESTIMATED MASS OF CONTAMINANTS IN GROUNDWATER

Laboratory analytical data from the groundwater samples obtained from the monitoring wells during the site assessment illustrate that the benzene plume (Figure 2-2) occupies an area of approximately 9800 ft^2. The impacted thickness of groundwater contamination is conservatively estimated at 15 ft, yielding a total volume of approximately 0.27 million gallons (MG) of contaminated groundwater. The thickness of 15 feet was chosen based on the levels of contaminants detected in monitoring wells CEF-271-7S, CEF-271-9S, and CEF-271-10S which are screened from 4 to 14 feet bls. No contamination was found in the deeper well (CEF-271-1I) co-located with CEF-271-9S and screened from 32.5 to 37.5 feet bls. The estimated quantity of dissolved hydrocarbons within the saturated zone is 101 lbs. This estimate includes the dissolved mass (7 lbs) as well as the mass adsorbed to the sediment within the saturated zone (94 lbs). The calculations used to derive these quantities are presented in Appendix A.

5.0 REMEDIAL ALTERNATIVE TECHNOLOGY SCREENING

TtNUS conducted a screening of available technologies to assess the best remedial alternative for the subject site. Potential remedial technologies and process options for the soil and groundwater remediation have been identified and evaluated based on their ability to meet clean-up objectives (effectiveness), applicability based on site conditions, feasibility of implementation, reliability, anticipated duration, and cost.

5.1 EVALUATION OF GROUNDWATER TREATMENT ALTERNATIVES

Dissolved phase hydrocarbons have been detected within the groundwater at the site. Based on the SAR Report (TtNUS, 2002), the dissolved hydrocarbon plume encompasses a surface area of approximately 9800 ft^2, extending vertically approximately 15 feet below the static water table. An estimated volume of 0.27 MG of groundwater exhibits dissolved hydrocarbon concentrations in excess of FDEP clean-up levels (calculations are presented in Appendix A).

The following actions have been identified for remediation of groundwater and will be evaluated in this RAP:

- Air sparging
- In-situ Aerobic Biological Treatment

The following sections briefly discuss each of these alternatives with respect to their suitability for implementation at this site. Natural attenuation monitoring only was not analyzed because monitoring only is not allowed per FAC 62-770.690.

5.1.1 <u>Air Sparging</u>

Air sparging can be used to remediate groundwater with petroleum hydrocarbons. The technology involves injecting air under pressure into the contaminated aquifer thereby increasing the mass transfer of the dissolved contaminants into the air bubbles followed by upward migration of the volatilized contaminants to the vadose zone. The supply of air to the contaminated zone will also stimulate indigenous biodegradation of volatile petroleum constituents through oxygen recharge.

This technology has proven effective in remediating groundwater contaminated with petroleum hydrocarbons. There are advantages to air sparging over other active remediation technologies in that operations and maintenance are typically less expensive. It should be noted that air sparging systems generally use an integrated SVE system in order to recover VOCs removed from the contaminated aquifer. However, a detailed characterization of potential air sparging vapors was conducted using the recalibrated Site 3 and Site 16 NAS Cecil Field sites model to assess if extraction and treatment of these vapors is necessary. The plume was evaluated with operational data from both Site 3 and Site 16 to develop a range of predicted remedial emissions (additional details are provided in Appendix B). The Minimum Emission was developed using Site 3 operational data (AS with no Vapor Extraction) and a Maximum Emission was developed using Site 16 operational data (AS/VE).

Based on the calculated emission rates, for the proposed system, the maximum total emissions will be less than 1 lb per day which does not exceed the FDEP requirements (emission of a single contaminant is not greater than 5.5 lbs per day, and total emissions are not greater than 13.7 lbs per day). Therefore the Vapor Extraction component is not required for the proposed Air Sparge systems.

Preliminary calculations indicate an approximate remedial time period range of 1.3 to 5 years using air sparging technology to attain the FDEP groundwater and soil cleanup target levels. Air sparging is a proven technology for reducing BTEX, naphthalenes, and MTBE levels in groundwater and is an economical approach to in-situ groundwater remediation. The use of air sparging is a preferred alternative based on: 1) low capital and operation and maintenance (O&M) costs, 2) low environmental impact of in-situ well installation, and 3) proven effectiveness. An estimated cost of air sparging implementation with 1 year of O&M is presented in Table 5-1 and Appendix C, Table C-1.

5.1.2 In-situ Aerobic Biological Treatment

Biological treatment involves the use of microorganisms, primarily bacteria, actinomycetes, and fungi to breakdown hazardous organic compounds into nontoxic or less toxic forms. This technology would enhance Natural Attenuation for treatment of the plume.

TABLE 5-1

GROUNDWATER REMEDIAL ALTERNATIVES SUMMARY
BUILDING 271 TANKS UL/R/SUL/D
REMEDIAL ACTION PLAN
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

ALTERNATIVE	CAPITAL COST	ANNUAL O&M	ESTIMATED YEARS OF OPERATION	PRESENT WORTH TOTAL COST	RECOMMENDATION / CONCLUSION
Air Sparging	$82,000	$66,000	3 years	$274,000	Retain - Cost effective, Installation intrusions minimal, Historically Effective
In-situ Aerobic Biological Treatment	$215,000	$47,000	3 years	$405,000	Eliminated - Higher Cost than Air Sparging Alternative, More intrusive than Air Sparging, Historically limited success

* Cost includes annual groundwater sampling of ten monitoring wells.
** Costs for 1 year of operation, time may vary.
Note: See Appendix C for detailed cost estimates for the remediation alternatives.

This option would consist of using an oxygen-release compound (ORC) to enhance the growth of indigenous microorganisms and natural biodegradation processes, while monitoring groundwater quality to assess the extent to which these microorganisms and processes would break down contaminants over time. ORCs, such as hydrogen or magnesium peroxide, would be used to enhance the aerobic biodegradation of BTEX. These compounds would initially be injected into the contaminant plume using direct push technology (DPT), after which a re-application dosage may be required. New monitoring wells would be installed as required, and samples from these new wells and existing wells would be regularly collected and analyzed.

Preliminary calculations indicate an approximate remedial time period range of 1.3 to 5 years using ORC technology to attain the FDEP groundwater and soil cleanup target levels. ORC is a proven technology for reducing BTEX, naphthalenes, and MTBE levels in groundwater and is an economical approach to in-situ groundwater remediation. The use of a ORC is a preferred alternative based on: 1) low capital and operation and maintenance (O&M) costs, 2) low environmental impact of in-situ well installation, and 3) proven effectiveness. An estimated cost of ORC implementation with 1 year of O&M is presented in Table 5-1 and Appendix C, Table C-2.

5.2 COST COMPARISON AND RATIONALE FOR SELECTION

A table comparing the estimated cost of remediation of soil and groundwater at the subject site using the combinations of the evaluated alternatives is provided in Table 5-1. Based on a review of the advantages, disadvantages, costs, and TtNUS project experience at sites with similar conditions, TtNUS recommends the design of an integrated Air Sparging System (AS) to remediate the groundwater contamination at this site.

AS provides the highest degree of overall protection to human health and the environment by providing reduction in risk and hydrocarbon concentrations through in-situ methods. AS will promote in-situ biodegradation and volatilization of hydrocarbon constituents within the soil and groundwater matrices. The equipment and controls needed for AS are reliable, easily operated, commonly available, and systems typically require minimal O&M cost. Minimal permitting is required for the implementation and operation of the AS system. In addition, AS will also provide a shorter duration to achieve cleanup standards and goals compared to the other alternatives.

6.0 REMEDIAL SYSTEM DESIGN

The preferred remedial alternative presented in this RAP was selected based on it being the most cost-effective method for recovery and/or treatment of hydrocarbons within the vadose and saturated zone at the site. The potential remedial technologies and process options for groundwater remediation were identified and screened, and the results were presented in Section 5.0. The selected alternative is air sparging (AS).

In addition, applicable technologies were presented at the NAS Cecil Field Partnering Team's petroleum sub-committee meeting, at which time consensus was reached on an integrated AS system as the remedial technology that will most effectively remediate the contaminated groundwater.

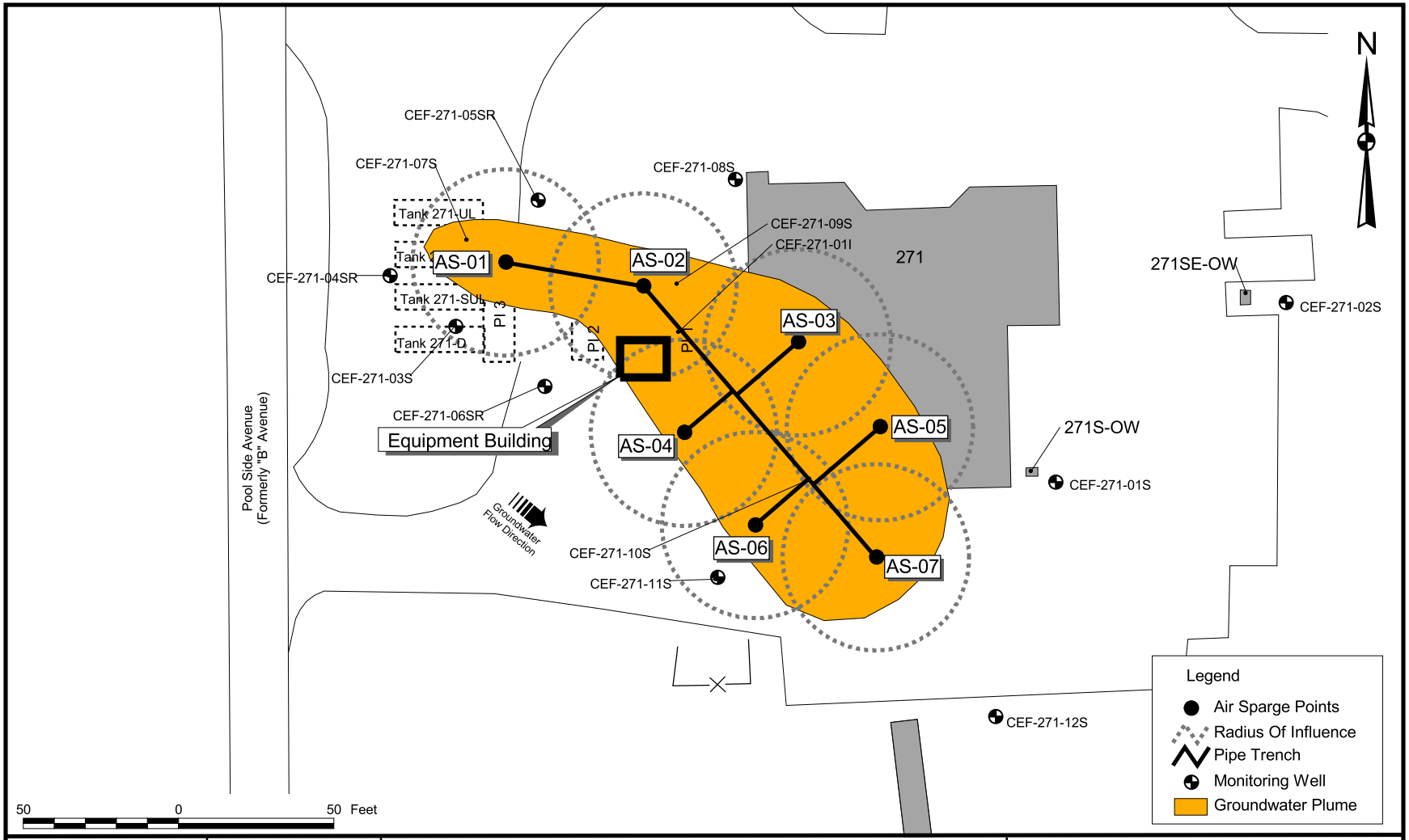
6.1 AIR SPARGE DESIGN DETAILS

The conceptual design of the proposed AS remedial system was developed based on knowledge of site lithology and soil permeability and based on AS systems at other sites with similar soil conditions at NAS Cecil Field. In particular, the design parameters were based on the radius of influence (ROI) and operational data for the existing shallow AS system at Cecil Field Sites 36/37. The following table summarizes the assumptions used to develop the design of the proposed AS remediation system.

System	Radius of Influence	Flow rate
Air Sparging	30	10 scfm[(a)] per well

(a) scfm = standard cubic feet per minute

The proposed remediation system layout and plan view schematic are shown on Figure 6-1. Piping and instrumentation diagram (P&ID) for the air sparging system is presented on Figure 6-2. The following subsections provide the design rationale and outline the components for the AS remedial system.



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COST/SCHEDULE-AREA	
SCALE	AS NOTED

PROPOSED REMEDIAL SYSTEM LAYOUT
BUILDING 271, TANKS 271 UL/R/SUL/D
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NUMBER	
N4248	
APPROVED BY	DATE
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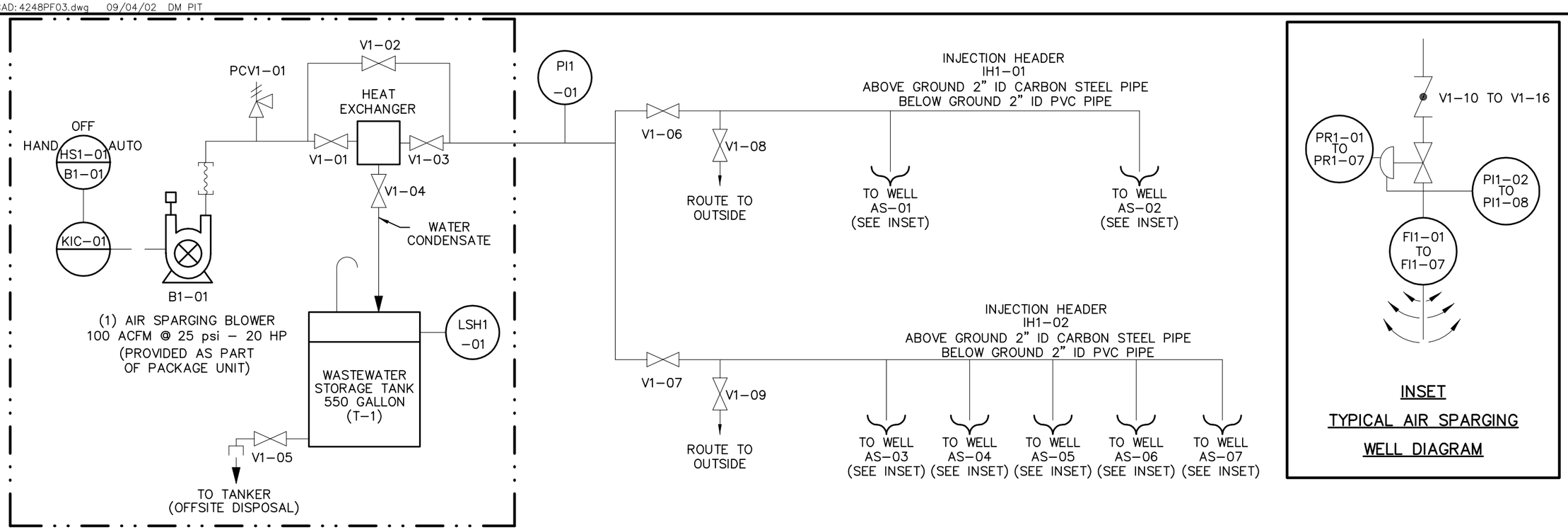

WELL	BUTTERFLY VALVE	PRESSURE REGULATOR	PRESSURE INDICATOR	FLOW INDICATOR
AS-01	V1-10	PR1-01	PI1-02	FI1-01
AS-02	V1-11	PR1-02	PI1-03	FI1-02
AS-03	V1-12	PR1-03	PI1-04	FI1-03
AS-04	V1-13	PR1-04	PI1-05	FI1-04
AS-05	V1-14	PR1-05	PI1-08	FI1-05
AS-06	V1-15	PR1-06	PI1-06	FI1-06
AS-07	V1-16	PR1-07	PI1-07	FI1-09

LEGEND:

FI	FLOW INDICATOR
HS	HAND SWITCH
IH	INJECTION HEADER
PCV	PRESSURE RELIEF VALVE
PI	PRESSURE INDICATOR
PR	PRESSURE REGULATOR
AS	SPARGE WELL
KIC	TIMER INDICATOR CONTROLLER

QUICK DISCONNECT COUPLING

PRESSURE REGULATOR

RELIEF VALVE

GATE VALVE

BUTTERFLY VALVE

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DM DATE 9/30/02
CHECKED BY DATE
COST/SCHED-AREA
SCALE NOT TO SCALE

AIR SPARGING
PIPING AND INSTRUMENTATION DIAGRAM
BUILDING 271, TANKS 271 UL/R/SUL/D
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO. 4248
APPROVED BY DATE
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DRAWING NO. FIGURE 6-2
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

6.1.1 Air Sparging System

As shown in Figure 2-3, the contaminant plume, as defined by the GCTL for naphthalene (20 ug/L) and benzene (1 ug/L), encompasses an area of approximately 9800 ft^2 within the Building 271 area. Table 2-2 shows the groundwater contamination extends to an approximate depth of 15 feet below the water table. Based on the plume area and the estimated 30 feet ROI, seven air sparging wells screened 24 to 26 feet bls are proposed to remediate the groundwater underlying the site. The locations of the proposed air sparging wells are presented in Figure 6-1.

Based on the proposed seven air sparing wells operated at 10 scfm per well, a total injection flow rate of 70 scfm will be used to ensure the transfer of air into the saturated zone and to maximize volatilization and addition of oxygen to the aquifer. An air sparging injection pressure of 15 psig has been selected to overcome the head losses and the average hydraulic head of 17 feet in each air sparging well. Air sparging pressure and flow calculations are presented in Appendix D.

6.1.1.1 Air Sparging Components

The air sparging system will consists of a sparge blower with a minimum inlet capacity of 100 scfm at a discharge pressure of 15 psig. The sparge blower shall be designed for continuous industrial service, delivering clean air free of oils or any other debris. The blower motor shall be a 20 horsepower, totally enclosed, fan-cooled (TEFC) motor, 460 VAC 3-phase. The motor will operate at 60 HZ to supply the specified flow rate and pressure.

The air sparging system will be mounted on a steel skid or frame. The skid of the unit will be constructed of carbon steel. The skid package will consist of the blower/motor, heat exchanger, OSHA-approved belt guard, motor slide base, intake air filter/silencer, inlet and discharge silencer, and air bleed exhaust valve and silencer. Temperature, pressure, and timing cutout switches and gauges, pressure relief valve, on/off valves, and pitot-tube flow sensors will be installed per manufacturer's written instructions at locations shown on Figure 6-3. The gauges will be mounted on the skid in an easy-to-read location without blocking maintenance activities. All piping and fittings shall be 2-inch carbon steel or black iron on the intake and discharge side of the blower. Underground piping to the well will be constructed of 2-inch, schedule 80 PVC. The skid will be equipped with lifting lugs for loading and unloading. All non-coated steel will be coated with corrosion-prohibiting, gray enamel primer and paint. Blower skid packages will be of a horizontal design with blowers mounted in the horizontal position. The in-line location of the

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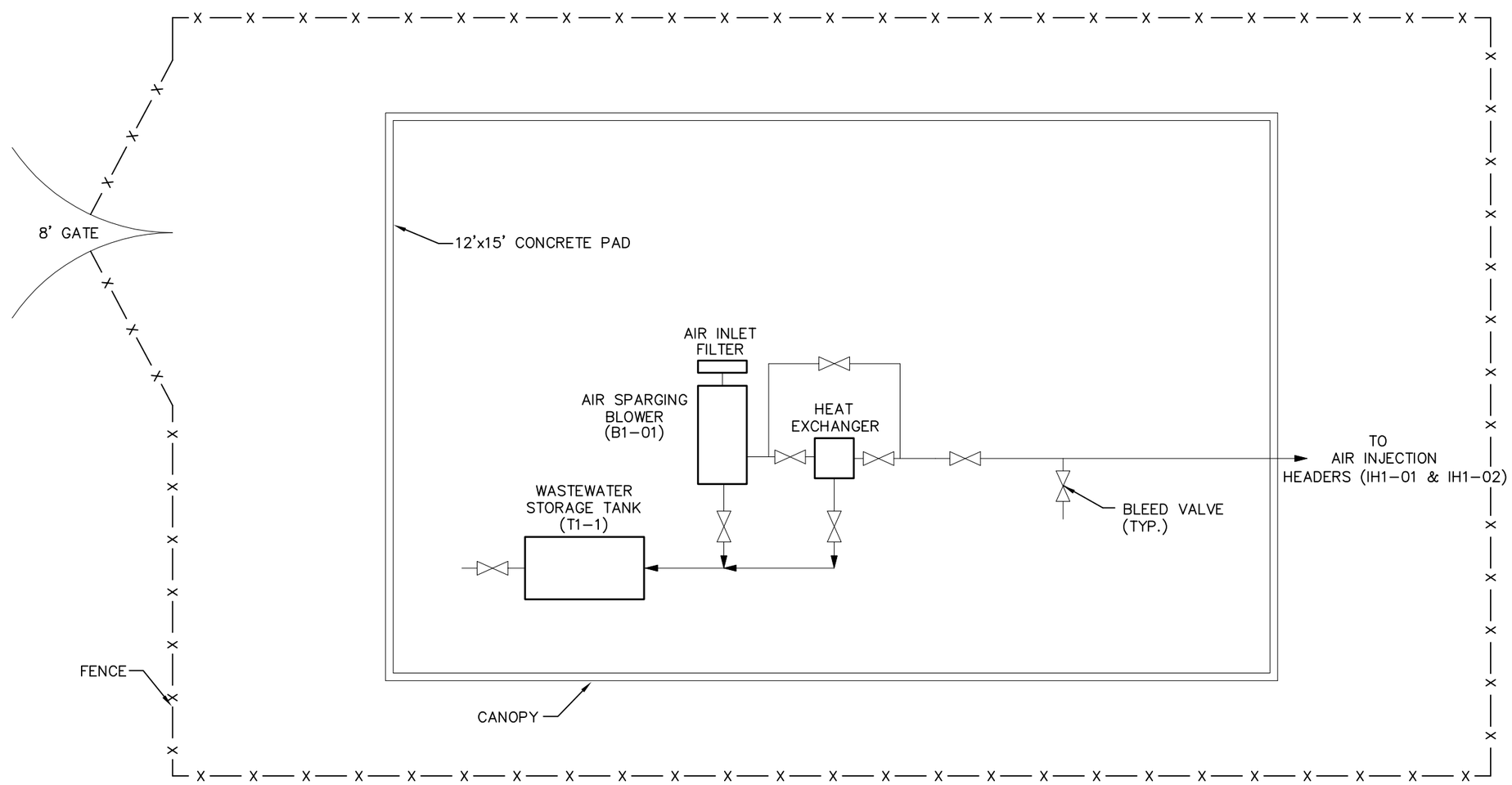


NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DATE: DM 9/3/02
CHECKED BY DATE
COST/SCHED-AREA
SCALE: NOT TO SCALE

REMEDIAL EQUIPMENT LAYOUT
BUILDING 271, TANKS 271 UL/R/SUL/D
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO. 4248
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 6-3
REV. 0

FORM CADD NO. SDV_BH12.DGN - REV 0 - 1/20/98

equipment components is shown on Figure 6-3. Manufacturer's specifications for the components of the proposed air sparging system are presented in Appendix E.

6.2 AIR SPARGE CONSTRUCTION DETAILS

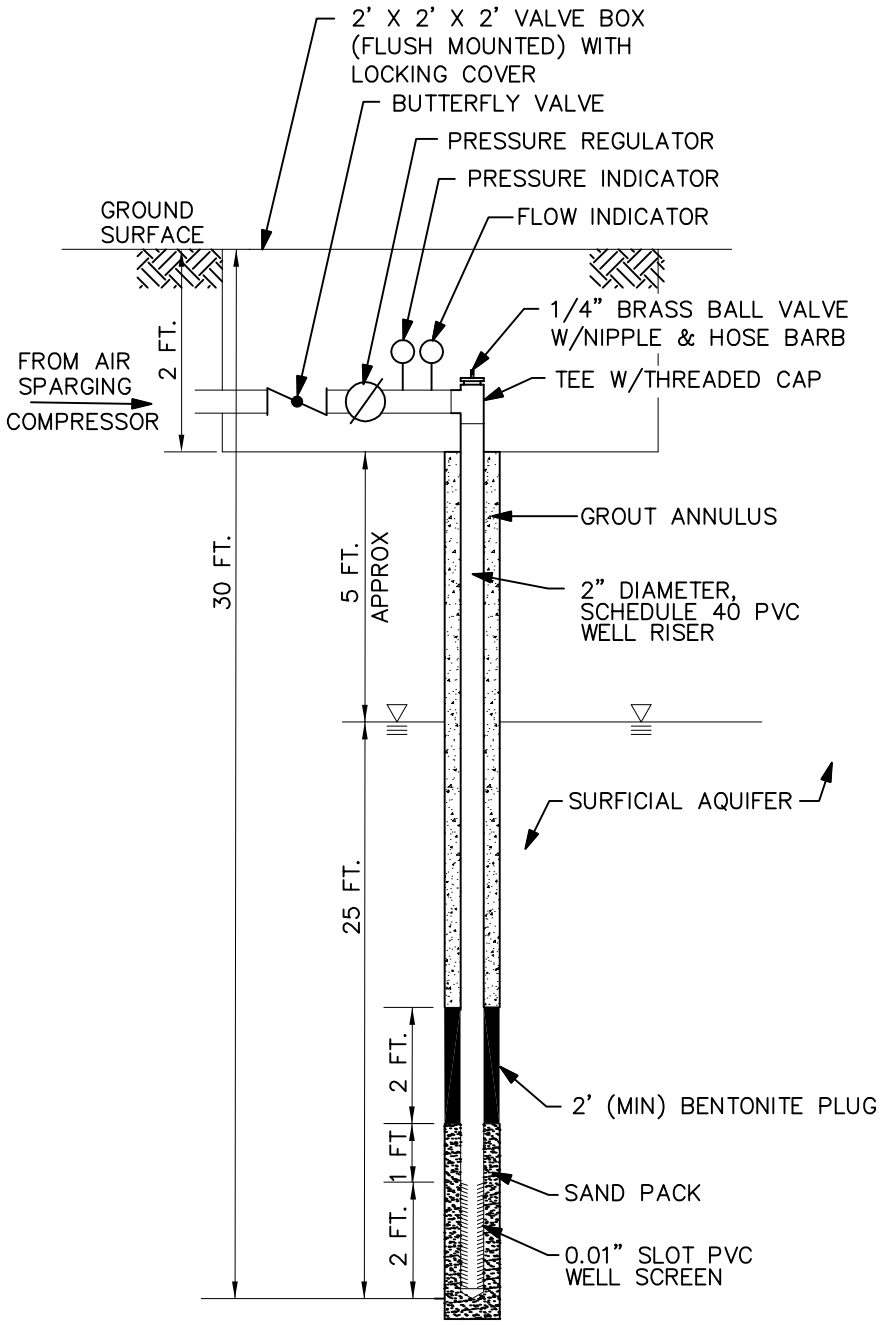
The proposed AS remedial system layout including sparging wells, secure equipment area, and associated trenching/piping is presented in Figure 6-1. The AS well system design for the subject site consists of seven air sparging wells. Support calculations are presented in Appendices B and E. Detailed design plans and specifications are presented in Figures 6-2 through 6-5. A 6-ft high wooden fence with a lockable 8-ft wide gate will surround the AS equipment outlined above.

6.2.1 Air Sparging Component Construction

The air sparging wells will consist of 2-inch Schedule 40 PVC with flush threaded joints. The air sparging wells will be installed to a depth of 26 feet with the bottom 2 feet (24-26 ft bls) screened with 0.010-inch slot PVC. Wells will be installed with a 20/30 sand pack around the screen with 2-feet of bentonite above the sand pack. The remaining borehole will be filled with cement grout. A 2-foot by 2-foot by 2-foot, flush-mounted steel well box with bolt-down driveover lid will be placed over the top of each air sparging well. All air sparging wells will be fully developed. The air sparging well details are shown on Figure 6-4.

To ensure a uniform air injection flow rate at each proposed air sparging well, a ½-inch pressure regulator rated for 10 scfm at a discharge pressure of 15 psig will be installed at each air sparging wellhead as shown on Figure 6-4. Also, each sparging well will be equipped with a ¼-inch sample port and a 2-inch butterfly valve.

The pressurized air will be supplied to the air sparging wells through 2-inch carbon steel or black iron piping from the air-sparging blower within the secure equipment area. The blower will be connected to the air sparging wells by a common header pipe. The air sparging piping will be placed under the existing ground surface and will be buried a minimum of 24 inches below grade. Underground sections of the air sparging pipe will be 2-inch Schedule 80 PVC. A typical cross-section of the pipeline trenches is shown on Figure 6-5. All pipe sections, joints, couplings, and connections will be checked for tightness prior to trench backfilling.



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CHECKED BY DATE		AIR SPARGING WELL DETAIL BUILDING 271, TANKS 271 UL/R/SUL/D NAVAL AIR STATION CECIL FIELD JACSONVILLE, FLORIDA	APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE NOT TO SCALE			DRAWING NO. FIGURE 6-4 / REV. 0

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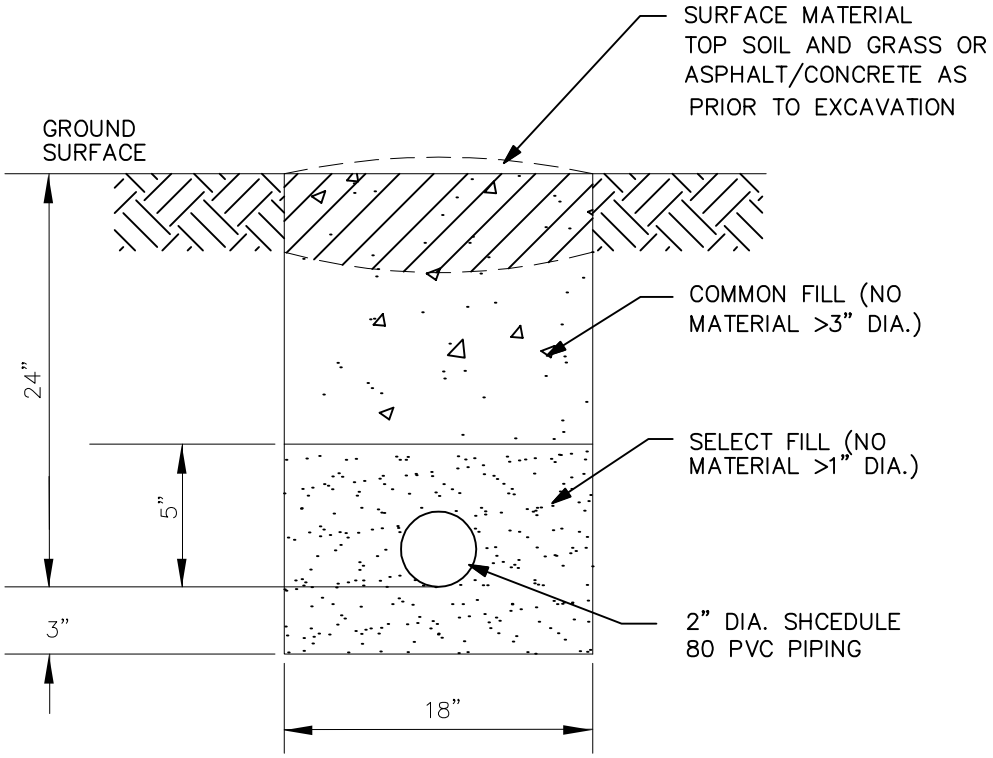

PVC PIPE TRENCH
CROSS SECTION

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CHECKED BY DATE		TRENCH DETAIL BUILDING 271, TANKS 271 UL/R/SUL/D NAVAL AIR STATION CECIL FIELD JACKSONVILL, FLORIDA	APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
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6.3 OFF-GAS TREATMENT

The Florida Department of Environmental Protection (FDEP) requires off-gas treatment for at least thirty (30) days, and until the total VOC effluent discharge is less than 13.7 lbs/day. Based upon hydrocarbon concentrations in the soil and groundwater and using the estimated time for AS to effectively remediate the groundwater as the remediation time required to complete the removal of hydrocarbons from the subsurface, an estimated average air emission rate of less than 1 lb/day has been calculated for this site. Since the maximum emission rate is below the discharge rate of 13.7 lbs / day, collection and treatment of off gas will not be required at this site.

6.4 ELECTRICAL AND CONTROLS

6.4.1 Control Panel

There will be a single field-mounted control panel for the AS system. There will be a single "ON/OFF" switch with additional subsystem control switches and individual Hand-On-Auto (HOA) switches for individual motors. When in “ON” position, all devices which are equipped with HOA switches will operate when their switch is in the “HAND” position and shall be enabled when their switch is in the “AUTO” position.

The control panel will be designed and fabricated to receive 3-phase, 460 VAC as well as 120 VAC single-phase power from a breaker panel. Individual power sources (circuit breakers) for each load will be provided in the power panel, to be wired directly to the individual motor starters. The control panel will be designed to properly operate system electrical equipment. The control panel will contain all relays, motor starters, terminal blocks, transformers and other components necessary for operation of the electrical equipment. The panel will be pre-wired and fabricated in accordance with the National Electric Code and will utilize readily available electrical components.

The control panel will contain motor starters with thermal overload and overcurrent protection, automatic reset, HOA switches, and on/off control logic for the air sparging blowers. The panel will also contain all relays, terminal blocks, and other components necessary for automatic operation of the AS system. All alarm circuits will be equipped with indicator lights at the control panel to serve as 'first out annunciators' when alarm conditions occur. The alarm conditions will include a high-high level in the condensate holding tank.

A starter timer will be included on the air sparging blower to allow intermittent operation. The electrical control panel will be located outside, therefore a NEMA 4 external flange mounted enclosure surrounding a NEMA 1 enclosure that is complete with externally-mounted blower hour meters, HOA blower switches, reset button, and high liquid level indicator lights will be required. The NEMA 4 enclosure will have a locking cover for controlled access.

6.4.2 AS System Controls/Operation

The control panel will control the on/off operation of the air sparging blower, and associated control valves, high pressure and high temperature cut-outs switches on blower, and liquid level (high-high level) shut off switches installed in the air/water separator and the holding tank.

The AS main control and operation components are listed below:

- One (1) blower motor starter with thermal overload, overcurrent protection, and loss of three-phase protection, automatic reset, external hour meters, and HOA switches.

- A high level sensor and controls in the condensate holding tank will deactivate the air sparge blower in the event of an abnormally high liquid level condition in the tank.

- One (1) high temperature sensor (located on the discharge of the blower) and controls will deactivate the blower in the event of an abnormally high temperature condition at the blower.

- One (1) high-pressure sensor (located at the discharge of the blower) and controls will deactivate the blower in the event a high-pressure condition is detected downstream of the blower.
- One (1) timer for intermittent operation (located in the control panel) that will be programmable by hour and/or day operation. This will provide the ability to run the system in pulse mode once leveling off of the stripping is detected.

7.0 OPERATION & MAINTENANCE AND MONITORING

The following sections establish procedures for the start-up of the system, routine operation and maintenance of the remediation equipment, monitoring of the AS operating parameters, and final system deactivation.

7.1 SYSTEM START-UP

Following final inspection, and acceptance by the Navy, the system will be set for initial start-up. Approximately 1 week prior to start-up, a full round (See Table 7-1) of water levels and dissolved oxygen (DO) measurements will be collected. During this event the air sparging in the area will also be surveyed in reference to elevation to establish a baseline top of casing elevation for each remedial well. Following collection of water levels, all of the wells will be sampled and analyzed using EPA Method SW846-8310 for polynuclear aromatic hydrocarbons, and EPA Method SW846-8021B for purgeable aromatics. The initial round of measurements and groundwater analytical results will establish the baseline contaminant profiles and comparable monitoring parameters.

System start-up will commence approximately 1 week following the initial round of sampling. The following steps outline the start-up procedures.

1. Prior to any testing, bump and check each motor for proper rotation.
2. Inspect all equipment and ensure that all moving parts are free from obstructions.
3. Energize the control panel disconnect switch. Confirm that the voltage supplied to the panel is as specified.
4. Check all control sensors, alarms, and control logic by forcing alarm conditions, e.g., filling holding tank with potable water to check operation of the high-high sensor and the interlocked logic.
5. Check all motor amp loads against manufacturer's specified operating loads provided in the operations manual. Any motors found to be exceeding full load amp draw will undergo troubleshooting activities and the cause will be determined and rectified.
6. Energize the air sparging blower. Check the discharge pressure of blower to ensure that it operates to manufacturer's specifications
7. Adjust the air bleed valve on the air sparging system until the specified discharge pressure and system airflow rate is reached.
8. Set/adjust temperature and pressure sensors and cut-out switches

TABLE 7-1

MONITORING WELL SAMPLE NUMBERS
LONG-TERM MONITORING
JETC AND TANK 334-OW REMEDIAL ACTION PLAN
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Monitoring Well No.	Position	Analysis
CEF-271-01S	Sidegradient	WL
CEF-271-02S	Sidegradient	WL
CEF-271-03S	Sidegradient	WL
CEF-271-4SR	Upgradient	WL
CEF-271-5SR	Upgradient	WL
CEF-271-6S	Sidegradient	WL
CEF-271-7S	Source	V, P
CEF-271-8S	Sidegradient	WL
CEF-271-9S	Source	V, P
CEF-271-10S	Source	V, P
CEF-271-11S	Downgradient	WL
CEF-271-12S	Downgradient	V, P
CEF-271-1I	Vertical Delineation	WL

V - VOCs by 8021
P - PAHs by 8310
WL - Water Levels only

9. Monitor the AS system for 2 hours and record the flow rate, and temperatures.
10. Balance the flow rates for all the air sparging wells.
11. Measure and record the outlet pressure of the flow regulator mounted at each air sparging well. The measured pressure at each air sparging well should be equal to or greater than 11 psig to evacuate the water from the well. If not, increase the discharge pressure at the air sparging blower until the pressure at the each air sparging well is equal to or greater than 11 psig.
12. Allow the system to operate for approximately 2 hours without adjustment, and then record the pressure and flow rate measurements.
13. Allow the system to run for 24 hours. Record all pressures and flows for future comparison to weekly visits for the first month of operation followed by monthly visits thereafter. Readjust as necessary.

7.2 DESIGNATION OF OBSERVATION WELLS

Based on the configuration of the dissolved hydrocarbon plume and the hydraulic gradient, monitor wells CEF-271-07S (source), CEF-271-09S (source), CEF-271-10S (source), and CEF-271-12S (downgradient) will be used to monitor the effectiveness of the remedial system efforts at the site.

7.3 MONITORING PLAN

A monitoring program is anticipated to be initiated upon approval of this RAP and subsequent installation and startup of the remedial action system. The monitoring plan has three main objectives:

- To monitor the overall effectiveness of the remedial system in removing hydrocarbons from the soil and groundwater
- To verify that the contaminant plume is not migrating beyond the remediation area
- To monitor the performance of the remedial equipment

The proposed monitoring plan includes the following:

- Measurements of groundwater levels and dissolved oxygen (DO) in the monitoring wells to determine groundwater mounding and to verify the radius of influence measurements will be taken weekly for the first month, monthly for the next 2 months, and quarterly thereafter. Measurement will be performed using a water level indicator and a DO meter.

- Measurements of air sparging pressure and flow rates will be performed weekly for the first month, monthly for the next two months, and quarterly thereafter. Measurements will be performed using pressure gauges and flow meters mounted in the well vaults.

- Sampling and laboratory testing of groundwater from the selected monitor wells to document remediation of the groundwater plume will be performed quarterly. The groundwater samples will be analyzed using EPA Method SW846-8310 for polynuclear aromatic hydrocarbons, and EPA Method SW846-8021B for purgeable aromatics.

- The results of quarterly sampling will be reported every quarter in a status report (See Section 7.6)

7.4 MONITORING REMEDIATION PROGRESS

The performance-monitoring program will be re-evaluated after 6 months of sampling and testing and will be modified as necessary to maximize the effectiveness of the remediation system. The overall effectiveness of the proposed remediation system and cleanup progress will be monitored by evaluating the following monitoring data:

- The trend of DO concentrations as the remedial system progresses.

- The trend of hydrocarbon concentrations in groundwater as the remedial system progresses.

The monitoring data will be used to assess if the objectives of the RAP and standards of the design criteria are being met. The remedial system will be modified if the monitoring data indicates that the cleanup goals cannot be met in the timeframe as specified in the RAP. Modifications of the remedial system will be based on the site-specific monitoring data.

7.5 SYSTEM OPERATIONS AND MAINTENANCE

The proposed remedial system is designed to operate continually and automatically with minimal maintenance. Site visits for system inspection and maintenance will be performed by a trained and qualified technician and will be performed in conjunction with system monitoring to reduce costs.

The following operation and maintenance items are scheduled to be performed weekly for the first month and monthly thereafter:

1. Record the AS equipment meter readings, flow rates, pressures, and the amount (if any) of water collected in the holding tank.
2. If there is significant condensate in the 500-gallon holding tank, it will be pumped out and disposed of by a licensed hauler.
3. Inspect the air sparging blower. Grease the bearings. Visually check the particle filters for signs of dust or debris accumulation and replace if necessary. Record the condition of the filters. Fully inspect the condition of the entire blower unit (belt tension, rust, etc.)
4. Inspect the heat exchanger. Visually check the particle filters for signs of dust or debris accumulation and replace if necessary.
5. Adjust the pressures and flow rates to the original operational levels established during system startup.
6. Maintain good housekeeping measures for the entire remediation system compound, picking up trash, cutting weeds as necessary.
7. Log all inspection activities and repairs performed.

An Operation and Maintenance (O&M) Manual will be provided with all equipment and systems acquired. The manual will have at a minimum, sections covering the unloading, installation, set-up, operation instruction, and maintenance instruction for each component of the system.

7.6 STATUS REPORTS

During the implementation and operation of the remedial system described in this RAP, quarterly status reports will be prepared and submitted to Navy. The reports will summarize all remedial activities and will contain at a minimum the following information:

- Startup date

- Hydrocarbon constituent concentrations in groundwater as measured from monitoring wells, together with water table elevations
- Dissolved oxygen in the groundwater
- Recent hydrocarbon plume and groundwater contour maps
- Summary of system operational data
- Conclusions as to the effectiveness of the active remedial system, and recommendations on further monitoring and operations of the system.

7.7 SYSTEM DEACTIVATION

The following criteria must be met for active remediation to be deemed complete and prior to deactivation of the AS system:

1. No Further Action criteria as defined in Chapter 62-770.680 FAC have been met.
2. Natural Attenuation criteria established in Chapter 62-770.690 FAC has been achieved.
3. Concentrations of chemicals of concern in the designated monitoring wells have “leveled off” as defined in Chapter 62-770.700 FAC.

After the site meets one the above criteria and the NAS Cecil Field Petroleum subcommittee agrees with the decision to deactivate the AS system, the system will be deactivated. The following steps shall be followed during system deactivation:

1. Deactivate the air-sparging blower and allow to cool down.
2. De-energize the control panel via the service disconnect.
3. Properly transport and dispose of the condensate water collected.
4. AS equipment will remain on site until after the post closure monitoring verifies that the site has been properly remediated, at which point it will be removed from the site as directed by the Navy.

Following AS system deactivation, a Post Active Remediation Monitoring Plan must be developed for the site and approved by the FDEP. The contents of this plan are included in 62-770.750 FAC. This monitoring shall occur for a minimum of 1 year.

8.0 REFERENCES

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APPENDIX A

GROUNDWATER MASS CALCULATIONS

TABLE A-1
ESTIMATED MASS OF DISSOLVED AND ADSORBED CONTAMINANTS IN SATURATED ZONE

Remedial Action Plan
Building 271, Tanks 271 UL/R/SUL/D
Naval Air Station Cecil Field
Jacksonville, Florida

Mass of Soluble Contaminants Calculations

Well No.	Benzene (ug/l)	Toluene (ug/l)	Ethyl-Benzene (ug/l)	Xylene (ug/l)	BTEX (ug/l)	MTBE (ug/l)	Naphthalene (ug/l)	1-Methyl (ug/l)	2-Methyl (ug/l)	Impacted Thickness (feet)
CEF-271-7S	89	2900	520	3300	6809.0	11	230	35	55	15
CEF-271-9S	9.8	270	1,600.0	87.2	168	<10	7.4	8.2	7.3	15
CEF-271-10S	1.8	6.2	1.2	8.0	17	<10	<1.0	<1.0	<1.0	15
Average Dissolved Contaminant Concentration (ug/l) =	**33.5**	**1,058.7**	**707.1**	**1,131.7**	**2,331.3**	**3.67**	**79.133**	**14.4**	**21**	

Estimated GW Volume: 'Impacted Area x Impacted Thickness x Porosity = (9800 ft)(15 ft)(0.25)(7.48 gal/ft^3) = **274,890** **gallons**

Estimated Mass of Soluble Contaminants: M(dissolved)(lbs) = C(dissolved)(ug/l) x V(gw)(gal) x 3.7854(l/gal) x 2.205E-9(lb/ug)

where: M(dissolved) = mass of dissolved contaminants (lbs)
C(dissolved) = average dissolved contaminant concentration (mg/l)
V(gw) = volume of impacted groundwater (gal)

Estimated Mass of Soluble Contaminants (lbs) =	**0.0769**	**2.4290**	**1.622**	**2.596**	**NA**	**0.00841**	**1.8E-01**	**0.0330**	**0.0476**

Estimated Total Mass of Soluble Contaminants Based on Sum of COCs = **6.9952** **lbs**

TABLE A-1 (Continued)

Mass of Adsorbed Contaminants Calculations

Concentration of Contaminants Adsorbed to Soil: C(soil) = C(dissolved) x Kd

where: C(soil) = contaminant concentration in soil (mg/kg)
C(dissolved) = average dissolved contaminant concentration (mg/l)
Kd = solid/liquid distribution coefficient (l/kg)

For organics: Kd = Koc x Foc

where: Koc = organic carbon/water partition coefficient (l/kg) (from Mullens & Rogers, AICE 1993)
Foc = fractional organic carbon content (0.5 % by weight for typical sand) (from EPA 440/5-89-002)

	Benzene	Toluene	Ethyl-Benzene	Xylene	BTEX	MTBE	Naphthalene	1-Methyl	2-Methyl
Koc (l/kg):	38	135	1288	240	NA	12	1288	1288	1288
Foc (kg/kg):	0.005	0.005	0.005	0.005	NA	0.005	0.005	0.005	0.005
Kd (l/kg) =	**0.19**	**0.68**	**6.44**	**1.20**	**NA**	**0.06**	**6.44**	**6.44**	**6.44**
C(dissolved) (mg/l):	0.034	1.059	0.707	1.132	NA	0.004	0.079	0.014	0.021
Kd (l/kg):	0.19	0.68	6.44	1.20	NA	0.06	6.44	6.44	6.44
C(soil) (mg/kg) =	**0.0064**	**0.715**	**4.554**	**1.358**	**NA**	**0.000**	**0.510**	**0.093**	**0.13**

(*) - Based on Naphthalene value

Estimated Impacted Soil Mass: M(soil) = Impacted Area x Impacted Thickness x (1-n) = (9800 ft^2)(15 ft)(1-0.25)(1.0 yd^3/27 ft^3)(1.4 tons/yd^3)(1016 kg/ton) = **5.81E+06** kg

Estimated Mass of Contaminants Adsorbed to Soil: M(adsorbed)(lbs) = C(soil)(mg/kg) x M(soil)(kg) x 2.205E-6 (lb/mg)

C(soil) (mg/kg):	0.00637	0.714645	4.554	1.358	NA	0.00	0.51	0.093	0.13
M(soil):	5.81E+06	5.81E+06	5.81E+06	5.81E+06	NA	5.81E+06	5.81E+06	5.81E+06	5.81E+06
M(adsorbed) (lbs) =	**0.082**	**9.152**	**58.32**	**17.393**	**NA**	**0.00**	**6.53**	**1.19**	**1.713**

Estimated Total Mass of Adsorbed Contaminants Based on Sum of COC Concentrations = **94** **lbs**

TOTAL ESTIMATED MASS OF HYDROCARBONS IN SATURATED ZONE (LBS) = ADSORBED MASS + DISSOLVED MASS = **101** **lbs**

Notes:
1) NS: Not Sampled
2) NA: Not applicable to mass calculation
3) ND: No Data Available
4) Values in shaded cells equal to 1/2 the method detection limits (MDLs) were used when concentrations were <MDLs.

Prepared by: _____ **Checked by:** _____
Date

APPENDIX B

REMEDIAL TIME ESTIMATIONS

AIR SPARGING CLEANUP DURATION ESTIMATION
JETC NORTH AND SOUTH PLUMES

CLIENT SITE NO.:	NAS Cecil Field Building 271 Tanks UL/R/SUL/D		
TTNUS PROJECT NO.:	CTO-248	By:	Priscilla Fritsch
DATE CALCULATED:	10/1/2002	Checked By:	

(Source: "Air Sparging Model for Predicting Groundwater Cleanup Rate" K.L. Sellers and R.P Schreiber, CDM Inc. 1992)

The following first order decay/rate equation may be used to estimate a conservative time for the contaminants of concern concentrations to be reduced below the remedial action ojectives. This model calculates both the average and maximum clean-up times as dictated by the initial concemtrations. This model has been calibrated to Site-16 and Site-3 long term data. You will see two versions of this calculation.

$$C_{(t)} = C_{(o)} \times e^{-Bt}$$

Variables:

$C_{(t)}$ = Concentration at end of duration or RAO's (ug/L)

$C_{(o)}$max = Initial Maximum Concentration (ug/L)

$C_{(o)}$ave = Initial Weighted Average Concentration (ug/L)

e = base of the natural log (approx. 2.71828)

B = first order differential rate constant (see page 2 of 10)

t = duration (solving for)

Solving for t reduces to:

$$t = \ln(C_{(t)}/C_{(o)}) / -B$$

CONTAMINANT TYPE	C_o Max (ug/l)*	C_o Ave (ug/L)*	C_t (ug/L)*	t Max (years)	t Ave (years)
Benzene	89	40	1.00	0.35	0.29
Ethylbenzene	1600	1123	30.00	0.31	0.28
Toluene	2900	1273	40.00	0.33	0.27
Xylenes, Total	3300	1322	20.00	0.39	0.32
Naphthalene	230	93	20.00	0.24	0.15
1-Methylnaphthalene	35	18	20.00	0.05	0.00
2-Methylnaphthalene	55	25	20.00	0.10	0.02
MTBE	11	4	50.00	0.00	0.00
			TOTAL	**1.76**	**1.32**

Assumptions:

The bubble radius was recalculated for Site-16 Air Sparging System using the time the systems ran and the amount of reduction at the site. The radius of the bubble size was the factor which was varied to meet the actual time and contaminant reduction for each site.

1) Maximum TCE prior to Startup: 410,000 ug/L @ CEF-016-45I during 9/98 sampling effort.
2) Maximum TCE when system was shut off: 318 ug/L @ CEF-016-09D during 4/00 sampling effort 45I was abandoned in March 2000 and 46I was installed as a replacement well. 46I was non detect for TCE in 4/00.
3) System ran for one year from 6/99 to 5/00.
4) Recalculated Bubble radius: 1.66E-03 m Original calculation was 4.49E-03 m.

AIR SPARGING CLEANUP DURATION
JETC NORTH AND SOUTH PLUMES
"Calculation of Rate Constant B"

CLIENT SITE NO.:	NAS Cecil Field Building 271 Tanks UL/R/SUL/D		
TTNUS PROJECT NO.:	CTO-248	By:	Priscilla Fritsch
DATE CALCULATED:	10/1/2002	Checked by:	

(Source:"Air Sparging Model for Predicting Groundwater Cleanup Rate" K.L. Sellers and R.P Schreiber,CDM Inc. 1992)

The first order rate coefficient B can be calculated by the following equation.

$$B = f \times d \times D/L \times S/V \times H/\upsilon \times Q/V_s$$

Variables:

f = Fraction of plume sparged (unitless)	f =	2.0	assumed
d = Fraction of 24-hour day unit operates (unitless)	d =	1.0	assumed
D = Contaminant diffusion coefficent (cm^2/s)	D =	see below	
L = Diffusive distance around bubble (m) [Recalculated using Site-16]	L =	**1.66E-03**	see page 3 of 10
S/V = effective surface area to volume ratio of a bubble (m^{-1})	S/V =	1812.5	see page 3 of 10
H = Depth of screen below water table (m)	H =	5.2	see page 4 of 10
υ = Bubble terminal Rise velocity (m/s)	υ =	2.53E-01	see page 3 of 10
Q = Total air flow (m^3/s)	Q =	2.18E-02	see page 4 of 10
V_s = Volume of water in plume that contact bubbles (m^3)	V_s =	2379.3	see page 4 of 10

CONTAMINANT TYPE	D	B (sec^{-1})	B (yr^{-1})
Benzene	1.00E-09	4.11E-07	1.30E+01
Ethylbenzene	1.00E-09	4.11E-07	1.30E+01
Toluene	1.00E-09	4.11E-07	1.30E+01
Xylenes, Total	1.00E-09	4.11E-07	1.30E+01
Naphthalene	8.00E-10	3.29E-07	1.04E+01
1-Methylnaphthalene	8.00E-10	3.29E-07	1.04E+01
2-Methylnaphthalene	8.00E-10	3.29E-07	1.04E+01
MTBE	8.00E-10	3.29E-07	1.04E+01

AIR SPARGING CLEANUP DURATION
JETC NORTH AND SOUTH PLUMES
"Calculation of Variables"

Estimation of Contaminant Diffusion Coefficient

Volatiles =	**1.00E-09**	**m^2/s**
Semi-Volatiles =	**8.00E-10**	**m^2/s**

Calculate the diffusive distance around bubble (L)

This model assumes L = r

Where r is equal to the effective radius of the bubble

$$r = 2 \times R \times \{6\sigma/[R^2 \times (P_w - P_a) \times g]\}^{1/3}$$

Given

R =	**1.27E-05**	**m**	(orifice diameter of the sparger or well screen slot)
σ =	**0.0728**	**N/m**	(air water surface tension)
Pw =	**1000**	**kg/m^3**	(density of water)
Pa =	**1.29**	**kg/m^3**	(density of air at 50F)
g =	**9.8**	**m/s^2**	(acceleration due to gravity)
well slot =	**0.0005**	**in**	(back calculated using actual conditions from Site-16 Air Sparing System)
L = r =	**1.66E-03**	**m**	

S/V is the effective surface area to volume ratio of a bubble

S/V = 3/r

r is calculated above, therefore

S/V = 1812.5 m^{-1}

υ is the terminal rise velocity of a bubble

$$\upsilon = \{1.04 \times g \times r + (1.07 \times \sigma)/(r \times P_w)\}^{1/2}$$

Where:

g =	**9.8**	**m/s^2**	(acceleration due to gravity)
r =	**1.66E-03**	**m**	(calculated above)
σ =	**0.0728**	**N/m**	(air water surface tension)
P_w =	**1000**	**kg/m^3**	(density of water)
υ =	**0.253**	**m/s**	

AIR SPARGING CLEANUP DURATION
JETC NORTH AND SOUTH PLUMES
"Calculation of Variables"

The height H is equal to the average total depth of the sparge well to the water table

TD =	26	**ft (7 wells @ 26 deep)**
DTW =	9	**ft**
H =	**17.0**	**ft**
H =	**5.2**	**m**

The air flow rate is determined by the number of sparge wells and a correction for pressure caused by well depth

Q = # wells x flow rate per well x adjustment for pressure

# wells =	7	**unitless**
low/well =	10	**SCFM**
TD =	26	**ft**
DTW =	9	**ft**
ADJF =	**0.66**	**unitless**
Q =	**46.20**	**CFM**
Q =	**2.18E-02**	**m^3/s**

Volume of plume in sparged area is determined by following calculation

Vs = A x h x η

Where:

A =	19,782	**ft2 (plume sparged area= 7 air sparging locations x 30 ft radius circles**
h =	**17.00**	**ft (groundwater plume average thickness)**
η =	0.25	**unitless (porosity from RI)**
V_s =	**84073.5**	**ft^3**
V_s =	**2379.3**	**m^3**

EMISSION RATE ESTIMATION
JETC NORTH AND SOUTH PLUMES

CLIENT SITE NO.:	NAS Cecil Field Building 271 Tanks UL/R/SUL/D		
TTNUS PROJECT NO.:	CTO-248	By:	Priscilla Fritsch
DATE CALCULATED:	10/1/2002	Checked By:	

Estimate the VOC emission rate from the AS system:

Emission from air sparging:

Vs x -dC(t)/dt

where:Vs= plume volume= 2379 m^3

dC(t)/dt= rate of decrease of gw concentration

= $C_{(o)}$ x (-B) x e^{-Bt}

Time (day)	Benzene (lb/day)	Ethylbenzene (lb/day)	Toluene (lb/day)	Xylenes, Tota (lb/day)	Naphthalene (lb/day)	1-Methylnaph (lb/day)	2-Methylnaph (lb/day)	MTBE (lb/day)	Total (lb/day)
0	7.5E-03	2.1E-01	2.4E-01	2.5E-01	1.4E-02	2.7E-03	3.8E-03	6.3E-04	0.72
30	2.6E-03	7.2E-02	8.2E-02	8.5E-02	5.9E-03	1.2E-03	1.6E-03	2.7E-04	0.25
180	1.3E-05	3.5E-04	3.9E-04	4.1E-04	8.3E-05	1.6E-05	2.3E-05	3.8E-06	0.00
365	1.7E-08	4.9E-07	5.5E-07	5.7E-07	4.3E-07	8.4E-08	1.2E-07	2.0E-08	0.00

Conclusion:

Emission for any single contaminant is less than 5.5 lbs per day and total is less than 13.7 lbs per day.

Therefore no vapor extraction will be required to attain the FDEP Air Regulations.

AIR SPARGING CLEANUP DURATION ESTIMATION
JETC NORTH AND SOUTH PLUMES

CLIENT SITE NO.:	NAS Cecil Field Building 271 Tanks UL/R/SUL/D		
TTNUS PROJECT NO.:	CTO-248	By:	Priscilla Fritsch
DATE CALCULATED:	10/1/2002	Checked By:	

(Source: "Air Sparging Model for Predicting Groundwater Cleanup Rate" K.L. Sellers and R.P Schreiber, CDM Inc. 1992)

The following first order decay/rate equation may be used to estimate a conservative time for the contaminants of concern concentrations to be reduced below the remedial action ojectives. This model calculates both the average and maximum clean-up times as dictated by the initial concemtrations.

$$C_{(t)} = C_{(o)} \times e^{-Bt}$$

Variables:

$C_{(t)}$ = Concentration at end of duration or RAO's (ug/L)

$C_{(o)}$max = Initial Maximum Concentration (ug/L)

$C_{(o)}$ave = Initial Weighted Average Concentration (ug/L)

e = base of the natural log (approx. 2.71828)

B = first order differential rate constant (see page 7 of 10)

t = duration (solving for)

Solving for t reduces to:

$$t = \ln(C_{(t)}/C_{(o)}) / -B$$

CONTAMINANT TYPE	C_o Max (ug/l)*	C_o Ave (ug/L)*	C_t (ug/L)*	t Max (years)	t Ave (years)
Benzene	89	40	1.00	1.31	1.08
Ethylbenzene	1600	1123	30.00	1.16	1.06
Toluene	2900	1273	40.00	1.25	1.01
Xylenes, Total	3300	1322	20.00	1.49	1.22
Naphthalene	230	93	20.00	0.89	0.56
1-Methylnaphthalene	35	18	20.00	0.20	0.00
2-Methylnaphthalene	55	25	20.00	0.37	0.09
MTBE	11	4	50.00	0.00	0.00
			TOTAL	**6.67**	**5.02**

Assumptions:

The bubble radius was recalculated for Site-3 Air Sparging System using the time the systems ran and the amount of reduction at the site. The radius of the bubble size was the factor which was varied to meet the actual time and contaminant reduction for each site.

1) Maximum TCE prior to Startup: 1700 ug/L @ CEF-003-13S during 2/98 sampling effort
2) Maximum TCE when system was shut off: 410 ug/L @ CEF-003-03S during 4/00 sampling effort 13S was 35.3 ug/L.
3) System ran for one year from 5/99 to 5/00.
4) Recalculated Bubble radius: 3.31E-03 m Original calculation was 4.49E-03 m.

AIR SPARGING CLEANUP DURATION
JETC NORTH AND SOUTH PLUMES
"Calculation of Rate Constant B"

CLIENT SITE NO.:	NAS Cecil Field Building 271 Tanks UL/R/SUL/D		
TTNUS PROJECT NO.:	CTO-248	By:	Priscilla Fritsch
DATE CALCULATED:	10/1/2002	Checked by:	

(Source:"Air Sparging Model for Predicting Groundwater Cleanup Rate" K.L. Sellers and R.P Schreiber,CDM Inc. 1992)

The first order rate coefficient B can be calculated by the following equation.

$$B = f \times d \times D/L \times S/V \times H/\upsilon \times Q/V_s$$

Variables:

f = Fraction of plume sparged (unitless)	f =	2.0	assumed
d = Fraction of 24-hour day unit operates (unitless)	d =	1.0	assumed
D = Contaminant diffusion coefficent (cm^2/s)	D =	see below	
L = Diffusive distance around bubble (m) [Recalculated using Site-3]	L =	**3.31E-03**	see page 8 of 10
S/V = effective surface area to volume ratio of a bubble (m^{-1})	S/V =	906.3	see page 8 of 10
H = Depth of screen below water table (m)	H =	5.2	see page 9 of 10
υ = Bubble terminal Rise velocity (m/s)	υ =	2.39E-01	see page 8 of 10
Q = Total air flow (m^3/s)	Q =	2.18E-02	see page 9 of 10
V_s = Volume of water in plume that contact bubbles (m^3)	V_s =	2379.3	see page 9 of 10

CONTAMINANT TYPE	D	B (sec^{-1})	B (yr^{-1})
Benzene	1.00E-09	1.09E-07	3.43E+00
Ethylbenzene	1.00E-09	1.09E-07	3.43E+00
Toluene	1.00E-09	1.09E-07	3.43E+00
Xylenes, Total	1.00E-09	1.09E-07	3.43E+00
Naphthalene	8.00E-10	8.69E-08	2.74E+00
1-Methylnaphthalene	8.00E-10	8.69E-08	2.74E+00
2-Methylnaphthalene	8.00E-10	8.69E-08	2.74E+00
MTBE	8.00E-10	8.69E-08	2.74E+00

Estimation of Contaminant Diffusion Coefficient

Volatiles =	**1.00E-09**	**m^2/s**
Semi-Volatiles =	**8.00E-10**	**m^2/s**

Calculate the diffusive distance around bubble (L)

This model assumes L = r

Where r is equal to the effective radius of the bubble

$$r = 2 \times R \times \{6\sigma/[R^2 \times (P_w - P_a) \times g]\}^{1/3}$$

Given

R =	**1.02E-04**	**m**	(orifice diameter of the sparger or well screen slot)
σ =	**0.0728**	**N/m**	(air water surface tension)
Pw =	**1000**	**kg/m^3**	(density of water)
Pa =	**1.29**	**kg/m^3**	(density of air at 50F)
g =	**9.8**	**m/s^2**	(acceleration due to gravity)
well slot =	**0.004**	**in**	(back calculated using actual conditions from Site-3 Air Sparing System)
L = r =	**3.31E-03**	**m**	

S/V is the effective surface area to volume ratio of a bubble

S/V = 3/r

r is calculated above, therefore

S/V = 906.3 m^{-1}

υ is the terminal rise velocity of a bubble

$$\upsilon = \{1.04 \times g \times r + (1.07 \times \sigma)/(r \times P_w)\}^{1/2}$$

Where:

g =	**9.8**	**m/s^2**	(acceleration due to gravity)
r =	**3.31E-03**	**m**	(calculated above)
σ =	**0.0728**	**N/m**	(air water surface tension)
P_w =	**1000**	**kg/m^3**	(density of water)
υ =	**0.239**	**m/s**	

The height H is equal to the average total depth of the sparge well to the water table

TD =	26	**ft (7 wells @ 26 deep)**
DTW =	9	**ft**
H =	**17.0**	**ft**
H =	**5.2**	**m**

The air flow rate is determined by the number of sparge wells and a correction for pressure caused by well depth

Q = # wells x flow rate per well x adjustment for pressure

# wells =	7	**unitless**
low/well =	10	**SCFM**
TD =	26	**ft**
DTW =	9	**ft**
ADJF =	**0.66**	**unitless**
Q =	**46.20**	**CFM**
Q =	**2.18E-02**	**m^3/s**

Volume of plume in sparged area is determined by following calculation

Vs = A x h x η

Where:

A =	19,782	**ft2 (plume sparged area= 7 air sparging locations x 30 ft radius circles**
h =	**17.00**	**ft (groundwater plume average thickness)**
η =	0.25	**unitless (porosity from RI)**
V_s =	**84073.5**	**ft^3**
V_s =	**2379.3**	**m^3**

EMISSION RATE ESTIMATION
JETC NORTH AND SOUTH PLUMES

CLIENT SITE NO.:	NAS Cecil Field Building 271 Tanks UL/R/SUL/D		
TTNUS PROJECT NO.:	CTO-248	By:	Priscilla Fritsch
DATE CALCULATED:	10/1/2002	Checked By:	

Estimate the VOC emission rate from the AS system:

Emission from air sparging:

Vs x -dC(t)/dt

where:Vs= plume volume= 2379 m^3

dC(t)/dt= rate of decrease of gw concentration

= $C_{(o)}$ x (-B) x e^{-Bt}

Time (day)	Benzene (lb/day)	Ethylbenzene (lb/day)	Toluene (lb/day)	Xylenes, Tota (lb/day)	Naphthalene (lb/day)	1-Methylnaph (lb/day)	2-Methylnaph (lb/day)	MTBE (lb/day)	Total (lb/day)
0	2.0E-03	5.5E-02	6.3E-02	6.5E-02	3.6E-03	7.2E-04	1.0E-03	1.7E-04	0.19
30	1.5E-03	4.2E-02	4.7E-02	4.9E-02	2.9E-03	5.7E-04	8.0E-04	1.3E-04	0.14
180	3.7E-04	1.0E-02	1.2E-02	1.2E-02	9.4E-04	1.9E-04	2.6E-04	4.3E-05	0.04
365	6.5E-05	1.8E-03	2.0E-03	2.1E-03	2.4E-04	4.6E-05	6.4E-05	1.1E-05	0.01

Conclusion:

Emission for any single contaminant is less than 5.5 lbs per day and total is less than 13.7 lbs per day.

Therefore no vapor extraction will be required to attain the FDEP Air Regulations.

APPENDIX C

REMEDIAL ALTERNATIVE COST ESTIMATES

Table C-1
Air Sparging

Remedial Action Plan
Building 271, Tanks 271/UL/R/SUL/D
Naval Air Station Cecil Field
Jacksonville, Florida

Estimator: PKF
Checked By:

COST SUMMARY TABLE (costs rounded to nearest $1000)

DIRECT COSTS		
Site Preparation		$11,000
Piping and Equipment		$57,000
TOTAL DIRECT COST		**$68,000**
INDIRECT COSTS		
Engineering and Design (10%)		$7,000
Contingency (10%)		$7,000
TOTAL INDIRECT COST		**$14,000**
Total Capital Costs (Direct + Indirect)		**$82,000**
OPERATIONS AND MAINTENANCE		
Administrative O&M		
O&M Manual		$5,000
Health and Safety Plan for Monitoring Activities		$6,000
Sampling and analysis Plan (SAP) for Monitoring Activities		$8,000
Total Treatment System O&M 1st year costs only		**$19,000**
Groundwater Monitoring		
Quarterly Groundwater Sampling Activities (4 Events)		$23,000
Total Reporting Cost for 4 Sampling Events		$24,000
Treatment System O&M		
System Maintenance		$14,000
Utilities		$5,000
Total Treatment System O&M		**$66,000**
Present Worth of Treatment System O&M (7%, 3 yrs)	($173,205)	$173,000
Present Worth O&M (Administrative + Treatment System O&M)		
Assumption - System will run for three years,		
TOTAL COST		**$274,000**

Table C-1 (Continued)
Air Sparging Cost Alternative

DIRECT COSTS	Quantity	Unit	Unit Cost: Subcontract	Material	Labor	Equipment	Total Cost
Site Preparation							
Storage trailer	2	mo	$85	$0	$0	$0	$170
Treatment system concrete pad (6")	180	ft^2	$0	$3	$3	$1	$1,210
Chain-link fence, 6' high	70	ft	$0	$10	$3	$2	$1,042
8' Gates for access to treatment system fence	1	ea	$0	$504	$235	$169	$908
Utility connection for treatment system assumes power available from Bldg 334	1	ls	$5,000	$0	$0	$0	$5,000
Pressure washer and water tank	2	mo	$0	$0	$0	$528	$1,056
ODCs(Plastic sheeting, drums, pumps, hoses, supplies,etc.)	1	ls	$0	$2,000	$0	$0	$2,000
Total Site Preparation							**$11,385**
Air Sparge System							
Piping and Equipment							
20 HP Oilless Blower, Heat Exchanger, Sound Enclosure, Control Panel, & Shipping	1	ls	$23,470	$0	$929	$0	$24,399
Wastewater Storage Tank - 500 Gallon	1	ea	$0	$530	$421	$0	$951
Equipment plumbing (piping, elbows, instruments, etc.)	1	ls	$0	$5,582	$843	$0	$6,425
Install Air Sparging Wells - Drilling Rotary Mud (7 @26' depth)	182	ft	$27	$0	$0	$0	$4,914
Install Air Sparging Wells - Development	7	well	$75	$0	$0	$0	$525
Air Sparge Well plumbing (piping, elbows, instruments, etc.)	1	ls	$0	$10,868	$2,698	$0	$13,565
Misc construction materials	1	ls	$0	$1,000	$0	$0	$1,000
Trench/Backfill, 24" deep	320	lf	$0.00	$0.26	$0.50	$0.29	$336
Site restoration (paving, hydroseeding, etc.)	1	ls	$3,000	$0	$0	$0	$3,000
Remedial well survey (survey of new well locations)	1	ls	$1,000	$0	$0	$0	$1,000
System start-up	1	day	$0	$0	$886	$0	$886
Total Piping and Equipment							**$57,002**
TOTAL DIRECT COSTS							**$68,386**

OPERATIONS AND MAINTENANCE

	Quantity	Unit	Subcontract	Material	Labor	Equipment	Total Cost
O&M Manual							
Labor:							
Mid-level Engineer	40	hrs	$0	$0	$45	$0	$1,800

Table C-1 (Continued)
Air Sparging Cost Alternative

				Unit Cost			
Word Processor	16	hrs	$0	$0	$35	$0	$560
CADD	32	hrs	$0	$0	$40	$0	$1,280
Editor	8	hrs	$0	$0	$60	$0	$480
Copying: 50 pgs x 25 copies	1250	page	$0	$0.10	$0	$0	$125
Binding/shipping, 25 copies	25	ea	$0	$20	$0	$0	$500
Total O&M Manual							**$4,745**
LONG TERM MONITORING							
Health and Safety Plan for Monitoring Activities							
Labor:							
H&S Supervisor	16	hrs	$0	$0	$60	$0	$960
Mid-level Geologist/Scientist	40	hrs	$0	$0	$45	$0	$1,800
Word Processor	16	hrs	$0	$0	$35	$0	$560
CADD	32	hrs	$0	$0	$40	$0	$1,280
Editor	8	hrs	$0	$0	$60	$0	$480
Copying: 50 pgs x 25 copies	1250	page	$0	$0.10	$0	$0	$125
Binding/shipping, 25 copies	25	ea	$0	$20	$0	$0	$500
Total HASP							**$5,705**
Sampling and analysis Plan (SAP) for Monitoring Activities							
Labor:							
Jr.-Level Geologist/Scientist	80	hrs	$0	$0	$45	$0	$3,600
Senior Geologist	16	hrs	$0	$0	$80	$0	$1,280
ODC's, Production Support (editing, copying, binders, etc.)							
Word Processor	16	hrs	$0	$0	$35	$0	$560
CADD	32	hrs	$0	$0	$40	$0	$1,280
Editor	8	hrs	$0	$0	$60	$0	$480
Copying: 50pgs x 25 copies	1250	page	$0	$0.10	$0	$0	$125
Binding/shipping, 25 copies	25	ea	$0	$20	$0	$0	$500
Total SAP							**$7,825**
Quarterly Groundwater Sampling Activities Per Event							
1 geologist & 1 technician per sampling event @ 10 hour days	40	hrs	$0	$0	$75	$0	$3,000
Lab analysis							
Volatile Organics, Method SW846-8021B, assume 4 wells, 1 QC samples	5	ea	$80	$0	$0	$0	$400
PAHs, Method SW846-8310, assume 4 wells, 1 QC samples	5	ea	$135	$0	$0	$0	$675
Expendables and equipment	1	ls	$300	$928	$0	$410	$1,638

Table C-1 (Continued)
Air Sparging Cost Alternative

			Unit Cost				
Total Sampling Cost:							**$5,713**

			Unit Cost				
REPORTING	Quantity	Unit	Subcontract	Material	Labor	Equipment	Total Cost
Site Activities Report (Quarterly)							
Jr. Level Engineer	40	hrs	$0	$0	$45	$0	$1,800
Senior Engineer	16	hrs	$0	$0	$80	$0	$1,280
Production:							
Word processing	12	hrs	$0	$0	$35	$0	$420
Technical Expert	6	hrs	$0	$0	$75	$0	$450
Editor	8	hrs	$0	$0	$60	$0	$480
CADD operator, 3 dwgs per report @ 8 hours per dwg	24	hrs	$0	$0	$40	$0	$960
Reproduction: 100 pgs @ 20 copies	2000	pg	$0.00	$0.10	$0.00	$0.00	$200
Shipping/binding: 20 reports	20	ea	$0	$20	$0	$0	$400
Total Report Cost:							**$5,990**
TOTAL LONG TERM MONITORING COSTS 12 Quarters							**$153,966**

			Unit Cost				
TREATMENT SYSTEM O&M	Quantity	Unit	Subcontract	Material	Labor	Equipment	Total Cost
System Maintenance							
Technicain, 8 hrs per month	96	hrs	$0	$0	$30	$0	$2,880
Project Manager, 2 hrs per month	96	hrs	$0	$0	$100	$0	$9,600
Electrician/Plummer, 4 hrs per year	4	hrs	$0	$0	$500	$0	$2,000
Utilities (Electric)							
Assume 10 kW*24 hr/day*365 day/yr= 87600KWh	87600	KWh	$0	$0.06	$0	$0	$5,256
Total Treatment System O&M (Annual)							**$19,736**

	Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost	Source
	Equipment Control Area												
	2.41 Piping, 2" Galvanized Carbon Steel	50	lf		$4.47			$0	$224	$0	$0	$224	m00-15107-620-5580
	2.42 2" Steel 90^0 elbows (outside of equipment control area)	8	ea		$8.69			$0	$70	$0	$0	$70	McMaster's 2001 + 20%
	2.43 2" Steel Tee	5	ea		$12.41			$0	$62	$0	$0	$62	McMaster's 2001 + 20%
	2.44 2" Steel Gate Valve	2	ea		$220.14			$0	$440	$0	$0	$440	McMaster's 2001 + 20%
	2.45 2" Steel Butterfly Valve	5	ea		$266.84			$0	$1,334	$0	$0	$1,334	McMaster's 2001 + 20%
	2.46 2" Pressure Regulator	2	ea		$61.48			$0	$123	$0	$0	$123	Site-16 AS/VE cost estimate
	2.47 Pressure Gauge/Indicator, 0 - 150 psi	2	ea		$44.83			$0	$90	$0	$0	$90	McMaster's 2001 + 20%
	2.48 2" Steel Flow Meters	2	ea		$1,452.20			$0	$2,904	$0	$0	$2,904	Site-16 AS/VE cost estimate
	2.49 Piping, Connections, 2" Carbon Steel to 2" PVC	2	ea		$103.40			$0	$207	$0	$0	$207	McMaster's 2001 + 20%
	2.50 Quick Disconnect Coupling	1	ea		$16.82			$0	$17	$0	$0	$17	
	2.51 Plumber and Apprentice	2	day			$421.34		$0	$0	$843	$0	$843	Means Crew Q-1
								$0	$5,470	$843	$0	$6,313	
	Wells and Piping												
7	2.1 Install Air Sparging Wells - Drilling Rotary Mud	182	vlf										
	2.2 Install Air Sparging Wells - Development	7	well										
	2.6 Tee with Threaded Cap	7	ea		$10.12			$0	$71	$0	$0	$71	McMaster's 2001 + 20%
	2.7 1/4" Brass Ball Valve/Nipple	7	ea		$7.04			$0	$49	$0	$0	$49	McMaster's 2001 + 20%
	2.8 1" Butterfly Valve	7	ea		$15.91			$0	$111	$0	$0	$111	McMaster's 2001 + 20%
	2.9 2' x 2' x 2' Valve Box with Locking Cover H-20 rating	7	ea		$197.00	$265.00		$0	$1,379	$1,855	$0	$3,234	Verbal Quote from Atlantic Drilling
	2.14 Piping, 2" PVC Sch 80 Pipe	320	lf		$1.49			$0	$477	$0	$0	$477	McMaster's 2001 + 20%
	2.15 Piping, 2" PVC Sch 80 90^0 Elbow	5	ea		$6.39			$0	$32	$0	$0	$32	NIBCO Sch 80 List Prices 02/28/00 Labor Site-16
	2.16 Piping, 2" PVC Sch 80 Reducing Tee 2" x 1"	7	ea		$15.35			$0	$107	$0	$0	$107	NIBCO Sch 80 List Prices 02/28/00 Labor Site-16
	2.17 Piping, 2" PVC Sch 80 Tee 2" x 2"	7	ea		$22.69			$0	$159	$0	$0	$159	NIBCO Sch 80 List Prices 02/28/00 Labor Site-16
	2.18 Piping, 2" PVC Sch 80 Couple	32	ea		$7.92			$0	$253	$0	$0	$253	NIBCO Sch 80 List Prices 02/28/00 Labor Site-16
	2.19 2" PVC Sch 80 Ball Valves	0	ea		$17.46			$0	$0	$0	$0	$0	McMaster's 2001 + 20%
	2.20 2" PVC Pressure Regulator Valves	7	ea		$445.20			$0	$3,116	$0	$0	$3,116	Site-16
	2.21 2" Pressure Gauge	7	ea		$44.83			$0	$314	$0	$0	$314	McMaster's 2001 + 20%
	2.22 1" Flow Indicator 0-20 CFM	7	ea		$676.00			$0	$4,732	$0	$0	$4,732	Call Chris
	2.23 Piping, 1" PVC Sch 80 Pipe	28	lf		$0.66			$0	$19	$0	$0	$19	McMaster's 2001 + 20%
	2.24 1" PVC Sch 80 Ball Valves	7	ea		$6.82			$0	$48	$0	$0	$48	McMaster's 2001 + 20%
	2.25 Piping, 1" PVC 90^0 Sch 80 Elbow	0	ea		$3.68			$0	$0	$0	$0	$0	NIBCO Sch 80 List Prices 02/28/00 Labor Site-16
	2.28 Plumber and Apprentice	2	day			$421.34		$0	$0	$843	$0	$843	Means Crew Q-1
								$0	$10,868	$2,698	$0	$13,565	

Table C-2
ORC Injection

Remedial Action Plan
Building 271, Tanks 271 UL/R/SUL/D
Naval Air Station Cecil Field
Jacksonville, Florida

Estimator: MJJ
Checked By:

COST SUMMARY TABLE (costs rounded to nearest $1000)

DIRECT COSTS		
Site Preparation		$3,000
Total ORC Injection		$221,000
TOTAL DIRECT COST		**$224,000**
INDIRECT COSTS		
Engineering and Design (10%)		$22,000
Contingency (10%)		$22,000
TOTAL INDIRECT COST		**$44,000**
Total Capital Costs (Direct + Indirect)		**$268,000**
MONITORING COSTS		
Health and Safety Plan for Monitoring Activities		$6,000
Sampling and analysis Plan (SAP) for Monitoring Activities		$8,000
Monitoring Costs (1st year costs only)		**$14,000**
Quarterly Groundwater Sampling Activities 4 Events		$23,000
Total Reporting Cost for 4 Sampling Events		$24,000
Monioring Costs, (3 year duration)		**$47,000**
Present worth of LTM (7%, 3 yrs)	($123,343)	$123,000
Assumption - Remediation duration will be two years,		
TOTAL COST		**$405,000**

Table C-2 (Continued)
ORC Cost Alternative

DIRECT COSTS	Quantity	Unit	Subcontract	Unit Cost Material	Labor	Equipment	Total Cost
Site Preparation							
Storage trailer	1	mo	$85	$0	$0	$0	$85
Pressure washer and water tank	1	mo	$0	$0	$0	$528	$528
ODCs(Plastic sheeting, drums, pumps, hoses, supplies,etc.)	1	ls	$0	$2,000	$0	$0	$2,000
Total Site Preparation							**$2,613**
ORC Injection (1st Application)							
Treatability Study	1	ls	$15,000	$0	$0	$0	$15,000
Direct Push Holes (mob/demob)	1	ls	$5,000	$0	$0	$0	$5,000
Direct Push Holes (56 injection locations)	15	day	$4,500	$0	$0	$0	$67,500
Inject ORC	4157	lb	$0	$8	$0	$0	$33,256
ORC Injection (2nd Application)							
Direct Push Holes (mob/demob)	1	ls	$5,000	$0	$0	$0	$5,000
Direct Push Holes (27 injection locations)	7	day	$4,500	$0	$0	$0	$31,500
Inject ORC	2078.5	lb	$0	$8	$0	$0	$16,628
ORC Injection (3rd Application)							
Direct Push Holes (mob/demob)	1	ls	$5,000	$0	$0	$0	$5,000
Direct Push Holes (27 injection locations)	7	day	$4,500	$0	$0	$0	$31,500
Inject ORC	1039.25	lb	$0	$8	$0	$0	$8,314
Site restoration (paving, hydroseeding, etc.)	1	ls	$2,000	$0	$0	$0	$2,000
Total ORC Injection							**$220,698**
TOTAL DIRECT COSTS							**$223,311**

Unit Cost

Table C-2 (Continued)
ORC Cost Alternative

LONG TERM MONITORING	Quantity	Unit	Subcontract	Unit Cost Material	Labor	Equipment	Total Cost
Health and Safety Plan for Monitoring Activities							
Labor:							
H&S Supervisor	16	hrs	$0	$0	$60	$0	$960
Mid-level Geologist/Scientist	40	hrs	$0	$0	$45	$0	$1,800
Word Processor	16	hrs	$0	$0	$35	$0	$560
CADD	32	hrs	$0	$0	$40	$0	$1,280
Editor	8	hrs	$0	$0	$60	$0	$480
Copying: 50 pgs x 25 copies	1250	page	$0	$0.10	$0	$0	$125
Binding/shipping, 25 copies	25	ea	$0	$20	$0	$0	$500
Total HASP							**$5,705**
Sampling and analysis Plan (SAP) for Monitoring Activities							
Labor:							
Jr.-Level Geologist/Scientist	80	hrs	$0	$0	$45	$0	$3,600
Senior Geologist	16	hrs	$0	$0	$80	$0	$1,280
ODC's, Production Support (editing, copying, binders, etc.)							
Word Processor	16	hrs	$0	$0	$35	$0	$560
CADD	32	hrs	$0	$0	$40	$0	$1,280
Editor	8	hrs	$0	$0	$60	$0	$480
Copying: 50pgs x 25 copies	1250	page	$0	$0.10	$0	$0	$125
Binding/shipping, 25 copies	25	ea	$0	$20	$0	$0	$500
Total SAP							**$7,825**
Quarterly Groundwater Sampling Activities Per Event							
1 geologist & 1 technician per sampling event @ 10 hour days	40	hrs	$0	$0	$75	$0	$3,000
Lab analysis							
Volatile Organics, Method 8260, assume 4 wells, 1 QC samples	5	ea	$80	$0	$0	$0	$400
PAHs, Method 8310, assume 4 wells, 1 QC samples	5	ea	$135	$0	$0	$0	$675
Expendables and equipment	1	ls	$300	$928	$0	$410	$1,638
Total Sampling Cost:							**$5,713**

Table C-2 (Continued)
ORC Cost Alternative

REPORTING	Quantity	Unit	Unit Cost Subcontract	Material	Labor	Equipment	Total Cost
Site Activities Report (Quarterly)							
Jr. Level Engineer	40	hrs	$0	$0	$45	$0	$1,800
Senior Engineer	16	hrs	$0	$0	$80	$0	$1,280
Production:							
Word processing	12	hrs	$0	$0	$35	$0	$420
Technical Expert	6	hrs	$0	$0	$75	$0	$450
Editor	8	hrs	$0	$0	$60	$0	$480
CADD operator, 3 dwgs per report @ 8 hours per dwg	24	hrs	$0	$0	$40	$0	$960
Reproduction: 100 pgs @ 20 copies	2000	pg	$0.00	$0.10	$0.00	$0.00	$200
Shipping/binding: 20 reports	20	ea	$0	$20	$0	$0	$400
Total Report Cost:							**$5,990**

APPENDIX D

AS DESIGN CALCULATIONS

Pressure Loss Air Sparging System
By: Priscilla Fritsch
Checked by: _____

Pressure Loss Calculation: Air Sparging Systems

Start with the pressure required to force out/evacuate the water column in the deeper air sparging well
Calculate fitting and line losses from farthest air spraging well location to the treatment plant
Within the treatment plant, include fittings and line losses

All piping outside the plant is Schedule 80 PVC
All piping inside the plant is Schedule 80 carbon steel
For the purposes of pressure loss, both are assumed identical

For all line losses and all fitting losses:

Crane manual (1942) is used (see attached copy)
ChemAire Product Guide & technical Manual (see attached copy)
Dwyer Flow Meters spec sheet (see attached copy)
American Industrial ASA Heat Exchanger (See attached copy)

	Run or L/D Ft	CFM	Available Pressure PSI	Pressure Loss or Required PSI	Reference
Blower		100	25		
2" Gate 100% open	1.2				Crane - 1942 Tech Paper 409
Heat Exchanger			24.5	0.5	American Industrial ACA 3362-3
2" Gate 100% open	1.2				Crane - 1942 Tech Paper 409
Pressure Indicator					
2" Gate 25% open	150				Crane - 1942 Tech Paper 409
Say 2-inch pipe 100 CFM 0.22 psi / 100 ft @ 25 psi	152.4		24	0.33	Crane -1988 Tech Paper 410 Schedule 40 Steel Pipe @ 60^0F Page B-15
From blower		100 -> 60			
2" - 90^0 Elbow	4				Chem Aire tech paper
2" - 90^0 Elbow	4				Chem Aire tech paper
2" - Flow Thru Tee	2.7				Chem Aire tech paper
2" - Flow Thru Tee	2.7				Chem Aire tech paper
2" - Side Flow Tee	8.1				Chem Aire tech paper
2" - 90^0 Elbow	4				Chem Aire tech paper
2" - Butterfly Valve Gate 25% open	120				Crane - 1942 Tech Paper 409
Pipe Run	265				
Say 2-inch pipe 60 CFM 0.13 psi / 100 ft @ 24 psi	410.5		24	0.53	Crane -1988 Tech Paper 410 Schedule 40 Steel Pipe @ 60^0F Page B-15
		60 -> 10			
Pressure Regulator		10	19	5	Fisher-Rosemount 1stView
1/2" - hose	2.6				Chem Aire tech paper
1/2" Flow Indicator			17	2	Dwyer model RMC-123-SSV
1/2" - hose	1.7				Chem Aire tech paper
2" - Side Flow Tee with adaptor	12				Chem Aire tech paper
Head	25			8.6	Static Pressure of Water
Screen			14	3	Profession Judgement
Say 1/2 hose 10 CFM 0.15 psi / 100 ft @ 14 psi	41.3		14	0.062	Crane -1988 Tech Paper 410 Schedule 40 Steel Pipe @ 60^0F Page B-15
		10			
				20	Total Pressure Required

APPENDIX E

AS EQUIPMENT SPECIFICATIONS

Fliteway Technologies, Inc.
P.O. Box 108
6901 Industrial Loop
Greendale, WI 53129

Fax Cover Sheet

DATE:	August 19, 2002	**TIME:**	12:22 PM
TO:	Tetra Tech Mark Jonnet	**PHONE:** **FAX:**	412-921-7090 412-921-4040
FROM:	William E. Diehl	**PHONE:** **FAX:**	414-423-5600 414-423-9007
RE:	**Q12413 Rev 1**		
CC:			

Number of pages including cover sheet: [3]

Message

Mark,

Please call if you have any questions

Bill Diehl

Fliteway Technologies, Inc.
6801 Industrial Loop • P.O. Box 108 • Greendale, WI 53129
(414) 423-8600 • 1-800-238-3580 • FAX (414) 423-9007

August 19, 2002

Tetra Tech
Pittsburg, PA

Q12413 Rev 1

Attn: Mark Jonnet
Reference: Quotation for Air Sparge Unit for Florida

Dear Mark,

We are pleased to provide our quotation on the following Air Sparging System for your project.

Air Sparging System
Fliteway Model FS20N3-DTLF 250 (86 DBA) rated for 150 SCFM at up to 25 PSIG

- 20 HP TEFC C Face 208-230 / 460 VAC Three Phase Motor
- Becker DTLF 250 Oilless Rotary Vane Pump.
- Built in internal Carbon Dust Inlet and Discharge Filters
- Mini magnahclic to monitor differential pressure across filter element
- Built in Pressure Regulating Valve
- External Discharge Silencer
- Relief Valve
- Air Bleed Valve with silencer
- All iron pipe and fittings
- American Industrial Model ACA-3362-3 Low Pressure Drop Heat Exchanger
  - 1 HP TEFC Motor
    (Sized for discharge temperature within 15 degrees of ambient Temperature)
- Discharge Check Valve
- Discharge Pressure and Temperature Gauges before and after heat exchanger
- High Temperature Shutdown Switch
- Discl rge Pressure Switch
- Steel Base Frame with Forklift Pockets

$ 13,312

- Steel Sound Enclosure surrounding Blower and Motor with:
  - TEFC Vent Fan
  - One Layer of 2" Convoluted Polyether Noise Absorption Foam

$ 1,895

- **NEMA 4 Control Panel (Mounted and Tested)**

  - Lockable NEMA 4 Panel with inner panel
  - Fused Disconnect
  - Motor Starter and overload Protectionfor:
    - 20 HP Air Sparge Motor
    - 1 HP Heat Exchanger Motor
  - Two (2) HOA Switches
    - Air Sparge
    - Heat Exchanger
  - Control Transformer
  - Relay Logic
  - Alarm Lights
    - Air Sparge Motor Failure
    - High Discharge Temperature
    - High Discharge Pressure
  - 24 Hour Timer
  - Weekly Timer
  - Alarm Reset
  - Surge Protection
  - Lightning Protection
  - Pha: Monitor
  - UL Certification

$ 5,802

Total $ 21,009

6% Florida State Sales Tax $ 1,261

Estimated Freight $ 1,200

Quotation Valid for 30 Days

Pricing: FOB Greendale, WI (Applicable sales taxes if any not included)

Terms: Net 30 days (1 1/2 % per month finance charge on unpaid balance over 30 days).

Delivery: 6-7 weeks from date written order.

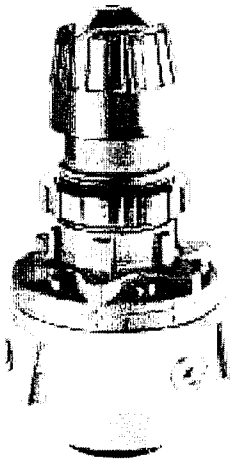
Sincerely,

William E. Diehl
President

Regulator
R26

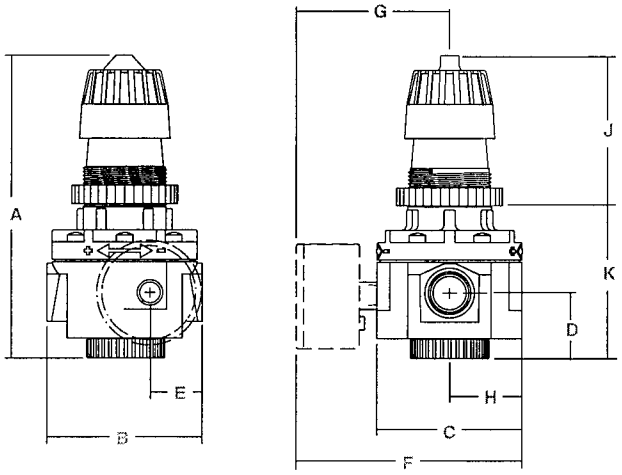
Relieving

Non-relieving



Features

- Non-rising adjustment knob with friction lock knob.
- Standard with two full flow 1/4" NPT/BSPT-Rc gauge ports
- Panel mount nut.
- High flow capacity.
- Balanced valve design for excellent regulation characteristics.



NOTE: 1.88" Dia. (47.8 mm) hole required for panel nut mounting

Specifications

Flow Capacity*	1/4	112 scfm (53 dm³/s)
	3/8	148 scfm (70 dm³/s)
	1/2	185 scfm (87 dm³/s)
Maximum Operating Temperature		175°F (79°C)
Maximum Supply Pressure		300 psig (21 bar)
Adjusting Range Pressure		0-60 psig (0-4,1 bar) 0-125 psig (0-8,5 bar) 0-250 psig (0-17,1 bar)
Port Size	NPT/BSPP-G	1/4, 3/8, 1/2
Gauge Port (2 ea.)	NPT/BSPT-Rc	1/4
Weight	lb. (kg)	2.5 (1,34)

*Inlet pressure 100 psig (7 bar). Secondary pressure 90 psig (6 bar).

Materials of Construction

Body	Zinc
Bonnet	PBT
Diaphragm	Nitrile/Zinc
Valve Assembly	Brass/Nitrile/Acetal
Springs	Steel
Seals	Nitrile
Panel Nut	Acetal

Dimensions

Models	Inches mm	A	B	C	D	E	F	G	H	J	K
Standard Unit		6.48	3.35	3.10	1.35	1.13	—	—	1.55	3.3	3.18
R26-XX-000		165	85	79	34	28.7	—	—	39.4	82.6	82.4
With Gauge		6.48	3.35	3.10	1.35	1.13	4.80	3.13	1.55	3.3	3.18
R26-XX-G00		165	85	79	34	28.7	122	79.5	39.4	82.6	82.4

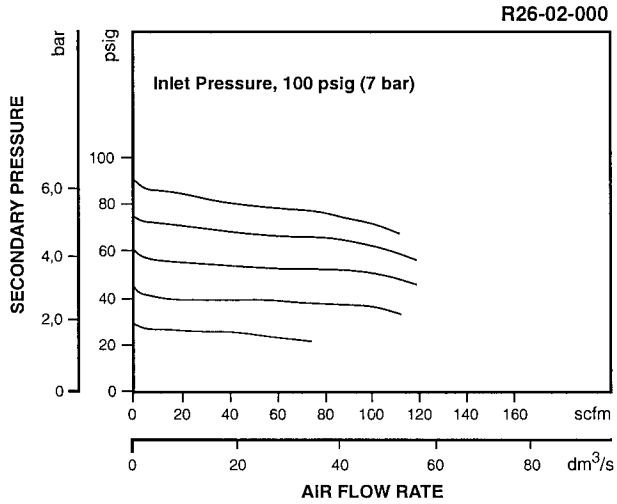
Replacement Kits

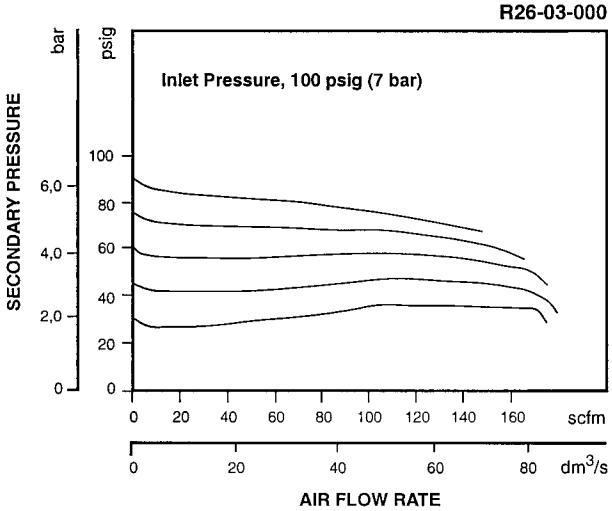
Diaphragm Assembly, Non-relieving RRP-96-332
Diaphragm Assembly, Self-relieving.....RRP-96-238
Knob, Adjusting (Series A)—used on units
with plastic bonnets.....RRP-95-023
Spring, Regulating, 0-60 psig (0-4,1 bar).....RRP-95-962
Spring, Regulating, 0-125 psig (0-8,6 bar).....GRP-95-225
Spring, Regulating, 0-250 psig (0-17,2 bar).....RRP-95-219
Valve Assembly (Series A)—Valve, Valve Spring,
Bottom Plug O-ring.....RRP-96-294

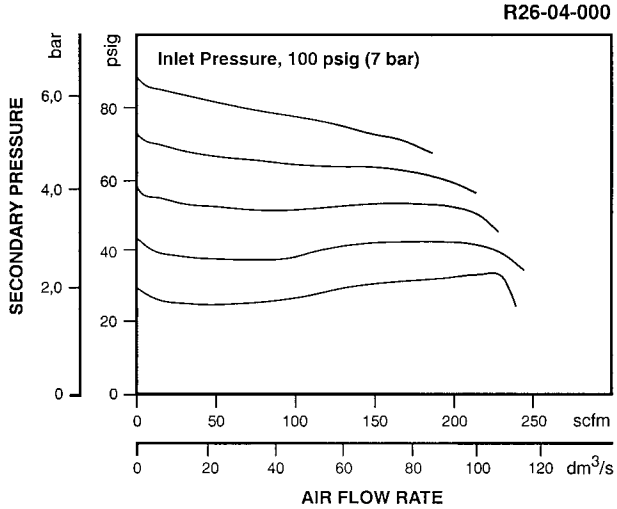
Accessories

Wall Mounting Bracket, Gauge Port Adapter, 1/4 NPT....RRP-95-590
Wall Mounting Bracket, C-Type.....GPA-95-051
Wall Mounting Bracket, C-Type.....RPA-95-947
Wall Mounting Bracket, L-Type—Heavy Duty GPA-95-956
Gauge, Pressure, 0-60 psig (0-4 bar),
2 Dial Face, 1/4 NPT, CBM.....RRP-95-230
Gauge, Pressure, 0-160 psig (0-11 bar)
2 Dial Face, 1/4 NPT, CBM.....GRP-95-229
Gauge, Pressure, 0-300 psig (0-20 bar)
2 Dial Face, 1/4 NPT, CBM.....RRP-95-231
Nut, Panel Mount, Plastic.....RRP-95-954
Tamper Resistant Kit (Series A), Ring Style
used on plastic bonnets.....RPA-95-006

For best performance, regulated pressure should always be set by increasing the pressure up to the desired setting.







Ordering Information

Model Type	Port Size	Without Gauge 5-125 psig (0,4-8,5 bar)	Without Gauge 10-250 psig (0,7-17 bar)	Without Gauge 3-60 psig (0,2-4,1 bar)	With Gauge 5-125 psig (0,4-8,5 bar)	With Gauge 10-250 psig (0,7-17 bar)	With Gauge 3-60 psig (0,2-4,1 bar)
Relieving	1/4	R26-02-000	R26-02-H00	R26-02-L00	R26-02-G00	R26-02-GH0	R26-02-GL0
	3/8	R26-03-000	R26-03-H00	R26-03-L00	R26-03-G00	R26-03-GH0	R26-03-GL0
	1/2	R26-04-000	R26-04-H00	R26-04-L00	R26-04-G00	R26-04-GH0	R26-04-GL0
Non-relieving	1/4	R26-02-N00	R26-02-HN0	R26-02-LN0	R26-02-GN0	R26-02-GHN	R26-02-GLN
	3/8	R26-03-N00	R26-03-HN0	R26-03-LN0	R26-03-GN0	R26-03-GHN	R26-03-GLN
	1/2	R26-04-N00	R26-04-HN0	R26-04-LN0	R26-04-GN0	R26-04-GHN	R26-04-GLN

Options - To order an option supplied with the unit model, add the appropriate coded suffix letter in position 6, 7, 8 of the model number.
For additional information on accessories and repair kits refer to pages 326 through 334.

APPENDIX F

RAP CHECKLIST

Remedial Action Plan Summary

DEP Form # 62-770.900(4)
Form Title: Remedial Action Plan Summary
Effective Date: September 23, 1997

Site Name _____
Location _____
Media Contaminated: ☐ Groundwater ☐ Soil

FDEP Facility ID No. _____
Current Date ___/___/___
Date of Last GW Analysis ___/___/___

Type(s) of Product(s) Discharged:
☐ Gasoline Analytical Group
☐ Kerosene Analytical Group (Diesel)
- Estimated Petroleum Mass (lbs):
  Groundwater _____
  Saturated Zone Soil _____
  Vadose Zone Soil _____
- Area of Plume _____ (ft^2)
- Thickness of Plume _____ (ft)

Groundwater Recovery and Specifications:
- No. of Recovery Wells _____
  ☐ Vertical ☐ Horizontal
- Design Flow Rate/Well _____ (gpm)
- Total Flow Rate _____ (gpm)
- Hydraulic Conductivity _____ (ft/day)
- Recovery Well Screen Interval _____ (ft)
- Depth to Groundwater _____ (ft)

Method of Groundwater Remediation:
☐ Pump-and-Treat
  ☐ Air Stripper
    ☐ Low Profile ☐ Packed Tower
  ☐ Diffused Aerator
  ☐ Activated Carbon
    ☐ Primary Treatment ☐ Polishing
☐ In Situ Air Sparging
- No. of Sparge Points _____
  ☐ Vertical ☐ Horizontal
- Pressure _____ (psi)
- Design Air Flow Rate/Well _____ (cfm)
- Total Air Flow Rate _____ (cfm)

☐ Biosparging
- No. of Sparge Points _____
  ☐ Vertical ☐ Horizontal
- Design Air Flow Rate/Well _____ (cfm)

☐ Bioremediation
  ☐ In Situ ☐ Ex Situ
☐ Other _____

Method of Groundwater Disposal:
☐ Infiltration Gallery ☐ Sanitary Sewer
☐ Surface Discharge/NPDES ☐ Injection Well
☐ Other _____

Free Product Present: ☐ Yes ☐ No
- Estimated Volume _____ (gal)
- Maximum Thickness _____ (in)
- Method of Recovery (check all that apply):
  ☐ Manual Bailing ☐ Skimming Pump
  ☐ Other _____

Method of Soil Remediation:
☐ Excavation
  Volume to be Excavated _____ (yds^3)
  ☐ Thermal Treatment ☐ Land Farming On Site
  ☐ Landfill ☐ Bioremediation
  ☐ Other _____
☐ Vapor Extraction System (VES)
- No. of Venting Wells _____
  ☐ Vertical ☐ Horizontal
- VES - Applied Vacuum _____ (wg)
- Design Air Flow Rate _____ (cfm)
- Design Radius of Influence _____ (ft)
- Air Emissions Treatment
  ☐ Thermal Oxidizer ☐ Catalytic Converter
  ☐ Carbon ☐ Other _____

☐ Soil Bioventing
- No. of Venting Wells _____
  ☐ Vertical ☐ Horizontal
- Design Air Flow Rate _____ (cfm)

☐ In Situ Bioremediation
☐ Other _____

Natural Attenuation:
- Method of Evaluation
  ☐ Rule 62-770.690(1)(e), F.A.C.
  ☐ Rule 62-770.690(1)(f), F.A.C.

Estimated Time of Cleanup: _____ (days)
- Method of Estimation
  ☐ Pore Volumes (no. of pore vols. = _____)
  ☐ Exponential Decay (Decay Rate) ____ (day^{-1})
  ☐ Groundwater Model
  ☐ Other _____

Estimated Cost:
- Est. Capital Cost (incl. install.) $ _____
- Est. O & M Cost (per year) $ _____
- Est. Total Cleanup Cost $ _____