Science Applications International Corporation — An Employee-Owned Company

800 Oak Ridge Turnpike, Oak Ridge, TN 37831 (423) 481-4600

CHAIN OF CUSTODY RECORD

COC NO.: HAAF04239905

PROJECT NAME: HAAF CAP-OLD PROPERTY DISPOSAL (PDO) YARD

PROJECT NUMBER: DACA21-95-D-0022, DO # 36

PROJECT MANAGER: Allison Bailey

Sampler (Signature): [signature] (Printed Name): MIKE KLIDEEJS

LABORATORY NAME: Catlin Laboratories

LABORATORY ADDRESS: 1051 Johnnie Dodds Blvd. Suite C Mt. Pleasant, SC 29464

PHONE NO: (803) 881-6000

Sample ID	Date Collected	Time Collected	Matrix	MOISTURE CONTENT	GRAIN SIZE (SIEVE)	ATTERBERG LIMITS	PERMEABILITY	SPECIFIC GRAVITY	POROSITY/BULK DENSITY	No. of Bottles/ Vials:	OVA SCREENING	OBSERVATIONS, COMMENTS, SPECIAL INSTRUCTIONS
PG14000	4/15/99	1600	SOIL	X	X	X	X	X	X	1	N/A	6.0-8.0FT

A-27

RELINQUISHED BY:	Date/Time	RECEIVED BY:	Date/Time	TOTAL NUMBER OF CONTAINERS: 1	Cooler Temperature: NA
[signature] Hall	4-23-99 1200	[signature]	4/26/99 1:00pm	Cooler ID: NA	FEDEX NUMBER: 811236285401
COMPANY NAME: SAIC		COMPANY NAME: CATLIN			
RECEIVED BY: FedEx	Date/Time 4-23-99 1200	RELINQUISHED BY:	Date/Time		
COMPANY NAME:		COMPANY NAME:			
RELINQUISHED BY:	Date/Time	RECEIVED BY:	Date/Time		
COMPANY NAME:		COMPANY NAME:			

Science Applications International Corporation — An Employee-Owned Company

800 Oak Ridge Turnpike, Oak Ridge, TN 37831 (423) 481-4600

CHAIN OF CUSTODY RECORD

COC NO.: HAAF04239901

PROJECT NAME: HAAF CAP-OLD PROPERTY DISPOSAL (PDO) YARD

PROJECT NUMBER: DACA21-95-D-0022, DO # 36

PROJECT MANAGER: Allison Bailey

Sampler (Signature) [signature] (Printed Name) MIKE KLIDZEJS

LABORATORY NAME: Catlin Laboratories

LABORATORY ADDRESS: 1051 Johnnie Dodds Blvd. Suite C Mt. Pleasant, SC 29464

PHONE NO: (803) 881-6000

REQUESTED PARAMETERS

Sample ID	Date Collected	Time Collected	Matrix	MOISTURE CONTENT	GRAIN SIZE (SIEVE)	ATTERBERG LIMITS	PERMEABILITY	SPECIFIC GRAVITY	POROSITY/BULK DENSITY	No. of Bottles/ Vials:	OVA SCREENING	OBSERVATIONS, COMMENTS, SPECIAL INSTRUCTIONS
PG3400	4/15/99	1526	SOIL	X	X	X				1	N/A	6.0-7.0FT
PG2400	4/15/99	1441	SOIL	X	X	X				1	N/A	6.0-7.6FT

RELINQUISHED BY:	Date/Time	RECEIVED BY:	Date/Time
[signature]	4-23-99 1200	[signature]	4/26/99 1:00pm
COMPANY NAME: SAIC		COMPANY NAME: CATLIN	
RECEIVED BY: FedEx	4-23-99 1200	RELINQUISHED BY:	
COMPANY NAME:		COMPANY NAME:	
RELINQUISHED BY:		RECEIVED BY:	
COMPANY NAME:		COMPANY NAME:	

TOTAL NUMBER OF CONTAINERS: 2

Cooler ID: NA

Cooler Temperature: NA

FEDEX NUMBER: 811236285397

Summary Table of Results for HAAF CAP - PDO Yard			
Sample	PG1400	PG2400	PG3400
Moisture Content, %	20.6	20.5	26.4
Bulk Density, pcf	103.22		
Porosity	0.38		
Permeability, cm/sec	1.03E-06		
Specific Gravity	2.65		
Atterberg Limits			
Liquid Limit	-	20.1	28.5
Plastic Limit	-	19.34	27.96
Plastic Index	-	0.76	0.54
Classification	NP	ML	ML
Grain Size - Sieve (% passing)			
3" to 3/4"	100	100	100
3/8"	100	100	100
#4	100	100	99.39
#10	100	99.99	99.35
#20	99.97	99.76	98.67
#40	99.09	98.64	97.50
#60	97.28	93.19	93.83
#140	23.07	37.29	48.73
#200	20.28	33.82	44.50

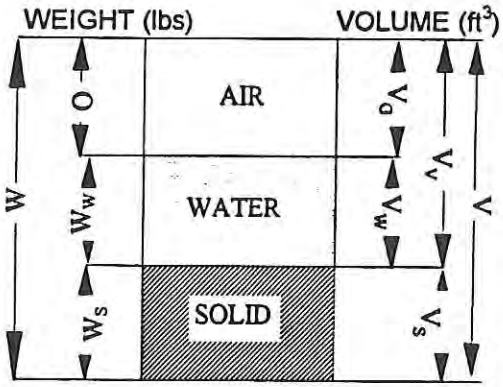
John T. Jones, P.E.

Lab Manager

BULK DENSITY, SPECIFIC GRAVITY AND POROSITY

PROJECT: SAIC
LOCATION OF PROJECT: PDO YARD
DESCRIPTION OF SOIL: Dark Gray Silty Sand
TESTED BY: B.J. Vance

JOB NO.: 99062Y
SAMPLE NO.: PG1400
DEPTH OF SAMPLE: 6-8 ft.
DATE OF TESTING: 4/28/99



W = 0.91512
W_W = W - W_S = 0.15642
W_S = Y_d*V = 0.7587

V = 0.00735
V_W = W_W/Y_W = 0.0025
V_S = W_S/G_S*Y_W = 0.0046
V_G = V - (V_S + V_W) = 0.00026
V_V = V_G + V_W = 0.0028

MEASUREMENTS OF TUBE/CAN

HEIGHT= 11.5 cm
DIAMETER= 4.8 cm

CALCULATED VOLUME OF TUBE/CAN

V= 208.10 cm^3
0.00735 ft^3

WT. OF TUBE/CAN + WET SOIL= 581.80 g
WEIGHT OF TUBE/CAN= 166.7 g
WEIGHT OF WET SOIL= 415.10 g
W = 0.91512 lb

MOISTURE CONTENT

M_{CWS} =	37.80	g	M_C =	15.10	g
M_{CDS} =	33.92	g	M_S =	18.82	g
M_W =	3.88	g	w =	20.6	%

Wet Density, Y_m = W / V

Dry Density, Y_d = W_s / V or Y_d = Y_m / (1+ w)

double check
Y_d = W_s / V
Y_d= 103.22 lbs/ft^3

Y_d = Y_m / (1+ w)
Y_m= 124.51 lbs/ft^3
Y_d= 103.22 lbs/ft^3

Void Ratio, e = V_V/V_S
e = 0.6027

Porosity, n = V_V /V
n = 0.38

Specific Gravity = 2.65

Degree of Saturation, S = V_W/V_V
S = 0.9065

CATLIN Engineers and Scientists
Geotechnical Laboratories

PERMEABILITY TEST ANALYSIS (ASTM D5084)

Project : SAIC

Location of Project : PDO Yard

Description of Soil : Dark Gray Clayey Sand

Job # : 99062 Y
Date of Testing: 4/28-5/6/99
Tested by: FB/CA
Boring # :
Sample # : PG1400
Sample Depth : 6-8'

Sample Type (Undisturbed or Remolded)
Standard Proctor:
Maximim Dry Density: _____ pcf
Optimum Moisture Content: _____ %

% Sample Compaction: _____ %
Sample Dry Density: _____ pcf
Sample Moisture Content: _____ %
Sample Wet Density: _____ pcf

Sample Permeation:

De-Aired Water
% Saturation: 100 %
Cell Pressure: 71.5 psi
Lower Pressure: 66.5 psi
Upper Pressure: 65 psi
Gradient: 20.30

Sample Dimensions		
	Before	After
Length (cm)	5.20	4.70
Diameter (cm)	4.70	5.30
Water Content (%)	20.6	19.1
Weight (g)	189.3	188.7

Constant Head Calculation:

$$K = [V(t_1,t_2)\, LR_T]/[P_B A t] \text{ (cm/sec)}$$

$V(t_1,t_2)$ = Volume of flow from t_1 to t_2 (cm^2)
L = Length of Sample = 5.20 cm
A = Area of Sample = 17.35 cm^2
t = $t_2 - t_1$ (sec)
P_B = Bias Pressure = 1.5 psi x 70.37 cm/psi $_{(cm - H2O)}$ 105.56 cm
R_T = Temperature correction = 0.931

t_2 (min)	t_1 (min)	$(t_2 - t_1)*60$ (sec)	V (cm^3)	$[LR_T]/[P_B A]$ (cm^3)	K (cm/sec)
330	275	3300	1.4	2.64E-03	1.12E-06
380	330	3000	1	2.64E-03	8.81E-07
435	380	3300	1.3	2.64E-03	1.04E-06
460	435	1500	0.6	2.64E-03	1.06E-06

K_{avg} = 1.03E-06 cm/sec

CATLIN Engineers and Scientists
Geotechnical Laboratories

Project: SAIC	Job No.:99062Y
Project Location: Hunter PDO YARD	Sample No.: PG1400
Sample Description: Dark Gray Clayey Sand	Sample Depth: 6-8'
	Boring No.:
Tested By: BJV	Date of Testing: 4/28/99

Mcws	Mcds	Mc : A22	Mw	Ms	w%	Mws	Ms
25.84	25.55	11.28	0.29	14.27	2.0	290.90	285.11

Sieve No.	Diam. (mm)	Wt. retained	% retained	E % retained	% passing
3	76.2	0	0.00	0.00	100.00
2	50.8	0	0.00	0.00	100.00
1 1/2	25.4	0	0.00	0.00	100.00
3/4	19.05	0	0.00	0.00	100.00
3/8	9.51	0	0.00	0.00	100.00
4	4.76	0	0.00	0.00	100.00
10	2.00	0	0.00	0.00	100.00
20	0.841	0.08	0.03	0.03	99.97
40	0.42	2.52	0.88	0.91	99.09
60	0.25	5.16	1.81	2.72	97.28
140	0.106	211.57	74.21	76.93	23.07
200	0.074	7.96	2.79	79.72	20.28
pan	---	0.48	0.17	79.89	20.11
total		227.77			

CATLIN Engineers and Scientists
Geotechnical Laboratories

ATTERBERG LIMITS DETERMINATION (ASTM D4318-93)

Project: SAIC	Job No.: 99062Y
Location of project: HUNTER ARMY AIR FIELD	Sample No.: PG2400
Description Of Soil: DARK GRAY SANDY CLAY	Depth of Sample: 6' - 7'
Tested By: CA/AJ	Date of Testing: 5/13/99

Liquid Limit Dermination

Can No.	A53	A51	A3	A56	A13	
Wt of Soil + can, Mcws	18.40	20.30	21.40	19.99	18.01	
Wt. of dry soil + can,Mcds	17.73	19.54	20.32	19.12	16.83	
Wt. of can, Mc	14.90	15.40	15.40	14.90	10.90	
Wt. of dry soil, Ms	2.83	4.14	4.92	4.22	5.93	
Wt. of moisture	0.67	0.76	1.08	0.87	1.18	
Water content, w%	23.67	18.36	21.95	20.62	19.90	
No. of blows, N	22	32	13	18	26	

Plastic Limit Determination

Can no.	C23	C24	C19			
Wt. of wet soil + can, Mcws	3.40	3.80	3.70			
Wt. of dry soil +can, Mcds	3.17	3.57	3.38			
Wt. of can, Mc	1.90	2.40	1.80			
Wt. of dry soil, Ms	1.27	1.17	1.58			
Wt. of moisture, Mw	0.23	0.23	0.32			
Water content, W% = Wp	18.11	19.66	20.25			

LIQUID LIMIT = 20.1
PLASTIC LIMIT = 19.34
PLASTICITY INDEX = 0.76
CLASSIFICATION = ML

CATLIN Engineers and Scientists
Geotechnical Laboratories

Project: SAIC	Job No.:99062Y
Project Location: PDO YARD-GEO	Sample No.: PG2400
Sample Description: Dark Gray Silty Sand	Sample Depth: 0.0-2.0'
	Boring No.:
Tested By: CA/FB	Date of Testing: 5/10/99

Mcws	Mcds	Mc : A38	Mw	Ms	w%	Mws	Ms
15.84	15.80	11.22	0.04	4.58	0.9	200.32	198.59

Sieve No.	Diam. (mm)	Wt. retained	% retained	E % retained	% passing
3	76.2	0	0.00	0.00	100.00
2	50.8	0	0.00	0.00	100.00
1 1/2	25.4	0	0.00	0.00	100.00
3/4	19.05	0	0.00	0.00	100.00
3/8	9.51	0	0.00	0.00	100.00
4	4.76	0	0.00	0.00	100.00
10	2.00	0.01	0.01	0.01	99.99
20	0.841	0.46	0.23	0.24	99.76
40	0.42	2.23	1.12	1.36	98.64
60	0.25	10.83	5.45	6.81	93.19
140	0.106	111	55.90	62.71	37.29
200	0.074	6.89	3.47	66.18	33.82
pan	---	0.19	0.10	66.27	33.73
total		131.61			

CATLIN Engineers and Scientists
Geotechnical Laboratories

ATTERBERG LIMITS DETERMINATION (ASTM D4318-93)

Project: SAIC	Job No.: 99062Y
Location of project: HUNTER ARMY AIR FIELD	Sample No.: PG3400
Description Of Soil: BLACK SANDY CLAY	Depth of Sample: 6' - 7'
Tested By: CA/AJ	Date of Testing: 5/13/99

Liquid Limit Dermination

Can No.	A16	A47	A37	A40	A50	
Wt of Soil + can, Mcws	20.77	22.53	22.10	20.97	24.46	
Wt. of dry soil + can,Mcds	18.58	20.92	20.61	19.68	22.33	
Wt. of can, Mc	11.07	15.10	14.98	14.99	15.30	
Wt. of dry soil, Ms	7.51	5.82	5.63	4.69	7.03	0.00
Wt. of moisture	2.19	1.61	1.49	1.29	2.13	0.00
Water content, w%	29.16	27.66	26.47	27.51	30.30	#DIV/0!
No. of blows, N	16	24	27	33	19	

Plastic Limit Determination

Can no.	C18	C1	C28			
Wt. of wet soil + can, Mcws	3.04	3.06	4.78			
Wt. of dry soil +can, Mcds	2.89	2.93	4.64			
Wt. of can, Mc	2.42	2.40	4.13			
Wt. of dry soil, Ms	0.47	0.53	0.51	0	0	0
Wt. of moisture, Mw	0.15	0.13	0.14	0	0	0
Water content, W% = Wp	31.91	24.53	27.45	#DIV/0!	#DIV/0!	#DIV/0!

LIQUID LIMIT = 28.5
PLASTIC LIMIT = 27.96
PLASTICITY INDEX = 0.54
CLASSIFICATION = ML

CATLIN Engineers and Scientists
Geotechnical Laboratories

Project: SAIC	Job No.: 99062Y
Project Location: PDO YARD-GEO	Sample No.: PG3400
Sample Description: Black Sandy Clay	Sample Depth: 6.0-7.0'
	Boring No.:
Tested By: AJ/FB	Date of Testing: 5/10/99

Mcws	Mcds	Mc : A47	Mw	Ms	w%	Mws	Ms
20.08	20.02	15.10	0.06	4.92	1.2	200.00	197.59

Sieve No.	Diam. (mm)	Wt. retained	% retained	E % retained	% passing
3	76.2	0	0.00	0.00	100.00
2	50.8	0	0.00	0.00	100.00
1 1/2	25.4	0	0.00	0.00	100.00
3/4	19.05	0	0.00	0.00	100.00
3/8	9.51	0.08	0.04	0.00	100.00
4	4.76	1.2	0.61	0.61	99.39
10	2.00	0.09	0.05	0.65	99.35
20	0.841	1.33	0.67	1.33	98.67
40	0.42	2.32	1.17	2.50	97.50
60	0.25	7.26	3.67	6.17	93.83
140	0.106	89.1	45.09	51.27	48.73
200	0.074	8.37	4.24	55.50	44.50
pan	—	0.35	0.18	55.68	44.32
total		110.02			

CATLIN Engineers and Scientists
Geotechnical Laboratories

SAIC An Employee-Owned Company
Science Applications International Corporation

800 Oak Ridge Turnpike, Oak Ridge, TN 37831 (423) 481-4600

CHAIN OF CUSTODY RECORD 9904529

COC NO.: HAAF041699 02

PROJECT NAME: ~~HAAF CAP B,UST 21/22,BLDG 1327,ID 9 025052~~ HAAF CAP- OLD PROPERTY DISPOSAL (PDO) YARD 4-16-99

PROJECT NUMBER: DACA21-95-D-0022, DO # ~~38~~ 36 4-16-99

PROJECT MANAGER: Allison Bailey

Sampler (Signature) Mitchell Hall (Printed Name) Mitchell Hall

LABORATORY NAME: General Engineering Laboratory

LABORATORY ADDRESS: 2040 Savage Road, Charleston, SC 29407

PHONE NO: (843) 556-8171

REQUESTED PARAMETERS

Sample ID	Date Collected	Time Collected	Matrix	BTEX	PAH, TPH-DRO, MOISTURE	THP-GRO	PAH	Total Organic Carbon	No. of Bottles/ Vials:	OVA SCREENING	OBSERVATIONS, COMMENTS, SPECIAL INSTRUCTIONS
PG1400	4/15/99	1600	soil					1	1	NA	NA 01
PG2400	4/15/99	1441	soil					1	1	NA	NA 02
PG3400	4/15/99	1526	soil					1	1	NA	NA 03

RELINQUISHED BY: Mitchell Hall	Date/Time 4-16-99 1320	RECEIVED BY: D Francis	Date/Time 4/16/99 1635	TOTAL NUMBER OF CONTAINERS: 3	Cooler Temperature: 4°C
COMPANY NAME: SAIC		COMPANY NAME: GEL		Cooler ID: 521, 4°C	FEDEX NUMBER: N/A
RECEIVED BY: [signature]	Date/Time 4-16-99 1320	RELINQUISHED BY:	Date/Time	Temperature Blank Included	
COMPANY NAME: GEL		COMPANY NAME:			
RELINQUISHED BY: [signature]	Date/Time 4-16-99 1635	RECEIVED BY:	Date/Time		
COMPANY NAME: GEL		COMPANY NAME:			

THIS PAGE INTENTIONALLY LEFT BLANK

Location: PDO YARD-GEO
Station : G-1

PG1400 6.0 - 8.0 FT Field Sample Type: Grab Matrix: Soil Collected: 04/15/99

Sample Type	Total Organic Carbon (TOC)	Result	Units	Qualifiers Lab	Qualifiers Data	Validation Code
REG	Total Organic Carbon	2860	MG/KG		=	

Location: PDO YARD-GEO
Station : G-2

PG2400 6.0 - 8.0 FT Field Sample Type: Grab Matrix: Soil Collected: 04/15/99

Sample Type	Total Organic Carbon (TOC)	Result	Units	Qualifiers Lab	Qualifiers Data	Validation Code
REG	Total Organic Carbon	13100	MG/KG		=	

Location: PDO YARD-GEO
Station : G-3

PG3400 6.0 - 8.0 FT Field Sample Type: Grab Matrix: Soil Collected: 04/15/99

Sample Type	Total Organic Carbon (TOC)	Result	Units	Qualifiers Lab	Qualifiers Data	Validation Code
REG	Total Organic Carbon	5880	MG/KG		=	

THIS PAGE INTENTIONALLY LEFT BLANK

SAIC An Employee-Owned Company
Science Applications International Corporation
800 Oak Ridge Turnpike, Oak Ridge, TN 37831 (423) 481-4600

9900836

CHAIN OF CUSTODY RECORD

COC NO.:

PROJECT NAME: HAAF Bulk Fuel Facility CAP - Part A

PROJECT NUMBER: DACA21-95-D-0022, DO # 0051

PROJECT MANAGER: Allison Bailey

Sampler (Signature) C. Allison Bailey (Printed Name) C. Allison Bailey

REQUESTED PARAMETERS (3-encores)

Sample ID	Date Collected	Time Collected	Matrix	BTEX	PAH, TPH-DRO	THP-GRO, MOISTURE	PAH	CHLOR. SOLVENTS	VOC	SVOC, pH, Oil & Grease, Phenols	TCLP VOC	TCLP SVOC	TCLP Metal	TOC	Evaporation Loss	No. of Bottles/ Vials:	PID ~~OVA~~ SCREENING	OBSERVATIONS, COMMENTS, SPECIAL INSTRUCTIONS
PD∅111	11/3∅/99	1∅3∅	Soil					1							1	2	∅ppm	7-10 day turn
PD∅211	11/3∅/99	1115	Soil					1							1	2	∅ppm	7-10 day turn
PD∅311	11/3∅/99	131∅	Soil					1							1	2	∅ppm	7-10 day turn
PD∅411	11/3∅/99	1355	Soil					1							1	2	∅ppm	7-10 day turn
PD∅511	11/3∅/99	1435	Soil					1							1	2	∅ppm	7-10 day turn
PD∅611	11/3∅/99	153∅	Soil					1							1	2	∅ppm	7-10 day turn

A-41

LABORATORY NAME: General Engineering Laboratory

LABORATORY ADDRESS: 2040 Savage Road, Charleston, SC 29407

PHONE NO: (843) 556-8171

RELINQUISHED BY:	Date/Time	RECEIVED BY:	Date/Time
C. Allison Bailey	12/1/99	[illegible]	12/1/99
COMPANY NAME: SAIC	12∅∅	COMPANY NAME: GEL	1610
RECEIVED BY: [illegible]	Date/Time 12-1-99	RELINQUISHED BY:	Date/Time
COMPANY NAME: GEL	1210	COMPANY NAME:	
RELINQUISHED BY: [illegible]	Date/Time 12-1-99	RECEIVED BY:	Date/Time
COMPANY NAME: GEL	1610	COMPANY NAME:	

TOTAL NUMBER OF CONTAINERS: 12

Cooler ID: AB-1

Cooler Temperature: 4°C

FEDEX NUMBER: NA

Charge # 01-1624-34-1958-22∅

7-10 day turn around time.

THIS PAGE INTENTIONALLY LEFT BLANK

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

PD0111

Lab Name: GENERAL ENGINEERING LABOR Contract: N/A

Lab Code: N/A Case No.: N/A SAS No.: N/A SDG No.: HBFA03S

Matrix: (soil/water) SOIL Lab Sample ID: 9900836001

Sample wt/vol: 5.8 (g/mL) G Lab File ID: 8M424

Level: (low/med) LOW Date Received: 12/01/99

% Moisture: not dec. 19 DATA VALIDATION COPY Date Analyzed: 12/09/99

GC Column: DB-624 ID: 0.25 (mm) Dilution Factor: 1.0

Soil Extract Volume:_____(uL) Soil Aliquot Volume: _____(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q	
74-87-3	Chloromethane	1.1	U	U
75-01-4	Vinyl chloride	1.1	U	↓
75-00-3	Chloroethane	1.1	U	↓
75-09-2	Methylene chloride	5.1	B	U F01,F07
75-35-4	1,1-Dichloroethylene	1.1	U	U
75-34-3	1,1-Dichloroethane	1.1	U	↓
67-66-3	Chloroform	1.1	U	↓
107-06-2	1,2-Dichloroethane	1.1	U	↓
71-55-6	1,1,1-Trichloroethane	1.1	U	↓
56-23-5	Carbon tetrachloride	1.1	U	↓
78-87-5	1,2-Dichloropropane	1.1	U	↓
10061-01-5	cis-1,3-Dichloropropylene	1.1	U	↓
79-01-6	Trichloroethylene	1.1	U	↓
79-00-5	1,1,2-Trichloroethane	1.1	U	↓
10061-02-6	trans-1,3-Dichloropropylene	1.1	U	↓
127-18-4	Tetrachloroethylene	1.1	U	↓
79-34-5	1,1,2,2-Tetrachloroethane	1.1	U	↓
108-90-7	Chlorobenzene	1.1	U	↓
106-93-4	1,2-Dibromoethane	1.1	U	↓
540-59-0	1,2-Dichloroethylene(total)	2.1	U	↓

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

PD0211

Lab Name: GENERAL ENGINEERING LABOR Contract: N/A

Lab Code: N/A Case No.: N/A SAS No.: N/A SDG No.: HBFA03S

Matrix: (soil/water) SOIL Lab Sample ID: 9900836002

Sample wt/vol: 5.2 (g/mL) G Lab File ID: 8M425

Level: (low/med) LOW DATA VALIDATION COPY Date Received: 12/01/99

% Moisture: not dec. 20 Date Analyzed: 12/09/99

GC Column: DB-624 ID: 0.25 (mm) Dilution Factor: 1.0

Soil Extract Volume:_____(uL) Soil Aliquot Volume: _____(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q	
74-87-3	Chloromethane	1.2	U	U
75-01-4	Vinyl chloride	1.2	U	
75-00-3	Chloroethane	1.2	U	
75-09-2	Methylene chloride	8.0	B	U F01,F07
75-35-4	1,1-Dichloroethylene	1.2	U	U
75-34-3	1,1-Dichloroethane	1.2	U	
67-66-3	Chloroform	1.2	U	
107-06-2	1,2-Dichloroethane	1.2	U	
71-55-6	1,1,1-Trichloroethane	1.2	U	
56-23-5	Carbon tetrachloride	1.2	U	
78-87-5	1,2-Dichloropropane	1.2	U	
10061-01-5	cis-1,3-Dichloropropylene	1.2	U	
79-01-6	Trichloroethylene	1.2	U	
79-00-5	1,1,2-Trichloroethane	1.2	U	
10061-02-6	trans-1,3-Dichloropropylene	1.2	U	
127-18-4	Tetrachloroethylene	1.2	U	
79-34-5	1,1,2,2-Tetrachloroethane	1.2	U	UJ K01
108-90-7	Chlorobenzene	1.2	U	U
106-93-4	1,2-Dibromoethane	1.2	U	
540-59-0	1,2-Dichloroethylene(total)	2.4	U	

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

PD0311

Lab Name: GENERAL ENGINEERING LABOR Contract: N/A

Lab Code: N/A Case No.: N/A SAS No.: N/A SDG No.: HBFA03S

Matrix: (soil/water) SOIL Lab Sample ID: 9900836003

Sample wt/vol: 5.7 (g/mL) G Lab File ID: 8M334

Level: (low/med) LOW Date Received: 12/01/99

% Moisture: not dec. 20 Date Analyzed: 12/09/99

GC Column: DB-624 ID: 0.25 (mm) Dilution Factor: 1.0

Soil Extract Volume:_____(uL) Soil Aliquot Volume: _____(uL

DATA VALIDATION COPY

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q	
74-87-3	Chloromethane	1.1	U	U
75-01-4	Vinyl chloride	1.1	U	U
75-00-3	Chloroethane	1.1	U	U
75-09-2	Methylene chloride	3.6	B	U F01, F07
75-35-4	1,1-Dichloroethylene	1.1	U	U
75-34-3	1,1-Dichloroethane	1.1	U	
67-66-3	Chloroform	1.1	U	
107-06-2	1,2-Dichloroethane	1.1	U	
71-55-6	1,1,1-Trichloroethane	1.1	U	
56-23-5	Carbon tetrachloride	1.1	U	
78-87-5	1,2-Dichloropropane	1.1	U	
10061-01-5	cis-1,3-Dichloropropylene	1.1	U	
79-01-6	Trichloroethylene	1.1	U	
79-00-5	1,1,2-Trichloroethane	1.1	U	
10061-02-6	trans-1,3-Dichloropropylene	1.1	U	
127-18-4	Tetrachloroethylene	1.1	U	
79-34-5	1,1,2,2-Tetrachloroethane	1.1	U	UJ K01
108-90-7	Chlorobenzene	1.1	U	U
106-93-4	1,2-Dibromoethane	1.1	U	
540-59-0	1,2-Dichloroethylene(total)	2.2	U	

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

FD3411

Lab Name: GENERAL ENGINEERING LABOR Contract: N/A

Lab Code: N/A Case No.: N/A SAS No.: N/A SDG No.: HEFA03S

Matrix: (soil/water) SOIL Lab Sample ID: 9900836004

Sample wt/vol: 3.9 (g/mL) G Lab File ID: 8M509

Level: (low/med) LOW DATA VALIDATION COPY Date Received: 12/01/99

% Moisture: not dec. 18 Date Analyzed: 12/10/99

GC Column: DB-624 ID: 0.25 (mm) Dilution Factor: 1.0

Soil Extract Volume:_____(uL) Soil Aliquot Volume: _____(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q	
74-87-3	Chloromethane	1.5	U	U
75-01-4	Vinyl chloride	1.5	U	
75-00-3	Chloroethane	1.5	U	
75-09-2	Methylene chloride	8.7	B	U F01, F07
75-35-4	1,1-Dichloroethylene	1.5	U	
75-34-3	1,1-Dichloroethane	1.5	U	U
67-66-3	Chloroform	1.5	U	
107-06-2	1,2-Dichloroethane	1.5	U	
71-55-6	1,1,1-Trichloroethane	1.5	U	
56-23-5	Carbon tetrachloride	1.5	U	
78-87-5	1,2-Dichloropropane	1.5	U	
10061-01-5	cis-1,3-Dichloropropylene	1.5	U	
79-01-6	Trichloroethylene	1.5	U	
79-00-5	1,1,2-Trichloroethane	1.5	U	
10061-02-6	trans-1,3-Dichloropropylene	1.5	U	
127-18-4	Tetrachloroethylene	1.5	U	
79-34-5	1,1,2,2-Tetrachloroethane	1.5	U	U K01
108-90-7	Chlorobenzene	1.5	U	
106 93-4	1,2-Dibromoethane	1.5	U	U
540-59-0	1,2-Dichloroethylene(total)	3.1	U	

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

FD051

Lab Name: GENERAL ENGINEERING LABOR Contract: N/A

Lab Code: N/A Case No.: N/A SAS No.: N/A SDG No.: HBFA03S

Matrix: (soil/water) SOIL Lab Sample ID: 9900836005

Sample wt/vol: 4.2 (g/mL) G Lab File ID: 8M510

Level: (low/med) LOW Date Received: 12/01/99

% Moisture: not dec. 18 Date Analyzed: 12/10/99

GC Column: DB-624 ID: 0.25 (mm) Dilution Factor: 1.0

Soil Extract Volume:_____(uL) Soil Aliquot Volume: _____(uL

DATA VALIDATION COPY

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q	
74-87-3	Chloromethane	1.4	U	U
75-01-4	Vinyl chloride	1.4	U	
75-00-3	Chloroethane	1.4	U	
75-09-2	Methylene chloride	3.6	B	U F01, F07
75-35-4	1,1-Dichloroethylene	1.4	U	U
75-34-3	1,1-Dichloroethane	1.4	U	
67-66-3	Chloroform	1.4	U	
107-06-2	1,2-Dichloroethane	1.4	U	
71-55-6	1,1,1-Trichloroethane	1.4	U	
56-23-5	Carbon tetrachloride	1.4	U	
78-87-5	1,2-Dichloropropane	1.4	U	
10061-01-5	cis-1,3-Dichloropropylene	1.4	U	
79-01-6	Trichloroethylene	1.4	U	
79-00-5	1,1,2-Trichloroethane	1.4	U	
10061-02-6	trans-1,3-Dichloropropylene	1.4	U	
127-18-4	Tetrachloroethylene	1.4	U	
79-34-5	1,1,2,2-Tetrachloroethane	1.4	U	U K01
108-90-7	Chlorobenzene	1.4	U	
106-93-4	1,2-Dibromoethane	1.4	U	U
540-59-0	1,2-Dichloroethylene(total)	2.9	U	

1A

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

PD061

Lab Name: GENERAL ENGINEERING LABOR Contract: N/A

Lab Code: N/A Case No.: N/A SAS No.: N/A SDG No.: HBFA03S

Matrix: (soil/water) SOIL Lab Sample ID: 9900836006

Sample wt/vol: 3.8 (g/mL) G Lab File ID: 8M511

Level: (low/med) LOW DATA VALIDATION COPY Date Received: 12/01/99

% Moisture: not dec. 19 Date Analyzed: 12/10/99

GC Column: DB-624 ID: 0.25 (mm) Dilution Factor: 1.0

Soil Extract Volume:_____(uL) Soil Aliquot Volume: _____(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q	
74-87-3	Chloromethane	1.6	U	U
75-01-4	Vinyl chloride	1.6	U	
75-00-3	Chloroethane	1.6	U	
75-09-2	Methylene chloride	7.4	B	U FD1, FD7
75-35-4	1,1-Dichloroethylene	1.6	U	U
75-34-3	1,1-Dichloroethane	1.6	U	
67-66-3	Chloroform	1.6	U	
107-06-2	1,2-Dichloroethane	1.6	U	
71-55-6	1,1,1-Trichloroethane	1.6	U	
56-23-5	Carbon tetrachloride	1.6	U	
78-87-5	1,2-Dichloropropane	1.6	U	
10061-01-5	cis-1,3-Dichloropropylene	1.6	U	
79-01-6	Trichloroethylene	1.6	U	
79-00-5	1,1,2-Trichloroethane	1.6	U	
10061-02-6	trans-1,3-Dichloropropylene	1.6	U	
127-18-4	Tetrachloroethylene	1.6	U	
79-34-5	1,1,2,2-Tetrachloroethane	1.6	U	J KD1
108-90-7	Chlorobenzene	1.6	U	
106-93-4	1,2-Dibromoethane	1.6	U	U
540-59-0	1,2-Dichloroethylene(total)	3.3	U	

FORM I VOA OLM03.0

ATTACHMENT A-3

BORING LOGS
FOR
SOIL SUPPLEMENTAL SAMPLING
(APRIL AND NOVEMBER 1999)
AT THE
OLD PROPERTY DISPOSAL (PDO) YARD
HUNTER ARMY AIRFIELD, GEORGIA

THIS PAGE INTENTIONALLY LEFT BLANK

HTRW DRILLING LOG

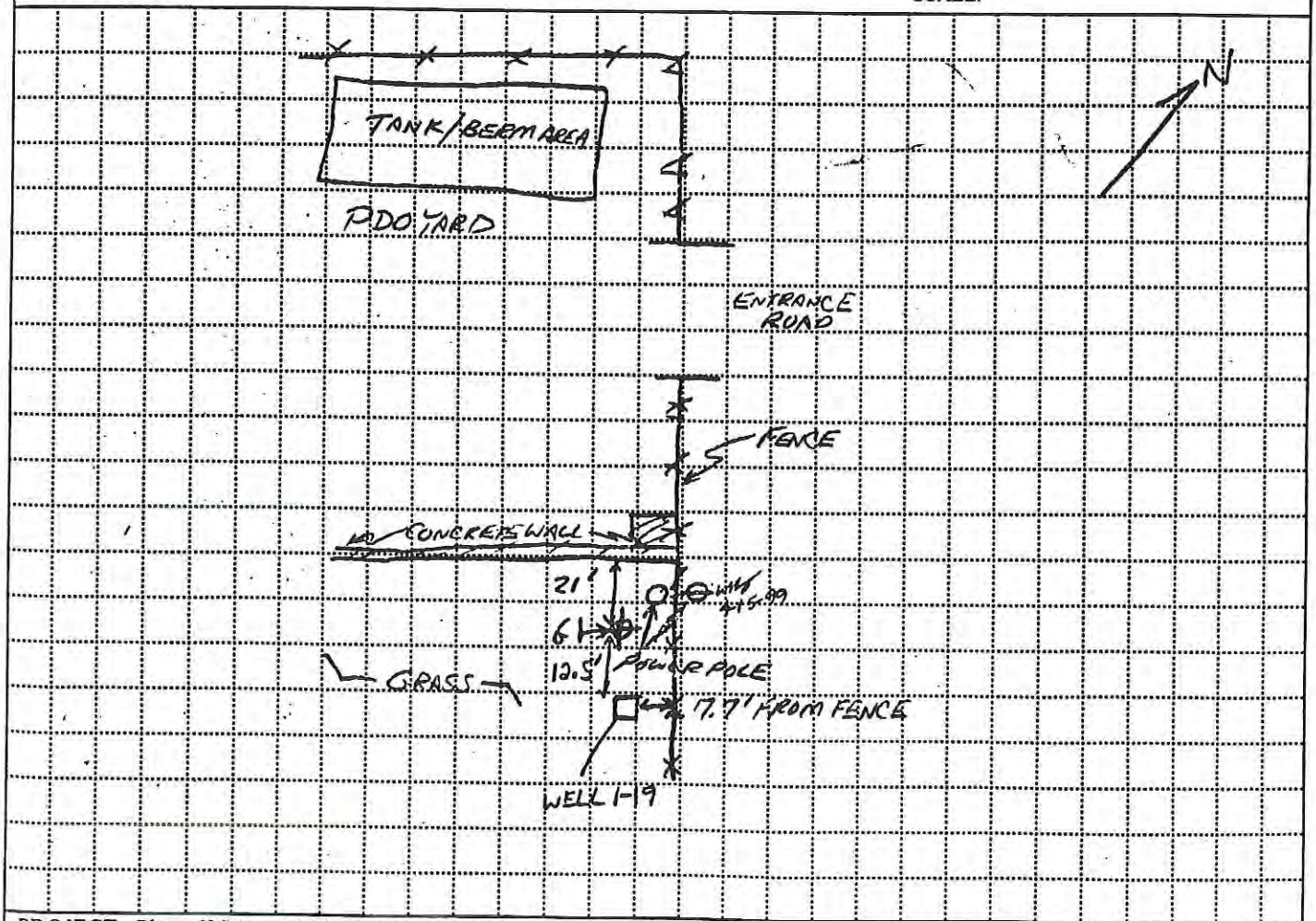
DISTRICT ~~Louisville Corps~~ SAVANNAH USACE		HOLE NUMBER G1
1. COMPANY NAME SAIC	2. DRILL SUBCONTRACTOR ~~Bowser-Morner~~ SAIC - Middletown	SHEET 1 OF 2
3. PROJECT ~~Phase II RI at Winklepeck Burning Ground and Background Investigation~~	4. LOCATION PDO YARD, HUNTER AAF	
5. NAME OF DRILLER JIM HEWITT	6. MANUFACTURERS DESIGNATION OF DRILL Geoprobe Model 66DT	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT 2.0-IN DIA MACROCORE SAMPLER WITH 1.75-in. DIA Acetate Liners, 4.0-ft length. Expendable drive points.	8. HOLE LOCATION PDO YARD	
	9. SURFACE ELEVATION N/A	
	10. DATE STARTED 4-15-99	11. DATE COMPLETED 4-15-99
12. OVERBURDEN THICKNESS N/A	15. DEPTH GROUNDWATER ENCOUNTERED N/A	
13. DEPTH DRILLED INTO ROCK N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED N/A	
14. TOTAL DEPTH OF HOLE 8.0 FT BGS	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY) N/A	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
PG1400		1 (6.0 TO 8.0')	N/A

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	SVOC	CYANIDE	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
~~0-1', 1-2', 2-3', 3-4'~~ ~~N/A~~ PG1400					TOC	

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
Plugged	Bentonite			W. Kevin Grace

LOCATION SKETCH/COMMENTS SCALE:



PROJECT ~~Phase II RI at Winklepeck Burning Ground and Facility-wide Background Investigation, RVAAP~~ PDO YARD NATURAL ATTENUATION STUDY

HOLE NO. G1

PDO YARD Natural Attenuation Study | INSPECTOR W. KEVIN JAGO | SHEET 2 OF 2

DEPTH (ft)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO (E)	ANALYTICAL SAMPLE NO (F)	REMARKS (G)
	TOPSOIL / ROOT ZONE/FILL/SOIL	BZA=0.0ppm			RUN 1:
	SM; Silty SAND, 10YR 7/4 (yellowish brown) 10YR 2/1 (black)				START: 1545
1.0					STOP: 1547
					RUN: 4.0 FT
					RECOVERY: 2.1 FT
2.0					
	NO RECOVERY				
3.0					
4.0	CONTINUED ABOVE INTERVAL	BZA=0.0ppm	VKJ 4.13.99 Geotechnical Sample		RUN 2 =
					START:
	WET ZONE				STOP:
5.0					RUN: 2.0 FT
					RECOVERY: 1.8
6.0	NO RECOVERY				
	Shelby tube 6.0 to 8.0		PG-1400 undisturbed geotechnical 6.0 to 8.0 FT BGS	PG-1400 TOC 6.0 to 8.0 FT BGS	RUN 3: Shelby tube 6.0 to 8.0 FT BGS. START: 1606 STOP: 1610
7.0					
8.0	TD=G1 = 8.0 FT BGS				

PROJECT: PDO YARD NATURAL ATTENUATION STUDY

HOLE NO: G-1

HTRW DRILLING LOG

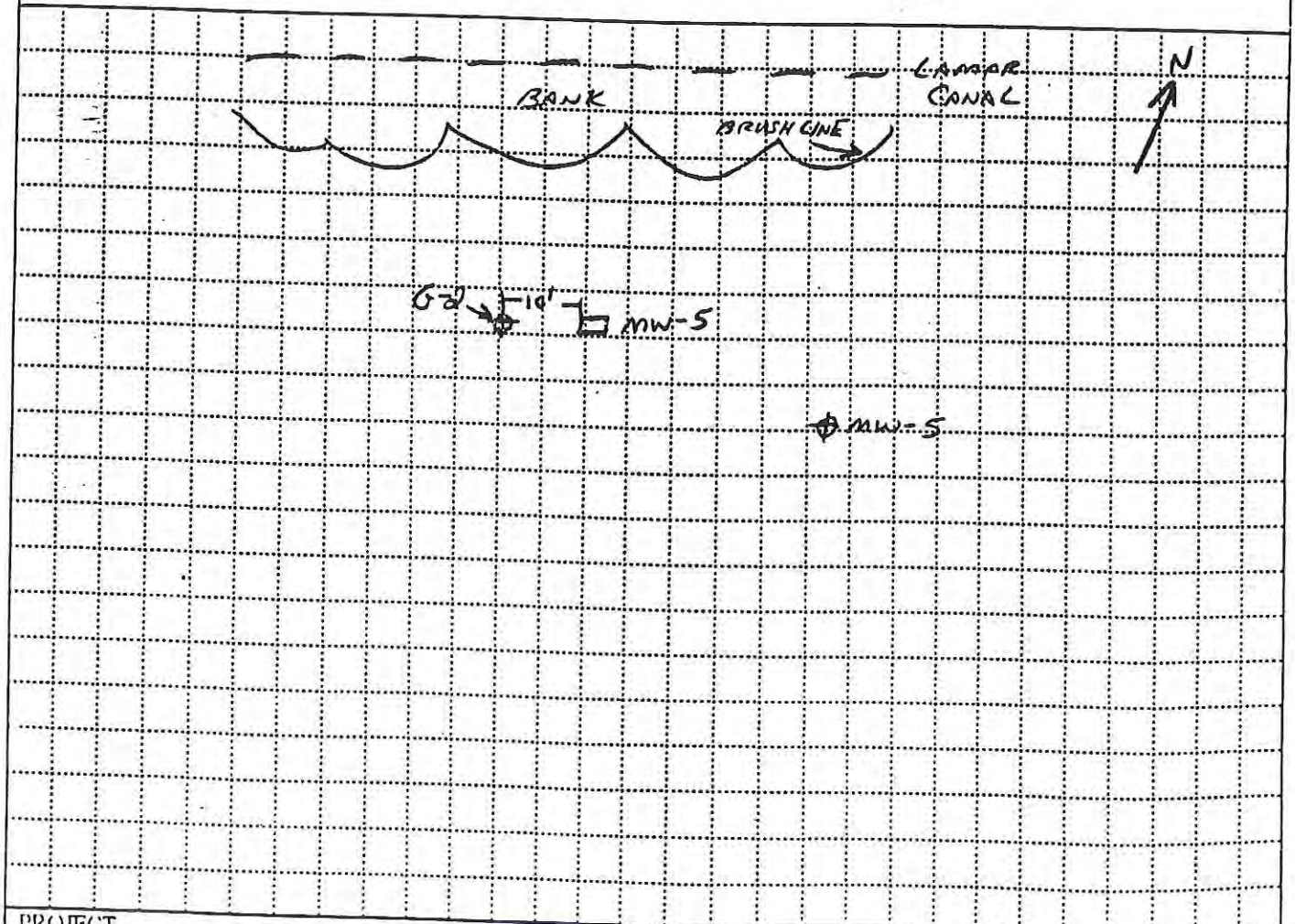
1. COMPANY NAME: SAIC	DISTRICT: SAVANNAH USACE	HOLE NUMBER: G2
2. DRILL SUBCONTRACTOR: SAIC - Middletown		SHEET 1 OF 2 SHEETS
3. PROJECT: PDO YARD NATURAL ATTENUATION STUDY	4. LOCATION: PDO YARD, HUNTER AAF	
5. NAME OF DRILLER: JIM HEWITT	6. MANUFACTURERS DESIGNATION OF DRILL: Geoprobe 66DT	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: 2.0-inch DIA. MACROCORE SAMPLER WITH 1.75-inch DIA. acetate liner, 4.0-FT length. Expendable carbon steel drive points	8. HOLE LOCATION: PDO YARD	
	9. SURFACE ELEVATION: N/A	
	10. DATE STARTED: 4-15-99	11. DATE COMPLETED: 4-15-99
12. OVERBURDEN THICKNESS: N/A	15. DEPTH GROUNDWATER ENCOUNTERED: N/A	
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A	
14. TOTAL DEPTH OF HOLE: 8.0 FT BGS	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
PG 2400	1 (6.0 TO 7.6')		N/A

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
WIC 4-15-99 ~~WTA~~ PG 2400					TOC	

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
Plugged	bentonite			W. Kevin Gray

LOCATION SKETCH/COMMENTS — SCALE:



PROJECT: PDO YARD Natural Attenuation Study

HOLE NO.: G2

PDO YARD NATURAL ATTENUATION | INSPECTOR W. KEVIN JAGS | SHEET 2 OF 2

DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	SAMPLE OR CORE BOX NO (E)	ANALYTICAL SAMPLE NO (F)	REMARKS (G)
0	Fill, root zone	BZA=0.0 ppm			RUN 1
		FS=0.0 ppm			RUN: 4.0
	coal fines				RECOVERY: 3.4 FT
1.0					START: 1433
					STOP: 1435
	SP-SM; fine-grained silty sand, 10YR 3/2 (very dark brown) to 10YR 2/1 (black)				
2.0					
3.0					
	NO RECOVERY				
4.0					
	Continued 1.2 TO 3.4 FT BGS INTERVAL.	FS=0.0 ppm			RUN 2
					START: 1437
					STOP: 1459
5.0					RUN: 4.0 FT
					RECOVERY: 3.6 FT
		WKS 4-15-99			
6.0			Geotech sample 6.0 TO 7.6 FT BGS PG-2400	TOC sample 6.0 TO 7.6 FT BGS PG-2400	
7.0					
	NO RECOVERY				
8.0					TD = 8.0 FT BGS

PROJECT: PDO YARD NATURAL ATTENUATION STUDY

HOLE NO: F2

HTRW DRILLING LOG

1. COMPANY NAME: SAIC	2. DISTRICT: SAVANNAH USACE	HOLE NUMBER: Geotech 3 (63)
	3. DRILL SUBCONTRACTOR: SAIC - Middletown	SHEET 1 OF 2 SHEETS

4. PROJECT: PDO YARD NATURAL ATTENUATION STUDY	5. LOCATION: PDO YARD, HUNTER AAF
6. NAME OF DRILLER: JIM HEWITT	7. MANUFACTURERS DESIGNATION OF DRILL: Geoprobe Model 66DT
8. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: 2.0-inch DIA MACROCORE SAMPLER WITH 1.75-inch DIA acetate liners, 4.0-ft length. Expendable drive points	9. HOLE LOCATION: PDO YARD
	10. SURFACE ELEVATION: N/A
	11. DATE STARTED: 4-15-99 — 12. DATE COMPLETED: 4-15-99
13. OVERBURDEN THICKNESS: N/A	14. DEPTH GROUNDWATER ENCOUNTERED: N/A
15. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A
17. TOTAL DEPTH OF HOLE: 7.0 FT BGS	18. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A

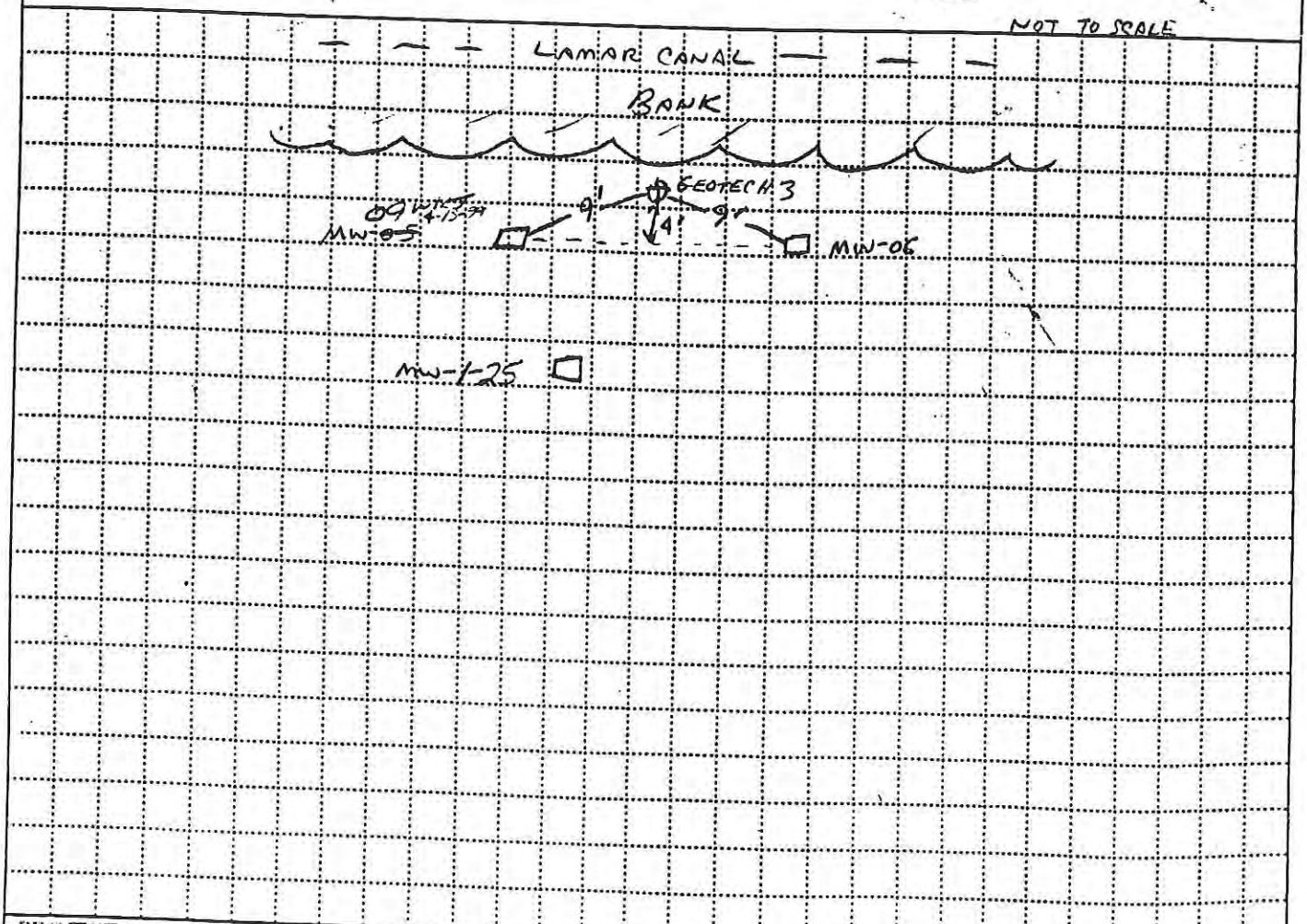
19. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	20. TOTAL NUMBER OF CORE BOXES
PG 3400	1 (6.0 to 7.0')		N/A

21. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	22. TOTAL CORE RECOVERY %
PG 3400			TOC			

23. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	24. SIGNATURE OF INSPECTOR
Plugged	bentonite			W. Kevin Pigott

LOCATION SKETCH/COMMENTS

SCALE: NOT TO SCALE



PROJECT: PDO YARD NATURAL ATTENUATION STUDY

HOLE NO.: Geotech 3

ENG FORM 5056-R, AUG 94

(Proponent CEC W-EG)

INSPECTOR: W Kevin Jacs

SHEET: 2 OF 2

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO. (E)	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0.0	Fill soil cover, root zone gravel fill sand.	BZA=0.0ppm FS=0.0ppm			RUN 1: 4.0 FT
		SM: silty sand. Dark olive gray 5Y3/2 to 10YR2/2 very dark brown.				RECOVERY = 3.1 FT START: 1520 STOP: 1522
	1.0					
	2.0					
	3.0–4.0	NO RECOVERY				~~RUN 2~~ WKJ 4-15-99 ~~RECOVERY = 3.0 FT~~
	4.0	Continued above interval fining downward increasing silt content.	BZA=0.0ppm FS=0.0ppm			RUN 2: 4.0 FT RECOVERY = 3.0 FT START: 1523 STOP: 1525
	5.0					
	6.0–7.0			PG 3400	PG 3400 TOC	
	7.0–8.0	NO RECOVERY				
	8.0	TD = 8.0 FT BGS				

(G3)

PROJECT: PDO YARD Natural Attenuation Study.

HOLE NO: G3

HTRW DRILLING LOG

1. COMPANY NAME: SAIC	2. DRILL SUBCONTRACTOR: SAIC - Middletown	HOLE NUMBER: PDO-1
	DISTRICT: Savannah Corp's	SHEET 1 OF 2 SHEETS

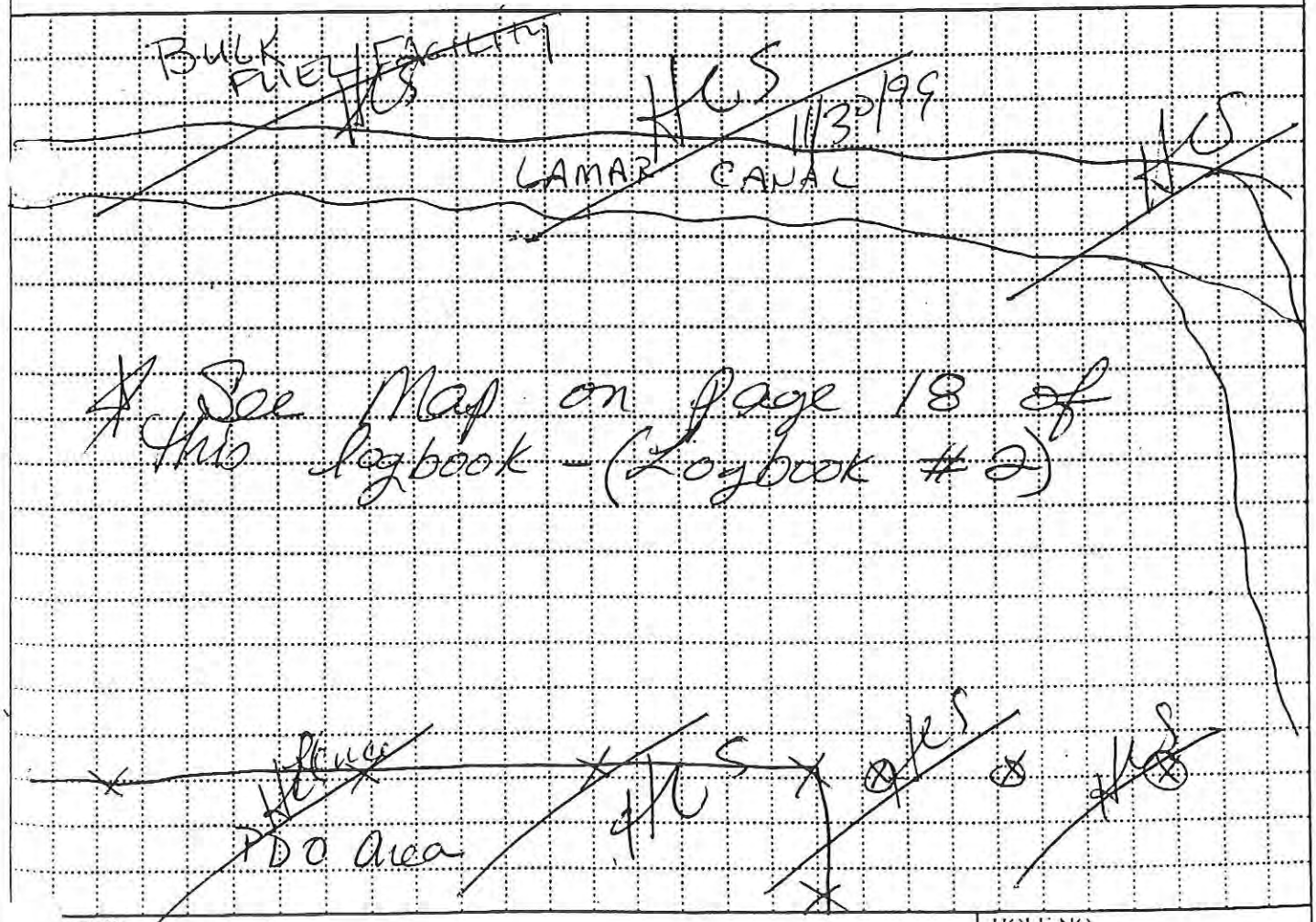
3. PROJECT: P.D.O. Yard.	4. LOCATION: HAAF - PDO YARD
5. NAME OF DRILLER: John Haselhoff	6. MANUFACTURERS DESIGNATION OF DRILL: Geoprobe 5400
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: 2" Macrocore 4' long Stainless Steel, Acetate liners	8. HOLE LOCATION: See Map on Pg 18
	9. SURFACE ELEVATION:
	10. DATE STARTED: 11-30-99 / 11. DATE COMPLETED: 11-30-99
12. OVERBURDEN THICKNESS: greater than total depth.	13. DEPTH GROUNDWATER ENCOUNTERED: 6.6' BGS - CORE IS WET
13. DEPTH DRILLED INTO ROCK: NA	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: NA
14. TOTAL DEPTH OF HOLE: 8.0' BGS	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): NA

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
NA	NA	NA	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
PDO111	ENCORE	—	ENAP Lab's.	—	—	NA %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
w/ bentonite	X	—	—	Heather L Smith

LOCATION SKETCH/COMMENTS — SCALE: NONE



OBJECT	HOLE NO
PDO Yard.	PDO-1

ENG FORM 5056-R, AUG 94 (Proponent CECW-EG)

DRILLING LOG

HOLE NUMBER PDO - 1

PROJECT P.D.O. Yard | INSPECTOR Heather Smith | SHEET 2 of 2

ELEV (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO (E)	ANALYTICAL SAMPLE NO (F)	REMARKS (G)
		grass TOP SOIL Sandy Silt				START: 1015
		SM- fine → v. fine Sand w/ SILT SILTY SAND loose dry some ↓ isses/ roots dk grayish brown, 10YR 4/2	Ø.Ø PPM	NA		FINISH: 1020
		Black consisting of angular sand to gravel dry SEEM BLACK				RUN 4.Ø
	1.Ø	GRANITE ROCK DRY BED				REC: 3.6
		SM- SILTY SAND fine gr. Sand, subang. to subrounded grains firm, non plastic, dry				LOSS: Ø.4'
	2.Ø	10YR 4/2 dk. grayish brown				
		SP-Poorly GRADED SAND FINE → MED gr. QTZ Sands rounded → subrounded, loose Soft, non plastic, DRY, well sorted grains 5Y 8/1 White	Ø.Ø PPM	NA		
	3.Ø	SM- Silty Sand FINE TO MED GR. Sand subrounded → ang. grains FIRM (Silver-black color) BLACKER THAN 10YR2/1 BLACK				
		LOSS				Loss
	4.Ø	SAME AS ABOVE				START 1020
		SP FINE → MED gr sand as * SEEN from 2.1 → 2.8' BGS	Ø.Ø PPM	NA		FINISH
		SM - Silty Sand FINE → MED gr sand Subrounded → ang. grains firm (silver-blk color) 10YR2/1 Black, DRY * AS SEEN 2.8 → 4.2' BGS.				RUN 4.Ø
	5.Ø					REC 4.Ø
						LOSS Ø.Ø
		SM- Silty Sand Fine → med. sand subrounded to sub angular grains, Soft to firm, moist	Ø.Ø PPM	NA	SAMPLED 5.6' → 6.6' SAMP. ID # PDØ111 @ 1034 SEMCORE 3 1/4 oz jar.	
	6.Ø	(CORE WET AT 6.6' BG) WET				TOP of WATER ON CORE
	7.Ø	(SAME AS ABOVE JUST WET) 10YR 3/1 Very dk. grey	Ø.Ø PPM	NA		
		SM - Silty Sand ~~Fine → med sand~~ Silty Sand fine gr. 10YR 5/2 GREYISH BROWN (WET)				
	8.Ø					B.O.B. 8.Ø' BGS
	9.Ø					
						10.Ø

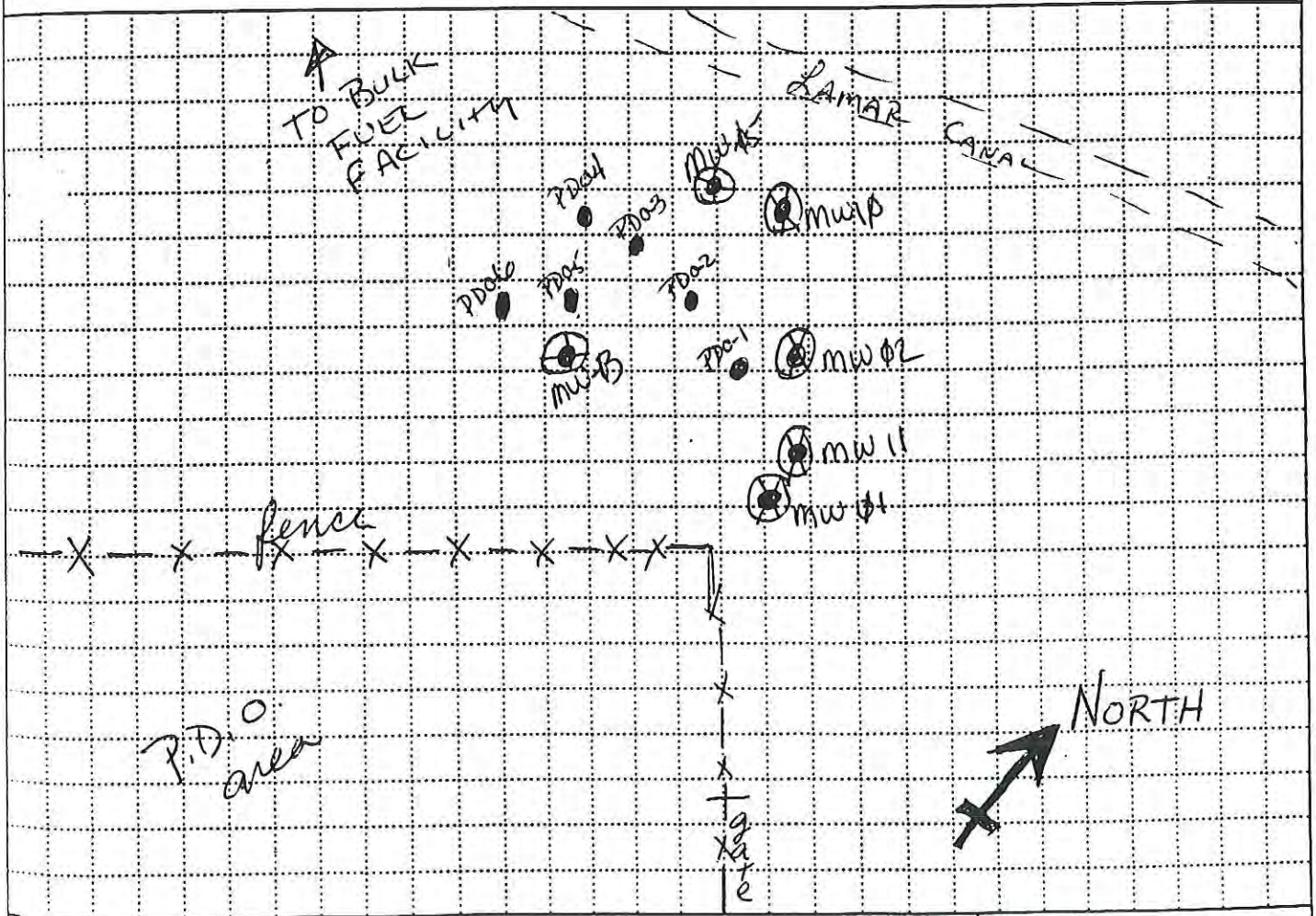
Heather Smith 11/30/94

PROJECT | HOLE NO

HTRW DRILLING LOG	DISTRICT Savannah Corp's	PDO-2
3. COMPANY NAME SAIC	2. DRILL SUBCONTRACTOR SAIC Middletown	SHEET 1 OF 2 SHEETS
4. PROJECT PDO Yard @ HAAF	5. LOCATION P. D. O. Yard.	
7. NAME OF DRILLER John Haselhoff	6. MANUFACTURER'S DESIGNATION OF DRILL geoprobe 5400	
8. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT 2" Stainless Steel 4' long macrocore sampler w/ acetate liners	8. HOLE LOCATION See map	
	9. SURFACE ELEVATION	
	10. DATE STARTED 11-30-99	11. DATE COMPLETED 11-30-99
12. OVERBURDEN THICKNESS greater than total depth	15. DEPTH GROUNDWATER ENCOUNTERED ~7' BGS	
13. DEPTH DRILLED INTO ROCK NA	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED NA	
14. TOTAL DEPTH OF HOLE 8.0' BGS.	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY) NA	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES			
NA	NA	NA	NA			
20. SAMPLES FOR CHEMICAL ANALYSIS	**VOC**	**METALS**	**OTHER (SPECIFY)**	**OTHER (SPECIFY)**	**OTHER (SPECIFY)**	**21. TOTAL CORE RECOVERY**
PDØ211	ENCORE's	—	EVAP. LOSS	—	—	NA%
22. DISPOSITION OF HOLE	**BACKFILLED**	**MONITORING WELL**	**OTHER (SPECIFY)**	**23. SIGNATURE OF INSPECTOR**		
w/ bentonite	X	—	—	Heather Smith		

LOCATION SKETCH/COMMENTS SCALE:



PROJECT P. D. O. Yard	HOLE NO PDO-2

ENG FORM 5056-R, AUG 94 (Proponent CECW-EG)

DRILLING LOG

HOLE NUMBER

P.D.O. Yard. | INSPECTOR Heather Smith | SHEET 2 of 2

DEPTH (ft)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO (L)	ANALYTICAL SAMPLE NO (F)	REMARKS (G)
	Topsoil w/ grass & Rootlets w/ SANDS				START 1100
	Silt - Silty Sand fine gr Sand, dry, nonplastic, soft, rootlets 10YR5/4 Yellowish Brown	0.0 ppm			FINISH 1105
			NA		RUN 4.0
1.0	SM - Silty Sand w/ gravel Black crystalline gravel, Virang. FILL some QTZ & granite gravel angular. fine → cs. gr Sand 10YR4/2 Dk Greyish brown dry soft to firm				REC 4.0
					LOSS 0
		0.0 ppm			
2.0	SM - Silty Sand. fine → med. gr. Sand dry, soft, loose.				1.0
	mottled colors - 10YR3/1 - V dk grey 10YR2/1 - BLACK 10YR7/1 Lt. grey		NA		
3.0					2.0
	SP - Poorly graded Sand. Well sorted, fine → med. Sand, Subang → subrounded grains homogeneous 10YR 8/1 White	0.0 ppm			3.0
4.0	SM - Silty Sand fine to med. grained Sand w/ Silt dry, loose, soft, nonplastic		NA		4.0
	Small pockets of ROUNDED WHITE QTZ Sands fine gr	0.0 ppm		SAMPLE ID # PD0211 @ 1115 3 encores 1 4oz Jar	START: 1105
5.0	10YR 2/2 V. dk. brown 10YR 4/2 dk greyish brown 10YR 5/2 greyish brown				FINISH: 1110
	mottled colors.				RUN: 4.0'
6.0		0.0 ppm	NA		REC: 3.9'
					LOSS: 0.1'
					5.0
				Run 5.0 → 7.0' BGS	
	SM - Silty Sand 10YR 7/2 V. dk. brown fine → med grained Sand, w/ Silt dry, loose, soft, nonplastic WET after 7.0' BGS, moist Prior to 7.0' BGS				This RUN has a smell to it @ the bottom
7.0		0.0 ppm			CORE is WET at 7.0' BGS
			NA		6.0
8.0	LOSS				7.0
					8.0
					B.O.B. 8.0' BGS

Heather Smith
11/30/99

PROJECT

HOLE NO

HTRW DRILLING LOG

1. COMPANY NAME: SAIC	2. DISTRICT: Savannah Corps	HOLE NUMBER: PDO-3
	3. DRILL SUBCONTRACTOR: SAIC - Middletown	SHEET: 1 of 2

5. PROJECT: P.D.O. yard @ HAAF	4. LOCATION: PDO YARD
7. NAME OF DRILLER: John Haselhoff	6. MANUFACTURERS DESIGNATION OF DRILL: geoprobe 5400
8. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: 2" Macrocore barrel - 4' long Stainless steel w/ acetate liners	8. HOLE LOCATION: See map
	9. SURFACE ELEVATION:
	10. DATE STARTED: 11-30-99 / 11. DATE COMPLETED: 11-30-99
12. OVERBURDEN THICKNESS: Greater than total depth	15. DEPTH GROUNDWATER ENCOUNTERED: ~6.7' BGS
13. DEPTH DRILLED INTO ROCK: NA	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: NA
14. TOTAL DEPTH OF HOLE: 8.0' BGS	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): NA

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
NA	NA	NA	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
# PD0311	encore's	—	e/AZ. Loss	—	—	NA

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
w/ bentonite	X	—	—	Heather Smith

LOCATION SKETCH/COMMENTS — SCALE:

See map on page 18 of this logbook (logbook #2)

PROJECT	HOLE NO
P.D.O. yard.	PDO-3

ENG FORM 5056-R, AUG 94 — (Proponent CECW-EG)

DRILLING LOG

PROJECT: PDO Yard | INSPECTOR: Heather Smith | HOLE NO: PDO-3 | SHEET: 2 of 2

ELEV (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO (E)	ANALYTICAL SAMPLE NO (F)	REMARKS (G)
		SM- Silty Sand w/ topsoil/organics.				START ~~1250~~ 1245 1250
		SM - Silty Sand. fine gr. Sand Subrounded → Sub.ang. grains DRY, soft, louse, Some Rootlets	Ø.Ø ppm	NA		FINISH ~~1255~~ 1245/345/1255
1.Ø		10YR5/4 Yellowish Brown				RUN 4.Ø' ~~BGS~~
		SM - Silty Sand w/ black, crystalline gravel · med gr. angular sand 10YR2/1 Black (FILL) dry				REC 3.5'
		SM - Silty Sand M-f.gr. Sand, dry, soft louse 2.5Y3/1 V.dk. grey				LOSS Ø.5'
2.Ø		SM - Silty Sand Med. → fine gr., loose, dry, soft, nonplastic 2.5Y4/2 dk. greyish brown				
		SM - Silty Sand (as above w/ color change to 2.5Y5/4 light olive brown.	Ø.Ø ppm			
3.Ø		SP - Poorly Graded Sand (w/trace Silt) (well sorted) Subrounded, soft, loose homogeneous 10YR7/1 LT. GREY		NA		
		Loss (contact estimated)	Ø.Ø			
4.Ø		SM - Silty Sand, fine → med. gr. 2.5Y4/1 DK. grey	ppm			START 1255
		vague contact here contact grades into diff. color				FINISH 1300
		SM - Silty Sand fine to medium Sand loose, dry to slightly moist to 6.7' BGS. WET from 6.7' to T.D. grains are Subrounded → Sub angular, nonplastic	Ø.Ø ppm		SAMPLE ID # PDØ311B TIME @ 1310 SAMPLED: 3-encores 1-4oz jar	RUN 4.Ø'
5.Ø						REC 4.Ø
						LOSS Ø
6.Ø		10YR3/2 V.dk. greyish brown	Ø.Ø ppm	NA		
		Water level @ 6.7 in core				CORE WET @ 6.7' BGS
7.Ø		~~Same mtrl. as above just wet~~ HS (11-30-99)	Ø.Ø ppm.			
		SM - Silty Sand w/ <10% clay low plasticity, wet, Sand is med. → fine grained Sand. Soft 10YR3/2 V.dk greyish brown.		NA		
8.Ø						B.O.B. 8.Ø'
9.Ø						
						10.Ø

Heather Smith 11/30/99

PROJECT: P.D.O Yard | HOLE NO: PDO-3

PDO-4 44

HTRW DRILLING LOG

1. COMPANY NAME: SAIC	2. DRILL SUBCONTRACTOR: SAIC - Middletown	HOLE NUMBER: ~~PDO-4~~ HKS 11/30/99
3. PROJECT: P.D.O Yard @ HAAF	4. LOCATION: PDO yard	SHEET 1 of 3
5. NAME OF DRILLER: John Hasselhoff	6. MANUFACTURERS DESIGNATION OF DRILL: geoprobe 5400	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: 2" macrocore barrels - 4' lengths Stainless Steel w/ acetate liners	8. HOLE LOCATION: See Map 9. SURFACE ELEVATION	
	10. DATE STARTED: 11-30-99	11. DATE COMPLETED: 11-30-99
12. OVERBURDEN THICKNESS: greater than T.D.	15. DEPTH GROUNDWATER ENCOUNTERED: ~ 6½' (estimated)	
13. DEPTH DRILLED INTO ROCK: NA	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: NA	
14. TOTAL DEPTH OF HOLE: 11.0' BGS	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): NA	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
NA	NA	NA	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY: NA %
PDØ411	encore's	—	EVAP. LOSS	—	—	

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
w/ bentonite	X	—	—	Heather L Smith

LOCATION SKETCH/COMMENTS — SCALE: NONE

See Map on page 18 of this logbook (logbook # 2)

PROJECT	HOLE NO
P.D.O. Yard.	P.D.O-4

ENG FORM 5056-R, AUG 94 (Proponent CECW-EG)

(Signature and Date) (Weather, atmosphere, soil core, breathing zone, venting compressed air, etc.)

DRILLING LOG — Heather Smith — PDO-4 — 11

PROJECT: PDO Yard — INSPECTOR: Heather Smith — SHEET: 2 of 3

ELEV (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO (E)	ANALYTICAL SAMPLE NO (F)	REMARKS (G)
		SM - Silty Sand ? TOPSOIL w/ ROOTLETS.				START : 1345
		SM - Silty Sand fine → med. grained Sand soft, dry, nonplastic 10YR3/1 V. dk. grey	Φ.Φ ppm	NA		FINISH : 1350
		BLACK crystalline RX. V. CS. gr. Sands				RUN : 4.Φ'
	1.Φ					REC : 3.9'
		SM - Silty Sand. fine → med. Sand. dry homogeneous color 10YR3/2 V. dk. grey ish brown	Φ.Φ ppm			LOSS : Φ.1'
		SM - Silty Sand med → fine gr. Sand; soft, loose, non plastic mottled colors, dry 10YR6/6 brownish yellow w/ 10YR3/1 V. dk. grey.				
	2.Φ					1.Φ
		SM - Silty Sand • fine to med Sand, subangular grains • lenses of fine grained Subrounded sand sporatic throughout core Lenses are 10YR7/1 lt grey Surrounding Sand is 10YR3/1 V. dk. grey. Slightly moist	Φ.Φ ppm	NA		2.Φ
	3.Φ					CORE IS SMELLY but PID HCS = Φ.Φ ppm
	4.Φ		Φ.Φ ppm			3.Φ
					SAMPLE ID # PDO411 @1355 TOOK 3 encore's & 1, 4oz Jar	4.Φ
		SM - Silty Sand • fine to med. grained Sands. Subrounded → Subangular. Soft, loose, & nonplastic 10YR3/1 V. dk. grey. Slightly moist		NA		START : 1350 FINISH : 1355 RUN : 4.Φ' REC : 2.Φ' LOSS : 2.Φ'
	5.Φ		Φ.Φ ppm			
	6.Φ					• WET STUFF FELL OUT of acetate liner
			Φ.Φ ppm	NA		• Core is SMELLY NO PID hits
	7.Φ	LOSS				6.Φ
			Φ.Φ ppm			7.Φ
	8.Φ					8.Φ
		LOSS		NA		START 1355 FINISH 1400 RUN 3' LOSS 3' REC Φ
	9.Φ					9.Φ
						10.Φ

PROJECT: P.D.O. Yard — A-64 — HOLE NO: PDO-4

DRILLING LOG

PROJECT	INSPECTOR	HOLE NUMBER
P.D.O. Yard	Heather J Smith	PDO-4
		SHEET 3 of 3

ELEV (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GLOVE OR SAMPLE OR CORE BOX NO (E)	ANALYTICAL SAMPLE NO (F)	REMARKS (G)
	10.0					10.0
		Loss		NA		
	11.0					11.0
						B.O.B 11.0'

Heather J Smith 11/30/18

THIS PAGE INTENTIONALLY LEFT BLANK

PDØ-6

HTRW DRILLING LOG

1. COMPANY NAME: SAIC	2. DISTRICT: Savannah Corps	HOLE NUMBER: P.D.O. 5
	3. DRILL SUBCONTRACTOR: SAIC - Middletown	SHEET 1 of 3

4. PROJECT: P.D.O. Yard.	5. LOCATION: PDO yard
6. NAME OF DRILLER: John Hasselhoff	7. MANUFACTURERS DESIGNATION OF DRILL: Geoprobe 5400
8. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: 2" Macrocore barrel - 4' length Stainless Steel w/ acetate liners	8. HOLE LOCATION: See map
	9. SURFACE ELEVATION:
10. DATE STARTED: 11-30-99	11. DATE COMPLETED: 11-30-99
12. OVERBURDEN THICKNESS: Greater than T. Depth	15. DEPTH GROUNDWATER ENCOUNTERED: Core wet @ 6.7' BGS PDO-5 & 5.7' BGS PDO-6
13. DEPTH DRILLED INTO ROCK: NA	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: NA
14. TOTAL DEPTH OF HOLE: 8.Ø' BGS	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): NA

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
NA	NA	NA	NA

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY
PDØ511 & PDØ611	encore	—	~~EPA~~ EVAP. Loss	—	—	NA

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	X	—	—	Heather L Smith

LOCATION SKETCH/COMMENTS — SCALE: NA

See map on page 18 of logbook #2 (this logbook) for map of locations.

PROJECT	HOLE NO
P.D.O. Yard.	PDO-5 & PDO-6

ENG FORM 5056-R, AUG 94 (Proponent CECW-EG)

(Signature and Date)

DRILLING LOG

HOLE NUMBER PDO-5

PROJECT PDC Yard. INSPECTOR Heather Smith SHEET 2 of 3

ELEV (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO (E)	ANALYTICAL SAMPLE NO (F)	REMARKS (G)
		SM - Silty Sand w/ topsoil grasses/organics				START 1420
	1.0	SM - Silty Sand fine to med. grained sands soft, loose, dry, Rootlets 7.5YR 4/3 BROWN	0.0 PPM	NA		FINISH 1425
		SM - Silty Sand w/ gravel Rock: V. angular crystaline rock 10YR 4/1 fine sand, sands subrounded → ang., dry				RUN 4.0
	1.5					REC 3.6
		SM - Silty Sand. fine → med. gr Sands	0.0 PPM	NA		LOSS 0.4
	2.0	Soft, dry 10YR 4/2 dk. greyish brown				
	2.5	SM - Silty Sand. fine → med. gr. Sand. Subrounded → Subangular grains. Soft dry. 10YR 5/6 yellowish brown				
	3.0					
	3.5	SM - silty sand - soft, dry black, 10YR 2/1, nonplastic	0.0 PPM	NA		
	4.0	LOSS				
		SM - Silty Sand - Soft dry mottled color. 10YR 5/4 yellowish brown & 10YR 3/2 V. dk greyish brown.				START 1425
		SM - Silty Sand fine grained sands w/ silt 10YR 2/2 Very dk brown Silver color from clear QTZ crystals. on top of dk brown Sands.	0 PPM	NA	SAMPLE ID # PDO511 @ 1435 3 encores 1-4oz Jar.	FINISH 1430
	5.0					RUN 4.0
	6.0					REC 4.0
						LOSS 0
						CORE IS SMELLY ~~and~~ BUT PID READS 0.0 PPM
		SM - Silty Sand w/ Clay lenses ranging from 2" to 1/2" thick - Lean clay clay lenses are moist, high plasticity, soft	0.0 PPM	NA		WATER ON CORE @ 6.7' BGS.
	7.0					
		~~SM~~ SP - Poorly graded Sand w/ trace silt (well sorted) WET, loose, soft, nonplastic	0.0 PPM			
	8.0					
						B.O.B. @ 8.0' BGS
	9.0					
	10.0					

PROJECT PDC Yard HOLE NO PDO-5

DRILLING LOG

PROJECT: PDO Yard | INSPECTOR: Heather Smith | HOLE NUMBER: PDO-6 | SHEET: 3 of 3

UNIT (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO (E)	ANALYTICAL SAMPLE NO (F)	REMARKS (G)
	0.0	SM - Silty Sand w/ TOPSOIL ? Rootlets ? grasses	0.0 ppm	NA		START : 1515 FINISH : 1520 RUN : 4.0 RECOVER : 3.2 LOSS : 0.8
		SM - Silty Sand, med. gr. sand - Sub rounded → sub ang loose soft dry nonplastic - 10YR4/3 BROWN				
	1.0	SM - Silty Sand w/ gravel sand is angular fine → cs. gr w/ black crystaline RX pebbles → gravel 10YR2/1 BLACK				
		SM - Silty Sand - med → fine grained sands Mottled colors White: 10YR8/1 black: 10YR2/1 brown: 10YR4/3	0.0 ppm	NA		
	2.0	Soft, dry loose Color ↓ indicates possible configuration bedding planes.				
	3.0	LOSS	0.0 ppm			
	4.0	SAME AS ABOVE			4.0	
		SM - Silty Sand fine → med. gr. Sand. Silt color is 10YR3/1 v. dk grey w/ clear QTZ Sand grains that give a silver look Soft, moist, loose, nonplastic	0.0 ppm	NA	SAMPLE ID # PDO611 3-encores 1-4oz jar @ 1530	START 1520 FINISH 1525 RUN 4.0 REC : LOSS :
	5.0	TOP of CORE WET @ 5.7' BGS			5.7	CORE is WET @ 5.7' BGS ON THIS RUN
	6.0	SM - Silty Sand w/ <10% clay fine → med grained sand WET, SOFT, loose Same colors as above unit "thick clay is in lenses ~ ½" clay is lean, high plasticity not found uniform throughout section	0.0 ppm	NA		
	7.0	~~SP - Poorly Graded Sand TRACE~~ AS ABOVE 10YR2/1 BLACK SM Silty Sand, w/ lgr clay lenses up to 1" across				
		SP - Poorly GRADED SAND w/ TRACE SILT, soft 10YR 1/2 Very Pale Brown Wet well sorted grains, homogeneous nonplastic	0.0 ppm	NA		
	8.0					B.O.B. 8.0' BGS
	9.0					
	10.0					

Heather J. Smith 11/30/95

PROJECT: PDO Yard | HOLE NO: PDO-6

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX B

FATE AND TRANSPORT MODELING

THIS PAGE INTENTIONALLY LEFT BLANK

1.0 INTRODUCTION

Monitored Natural Attenuation is appropriate as a remedial approach only where it can be demonstrated capable of achieving a site's remedial objectives within a time frame that is reasonable (Office of Solid Waste and Emergency Response Directive 9200.4-17P). In order to determine whether Monitored Natural Attenuation is an appropriate remedy for soils and groundwater at a given site, fate and transport modeling must be performed to show that contaminants present in soils and groundwater can be effectively remediated by natural attenuation processes. The following summarizes the modeling performed for evaluating natural attenuation as an alternative for the Corrective Action Plan (CAP) for the Old Property Disposal (PDO) Yard at Hunter Army Airfield (HAAF), Georgia.

2.0 MODELING APPROACH

A brief summary of the modeling approach is presented as follows:

1. Develop the conceptual model for each distinct flow path including contaminated soils, groundwater plume, flow path direction and characteristics, and receptor locations. For the PDO Yard, two separate groundwater plumes were modeled, one for benzene and one for tetrachloroethene (PCE).

2. Identify the chemicals of concern (COCs) and select a surrogate chemical to represent the chemical group with conservatism. For the PDO Yard, benzene and PCE are selected as the representative chemicals used in the modeling.

3. Perform leachate modeling using the Seasonal Soil (SESOIL) compartment model. This step was not required at the PDO Yard because there are no COCs in soils and no remaining source in soil.

4. Perform steady-state saturated flow and contaminant transport modeling using the Analytical Transient 1-, 2-, 3-Dimensional (AT123D) model to predict the maximum concentration of the surrogate chemicals at the selected receptor locations. For the PDO Yard, the model uses the existing concentrations within the groundwater plume, because there are no soil COCs at this site, and then calculates the lateral flow and transport of the surrogate chemicals. A dilution attenuation factor (DAF) is calculated as $DAF_{GWS\text{-}GWR} = C_{GWS}/C_{GWR}$, where C_{GWR} is the predicted maximum concentration at the receptor location, and C_{GWS} is the concentration of groundwater in the existing source plume.

5. Perform saturated flow and contaminant transport modeling using AT123D to predict the maximum concentration over time, in conjunction with remediation of the existing source plume, in order to identify a reasonable time frame for the Monitored Natural Attenuation alternative.

3.0 MODELS SELECTED

AT123D. The AT123D model is a well-known and commonly used analytical groundwater pollutant fate and transport model. This model was developed by Yeh (1981) and has been updated by GSC (1996). It computes the spatial-temporal concentration distribution of constituents in the aquifer system and predicts the transient spread of a chemical plume through a groundwater aquifer. The fate and transport processes accounted for in AT123D are advection, dispersion, adsorption/retardation, and decay. This model can be used as a tool for estimating the dissolved concentration of a chemical in three dimensions in the

groundwater resulting from a mass release (either continuous release, instant release, or depleting source) over a source area (i.e., point, line, area, or volume source).

4.0 PARAMETERS

The hydrologic parameters used in the modeling are based on findings from previous investigations (Metcalf & Eddy 1999). The parameters are selected such that they are representative values and account for the variability in the hydraulic system and the most likely conditions within that variability. Time-varying model runs are performed using the representative values. The chemical-specific model parameters include solubility in water, organic carbon partition coefficient, Henry's Law constant, soil-water distribution coefficient, diffusion coefficients in air and water, and first-order decay constant. These are literature-based parameters, and a conservative approach was always utilized for selecting the values of these parameters. The input parameters are presented below.

Input Parameter	PCE model	Benzene model
Source dimension	30.5 meters × 6 meters	30 meters × 6 meters
Saturated thickness	15.2 meters (Metcalf & Eddy 1999)	15.2 meters (Metcalf & Eddy 1999)
Hydraulic gradient	0.0165 meter/meter toward north-northwest	0.016 meter/meter toward north-northwest
Hydraulic conductivity	0.6 meter/hour (average in shallow groundwater: Metcalf & Eddy 1999)	
Bulk density	1.6 gram/cubic centimeter (Metcalf & Eddy 1999)	
Effective porosity	0.18 (Metcalf & Eddy 1999)	
Fraction organic carbon (foc)	0.00728 (average of 0.00286, 0.00588 and 0.0131, for three samples from the shallow groundwater zone; Metcalf & Eddy 1999)	
Koc	265 milliliter/gram (EPA 1996)	81 milliliter/gram (GEPD)
Kd (koc × foc)	1.93 milliliter/gram	0.59 milliliter/gram
Molecular diffusion coefficient	2.95E-6 cubic meter/hour	3.53E-6 cubic meter/hour
Decay constant	0.0 (no degradation)	4.01E-5 liter/hour
Longitudinal dispersivity	20 meters (calibrated)	20 meters (calibrated)
Source loading	218.0 milligrams/hour	357.0 milligrams/hour

EPA = U.S. Environmental Protection Agency.
GEPD = Georgia Environmental Protection Division.

5.0 MODEL APPLICATION AND RESULTS

The AT123D model was applied to the saturated zone using benzene (a volatile aromatic hydrocarbon) and PCE (a volatile aliphatic chlorinated hydrocarbon) as the surrogate chemicals for the PDO Yard. Because benzene has a slower degradation rate and higher mobility than other chemicals within the aromatic hydrocarbon group, natural attenuation modeling results for benzene can be used for the remaining constituents with conservatism. PCE has been detected in a separate plume in the site groundwater and without any daughter products, suggesting that biodegradation of PCE is not occurring at this site. Therefore, these two compounds were chosen for separate fate and transport modeling.

Site-specific DAFs between the source and the receptor locations were developed. The DAF is a numerical value that represents the attempt to mathematically quantify the natural physical, chemical, and biological processes (e.g., advection-dispersion, sorption-retardation, biodegradation, volatilization) that result in the

decrease of a chemical concentration in an environmental medium. In simple terms, the DAF is the ratio of chemical concentration at the source (or the point of origin) to the concentration at the exposure point. DAFs reflect the natural attenuation concepts outlined in the American Society for Testing and Material's (ASTM's) risk-based corrective action (RBCA) protocol (ASTM 1995).

5.1 BENZENE MODELING RESULTS

A steady-state AT123D model for benzene was developed by calibrating the model against the observed maximum concentration of benzene in the groundwater beneath the site. It is assumed that the primary source of petroleum hydrocarbons in soils has been removed (i.e., June 1998 Interim Removal Action); however, a benzene plume in the groundwater has been observed. This benzene plume is considered as the initial condition for the modeling. A steady-state groundwater source is assumed for conservatism. The model calibration was performed matching benzene concentrations at wells MW01 and MW06. Based on the modeling results, the estimated DAF for benzene at Lamar Canal is 1.8.

Results of this modeling, shown in Figure B-1, indicate that benzene from the PDO Yard is not expected to be of potential concern at the nearest receptor location (i.e., Lamar Canal). The maximum benzene concentration observed during the most recent groundwater sampling event in May 1999 was 68 µg/L, which is less than its In-stream Water Quality Standard (IWQS) of 71.28 µg/L. Also, the results predict that the concentration of benzene within the existing source plume will be reduced to less than its MCL of 5 µg/L by natural attenuation processes within 2 years.

5.2 PCE MODELING RESULTS

Similarly, a steady-state AT123D model for PCE was developed by calibrating the model against the observed maximum concentration of PCE in the groundwater beneath the site, assuming no biodegradation. It is assumed that, over the past few years, a continuous release of PCE had occurred in the vicinity of the site (along the gravel roadway) that produced steady-state PCE concentrations in the groundwater. This is a conservative assumption that has not been directly observed; recent soil sampling does not indicate the presence of an existing PCE source in soil. Therefore, it is assumed that the primary source has been removed, and the concentration of PCE in groundwater is expected to decline due to advection and dispersion. Biodegradation is not considered in this modeling because PCE daughter products (i.e., an evidence of biodegradation) were not detected at this site. The existing PCE plume is considered as the initial condition for natural attenuation modeling. Therefore, an approach to calibrate the PCE plume has been undertaken. The model calibration was performed matching PCE concentrations at wells MW05 and MW1-22. The model was verified by predicting the concentrations at MW02. Based on the modeling results, the estimated DAF for PCE at Lamar Canal is 1.6.

Results of PCE modeling are shown in Figures B-2 and B-3. As can be seen from Figure B-2, the PCE concentration would be reduced to less than its MCL of 5 µg/L within the next 5 years. However, it should be noted here that, if there exists a source that is continuously loading PCE to groundwater at the same rate as was done in the past, the concentration of PCE will not decline as predicted in the near future. The modeling results further show that the PCE concentration in Lamar Canal is expected to exceed its In-stream Water Quality Standard (IWQS) of 8.85 µg/L. Therefore, simulations were performed to predict the concentrations in the groundwater at the source plume locations so that the concentrations at Lamar Canal do not exceed the IWQS for PCE. PCE concentrations versus time were back-calculated at different locations at the site, as represented in plots on Figure B-3. These plots show that if PCE concentrations were reduced to less than 15 µg/L in groundwater, then the IWQS would not be exceeded at any time within Lamar Canal. Further, these plots show that the concentration of PCE

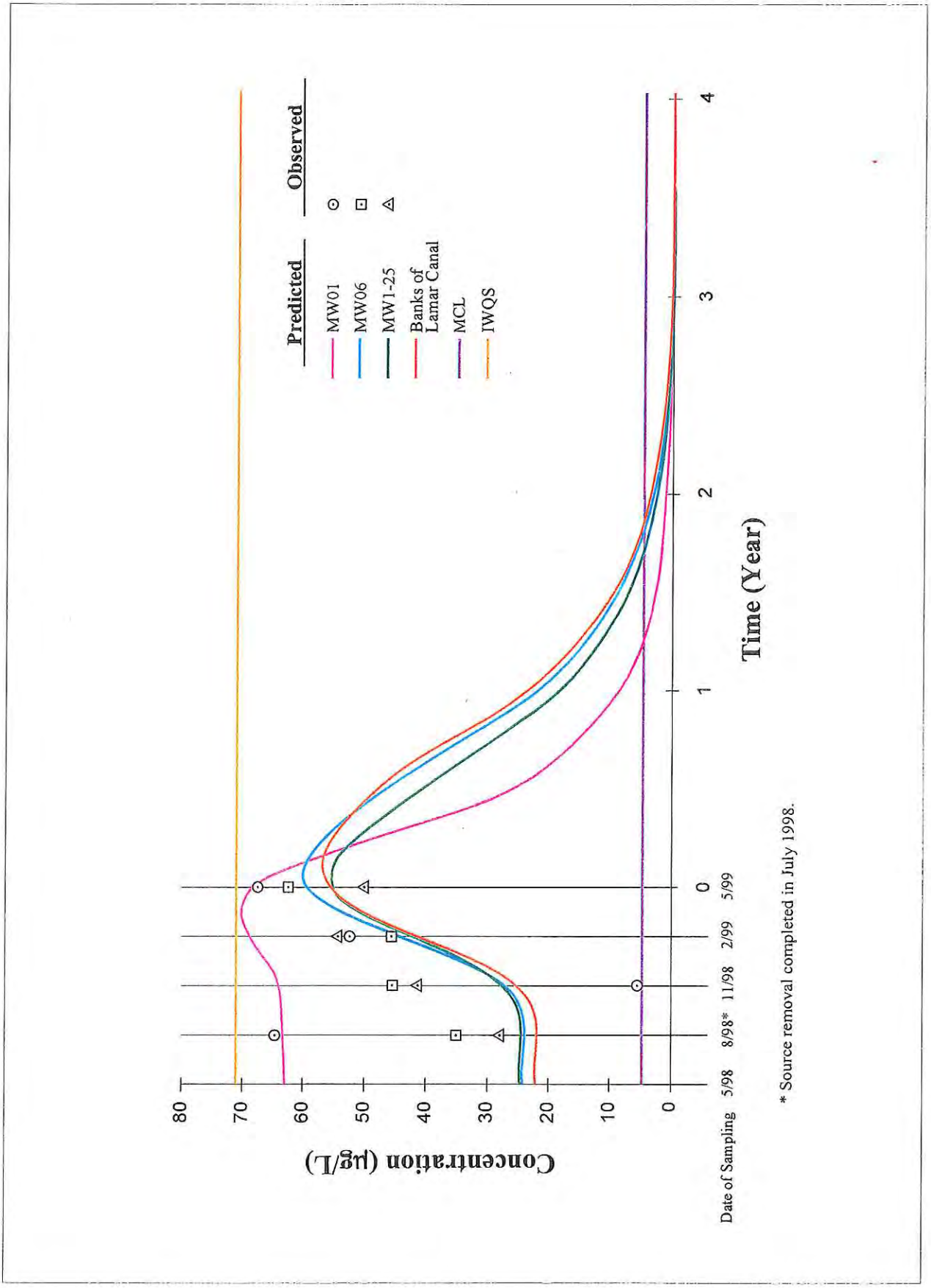


Figure B-1. Predicted Concentration of Benzene in Groundwater at Different Locations at the PDO Yard, Hunter Army Airfield, Georgia.

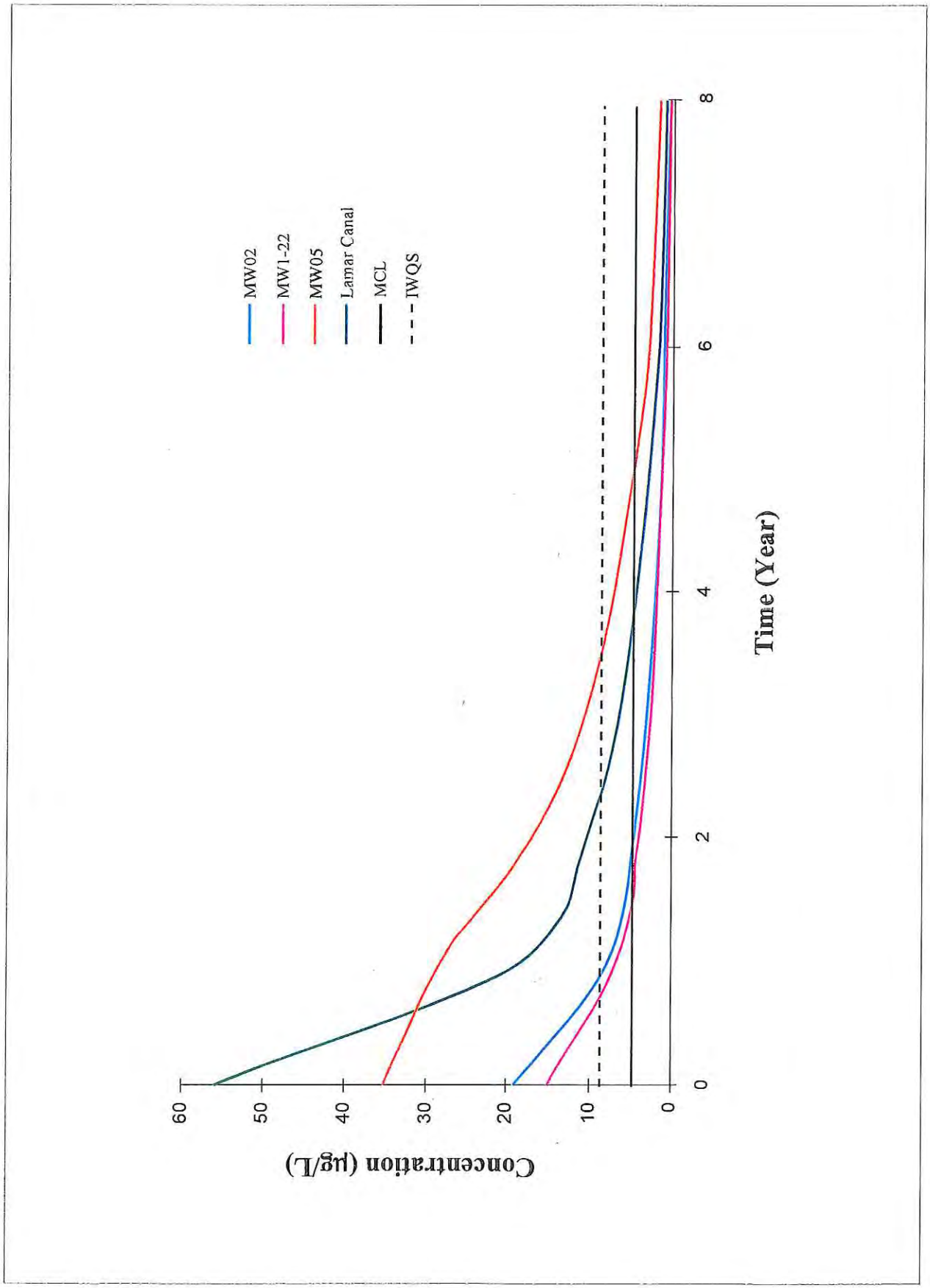


Figure B-2. Predicted Concentration of PCE in Groundwater at the PDO Yard, Hunter Army Airfield, Georgia.

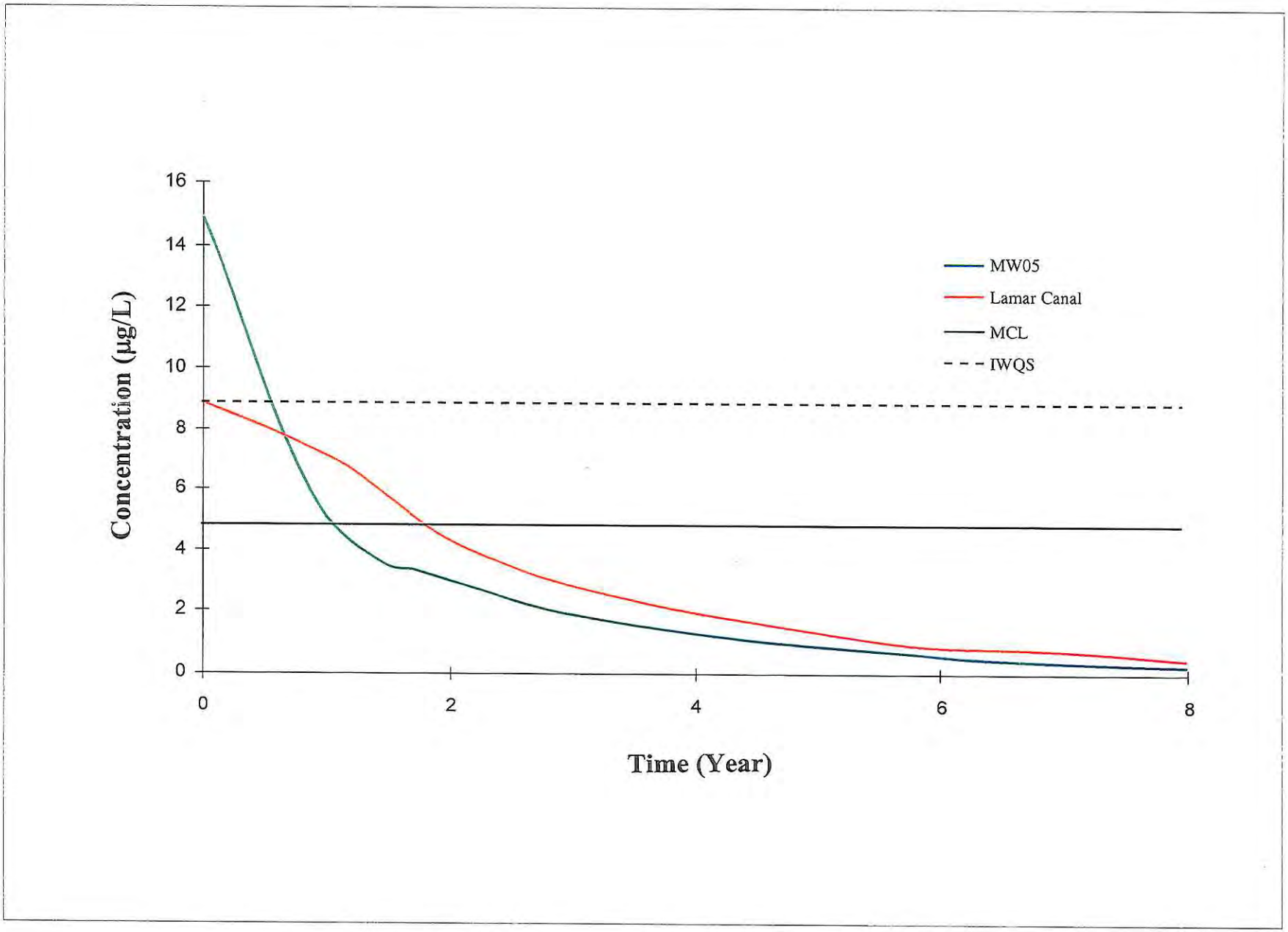


Figure B-3. Predicted Concentration of PCE in Groundwater at Different Locations at the PDO Yard, Hunter Army Airfield, Georgia.

would be reduced from that maximum of 15 μg/L to less than its MCL by natural attenuation processes within 2 years following remediation of the existing source plume "hot spot."

6.0 LIMITATIONS/ASSUMPTIONS

Based upon the data available, a conservative approach was used which may overestimate the contaminant concentration in the groundwater. Listed below are important assumptions used in this analysis:

- The use of K_d and R_d to describe the reaction term of the transport equation assumes that an equilibrium relationship exists between the solid- and solution-phase concentrations and that the relationship is linear and reversible.
- The most conservative biodegradation rate for benzene (from available literature sources) was used, and the biodegradation rate for PCE was set to zero.
- Flow and transport are not affected by density variations.
- The aquifer is homogenous and isotropic.
- Over the past, a steady-state source of contaminant loading to the aquifer has occurred, leading to lateral transport in groundwater; however, the primary source in soils has since been removed.

The inherent uncertainties associated with using these assumptions must be recognized. It is also important to note that the major geochemistry of the plume will change over time and be affected by multiple solutes that are present at the site. Projected organic concentrations in the aquifer are expected to be highly conservative due to use of a steady-state source in groundwater and a conservative literature-based decay rate for benzene. Although no source of PCE has been found in soils at the site, if there remains an undetected source in soils, then the projected concentrations are expected to be underestimated.

THIS PAGE INTENTIONALLY LEFT BLANK

ATTACHMENT B-1

FATE AND TRANSPORT MODELING
INPUT PARAMETERS AND OUTPUT VALUES
FOR BENZENE
AT THE
OLD PROPERTY DISPOSAL (PDO) YARD
HUNTER ARMY AIRFIELD, GEORGIA

THIS PAGE INTENTIONALLY LEFT BLANK

NO. OF POINTS IN X-DIRECTION	10
NO. OF POINTS IN Y-DIRECTION	6
NO. OF POINTS IN Z-DIRECTION	1
NO. OF ROOTS: NO. OF SERIES TERMS	400
NO. OF BEGINNING TIME STEP	19
NO. OF ENDING TIME STEP	111
NO. OF TIME INTERVALS FOR PRINTED OUT SOLUTION	6
INSTANTANEOUS SOURCE CONTROL = 0 FOR INSTANT SOURCE	1
SOURCE CONDITION CONTROL = 0 FOR STEADY SOURCE	0
INTERMITTENT OUTPUT CONTROL = 0 NO SUCH OUTPUT	1
CASE CONTROL =1 THERMAL, = 2 FOR CHEMICAL, = 3 RAD	2

AQUIFER DEPTH, = 0.0 FOR INFINITE DEEP (METERS) ...	0.1524E+02
AQUIFER WIDTH, = 0.0 FOR INFINITE WIDE (METERS) ...	0.0000E+00
BEGIN POINT OF X-SOURCE LOCATION (METERS)	-0.2000E+02
END POINT OF X-SOURCE LOCATION (METERS)	0.2000E+02
BEGIN POINT OF Y-SOURCE LOCATION (METERS)	-0.3000E+01
END POINT OF Y-SOURCE LOCATION (METERS)	0.3000E+01
BEGIN POINT OF Z-SOURCE LOCATION (METERS)	0.0000E+00
END POINT OF Z-SOURCE LOCATION (METERS)	0.2000E+01

POROSITY	0.1800E+00
HYDRAULIC CONDUCTIVITY (METER/HOUR)	0.6010E+00
HYDRAULIC GRADIENT	0.1600E-01
LONGITUDINAL DISPERSIVITY (METER)	0.1000E+02
LATERAL DISPERSIVITY (METER)	0.3000E+01
VERTICAL DISPERSIVITY (METER)	0.1000E+01
DISTRIBUTION COEFFICIENT, KD (M**3/KG)	0.5900E-03
HEAT EXCHANGE COEFFICIENT (KCAL/HR-M**2-DEGREE C)..	0.0000E+00

MOLECULAR DIFFUSION MULTIPLY BY POROSITY (M**2/HR)	0.3530E-05
DECAY CONSTANT (PER HOUR)	0.4010E-04
BULK DENSITY OF THE SOIL (KG/M**3)	0.1650E+04
ACCURACY TOLERANCE FOR REACHING STEADY STATE	0.1000E-02
DENSITY OF WATER (KG/M**3)	0.1000E+04
TIME INTERVAL SIZE FOR THE DESIRED SOLUTION (HR) ..	0.7300E+03
DISCHARGE TIME (HR)	0.1752E+05
WASTE RELEASE RATE (KCAL/HR), (KG/HR), OR (CI/HR) .	0.2890E-03

RETARDATION FACTOR	0.6408E+01
RETARDED DARCY VELOCITY (M/HR)	0.8336E-02
RETARDED LONGITUDINAL DISPERSION COEF. (M**2/HR) ..	0.8337E-01
RETARDED LATERAL DISPERSION COEFFICIENT (M**2/HR) .	0.2501E-01
RETARDED VERTICAL DISPERSION COEFFICIENT (M**2/HR).	0.8339E-02

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.0000E+00 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-1.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-2.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-3.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-4.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-5.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.1314E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.585E-01	0.117E+00	0.132E+00	0.122E+00	0.921E-01	0.630E-01	0.456E-01	0.256E-01	0.245E-01	0.225E-01
-1.	0.579E-01	0.116E+00	0.131E+00	0.121E+00	0.915E-01	0.627E-01	0.454E-01	0.256E-01	0.245E-01	0.224E-01
-2.	0.563E-01	0.112E+00	0.128E+00	0.118E+00	0.898E-01	0.619E-01	0.451E-01	0.255E-01	0.244E-01	0.223E-01
-3.	0.536E-01	0.107E+00	0.122E+00	0.114E+00	0.870E-01	0.605E-01	0.444E-01	0.252E-01	0.242E-01	0.221E-01
-4.	0.502E-01	0.101E+00	0.115E+00	0.108E+00	0.833E-01	0.588E-01	0.435E-01	0.249E-01	0.239E-01	0.219E-01
-5.	0.462E-01	0.926E-01	0.107E+00	0.101E+00	0.788E-01	0.566E-01	0.424E-01	0.246E-01	0.235E-01	0.216E-01

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.1752E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.586E-01	0.117E+00	0.133E+00	0.123E+00	0.929E-01	0.641E-01	0.471E-01	0.283E-01	0.273E-01	0.254E-01
-1.	0.580E-01	0.116E+00	0.132E+00	0.122E+00	0.923E-01	0.638E-01	0.469E-01	0.282E-01	0.272E-01	0.254E-01
-2.	0.564E-01	0.113E+00	0.128E+00	0.119E+00	0.906E-01	0.630E-01	0.465E-01	0.281E-01	0.271E-01	0.253E-01
-3.	0.537E-01	0.107E+00	0.123E+00	0.114E+00	0.878E-01	0.616E-01	0.459E-01	0.279E-01	0.269E-01	0.251E-01
-4.	0.503E-01	0.101E+00	0.115E+00	0.108E+00	0.840E-01	0.598E-01	0.450E-01	0.276E-01	0.266E-01	0.248E-01
-5.	0.463E-01	0.929E-01	0.107E+00	0.101E+00	0.796E-01	0.577E-01	0.439E-01	0.272E-01	0.262E-01	0.245E-01

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.2190E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X: -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.112E-01	0.240E-01	0.356E-01	0.482E-01	0.598E-01	0.682E-01	0.719E-01	0.612E-01	0.595E-01	0.559E-01
-1.	0.111E-01	0.238E-01	0.353E-01	0.478E-01	0.593E-01	0.677E-01	0.713E-01	0.608E-01	0.591E-01	0.555E-01
-2.	0.108E-01	0.232E-01	0.344E-01	0.466E-01	0.578E-01	0.660E-01	0.696E-01	0.597E-01	0.580E-01	0.546E-01
-3.	0.104E-01	0.222E-01	0.329E-01	0.446E-01	0.554E-01	0.634E-01	0.670E-01	0.578E-01	0.562E-01	0.530E-01
-4.	0.974E-02	0.209E-01	0.309E-01	0.420E-01	0.523E-01	0.599E-01	0.635E-01	0.553E-01	0.539E-01	0.509E-01
-5.	0.901E-02	0.193E-01	0.286E-01	0.389E-01	0.486E-01	0.558E-01	0.594E-01	0.524E-01	0.511E-01	0.484E-01

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.2628E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X: -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.296E-02	0.633E-02	0.980E-02	0.144E-01	0.200E-01	0.264E-01	0.330E-01	0.460E-01	0.467E-01	0.479E-01
-1.	0.294E-02	0.627E-02	0.971E-02	0.143E-01	0.198E-01	0.261E-01	0.327E-01	0.457E-01	0.464E-01	0.475E-01
-2.	0.286E-02	0.611E-02	0.946E-02	0.139E-01	0.193E-01	0.255E-01	0.319E-01	0.446E-01	0.453E-01	0.464E-01
-3.	0.274E-02	0.584E-02	0.905E-02	0.133E-01	0.185E-01	0.244E-01	0.306E-01	0.429E-01	0.436E-01	0.447E-01
-4.	0.258E-02	0.550E-02	0.852E-02	0.125E-01	0.174E-01	0.230E-01	0.289E-01	0.407E-01	0.413E-01	0.424E-01
-5.	0.239E-02	0.509E-02	0.790E-02	0.116E-01	0.162E-01	0.214E-01	0.269E-01	0.380E-01	0.386E-01	0.397E-01

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.3066E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X: -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.849E-03	0.181E-02	0.285E-02	0.433E-02	0.632E-02	0.889E-02	0.120E-01	0.213E-01	0.221E-01	0.238E-01
-1.	0.842E-03	0.179E-02	0.283E-02	0.429E-02	0.627E-02	0.881E-02	0.119E-01	0.211E-01	0.219E-01	0.236E-01
-2.	0.820E-03	0.175E-02	0.275E-02	0.418E-02	0.611E-02	0.858E-02	0.116E-01	0.206E-01	0.214E-01	0.230E-01
-3.	0.785E-03	0.167E-02	0.264E-02	0.400E-02	0.585E-02	0.823E-02	0.111E-01	0.198E-01	0.205E-01	0.221E-01
-4.	0.739E-03	0.157E-02	0.248E-02	0.377E-02	0.551E-02	0.775E-02	0.105E-01	0.187E-01	0.194E-01	0.209E-01
-5.	0.685E-03	0.146E-02	0.230E-02	0.350E-02	0.511E-02	0.720E-02	0.976E-02	0.174E-01	0.181E-01	0.195E-01

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.3504E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X: -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.253E-03	0.539E-03	0.858E-03	0.133E-02	0.199E-02	0.290E-02	0.410E-02	0.832E-02	0.876E-02	0.968E-02
-1.	0.251E-03	0.534E-03	0.851E-03	0.132E-02	0.197E-02	0.287E-02	0.406E-02	0.825E-02	0.869E-02	0.959E-02
-2.	0.245E-03	0.520E-03	0.829E-03	0.128E-02	0.192E-02	0.280E-02	0.396E-02	0.805E-02	0.847E-02	0.936E-02
-3.	0.234E-03	0.498E-03	0.794E-03	0.123E-02	0.184E-02	0.268E-02	0.379E-02	0.772E-02	0.813E-02	0.898E-02
-4.	0.221E-03	0.469E-03	0.748E-03	0.116E-02	0.174E-02	0.253E-02	0.358E-02	0.729E-02	0.767E-02	0.848E-02
-5.	0.205E-03	0.435E-03	0.694E-03	0.107E-02	0.161E-02	0.235E-02	0.332E-02	0.678E-02	0.714E-02	0.789E-02

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.3942E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X: -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.774E-04	0.164E-03	0.264E-03	0.412E-03	0.629E-03	0.937E-03	0.136E-02	0.302E-02	0.321E-02	0.361E-02
-1.	0.767E-04	0.163E-03	0.261E-03	0.409E-03	0.624E-03	0.929E-03	0.135E-02	0.300E-02	0.318E-02	0.358E-02
-2.	0.747E-04	0.159E-03	0.255E-03	0.398E-03	0.608E-03	0.905E-03	0.132E-02	0.292E-02	0.310E-02	0.349E-02
-3.	0.716E-04	0.152E-03	0.244E-03	0.381E-03	0.582E-03	0.867E-03	0.126E-02	0.280E-02	0.297E-02	0.334E-02
-4.	0.674E-04	0.143E-03	0.230E-03	0.359E-03	0.549E-03	0.818E-03	0.119E-02	0.264E-02	0.281E-02	0.316E-02
-5.	0.625E-04	0.133E-03	0.213E-03	0.334E-03	0.509E-03	0.759E-03	0.110E-02	0.246E-02	0.261E-02	0.294E-02

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.4380E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X: -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.240E-04	0.510E-04	0.821E-04	0.130E-03	0.200E-03	0.303E-03	0.448E-03	0.106E-02	0.113E-02	0.129E-02
-1.	0.238E-04	0.506E-04	0.814E-04	0.128E-03	0.198E-03	0.300E-03	0.444E-03	0.105E-02	0.112E-02	0.128E-02
-2.	0.232E-04	0.493E-04	0.793E-04	0.125E-03	0.193E-03	0.292E-03	0.433E-03	0.102E-02	0.109E-02	0.124E-02
-3.	0.222E-04	0.472E-04	0.760E-04	0.120E-03	0.185E-03	0.280E-03	0.415E-03	0.980E-03	0.105E-02	0.119E-02
-4.	0.209E-04	0.445E-04	0.716E-04	0.113E-03	0.174E-03	0.264E-03	0.391E-03	0.924E-03	0.988E-03	0.112E-02
-5.	0.194E-04	0.413E-04	0.664E-04	0.105E-03	0.162E-03	0.245E-03	0.363E-03	0.859E-03	0.918E-03	0.105E-02

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.4818E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X = -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.754E-05	0.160E-04	0.259E-04	0.410E-04	0.639E-04	0.978E-04	0.147E-03	0.363E-03	0.389E-03	0.447E-03
-1.	0.747E-05	0.159E-04	0.256E-04	0.407E-04	0.634E-04	0.969E-04	0.146E-03	0.360E-03	0.386E-03	0.443E-03
-2.	0.728E-05	0.155E-04	0.250E-04	0.396E-04	0.617E-04	0.945E-04	0.142E-03	0.350E-03	0.376E-03	0.432E-03
-3.	0.698E-05	0.148E-04	0.239E-04	0.380E-04	0.591E-04	0.905E-04	0.136E-03	0.336E-03	0.361E-03	0.414E-03
-4.	0.657E-05	0.140E-04	0.226E-04	0.358E-04	0.557E-04	0.853E-04	0.128E-03	0.317E-03	0.340E-03	0.391E-03
-5.	0.610E-05	0.130E-04	0.209E-04	0.332E-04	0.517E-04	0.792E-04	0.119E-03	0.294E-03	0.316E-03	0.363E-03

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.5256E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X = -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.239E-05	0.507E-05	0.821E-05	0.131E-04	0.205E-04	0.317E-04	0.481E-04	0.123E-03	0.132E-03	0.153E-03
-1.	0.237E-05	0.503E-05	0.814E-05	0.130E-04	0.203E-04	0.314E-04	0.477E-04	0.122E-03	0.131E-03	0.152E-03
-2.	0.231E-05	0.490E-05	0.793E-05	0.126E-04	0.198E-04	0.306E-04	0.465E-04	0.119E-03	0.128E-03	0.148E-03
-3.	0.221E-05	0.469E-05	0.760E-05	0.121E-04	0.190E-04	0.293E-04	0.445E-04	0.114E-03	0.123E-03	0.142E-03
-4.	0.208E-05	0.442E-05	0.716E-05	0.114E-04	0.179E-04	0.276E-04	0.420E-04	0.107E-03	0.116E-03	0.134E-03
-5.	0.193E-05	0.410E-05	0.664E-05	0.106E-04	0.166E-04	0.256E-04	0.390E-04	0.997E-04	0.107E-03	0.124E-03

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.5694E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X = -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.761E-06	0.162E-05	0.262E-05	0.419E-05	0.661E-05	0.103E-04	0.157E-04	0.413E-04	0.446E-04	0.519E-04
-1.	0.754E-06	0.160E-05	0.260E-05	0.416E-05	0.655E-05	0.102E-04	0.156E-04	0.410E-04	0.442E-04	0.515E-04
-2.	0.735E-06	0.156E-05	0.253E-05	0.405E-05	0.638E-05	0.992E-05	0.152E-04	0.399E-04	0.431E-04	0.502E-04
-3.	0.704E-06	0.150E-05	0.243E-05	0.388E-05	0.612E-05	0.951E-05	0.146E-04	0.383E-04	0.413E-04	0.481E-04
-4.	0.664E-06	0.141E-05	0.229E-05	0.366E-05	0.577E-05	0.896E-05	0.137E-04	0.361E-04	0.390E-04	0.454E-04
-5.	0.616E-06	0.131E-05	0.212E-05	0.339E-05	0.535E-05	0.832E-05	0.128E-04	0.335E-04	0.362E-04	0.421E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.6132E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X: -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.244E-06	0.518E-06	0.841E-06	0.135E-05	0.214E-05	0.334E-05	0.515E-05	0.138E-04	0.150E-04	0.175E-04
-1.	0.242E-06	0.513E-06	0.834E-06	0.134E-05	0.212E-05	0.331E-05	0.511E-05	0.137E-04	0.148E-04	0.174E-04
-2.	0.236E-06	0.500E-06	0.813E-06	0.130E-05	0.206E-05	0.323E-05	0.498E-05	0.134E-04	0.145E-04	0.169E-04
-3.	0.226E-06	0.479E-06	0.779E-06	0.125E-05	0.198E-05	0.309E-05	0.477E-05	0.128E-04	0.139E-04	0.162E-04
-4.	0.213E-06	0.452E-06	0.734E-06	0.118E-05	0.186E-05	0.291E-05	0.450E-05	0.121E-04	0.131E-04	0.153E-04
-5.	0.198E-06	0.419E-06	0.681E-06	0.109E-05	0.173E-05	0.271E-05	0.417E-05	0.112E-04	0.121E-04	0.142E-04

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.6570E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X: -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.787E-07	0.167E-06	0.271E-06	0.436E-06	0.693E-06	0.109E-05	0.169E-05	0.462E-05	0.500E-05	0.587E-05
-1.	0.780E-07	0.165E-06	0.269E-06	0.432E-06	0.687E-06	0.108E-05	0.167E-05	0.458E-05	0.496E-05	0.582E-05
-2.	0.760E-07	0.161E-06	0.262E-06	0.421E-06	0.670E-06	0.105E-05	0.163E-05	0.446E-05	0.484E-05	0.568E-05
-3.	0.728E-07	0.154E-06	0.251E-06	0.403E-06	0.641E-06	0.101E-05	0.156E-05	0.427E-05	0.463E-05	0.544E-05
-4.	0.686E-07	0.145E-06	0.237E-06	0.380E-06	0.605E-06	0.949E-06	0.147E-05	0.403E-05	0.437E-05	0.513E-05
-5.	0.637E-07	0.135E-06	0.220E-06	0.353E-06	0.561E-06	0.881E-06	0.137E-05	0.374E-05	0.406E-05	0.476E-05

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.7008E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X: -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.254E-07	0.536E-07	0.878E-07	0.141E-06	0.225E-06	0.355E-06	0.554E-06	0.154E-05	0.167E-05	0.197E-05
-1.	0.252E-07	0.532E-07	0.870E-07	0.140E-06	0.223E-06	0.352E-06	0.549E-06	0.152E-05	0.165E-05	0.195E-05
-2.	0.245E-07	0.518E-07	0.848E-07	0.137E-06	0.218E-06	0.343E-06	0.535E-06	0.149E-05	0.161E-05	0.190E-05
-3.	0.235E-07	0.496E-07	0.813E-07	0.131E-06	0.208E-06	0.329E-06	0.512E-06	0.142E-05	0.155E-05	0.182E-05
-4.	0.221E-07	0.468E-07	0.766E-07	0.123E-06	0.197E-06	0.310E-06	0.483E-06	0.134E-05	0.146E-05	0.172E-05
-5.	0.206E-07	0.434E-07	0.711E-07	0.115E-06	0.182E-06	0.288E-06	0.449E-06	0.125E-05	0.135E-05	0.159E-05

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.7446E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.815E-08	0.174E-07	0.284E-07	0.459E-07	0.733E-07	0.116E-06	0.182E-06	0.511E-06	0.556E-06	0.656E-06
-1.	0.808E-08	0.172E-07	0.282E-07	0.455E-07	0.726E-07	0.115E-06	0.180E-06	0.507E-06	0.551E-06	0.651E-06
-2.	0.787E-08	0.168E-07	0.274E-07	0.444E-07	0.708E-07	0.112E-06	0.176E-06	0.494E-06	0.537E-06	0.634E-06
-3.	0.754E-08	0.161E-07	0.263E-07	0.425E-07	0.678E-07	0.108E-06	0.168E-06	0.473E-06	0.515E-06	0.608E-06
-4.	0.711E-08	0.151E-07	0.248E-07	0.401E-07	0.639E-07	0.101E-06	0.159E-06	0.446E-06	0.485E-06	0.573E-06
-5.	0.659E-08	0.141E-07	0.230E-07	0.372E-07	0.594E-07	0.942E-07	0.147E-06	0.414E-06	0.451E-06	0.532E-06

STEADY STATE SOLUTION HAS NOT BEEN REACHED BEFORE FINAL SIMULATING TIME.

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.7884E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.5900E+00 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X -15.	0.	10.	20.	30.	40.	50.	74.	76.	80.
0.	0.262E-08	0.545E-08	0.916E-08	0.148E-07	0.239E-07	0.382E-07	0.598E-07	0.170E-06	0.185E-06	0.219E-06
-1.	0.259E-08	0.540E-08	0.908E-08	0.147E-07	0.237E-07	0.378E-07	0.592E-07	0.168E-06	0.183E-06	0.217E-06
-2.	0.253E-08	0.526E-08	0.885E-08	0.143E-07	0.231E-07	0.369E-07	0.577E-07	0.164E-06	0.179E-06	0.211E-06
-3.	0.242E-08	0.505E-08	0.848E-08	0.137E-07	0.221E-07	0.353E-07	0.553E-07	0.157E-06	0.171E-06	0.202E-06
-4.	0.228E-08	0.476E-08	0.799E-08	0.130E-07	0.208E-07	0.333E-07	0.522E-07	0.148E-06	0.162E-06	0.191E-06
-5.	0.211E-08	0.442E-08	0.742E-08	0.120E-07	0.193E-07	0.309E-07	0.484E-07	0.138E-06	0.150E-06	0.177E-06

THIS PAGE INTENTIONALLY LEFT BLANK

ATTACHMENT B-2

FATE AND TRANSPORT MODELING
INPUT PARAMETERS AND OUTPUT VALUES
FOR TETRACHLOROETHENE (PCE)
AT THE
OLD PROPERTY DISPOSAL (PDO) YARD
HUNTER ARMY AIRFIELD, GEORGIA

THIS PAGE INTENTIONALLY LEFT BLANK

NO. OF POINTS IN X-DIRECTION	10
NO. OF POINTS IN Y-DIRECTION	6
NO. OF POINTS IN Z-DIRECTION	1
NO. OF ROOTS: NO. OF SERIES TERMS	400
NO. OF BEGINNING TIME STEP	13
NO. OF ENDING TIME STEP	220
NO. OF TIME INTERVALS FOR PRINTED OUT SOLUTION	12
INSTANTANEOUS SOURCE CONTROL = 0 FOR INSTANT SOURCE.	1
SOURCE CONDITION CONTROL = 0 FOR STEADY SOURCE	0
INTERMITTENT OUTPUT CONTROL = 0 NO SUCH OUTPUT	1
CASE CONTROL =1 THERMAL, = 2 FOR CHEMICAL, = 3 RAD..	2
AQUIFER DEPTH, = 0.0 FOR INFINITE DEEP (METERS)	0.1524E+02
AQUIFER WIDTH, = 0.0 FOR INFINITE WIDE (METERS)	0.0000E+00
BEGIN POINT OF X-SOURCE LOCATION (METERS)	-0.6000E+01
END POINT OF X-SOURCE LOCATION (METERS)	0.0000E+00
BEGIN POINT OF Y-SOURCE LOCATION (METERS)	-0.1525E+02
END POINT OF Y-SOURCE LOCATION (METERS)	0.1525E+02
BEGIN POINT OF Z-SOURCE LOCATION (METERS)	0.0000E+00
END POINT OF Z-SOURCE LOCATION (METERS)	0.0000E+00
POROSITY	0.1800E+00
HYDRAULIC CONDUCTIVITY (METER/HOUR)	0.6010E+00
HYDRAULIC GRADIENT	0.1650E-01
LONGITUDINAL DISPERSIVITY (METER)	0.2000E+02
LATERAL DISPERSIVITY (METER)	0.7000E+01
VERTICAL DISPERSIVITY (METER)	0.2000E+01
DISTRIBUTION COEFFICIENT, KD (M**3/KG)	0.1930E-02
HEAT EXCHANGE COEFFICIENT (KCAL/HR-M**2-DEGREE C)	0.0000E+00
MOLECULAR DIFFUSION MULTIPLY BY POROSITY (M**2/HR)	0.2950E-05
DECAY CONSTANT (PER HOUR)	0.0000E+00
BULK DENSITY OF THE SOIL (KG/M**3)	0.1650E+04
ACCURACY TOLERANCE FOR REACHING STEADY STATE	0.1000E-02
DENSITY OF WATER (KG/M**3)	0.1000E+04
TIME INTERVAL SIZE FOR THE DESIRED SOLUTION (HR)	0.7300E+03
DISCHARGE TIME (HR)	0.8760E+05
WASTE RELEASE RATE (KCAL/HR), (KG/HR), OR (CI/HR)	0.2180E-03
RETARDATION FACTOR	0.1869E+02
RETARDED DARCY VELOCITY (M/HR)	0.2947E-02
RETARDED LONGITUDINAL DISPERSION COEF. (M**2/HR)	0.5895E-01
RETARDED LATERAL DISPERSION COEFFICIENT (M**2/HR)	0.2063E-01
RETARDED VERTICAL DISPERSION COEFFICIENT (M**2/HR)	0.5896E-02

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.0000E+00 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X -10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
10.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-10.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-23.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
-25.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.8760E+04 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X -10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.108E-01	0.133E-01	0.146E-01	0.154E-01	0.154E-01	0.135E-01	0.945E-02	0.638E-02	0.409E-02	0.246E-02
10.	0.281E-01	0.356E-01	0.395E-01	0.412E-01	0.404E-01	0.317E-01	0.184E-01	0.111E-01	0.673E-02	0.390E-02
0.	0.341E-01	0.431E-01	0.479E-01	0.499E-01	0.489E-01	0.385E-01	0.222E-01	0.133E-01	0.791E-02	0.453E-02
-10.	0.281E-01	0.356E-01	0.395E-01	0.412E-01	0.404E-01	0.317E-01	0.184E-01	0.111E-01	0.673E-02	0.390E-02
-23.	0.706E-02	0.847E-02	0.930E-02	0.982E-02	0.999E-02	0.925E-02	0.709E-02	0.502E-02	0.330E-02	0.202E-02
-25.	0.527E-02	0.624E-02	0.683E-02	0.724E-02	0.743E-02	0.713E-02	0.577E-02	0.420E-02	0.281E-02	0.174E-02

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.1752E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y	X -10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.134E-01	0.161E-01	0.177E-01	0.187E-01	0.190E-01	0.175E-01	0.140E-01	0.112E-01	0.880E-02	0.682E-02
10.	0.314E-01	0.393E-01	0.435E-01	0.455E-01	0.450E-01	0.369E-01	0.243E-01	0.173E-01	0.128E-01	0.950E-02
0.	0.377E-01	0.471E-01	0.522E-01	0.546E-01	0.539E-01	0.441E-01	0.286E-01	0.200E-01	0.145E-01	0.106E-01
-10.	0.314E-01	0.393E-01	0.435E-01	0.455E-01	0.450E-01	0.369E-01	0.243E-01	0.173E-01	0.128E-01	0.950E-02
-23.	0.933E-02	0.110E-01	0.121E-01	0.128E-01	0.131E-01	0.128E-01	0.111E-01	0.930E-02	0.753E-02	0.593E-02
-25.	0.736E-02	0.858E-02	0.937E-02	0.996E-02	0.103E-01	0.104E-01	0.951E-02	0.815E-02	0.671E-02	0.536E-02

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.2628E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.145E-01	0.174E-01	0.191E-01	0.202E-01	0.206E-01	0.193E-01	0.162E-01	0.137E-01	0.116E-01	0.982E-02
10.	0.328E-01	0.408E-01	0.451E-01	0.472E-01	0.469E-01	0.391E-01	0.269E-01	0.203E-01	0.161E-01	0.130E-01
0.	0.391E-01	0.487E-01	0.539E-01	0.564E-01	0.559E-01	0.464E-01	0.314E-01	0.231E-01	0.180E-01	0.143E-01
-10.	0.328E-01	0.408E-01	0.451E-01	0.472E-01	0.469E-01	0.391E-01	0.269E-01	0.203E-01	0.161E-01	0.130E-01
-23.	0.104E-01	0.122E-01	0.134E-01	0.142E-01	0.147E-01	0.146E-01	0.132E-01	0.117E-01	0.102E-01	0.874E-02
-25.	0.839E-02	0.974E-02	0.106E-01	0.113E-01	0.118E-01	0.121E-01	0.115E-01	0.104E-01	0.923E-02	0.802E-02

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.3504E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.152E-01	0.181E-01	0.199E-01	0.210E-01	0.215E-01	0.204E-01	0.175E-01	0.152E-01	0.134E-01	0.117E-01
10.	0.335E-01	0.416E-01	0.460E-01	0.482E-01	0.478E-01	0.403E-01	0.283E-01	0.220E-01	0.180E-01	0.152E-01
0.	0.398E-01	0.495E-01	0.548E-01	0.574E-01	0.569E-01	0.476E-01	0.328E-01	0.249E-01	0.200E-01	0.166E-01
-10.	0.335E-01	0.416E-01	0.460E-01	0.482E-01	0.478E-01	0.403E-01	0.283E-01	0.220E-01	0.180E-01	0.152E-01
-23.	0.110E-01	0.129E-01	0.141E-01	0.150E-01	0.155E-01	0.156E-01	0.144E-01	0.131E-01	0.118E-01	0.106E-01
-25.	0.898E-02	0.104E-01	0.113E-01	0.121E-01	0.126E-01	0.130E-01	0.126E-01	0.118E-01	0.108E-01	0.980E-02

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.4380E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.156E-01	0.185E-01	0.203E-01	0.215E-01	0.220E-01	0.210E-01	0.182E-01	0.161E-01	0.144E-01	0.130E-01
10.	0.339E-01	0.420E-01	0.465E-01	0.487E-01	0.484E-01	0.409E-01	0.291E-01	0.230E-01	0.192E-01	0.165E-01
0.	0.403E-01	0.500E-01	0.553E-01	0.579E-01	0.575E-01	0.483E-01	0.337E-01	0.259E-01	0.212E-01	0.179E-01
-10.	0.339E-01	0.420E-01	0.465E-01	0.487E-01	0.484E-01	0.409E-01	0.291E-01	0.230E-01	0.192E-01	0.165E-01
-23.	0.114E-01	0.133E-01	0.145E-01	0.154E-01	0.160E-01	0.161E-01	0.152E-01	0.140E-01	0.128E-01	0.118E-01
-25.	0.932E-02	0.108E-01	0.117E-01	0.125E-01	0.131E-01	0.136E-01	0.133E-01	0.126E-01	0.118E-01	0.109E-01

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.5256E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.158E-01	0.188E-01	0.206E-01	0.218E-01	0.223E-01	0.213E-01	0.187E-01	0.167E-01	0.151E-01	0.138E-01
10.	0.341E-01	0.423E-01	0.468E-01	0.490E-01	0.487E-01	0.413E-01	0.296E-01	0.236E-01	0.199E-01	0.174E-01
0.	0.405E-01	0.503E-01	0.556E-01	0.582E-01	0.579E-01	0.487E-01	0.342E-01	0.265E-01	0.219E-01	0.188E-01
-10.	0.341E-01	0.423E-01	0.468E-01	0.490E-01	0.487E-01	0.413E-01	0.296E-01	0.236E-01	0.199E-01	0.174E-01
-23.	0.116E-01	0.135E-01	0.148E-01	0.157E-01	0.163E-01	0.165E-01	0.156E-01	0.145E-01	0.135E-01	0.125E-01
-25.	0.954E-02	0.110E-01	0.120E-01	0.128E-01	0.134E-01	0.140E-01	0.138E-01	0.132E-01	0.124E-01	0.117E-01

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.6132E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.159E-01	0.189E-01	0.208E-01	0.220E-01	0.225E-01	0.216E-01	0.190E-01	0.170E-01	0.155E-01	0.143E-01
10.	0.343E-01	0.425E-01	0.470E-01	0.492E-01	0.489E-01	0.416E-01	0.299E-01	0.239E-01	0.204E-01	0.179E-01
0.	0.407E-01	0.504E-01	0.558E-01	0.584E-01	0.581E-01	0.490E-01	0.345E-01	0.269E-01	0.224E-01	0.194E-01
-10.	0.343E-01	0.425E-01	0.470E-01	0.492E-01	0.489E-01	0.416E-01	0.299E-01	0.239E-01	0.204E-01	0.179E-01
-23.	0.117E-01	0.137E-01	0.149E-01	0.159E-01	0.165E-01	0.167E-01	0.159E-01	0.149E-01	0.139E-01	0.130E-01
-25.	0.967E-02	0.112E-01	0.121E-01	0.129E-01	0.135E-01	0.142E-01	0.140E-01	0.135E-01	0.128E-01	0.122E-01

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.7008E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.160E-01	0.190E-01	0.209E-01	0.221E-01	0.226E-01	0.217E-01	0.191E-01	0.173E-01	0.158E-01	0.146E-01
10.	0.344E-01	0.426E-01	0.471E-01	0.493E-01	0.491E-01	0.417E-01	0.301E-01	0.242E-01	0.207E-01	0.182E-01
0.	0.407E-01	0.505E-01	0.559E-01	0.586E-01	0.582E-01	0.491E-01	0.347E-01	0.271E-01	0.227E-01	0.197E-01
-10.	0.344E-01	0.426E-01	0.471E-01	0.493E-01	0.491E-01	0.417E-01	0.301E-01	0.242E-01	0.207E-01	0.182E-01
-23.	0.118E-01	0.138E-01	0.150E-01	0.160E-01	0.166E-01	0.169E-01	0.161E-01	0.151E-01	0.142E-01	0.133E-01
-25.	0.976E-02	0.112E-01	0.122E-01	0.131E-01	0.137E-01	0.143E-01	0.142E-01	0.137E-01	0.131E-01	0.125E-01

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.7884E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.161E-01	0.191E-01	0.209E-01	0.222E-01	0.227E-01	0.218E-01	0.193E-01	0.174E-01	0.160E-01	0.148E-01
10.	0.344E-01	0.426E-01	0.471E-01	0.494E-01	0.492E-01	0.418E-01	0.302E-01	0.243E-01	0.209E-01	0.185E-01
0.	0.408E-01	0.506E-01	0.560E-01	0.586E-01	0.583E-01	0.492E-01	0.348E-01	0.273E-01	0.229E-01	0.200E-01
-10.	0.344E-01	0.426E-01	0.471E-01	0.494E-01	0.492E-01	0.418E-01	0.302E-01	0.243E-01	0.209E-01	0.185E-01
-23.	0.119E-01	0.138E-01	0.151E-01	0.161E-01	0.167E-01	0.170E-01	0.162E-01	0.152E-01	0.143E-01	0.136E-01
-25.	0.981E-02	0.113E-01	0.123E-01	0.131E-01	0.137E-01	0.144E-01	0.143E-01	0.139E-01	0.133E-01	0.127E-01

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.8760E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.161E-01	0.191E-01	0.210E-01	0.222E-01	0.227E-01	0.219E-01	0.193E-01	0.175E-01	0.161E-01	0.150E-01
10.	0.345E-01	0.427E-01	0.472E-01	0.494E-01	0.492E-01	0.419E-01	0.303E-01	0.244E-01	0.210E-01	0.186E-01
0.	0.408E-01	0.507E-01	0.560E-01	0.587E-01	0.583E-01	0.493E-01	0.349E-01	0.274E-01	0.230E-01	0.201E-01
-10.	0.345E-01	0.427E-01	0.472E-01	0.494E-01	0.492E-01	0.419E-01	0.303E-01	0.244E-01	0.210E-01	0.186E-01
-23.	0.119E-01	0.139E-01	0.152E-01	0.161E-01	0.167E-01	0.170E-01	0.162E-01	0.153E-01	0.145E-01	0.137E-01
-25.	0.985E-02	0.114E-01	0.124E-01	0.132E-01	0.138E-01	0.145E-01	0.144E-01	0.140E-01	0.134E-01	0.129E-01

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.9636E+05 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.712E-02	0.795E-02	0.859E-02	0.924E-02	0.989E-02	0.114E-01	0.133E-01	0.148E-01	0.158E-01	0.162E-01
10.	0.132E-01	0.147E-01	0.159E-01	0.171E-01	0.183E-01	0.209E-01	0.240E-01	0.260E-01	0.267E-01	0.261E-01
0.	0.154E-01	0.172E-01	0.186E-01	0.200E-01	0.214E-01	0.244E-01	0.279E-01	0.301E-01	0.307E-01	0.299E-01
-10.	0.132E-01	0.147E-01	0.159E-01	0.171E-01	0.183E-01	0.209E-01	0.240E-01	0.260E-01	0.267E-01	0.261E-01
-23.	0.564E-02	0.630E-02	0.680E-02	0.731E-02	0.783E-02	0.903E-02	0.106E-01	0.120E-01	0.130E-01	0.136E-01
-25.	0.486E-02	0.542E-02	0.586E-02	0.630E-02	0.675E-02	0.780E-02	0.923E-02	0.105E-01	0.115E-01	0.121E-01

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.1051E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.421E-02	0.468E-02	0.505E-02	0.543E-02	0.583E-02	0.680E-02	0.825E-02	0.970E-02	0.111E-01	0.123E-01
10.	0.754E-02	0.840E-02	0.906E-02	0.975E-02	0.105E-01	0.122E-01	0.146E-01	0.170E-01	0.191E-01	0.208E-01
0.	0.877E-02	0.976E-02	0.105E-01	0.113E-01	0.122E-01	0.141E-01	0.170E-01	0.197E-01	0.221E-01	0.239E-01
-10.	0.754E-02	0.840E-02	0.906E-02	0.975E-02	0.105E-01	0.122E-01	0.146E-01	0.170E-01	0.191E-01	0.208E-01
-23.	0.338E-02	0.376E-02	0.406E-02	0.437E-02	0.469E-02	0.547E-02	0.666E-02	0.787E-02	0.904E-02	0.101E-01
-25.	0.294E-02	0.327E-02	0.353E-02	0.380E-02	0.408E-02	0.476E-02	0.581E-02	0.689E-02	0.795E-02	0.893E-02

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.1139E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.266E-02	0.295E-02	0.318E-02	0.342E-02	0.368E-02	0.432E-02	0.532E-02	0.640E-02	0.753E-02	0.867E-02
10.	0.469E-02	0.521E-02	0.562E-02	0.605E-02	0.650E-02	0.761E-02	0.933E-02	0.112E-01	0.130E-01	0.148E-01
0.	0.544E-02	0.604E-02	0.652E-02	0.701E-02	0.753E-02	0.882E-02	0.108E-01	0.129E-01	0.150E-01	0.171E-01
-10.	0.469E-02	0.521E-02	0.562E-02	0.605E-02	0.650E-02	0.761E-02	0.933E-02	0.112E-01	0.130E-01	0.148E-01
-23.	0.215E-02	0.238E-02	0.257E-02	0.277E-02	0.298E-02	0.349E-02	0.431E-02	0.521E-02	0.615E-02	0.712E-02
-25.	0.188E-02	0.208E-02	0.225E-02	0.242E-02	0.260E-02	0.305E-02	0.377E-02	0.456E-02	0.541E-02	0.627E-02

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.1226E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.173E-02	0.192E-02	0.207E-02	0.223E-02	0.240E-02	0.282E-02	0.351E-02	0.428E-02	0.512E-02	0.603E-02
10.	0.303E-02	0.336E-02	0.362E-02	0.390E-02	0.419E-02	0.493E-02	0.611E-02	0.742E-02	0.883E-02	0.103E-01
0.	0.350E-02	0.389E-02	0.419E-02	0.452E-02	0.486E-02	0.571E-02	0.707E-02	0.858E-02	0.102E-01	0.119E-01
-10.	0.303E-02	0.336E-02	0.362E-02	0.390E-02	0.419E-02	0.493E-02	0.611E-02	0.742E-02	0.883E-02	0.103E-01
-23.	0.141E-02	0.156E-02	0.168E-02	0.181E-02	0.195E-02	0.229E-02	0.285E-02	0.349E-02	0.419E-02	0.495E-02
-25.	0.123E-02	0.137E-02	0.147E-02	0.159E-02	0.171E-02	0.201E-02	0.250E-02	0.306E-02	0.368E-02	0.436E-02

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.1314E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.115E-02	0.128E-02	0.138E-02	0.148E-02	0.159E-02	0.188E-02	0.235E-02	0.289E-02	0.350E-02	0.418E-02
10.	0.200E-02	0.222E-02	0.239E-02	0.258E-02	0.277E-02	0.326E-02	0.407E-02	0.499E-02	0.602E-02	0.715E-02
0.	0.231E-02	0.256E-02	0.277E-02	0.298E-02	0.320E-02	0.377E-02	0.470E-02	0.576E-02	0.695E-02	0.825E-02
-10.	0.200E-02	0.222E-02	0.239E-02	0.258E-02	0.277E-02	0.326E-02	0.407E-02	0.499E-02	0.602E-02	0.715E-02
-23.	0.938E-03	0.104E-02	0.112E-02	0.121E-02	0.130E-02	0.153E-02	0.192E-02	0.236E-02	0.287E-02	0.343E-02
-25.	0.823E-03	0.912E-03	0.984E-03	0.106E-02	0.114E-02	0.135E-02	0.168E-02	0.208E-02	0.252E-02	0.302E-02

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.1402E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.775E-03	0.859E-03	0.926E-03	0.998E-03	0.107E-02	0.127E-02	0.159E-02	0.197E-02	0.241E-02	0.290E-02
10.	0.134E-02	0.149E-02	0.160E-02	0.173E-02	0.186E-02	0.219E-02	0.274E-02	0.339E-02	0.413E-02	0.496E-02
0.	0.155E-02	0.172E-02	0.185E-02	0.199E-02	0.215E-02	0.253E-02	0.317E-02	0.391E-02	0.476E-02	0.572E-02
-10.	0.134E-02	0.149E-02	0.160E-02	0.173E-02	0.186E-02	0.219E-02	0.274E-02	0.339E-02	0.413E-02	0.496E-02
-23.	0.633E-03	0.702E-03	0.757E-03	0.815E-03	0.877E-03	0.104E-02	0.130E-02	0.161E-02	0.197E-02	0.238E-02
-25.	0.557E-03	0.617E-03	0.665E-03	0.716E-03	0.771E-03	0.911E-03	0.114E-02	0.142E-02	0.174E-02	0.210E-02

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.1489E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.527E-03	0.584E-03	0.630E-03	0.679E-03	0.730E-03	0.863E-03	0.109E-02	0.135E-02	0.166E-02	0.202E-02
10.	0.908E-03	0.101E-02	0.109E-02	0.117E-02	0.126E-02	0.149E-02	0.187E-02	0.232E-02	0.284E-02	0.344E-02
0.	0.105E-02	0.116E-02	0.125E-02	0.135E-02	0.145E-02	0.172E-02	0.216E-02	0.267E-02	0.328E-02	0.397E-02
-10.	0.908E-03	0.101E-02	0.109E-02	0.117E-02	0.126E-02	0.149E-02	0.187E-02	0.232E-02	0.284E-02	0.344E-02
-23.	0.431E-03	0.478E-03	0.515E-03	0.555E-03	0.597E-03	0.706E-03	0.889E-03	0.111E-02	0.136E-02	0.166E-02
-25.	0.380E-03	0.420E-03	0.453E-03	0.488E-03	0.526E-03	0.622E-03	0.782E-03	0.974E-03	0.120E-02	0.146E-02

STEADY STATE SOLUTION HAS NOT BEEN REACHED BEFORE FINAL SIMULATING TIME.

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT 0.1577E+06 HRS
(ADSORBED CHEMICAL CONC. = 0.1930E+01 * DISSOLVED CHEMICAL CONC.)

Z = 0.00

Y \ X	-10.	-6.	-3.	0.	3.	10.	20.	30.	40.	50.
20.	0.361E-03	0.400E-03	0.431E-03	0.465E-03	0.500E-03	0.592E-03	0.746E-03	0.931E-03	0.115E-02	0.141E-02
10.	0.620E-03	0.687E-03	0.741E-03	0.798E-03	0.859E-03	0.102E-02	0.128E-02	0.159E-02	0.197E-02	0.240E-02
0.	0.716E-03	0.793E-03	0.855E-03	0.921E-03	0.992E-03	0.117E-02	0.148E-02	0.184E-02	0.227E-02	0.276E-02
-10.	0.620E-03	0.687E-03	0.741E-03	0.798E-03	0.859E-03	0.102E-02	0.128E-02	0.159E-02	0.197E-02	0.240E-02
-23.	0.296E-03	0.328E-03	0.353E-03	0.381E-03	0.410E-03	0.485E-03	0.612E-03	0.764E-03	0.944E-03	0.116E-02
-25.	0.261E-03	0.289E-03	0.311E-03	0.335E-03	0.361E-03	0.427E-03	0.539E-03	0.673E-03	0.832E-03	0.102E-02

APPENDIX C

COST ESTIMATE SUMMARIES FOR CORRECTIVE ACTION ALTERNATIVES

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX C

Cost Estimate Summaries for Corrective Action Alternatives - Benzene Plume
Old Property Disposal (PDO) Yard, Hunter Army Airfield, Georgia

		Alt. 1	Alt. 2	Alt. 4
		Monitored Natural Attenuation	Air Sparging	Enhanced Bioremediation (Oxygen Injection)
1.0	**Capital Costs**			
1.1	**Engineering Services**			
1.1.1	Work Plan/Site Safety and Health Plan and Remedial Design	$3,248	$15,210	$15,210
1.1.2	Contracting/Procurement	$729	$958	$958
1.1.3	Permitting	$0	$2,655	$2,655
1.1.4	Construction Oversight/Labor for Monitoring Well Installation	$0	$0	$0
1.1.5	Construction Oversight/Labor for Injection Installation	$0	$9,791	$14,647
1.1.6	Construction Oversight/Labor System Startup	$0	$7,592	$7,592
1.1	**Total Costs for Engineering Services**	**$3,977**	**$36,205**	**$41,062**
1.2	**System Installation**			
1.2.1	Site Preparation and Mobilization/Demobilization			
1.2.1.1	Locate Underground Utilities	$0	$652	$1,304
1.2.1.2	Define Grid Layout	$0	$2,011	$2,011
1.2.1.3	Baseline Groundwater Monitoring	$10,968	$10,968	$10,968
1.2.1	**Total Costs for Site Preparation and Mobilization/Demobilization**	**$10,968**	**$13,632**	**$14,284**
1.2.2	Monitoring Well Installation	$0	$0	$0
1.2.3	Injection and Equipment Installation	$0	$41,798	$106,282
1.2	**Total Costs for System Installation**	**$10,968**	**$55,430**	**$120,566**
1.0	**Total Capital Costs**	**$14,945**	**$91,635**	**$161,628**
2.0	**System Maintenance**			
2.1	Groundwater Monitoring	$53,010	$127,060	$96,883
2.2	Operations and Maintenance for System	$0	$11,901	$8,434
2.0	**Total Costs for System Maintenance**	**$53,010**	**$138,961**	**$105,317**
	Subtotal Project Costs	**$67,955**	**$230,596**	**$266,944**
	Engineering Construction Management (10% of subtotal)	$6,795	$23,060	$26,694
	Contingency (20% of subtotal)	$13,591	$46,119	$53,389
	Health and Safety (7.5% of subtotal)	$5,097	$17,295	$20,021
	Contractor Profit (10% of subtotal)	$6,795	$23,060	$26,694
	Total Project Costs	**$100,233**	**$340,129**	**$393,743**

APPENDIX C

Cost Estimate Summaries for Corrective Action Alternatives - PCE Plume
Old Property Disposal (PDO) Yard, Hunter Army Airfield, Georgia (continued)

		Alt. 1	Alt. 2	Alt. 3	Alt. 4
		Monitored Natural Attenuation	Air Sparging	Geo-Cleanse® with Monitored Natural Attenuation	Geo-Cleanse® Full Plume Treatment
1.0	**Capital Costs**				
1.1	**Engineering Services**				
1.1.1	Work Plan/SSHP and Remedial Design	$4,228	$15,210	$19,280	$19,280
1.1.2	Contracting/Procurement	$1,458	$958	$958	$958
1.1.3	Permitting	$2,655	$5,309	$5,309	$5,309
1.1.4	Construction Oversight/Labor for Monitoring Well Installation	$14,280	$14,280	$28,561	$46,274
1.1.5	Construction Oversight/Labor for Injection Installation	$0	$22,570	$8,157	$16,314
1.1.6	Construction Oversight/Labor System Startup	$0	$11,231	$7,592	$14,683
1.1	**Total Costs for Engineering Services**	**$22,621**	**$69,559**	**$69,857**	**$102,819**
1.2	**System Installation**				
1.2.1	Site Preparation and Mobilization/Demobilization				
1.2.1.1	Locate Underground Utilities	$652	$652	$652	$652
1.2.1.2	Define Grid Layout	$2,011	$2,011	$2,011	$2,011
1.2.1.3	Baseline Groundwater Monitoring	$12,315	$12,315	$12,315	$12,315
1.2.1	**Total Costs for Site Preparation and Mob/Demob**	**$14,979**	**$14,979**	**$14,979**	**$14,979**
1.2.2	Monitoring Well Installation	$19,673	$19,673	$37,611	$60,087
1.2.3	Injection and Equipment Installation	$0	$71,539	$30,315	$47,646
1.2	**Total Costs for System Installation**	**$34,652**	**$106,191**	**$82,905**	**$122,712**
1.0	**Total Capital Costs**	**$57,273**	**$175,750**	**$152,761**	**$225,531**
2.0	**System Maintenance**				
2.1	Groundwater Monitoring	$134,367	$146,998	$60,476	$11,215
2.2	Operations and Maintenance for System	$0	$18,101	$97,630	$187,573
2.0	**Total Costs for System Maintenance**	**$134,367**	**$165,099**	**$158,106**	**$198,788**
	Subtotal Project Costs	**$191,640**	**$340,849**	**$310,867**	**$424,319**
	Engineering Construction Management (10% of subtotal)	$19,164	$34,085	$31,087	$42,432
	Contingency (20% of subtotal)	$38,328	$68,170	$62,173	$84,864
	Health and Safety (7.5% of subtotal)	$14,373	$25,564	$23,315	$31,824
	Contractor Profit (10% of subtotal)	$19,164	$34,085	$31,087	$42,432
	Total Project Costs	**$282,669**	**$502,752**	**$458,530**	**$625,871**

APPENDIX D

OPERATION AND MAINTENANCE PLAN FOR THE OLD PROPERTY DISPOSAL (PDO) YARD HUNTER ARMY AIRFIELD, GEORGIA

THIS PAGE INTENTIONALLY LEFT BLANK

1.0 INTRODUCTION/PURPOSE

This plan presents preliminary procedures for the operation and maintenance (O&M) of the Geo-Cleanse® chemical oxidation and groundwater monitoring systems for remediation of groundwater contamination at the Old Property Disposal (PDO) Yard, Hunter Army Airfield (HAAF), Georgia. This O&M Plan is based on the remediation system components as understood at this time. If system components change during installation, then a revised/updated O&M Plan will be submitted to the Georgia Environmental Protection Division (GEPD). Substantive changes in the remediation approach or schedule will require that the public be provided with an opportunity for review and comment in accordance with the Fort Stewart Hazardous Waste Permit HW-045 (S&T).

Groundwater at the PDO Yard is contaminated with benzene and tetrachloroethene (PCE). Corrective action is required to reduce the concentrations of these two contaminants within their respective source plumes and to achieve the remedial levels (RLs) presented in the GEPD-approved Revised Final Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report dated September 1999. The selected corrective action consists of in-situ chemical oxidation in the shallow groundwater within the PCE plume using the patented Geo-Cleanse® system and Monitored Natural Attenuation of the benzene plume. A description of the system components is presented in Section 5.0 of the Corrective Action Plan (CAP) and includes the following:

- Air compressors, variable speed pumps, and associated electrical connections.
- Twenty-nine reagent injection points, each consisting of 1¼-inch-diameter carbon steel casing and 2-inch- diameter stainless steel screen. Injection points will be completed at two separate injection levels (10 feet and 20 feet below land surface) and will be screened over the bottom 3 feet.
- Aboveground hydrogen peroxide, ferrous iron catalyst, and air storage tanks and supply lines consisting of 1-inch flexible tubing with quick-connect couplings and other fittings (pressure valves and gauges).
- A total of 18 monitoring wells, including 12 existing shallow wells, 3 existing deep wells, 2 additional new shallow wells, and 1 additional new deep well. Existing monitoring wells will be replaced if damaged during Geo-Cleanse® treatment.

2.0 TRAINING

Personnel who participate in field activities during remediation or subsequent O&M activities are subject to the training requirements presented in Table D-1. Casual visitors, such as package deliverers, who access only the staging areas of the site, are not subject to these training requirements.

Subcontractor personnel involved in the installation, adjustment, startup, and operation of the Geo-Cleanse® treatment system will be subject to the training requirements specified by the subcontracted system vendor, Geo-Cleanse® International, Inc., who specializes in the system installation. Personnel will also be subject to the requirements specified in this O&M Plan, the Sampling and Analysis Plan (SAP) as contained within the project-specific Work Plan and the project Site Safety and Health Plan (SSHP). Training will be in accordance with Science Applications International Corporation (SAIC) Quality Assurance Administrative Procedure (QAAP) 2.1, *Indoctrination and Training*. The Site Supervisor is responsible for (1) assessing qualifications and determining skill needs of personnel; (2) assuring that

appropriate training is provided to personnel and that the training (classroom, reading assignments, or on-the-job) is completed; and (3) forwarding training records for personnel to the SAIC Central Records Facility located in Oak Ridge, Tennessee. Health and safety-related documentation will also be maintained in on-site project files, in accordance with the SSHP.

Table D-1. Training Requirements
PDO Yard, Hunter Army Airfield, Georgia

Training	Type	Remediation Worker	Groundwater Monitoring Worker	Site Supervisor
Health and Safety Training				
Site Safety and Health Plan	Reading	✓	✓	✓
Hazardous Waste Safety (40 hours)	Classroom	✓	✓	✓
Hazardous Waste Safety Annual Refresher (8 hours)	Classroom	✓	✓	✓
Hazardous Waste Safety Supervisors Training (8 hours)	Classroom			✓
General Hazard Communication Training (contained in 40- and 8-hour courses)	Classroom	✓	✓	✓
Respiratory Protection Training (required only if Respirators are worn; contained in 40-hour course)	Classroom	✓	✓	✓
Hearing Conservation Training (contained in 40- and 8-hour courses)	Classroom	✓	✓	✓
Pre-entry Briefing (including site-specific hazards Communication	OTJ	✓	✓	✓
Safety Briefing (daily and whenever conditions or tasks change)	OTJ	✓	✓	✓
First Aid/CPR (standard Red Cross or equivalent)	Classroom	At least 2 workers		
Quality Assurance Training				
O&M Plan	Reading	✓	✓	✓
Sampling and Analysis Plan (with Addendum)	Reading	✓	✓	✓
Quality Assurance Project Plan (QAPjP), including applicable QA program elements	Reading	✓	✓	✓
General criteria, including applicable codes, standards, and regulations, and the purpose, scope, and implementation of manuals, instructions, and procedures	Reading	✓	✓	✓
Job responsibilities and authority	Reading	✓	✓	✓
Quality Assurance Administrative Procedures (QAAP)	Reading	✓	✓	✓
Quality Assurance Technical Procedures (QATP) for sampling and analysis	Reading	✓	✓	✓
Demonstration of proficiency for task-specific procedures and equipment	OTJ	✓	✓	✓

O&M = operation and maintenance.
OTJ = on-the-job.
✓ = required training.

3.0 WASTE MANAGEMENT PRACTICES

Wastes generated by installation and operation of the corrective action will be managed in accordance with RCRA requirements and the SAP, Section 7.0, Investigation-Derived Waste as contained in the project-specific Work Plan. The types of wastes anticipated to be generated are: (1) soil cuttings from monitoring well and injection point boreholes, (2) monitoring well and injection point development and purge waters, (3) decontamination fluids, and (4) sanitary waste (non-contaminated compactible and miscellaneous trash). Materials that can be effectively reused, recycled, or decontaminated in the field are not waste materials.

Decontamination sludge and soil cuttings generated during drilling of boreholes for monitoring well or injection point construction will be segregated by borehole and drummed at the point of generation. The drummed wastes will then be transported to a staging area established for the project and temporarily stored until the wastes are transported for final disposal. Analytical data gathered from environmental soil samples will be used to characterize indigenous soil waste from boreholes. If analytical data are insufficient for characterization of the containerized wastes, the wastes will be sampled and analyzed for RCRA toxicity characteristic contaminants using the Toxicity Characteristic Leaching Procedure (TCLP). Analytical data will be extrapolated to reflect TCLP values (i.e., 20 × divisor rule for soils). Soil cuttings will be managed as nonhazardous waste pending the analytical results. Based upon the results of the analytical data, the material will be transported to either a permitted RCRA Subtitle D or Subtitle C facility located off HAAF for disposal. The material will be disposed in accordance with all applicable U.S. Environmental Protection Agency (EPA), U.S. Department of Transportation (DOT), and State of Georgia regulations. Containerized hazardous waste will be transported offsite for disposal within 90 days of receipt of sample data indicating that the waste is hazardous.

Decontamination and monitoring well development or purge waters will be stored in poly tanks. The poly tanks will be transported to a staging area for temporary storage. Analytical data gathered from grab samples collected directly from filled poly tanks will be used to characterize liquid wastes. One grab sample will be collected from each filled poly tank and submitted to an off-site laboratory for analysis of VOCs, pH, oil and grease, and phenols. The analytical data reported for the grab samples, the quantity to be released, and the date of the release will be submitted to the Fort Stewart Directorate of Public Works (DPW) water engineer for evaluation.

The water engineer will determine if the liquid waste can be released into the HAAF Wastewater Treatment Plant or the Fort Stewart Industrial Wastewater Treatment Plant on a case-by-case basis using In-stream Water Quality Standards (IWQS) and facility National Pollutant Discharge Elimination System permit requirements as the disposal criteria. In the event that the Fort Stewart DPW water engineer rejects release of the liquid waste into either of the treatment plants, the contents of the subject poly tank will be transferred into 44-gallon 17E closed-top drums for disposal offsite. Based upon the results of the analytical data, the material will be transported to either a permitted RCRA Subtitle D or Subtitle C facility located off HAAF for disposal. The material will be disposed in accordance with all applicable EPA, DOT, and State of Georgia regulations. Containerized hazardous waste will be transported offsite for disposal within 90 days of receipt of sample data indicating that the waste is hazardous.

Sanitary wastes that are noncontaminated will be bagged and placed in a sanitary waste dumpster for disposal at the permitted Sanitary Landfill in Savannah, Georgia. No free liquids or hazardous substances will be placed in the dumpster.

4.0 SYSTEM OPERATION

The system operation strategy is to inject Fenton's reagent into the shallow groundwater zone at a continuous rate and pressure to chemically oxidize the contaminants in the groundwater and subsequently reduce the contaminant concentrations. Fenton's reagent consists of a mixture of 50% hydrogen peroxide reagent and ferrous iron catalyst. Groundwater treatment is to be operated until PCE concentrations, as measured in on-site wells, decrease to below 5 µg/L. Surrogate parameters (carbon dioxide, oxygen, and chloride ions) will be measured in wells during injection of the reagent to verify stabilization of the reaction. The chemical oxidation reaction is very rapid, so that treatment is expected to be completed within two weeks.

Concentrations of benzene in groundwater will be monitored throughout a Monitored Natural Attenuation period, predicted to be 2 years in duration. The operational strategy for Monitored Natural Attenuation involves collecting data on a semiannual basis to check continuity of trends. The initial conceptual site model will be periodically updated to include results of these Monitored Natural Attenuation data. This updated model will then be used as a basis for any change in groundwater monitoring system operation.

4.1 STARTUP PROCEDURES

Approximately 29 injector points will be installed at the locations shown on Figure 5-1 of the CAP. The actual number of injector points will depend on analytical results of the baseline groundwater sampling event. Each injector point will consist of 1¼-inch-diameter carbon steel casing and 2-inch-diameter stainless steel screen. Injector points will be installed at 2 separate injection levels (10 feet and 20 feet below land surface) and will be screened over the bottom 3 feet.

The Geo-Cleanse® system chemically oxidizes PCE within the groundwater by injection of Fenton's reagent (hydrogen peroxide and a ferrous iron catalyst) into the subsurface. The injection points are specially designed to withstand the elevated temperatures and pressures associated with chemical oxidation during the Geo-Cleanse® process. The vendor will provide the screens, riser pipe, and other fittings. A conventional drilling company will be used to install the injection points, with oversight provided by the vendor.

The proprietary treatment unit consists of a trailer containing the equipment necessary to inject hydrogen peroxide and catalyst into the subsurface. Patented mixing heads are attached to the injectors and connected via supply lines to the treatment unit.

Operational testing during startup will include a check of pressure gauge and valve configurations. A continuous supply of each respective reagent or catalyst, at a constant pressure, must be used to operate the system and control the chemical environment. No other startup procedures, system balancing, or system optimization are required.

4.2 ROUTINE OPERATING PROCEDURES

Multiple injectors will be used simultaneously in the treatment area. Once the initial injection begins, ferrous iron catalyst will be injected with the hydrogen peroxide to maintain the appropriate chemical environment. Ferrous iron catalyst (iron sulfate heptahydrate) will be injected at a 1,000 parts per million (ppm) concentration in a catalyst blend that typically results in concentrations in groundwater of less than 100 ppm. The catalyst is precipitated as a ferric oxide or hydroxide and thereby removed from solution. Hydrogen peroxide (50 percent technical grade) will be injected so as to result in an effective concentration of less than 1 percent hydrogen peroxide within the affected aquifer. Hydrogen peroxide concentrations

are expected fall to less than 25 ppm within several hours following injection, and to be absent in a matter of 2 to 3 days. The process will inject excess hydrogen peroxide to compensate for the losses due to decomposition to oxygen and water and from oxidation of contaminants. Delivery rates of 0.2 to 5.0 gallons per minute with pressures averaging 20 to 40 pounds per square inch (psi) will be maintained.

Initially, the ferrous iron catalyst solution will be injected with 2 to 4 cubic feet per minute (cfm) of air to sparge the catalyst away from the injector and into the formation. Sulfuric acid, phosphoric acid, or calcium phosphate may or may not be added for pH adjustment and stabilization of the reaction, depending on site-specific conditions. The groundwater will be adjusted to a pH between 4 and 6, where the iron will be at its optimal electron state (+2 valence).

This initial step will be followed by injection of hydrogen peroxide reagent and catalyst simultaneously. The patented injector contains a mixing head that promotes mixing of reagent and catalyst and stimulates circulation of groundwater, which in turn promotes rapid reagent diffusion and dispersion. Groundwater will be extracted from an adjacent injector point using a recirculating pump, then reinjected into the mixing head together with the ferrous iron catalyst solution. The mixing head also ensures that the reagent and catalyst do not mix in the sealed injection system until they are at the screened interval of the injector. This will eliminate the chance of reaction within the injection system. Mixing of catalyst and hydrogen peroxide in the subsurface will generate heat as the reaction with organic contaminants progresses. Injection of reagent and catalyst will be performed in a batch process mode, in volumes varying from 500 to 1,000 gallons per batch.

During injection, the vendor will routinely monitor pH, total iron, and hydrogen peroxide in groundwater. During each day of injection and prior to initiating the injection process, water level measurements will be taken and water samples collected from each monitoring well within the treatment area for routine water quality measurements. These measurements will include groundwater pH, total iron, and hydrogen peroxide concentration. Measurements will be performed with field test kits. In addition, the same suite of measurements will be conducted at the end of each day prior to concluding the injection. Additional samples may be measured for any of these parameters throughout the course of the day, but not at prescribed intervals.

The injection system delivery pressures will be continuously monitored at both the injection heads and in the control area of the treatment unit. Should the pressures exceed expectations, the pressures will be lowered by quenching the reaction and/or venting excess gasses. The injection equipment has automatic shutdown controls if the back pressure exceeds preset delivery pressures.

Reaction progress and efficiency will be monitored through measurement of carbon dioxide, oxygen, and chloride ion concentrations. Carbon dioxide and oxygen out-gassing from adjacent monitoring wells provide a sensitive measure of reaction progress. Carbon dioxide is a product of the oxidation of the carbon bonds of the organic contaminant and out-gassing increases rapidly during the initial stages of injection. As injection proceeds and the remaining contaminant mass is reduced, carbon dioxide production stabilizes and then begins to decrease. The decrease in carbon dioxide out-gassing is accompanied by an increase in oxygen out-gassing. The oxygen is a product of hydrogen peroxide decomposition in the absence of organic contaminants. Carbon dioxide and oxygen will be measured from the headspace in the injectors and monitoring wells adjacent to the treatment area. Routine sweeps of all injectors and monitoring wells will be conducted at approximately 2-hour intervals throughout the course of the day. Eight-hour workdays are anticipated.

Chloride ion concentration in groundwater is another measure of reaction progress. Chloride ion is an oxidation product of chlorinated hydrocarbons; thus, an increase in the groundwater chloride concentration is observed as the chlorinated hydrocarbons are oxidized. Chloride ion concentration will be measured

from grab samples taken from the injectors and monitoring wells adjacent to the treatment area, immediately following headspace sampling.

Hydrogen peroxide injection will be discontinued in a given injection well once these field measures become stabilized, or a maximum of 3,000 pounds (375 gallons) of hydrogen peroxide reagent have been injected. Because of the low concentrations and small mass of PCE reported in groundwater at the PDO Yard, the amount of hydrogen peroxide required for groundwater treatment is not stoichiometrically controlled. Less than 26 pounds of hydrogen peroxide would be needed to treat the estimated 6 pounds of total chlorinated hydrocarbons at the site. However, experience has shown that a minimum of 3,000 pounds of hydrogen peroxide is needed at each injector for effective treatment. Therefore, the conceptual design includes the injection of a total of 87,000 pounds of hydrogen peroxide.

5.0 SYSTEM MAINTENANCE

5.1 WEEKLY MAINTENANCE

Because the Geo-Cleanse® treatment will be completed within one week, weekly maintenance is not required. The aboveground components of the system will be removed from the site at the end of the injection period, after approximately one week.

5.2 ROUTINE (SEMIANNUAL) MAINTENANCE

During the Monitored Natural Attenuation period, the groundwater monitoring well system will be inspected semiannually (in conjunction with scheduled sampling events) for the following:

- check monitoring wells for silt accumulation, tampering, or other surficial damage; and
- clear brush or vegetative growth from around wells by mowing or scythe.

6.0 SAMPLING AND ANALYSIS

Sampling of groundwater will be conducted throughout the remediation period to verify effective O&M of the corrective measure. All information, data, and resulting decisions will be technically sound, statistically valid, and properly documented by following a Quality Assurance Project Plan (QAPP) as contained in the project-specific Work Plan. The QAPP will document all monitoring procedures, sampling, field measurements, and sample analyses performed during these activities. Appropriate quality assurance, quality control, and chain-of-custody procedures will be followed in accordance with the U.S. Army Corps of Engineers' Requirements for the Preparation of Sampling and Analysis Plans (EM200-1-3), EPA's Requirements for Quality Assurance Project Plans for Environmental Data Operations (QA/R-5), and EPA's Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans (QAMS-005/80). Detailed sampling and analysis procedures will be developed in conjunction with the Corrective Action Work Plan. Groundwater sampling will be performed using low-flow sampling techniques.

6.1 GROUNDWATER MONITORING DURING GEO-CLEANSE® SYSTEM OPERATION

The 10 on-site groundwater monitoring wells associated with the PCE plume will be sampled once every 2 hours during the Geo-Cleanse® system operation. As described in Section 4.2, well headspace will be sampled for carbon dioxide and oxygen off-gassing, and grab groundwater samples for chloride ion concentrations. The purpose of this sampling will be to evaluate reaction progress and efficiency. Injection will be ceased once these parameters have stabilized. Post-treatment groundwater samples will be analyzed for PCE to verify that completion criteria have been met.

6.2 GROUNDWATER MONITORING DURING MONITORED NATURAL ATTENUATION

Following the completion of groundwater treatment using the Geo-Cleanse® system, the eight on-site monitoring wells will be sampled for benzene to confirm that natural attenuation of these contaminants of concern (COCs) in groundwater is occurring at the predicted rate. Groundwater sampling and analysis will be conducted semiannually until concentrations of benzene have declined to less than 5 µg/L in all wells. Results of modeling predict a 2-year Monitored Natural Attenuation period for a total of four sampling events.

Samples will be analyzed for benzene, toluene, ethylbenzene, and total xylenes (BTEX) as shown in Table D-2. The samples will also be analyzed for methane gas and other natural attenuation parameters (carbon dioxide, nitrate/nitrite, sulfate/sulfide, and total iron). Samples will be analyzed at an off-site laboratory using then-current SW-846 methods. Field parameters will be measured at the time of sampling and will include DO, temperature, Eh, conductivity, and pH.

Table D-2. Analytical Parameters and Wells to be Sampled
PDO Yard, Hunter Army Airfield, Georgia

Groundwater Plume	Analytical Parameters	Wells to be Sampled
Benzene Plume	BTEX methane gas carbon dioxide nitrate/nitrite sulfate/sulfide total iron	MW01, MW02, MW06, MW07, MW08, MW09, MW1-23, and MW1-25
Benzene Plume (Confirmation Sampling)	Benzene	MW01, MW02, MW06, MW07, MW08, MW09, MW1-23, and MW1-25
PCE Plume (Confirmation Sampling)	PCE	MW02, MW03, MW05, MW1-22, MW1-24, MW10, MW11, MW26, MW27, and MW28

6.3 GROUNDWATER MONITORING DURING CONFIRMATION SAMPLING

Confirmation groundwater sampling and analysis will be conducted once (6 months following completion of the Geo-Cleanse® treatment) to verify that the groundwater RL for PCE (5 µg/L) has been met and maintained. The 10 on-site monitoring wells specific to the PCE plume (Table D-2) will be sampled and analyzed for PCE only.

Following the completion of the Monitored Natural Attenuation period for the benzene plume, the eight on-site monitoring wells will be sampled and analyzed for benzene only to confirm that the groundwater RL for benzene (5 µg/L) has been met and maintained. Confirmation groundwater sampling and analysis

will be conducted once (6 months after completion of Monitored Natural Attenuation of the benzene plume) to verify that corrective action for the benzene plume is complete.

Samples will be analyzed at an off-site laboratory for either benzene or PCE (as listed in Table D-2) using then-current SW-846 methods. Analysis of natural attenuation parameters is not required for confirmation sampling, since MCLs will have already been achieved in groundwater following the Monitored Natural Attenuation period. Field parameters will be measured at the time of sampling and will include DO, temperature, Eh, conductivity, and pH.

7.0 CORRECTIVE ACTION COMPLETION CRITERIA

The purpose of the corrective action is to achieve RLs in groundwater at the site. The RLs, as defined in the RFI Report, are as listed in Table D-3:

Table D-3. Summary of Remedial Levels
PDO Yard, Hunter Army Airfield, Georgia

Contaminant of Concern	Groundwater Remedial Level (µg/L)
Benzene	5
PCE	5

Geo-Cleanse® Treatment Completion Criteria. Injection of hydrogen peroxide reagent and ferrous iron catalyst using the Geo-Cleanse® system will be considered complete upon attaining a maximum PCE concentration in each of the 10 on-site wells of 5 µg/L. Confirmation groundwater sampling will be conducted 6 months following the Geo-Cleanse® treatment to verify the groundwater RL For PCE has been maintained.

Monitored Natural Attenuation Completion Criteria. Monitored Natural Attenuation will be considered complete upon attaining maximum concentrations for benzene in each of the eight on-site wells (Table D-2) of 5 µg/L. Confirmation groundwater sampling will be conducted 6 months following the Monitored Natural Attenuation period to verify that the groundwater RL for benzene has been maintained.

8.0 SYSTEM DECOMMISSIONING

Upon satisfactory completion of the confirmation groundwater sampling (see Section 7.0) and acknowledgment from the regulators that the corrective action is complete, the groundwater monitoring system will be decommissioned. The injection points and groundwater monitoring wells will be plugged and abandoned by filling the casings with a cement and bentonite grout mixture.

9.0 O&M CONTINGENCY PROCEDURES

In the event of a major breakdown and/or complete failure of the Geo-Cleanse® system (including emergency situations) at the PDO Yard, Fort Stewart will verbally notify GEPD within 24 hours of the

event and will notify GEPD in writing within 72 hours of the event. Written notification will, at a minimum, specify what happened, what response action is being taken and/or is planned, and any potential impacts on human health and/or the environment.

Contingency procedures may be considered during the operation of the Geo-Cleanse® system in response to observed operational malfunction or unanticipated trends in the predicted rate of remediation. Contingency actions that may be considered are listed in the following troubleshooting guide (Table D-4).

Table D-4. Troubleshooting Guide for Geo-Cleanse® Operational Malfunctions
PDO Yard, Hunter Army Airfield, Georgia

Problems	Considerations	Potential Solutions
The radius of influence of injection pressures is insufficient or not as predicted.	The soil may be less permeable in some locations or there may be a preferential flow path.	Further subsurface investigation Readjust injection rates/volumes Install additional injection points
The PCE concentrations have declined to less than 15 µg/L in some but not all wells.	Treatment may be completed in some areas of the site.	Reduce injected volumes at some injection points Eliminate some injection points
The PCE concentrations remain high or rebound	An undiscovered source of contamination or free product may be present.	Further investigation
The PCE concentrations decline but do not reach completion criteria.	Oxidation of contaminants may be incomplete.	Conduct additional injection as a polishing step
The system breaks down or the power is interrupted.	Operating conditions may be erratic.	Provide replacement or backup equipment
The extent of groundwater contamination is greater than anticipated.	Contamination may have migrated further than previously measured.	Further subsurface investigation Install additional injection points

Contingency procedures may also be considered during the Monitored Natural Attenuation period. Results of monitoring well sampling and analysis will be evaluated. In particular, an analysis of the trends in the rate of decline in contaminant concentrations will be performed. The conceptual site model will be modified, as appropriate. If trends do not match predicted modeled behavior, then contingent actions will be considered, including revising the computational model to correlate to the new data, extending or reducing the predicted duration of the Monitored Natural Attenuation period, or implementing active remediation. Specific alternatives for active remediation (such as use of oxygen-releasing compounds, air sparging, or enhanced biodegradation through injection of oxygen and/or nutrients) would be evaluated at that point in time. Table D-5 lists the contingency actions that may be considered for Monitored Natural Attenuation of the benzene plume.

Table D-5. Troubleshooting Guide for Monitored Natural Attenuation
PDO Yard, Hunter Army Airfield, Georgia

Problems/Triggers	Considerations	Potential solutions
Benzene concentrations in groundwater in any given well increase at least 10 percent for two consecutive quarters of sampling.	Contaminant "slug" may be migrating through aquifer; an undiscovered source of contaminant may be present.	Modify conceptual site model. Revise the AT123D numerical model. Extend (or reduce) the duration of MNA. Evaluate active remediation: • oxygen-releasing compounds; • air sparging; • enhanced biodegradation through injection of oxygen and/or nutrients.
Benzene concentrations in MW1-23 increase to a level exceeding 10 µg/L.	An undiscovered source of contamination may be present; a new release or upgradient release may be present.	
Benzene is detected in MW1-24, MW02, MW07, MW08, or MW09 (any individual well) at a level exceeding 5 µg/L.	Contaminant plume may be expanding outside the original plume boundary.	
Benzene concentrations in MW01, MW06, or MW1-25 (any individual well) are greater than (less than) the predicted concentration by more than 25 percent for two consecutive quarters.	Rate of attenuation may be slower (faster) than predicted; an undiscovered source of contamination may be present.	
Land use or groundwater use changes at the PDO Yard or in Lamar Canal.	Remediation objectives or timeframe may no longer be appropriate for new use.	

10.0 O&M SCHEDULE

The anticipated schedule for O&M is summarized in Table D-6.

Table D-6. Operations and Maintenance Schedule
PDO Yard, Hunter Army Airfield, Georgia

O&M Activity	Frequency	Duration
System startup	Once	Until system operational (~1 hour)
Groundwater sampling during Geo-Cleanse® system operation	Continuously	Continuously throughout injection operations (~14 days)
Groundwater sampling during Monitored Natural Attenuation	Semiannually	Semiannually until Remedial Levels are reached (predicted to be ~2 years)
Site inspection/semiannual maintenance	Semiannually	Semiannually throughout Monitored Natural Attenuation period (~2 years)
Confirmatory groundwater sampling	Once, 6 months after completion of Geo-Cleanse® treatment and Monitored Natural Attenuation	Two separate one-time events

11.0 DATA MANAGEMENT AND REPORTING DOCUMENTATION

A data management system will be maintained throughout the corrective action to accumulate, archive, and control project data. The data and operational information will be used to prepare Progress Reports and the final Corrective Action Completion Report. The types of data to be maintained in the data management system include those listed below:

- Monitoring and laboratory data, including sample location, date and time of collection, chain of custody, laboratory, test method, analytical results, detection limits, and associated quality control sample results.
- Records of operating parameters, including pressures, flow rates, volumes of each solution, temperatures, and other operating parameters recorded on injection operational checklists.
- Personnel, maintenance, and inspection records, including logbooks, maintenance checklists, or repairs.

11.1 PROGRESS REPORT INFORMATION

A progress report will be prepared following Geo-Cleanse® treatment. The report will summarize the installation, injection process, sampling, and analysis performed for the Geo-Cleanse® treatment. An analysis of any deviations from the required completion criteria and need for any contingent action will be discussed, as required.

A progress report will be prepared semiannually during the 2-year Monitored Natural Attenuation period. These reports will summarize the sampling and analytical results of the groundwater monitoring. In addition, an analysis of trends and effectiveness of the corrective action will be presented. The need for any contingent action will also be discussed, as required.

A checklist is presented in Attachment 1 to this O&M Plan summarizing the items to be addressed in each Progress Report.

11.2 COMPLETION REPORT INFORMATION

A final Corrective Action Completion Report will be prepared following the completion of the corrective action and confirmation sampling. The Corrective Action Completion Report will summarize the corrective measures taken at the site, provide a summary of sampling data, and give results of the confirmation groundwater sampling events.

THIS PAGE INTENTIONALLY LEFT BLANK

ATTACHMENT 1

PROGRESS REPORT CHECKLIST
Old Property Disposal (PDO) Yard, Hunter Army Airfield, Georgia

Progress Report Section	End of Geo-Cleanse® Treatment	Semiannual Monitored Natural Attenuation Sampling	Confirmatory Sampling Event
Work Accomplished (description of significant activities)	• System installation (well logs, facility layout, and components) • Baseline groundwater sampling event • System injection and operating parameters • Any changes made to the system design or operation	• Dates of sampling and analysis, including well inspections • Any monitoring well system maintenance performed	• Date of sampling and analysis
Problems Encountered	• Summary of any problems encountered • Actions taken to rectify problems	• Summary of any problems encountered • Actions taken to rectify problems	• Summary of any problems encountered • Actions taken to rectify problems
Analysis of Trends	• Plots of measured carbon dioxide, oxygen, and chloride ions in monitoring wells • Post-treatment results of PCE analyses in monitoring wells	• Comparison of groundwater analytical results to predicted performance	• Comparison of results of groundwater analysis to remedial levels • Summary of any deviations noted
Communications/Contacts	• Summaries of visitors to the site • Summaries of major contacts or communications with GEPD, the local community, or others	• Summaries of visitors to the site • Summaries of major contacts or communications with GEPD, the local community, or others	• Summaries of visitors to the site • Summaries of major contacts or communications with GEPD, the local community, or others
Conclusions and Recommendations	• Recommended changes in system design or operation • Recommendation for any contingent action (re-injection as polishing step)	• Completion of Monitored Natural Attenuation period, if remedial levels have been met • Need for contingent action (e.g., continued Monitored Natural Attenuation, contingent active remediation) if remedial levels have not been met	• Need for contingent action if remedial levels exceeded

GEPD = Georgia Environmental Protection Division.
PCE = Tetrachloroethene.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX E

IMPLEMENTATION CHECKLIST FOR MONITORED NATURAL ATTENUATION FOR BENZENE

THIS PAGE INTENTIONALLY LEFT BLANK

Table E-1. Implementation Checklist for Monitored Natural Attenuation for Benzene[a]
PDO Yard, Hunter Army Airfield, Georgia

ROLE OF MONITORED NATURAL ATTENUATION	
Source Control	• The source of contamination was removed in an Interim Removal action in 1998. Contaminated soil was excavated and removed from the site. There is no free petroleum product (NAPL) or residual soil contamination. There is, therefore, no principal-threat waste at the PDO Yard. • No other source control measures are needed to control long-term threat of release.
Restoration of Groundwater	• Groundwater will be restored to "beneficial use" through reduction of benzene concentrations to less than the MCL. Groundwater is not used at this site as a source of drinking water, and exposure by a future resident is highly unlikely. • The timeframe is reasonable for restoration of groundwater to this beneficial use. Results of AT123D modeling predict that benzene concentrations in groundwater will decline to less than the MCL of 5 µg/L in just 2 years. This is reasonable compared to the 4 to 12 months predicted for active remediation systems. • Further migration of the plume will be prevented. Downgradient migration is precluded through discharge to Lamar Canal; benzene has not been detected in Lamar Canal. Lateral migration is unlikely as evidenced by the historical reduction in benzene concentrations at the edge of the plume. Vertical migration is unlikely because benzene is lighter than water, and benzene has not been detected in deeper wells at the site. • Exposure to contaminated groundwater will be prevented through continuation of groundwater use restrictions and excavation permit restrictions at HAAF. Groundwater is not used at this site as a source of drinking water. • Further reduction in risk will occur as contaminant concentrations in groundwater continue to decline due to biodegradation, advection, and dispersion.
Soil Remediation	• Soils have been excavated from the source area in 1998, and there is no residual soil contamination. There is, therefore, no risk due to exposure to soils. • Similarly, transfer of contaminants from soil to other media is prevented because the soils have been excavated, and there is no residual contamination.
Public Involvement	• The public is provided with an opportunity for review and comment on the CAP in accordance with the Fort Stewart Hazardous Waste Facility Permit. The public will also be provided with an opportunity for review and comment on any substantive changes in the remediation approach or schedule that may arise during implementation of the corrective action.
Protective of Human Health and the Environment	• MNA is protective of human health and the environment at the PDO Yard. Based on the conclusions of the Revised Final RFI Report, there is no current human health or ecological risk associated with benzene in groundwater. Potential future exposure is unlikely because the shallow groundwater is not a viable source of drinking water in the HAAF area. Attainment of the benzene MCL will effectively eliminate any potential future risk. • The maximum concentration of benzene in groundwater (68 µg/L) is less than its IWQS of 71.28 µg/L, so that MNA is protective of human health and the environment through direct exposure within Lamar Canal.
Capable of Achieving Remedial Objectives	• The remedial objective is to attain media cleanup standards (MCL) for benzene in groundwater. Results of AT123D modeling predict that benzene concentrations in groundwater will decline from a current maximum of 68 µg/L to less than the MCL of 5 µg/L, thereby achieving remedial objectives.
Capable of Achieving Objectives in Reasonable Time Frame	• Results of AT123D modeling predict that benzene concentrations in groundwater will decline to less than the MCL of 5 µg/L in just 2 years. This is reasonable compared to the 4 to 12 months predicted for active remediation systems.

Table E-1. Implementation Checklist for Monitored Natural Attenuation for Benzene[a]
PDO Yard, Hunter Army Airfield, Georgia (continued)

ROLE OF MONITORED NATURAL ATTENUATION (CONTINUED)	
Demonstrated Effectiveness	• MNA is demonstrated to be effective through technical analysis of historical trends in groundwater, analysis of geochemical data, and AT123D numerical analysis. • Performance monitoring will include semiannual groundwater sampling to demonstrate the effectiveness of MNA. Performance monitoring of surface water is not necessary at the PDO Yard because benzene concentrations in groundwater have been consistently less than its IWQS and benzene has not been detected in Lamar Canal in historical sampling. Performance monitoring in groundwater will provide sufficient demonstration of natural attenuation for protection of surface waters. • Contingency (backup) measures are identified in the O&M Plan to ensure attainment of remedial objectives. Contingency measures include extension of MNA monitoring, addition of oxygen-releasing compounds to enhance natural biodegradation, or active injection of air, oxygen, and/or nutrients into the subsurface.
DEMONSTRATION OF EFFICACY	
Site-Specific Characterization: Conceptual Site Model	Former releases of petroleum-related constituents from ASTs located in an earthen bermed area resulted in contamination of soil and groundwater. The soil was excavated in 1998 and removed from the site. Groundwater contaminated with benzene at concentrations exceeding its MCL extends from the former earthen bermed area northward to Lamar Canal.
Nature and Distribution of Contamination in Groundwater	Benzene contamination is confined to a narrow plume less than 80 feet wide, approximately 275 feet in length, and less than 25 feet deep. Historical monitoring of both shallow and deep wells since 1996 have shown decreasing benzene concentrations in the shallow wells near the former source (MW1-23) and laterally (MW02 and MW1-24). Increases in downgradient shallow wells (MW01 and MW06) are consistent with the migration of a slug of contamination toward Lamar Canal. Benzene has not been detected in any of the deep monitoring wells in any historical sampling event. No other constituents of concern are present.
Nature and Distribution of Contaminant Sources	All contaminated soil was excavated to a depth of about 3 to 4 feet during Interim Removal activities. Eight confirmatory soil samples were analyzed for VOCs, SVOCs, and priority pollutant metals to document the source removal. No target analytes, including benzene, were identified in any of the confirmatory soil samples above screening criteria. There is, therefore, no residual source of benzene contamination in soil.
Potential Risk or Impacts to Receptors	There is no current human health or ecological risk associated with exposure to benzene. Potential future exposure is unlikely because the shallow groundwater is not a viable source of drinking water in the HAAF area. Attainment of the benzene MCL will effectively eliminate any potential future risk. The maximum concentration of benzene in groundwater (68 µg/L) is less than its IWQS of 71.28 µg/L, so that MNA is protective of human health and the environment through direct exposure within Lamar Canal. Benzene has not been detected in Lamar Canal.
Proximity of Receptors	Surficial groundwater is not used as a source of drinking water. The underlying Principal (Floridan) Aquifer is the primary source of drinking water in the vicinity of HAAF. Four water supply wells (Principal Aquifer) are located within a one-mile radius of the PDO Yard. Shallow groundwater discharges to Lamar Canal, located approximately 275 feet north of the former earthen bermed area.

Table E-1. Implementation Checklist for Monitored Natural Attenuation for Benzene[a]
PDO Yard, Hunter Army Airfield, Georgia (continued)

DEMONSTRATION OF EFFICACY (CONTINUED)	
Quantitative Understanding of Source Mass	There is no remaining source of contamination in soil. All contaminated soil was excavated to a depth of about 3 to 4 feet during Interim Removal activities. Results of confirmation soil sampling verified that the full source had been removed.
Groundwater Flow	The shallow groundwater aquifer has an average seepage velocity of 0.72 foot/day toward Lamar Canal, calculated using a hydraulic gradient of 1.3×10^{-2} feet/feet, an average hydraulic conductivity of 1.15×10^{-4} feet/second, and an effective porosity of 0.18 (Metcalf & Eddy 1999). Recharge is by local precipitation and discharge is to Lamar Canal. The aquifer consists of widely varying amounts of sand and clay. The top of the water table was measured at a depth of 5 to 7 feet bgs during the RFI. The shallow groundwater is able to be adequately monitored through the existing monitoring well network.
Contaminant Phase Distribution and Partitioning	There is no free-phase product (NAPL) present at the PDO Yard. There is no residual soil contamination that could partition into groundwater.
Rates of Biological and Non-biological Transformation	The rate of natural attenuation of benzene in groundwater has been simulated using AT123D numerical modeling. The model accounts for fate and transport processes of advection, dispersion, adsorption/retardation, and biological decay. Biological transformation has been simulated assuming a biodegradation half-life for benzene in groundwater of 2 years, which is a conservative literature-based value. Direct measurement of the nutrients, electron donors, or microbial population present has not been made. The concentration of methane, a byproduct of benzene biodegradation, was measured in four shallow wells in 1999 and indicated an elevated methane concentration in the area of highest benzene contamination, suggesting that active biodegradation of the benzene is occurring.
Variation in Factors with Time	Other remedial activities at the site, in particular the Interim Removal activities conducted in 1998 to remove contaminated soil, have a positive impact on the benzene contamination in groundwater by removing the source of contamination.
Site-specific Analysis: Estimated Rate of Attenuation	The rate of natural attenuation of benzene in groundwater has been simulated using AT123D numerical modeling. The estimated rate of attenuation varies at different locations within the aquifer, as indicated in Appendix B of this CAP. The model was calibrated by matching benzene concentrations at wells MW01 and MW06 and verified by predicting the concentrations at MW1-23 and MW09.
Anticipated Time Required to Achieve Remedial Objectives	Results of AT123D modeling predict that benzene concentrations in groundwater will decline to less than the MCL of 5 µg/L in just 2 years at all locations within the aquifer.

Table E-1. Implementation Checklist for Monitored Natural Attenuation for Benzene[a]
PDO Yard, Hunter Army Airfield, Georgia (continued)

DEMONSTRATION OF EFFICACY (CONTINUED)	
Lines of Evidence (3 Tiers of Information)	The efficacy of MNA at the PDO Yard is evidenced by means of 2 of the 3 tiers of information: historical monitoring trends and hydrogeologic and geochemical data analysis. These lines of evidence provide sufficient confidence in the rate of attenuation and the anticipated time required to achieve remediation objectives: 1. Historical monitoring trends have shown decreasing benzene concentrations in the shallow wells near the former source (MW1-23) and laterally (MW02 and MW1-24). Increases in downgradient shallow wells (MW01 and MW06) are consistent with the migration of a slug of contamination toward Lamar Canal. Benzene has not been detected in any of the deep monitoring wells in any historical sampling event. Table 2-1 of the CAP summarizes historical data. 2. Hydrogeologic and geochemical data have been used to simulate the rate of attenuation. Table 4.0 lists the data from site-specific characterization used in the analysis. Biological transformation has been simulated assuming a biodegradation half-life for benzene in groundwater of 2 years, which is a conservative literature-based value. The concentration of methane, a byproduct of benzene biodegradation, was measured in four shallow wells in 1999 and indicated an elevated methane concentration in the area of highest benzene contamination, providing indirect evidence that active biodegradation of the benzene is occurring. 3. Direct measurement of the nutrients, electron donors, or microbial population present has not been made.
APPROPRIATENESS	
Whether Contaminants in Soil or Groundwater can be Effectively Remediated by Natural Attenuation Processes	Benzene in groundwater can be effectively remediated by natural attenuation processes. Natural attenuation processes, particularly biological degradation, are well documented at petroleum fuel spill sites. Benzene may naturally degrade through microbial activity and ultimately produce non-toxic end products (e.g., carbon dioxide and water). At the PDO Yard, the source of contamination in soil has been removed and there is no residual petroleum hydrocarbon contamination.
Whether the Plume is Stable or Whether Conditions will Change Over Time	The benzene plume at the PDO Yard is not increasing in extent, but is shrinking. Results of historical monitoring have shown that benzene concentrations are decreasing at the former source area (MW1-23), and at the edges of the plume (MW02 and MW1-24). Increases in downgradient shallow wells (MW01 and MW06) are consistent with the migration of a slug of contamination toward Lamar Canal. Benzene has not been detected in any of the deep monitoring wells in any historical sampling event.
Whether Receptors will be Adversely Impacted	There is no current human health or ecological risk associated with exposure to benzene in groundwater. Potential future exposure is unlikely because the shallow groundwater is not a viable source of drinking water in the HAAF area. Attainment of the benzene MCL will effectively eliminate any potential future risk. The maximum concentration of benzene in groundwater (68 µg/L) is less than its IWQS of 71.28 µg/L, so that MNA is protective of human health and the environment through direct exposure within Lamar Canal. Therefore, receptors will not be adversely impacted by implementation of MNA.
Whether There is a Current or Projected Demand for the Affected Resources	Shallow groundwater is not a viable source of drinking water. The underlying Principal (Floridan) Aquifer is the primary source of drinking water in the vicinity of HAAF. Four water supply wells (Principal Aquifer) are located within a one-mile radius of the PDO Yard. Within the short timeframe of this remediation (2 years), there will be no demand for the affected groundwater resource.

Table E-1. Implementation Checklist for Monitored Natural Attenuation for Benzene[a]
PDO Yard, Hunter Army Airfield, Georgia (continued)

APPROPRIATENESS (CONTINUED)	
Whether Contamination will Exert Long-term Detrimental Impact on Water Supplies/Resources	The shallow aquifer is not a viable source of drinking water. Benzene contamination will be remediated at all points within the aquifer to less than the MCL of 5 µg/L within 2 years. There will, therefore, be no long-term detrimental impact to water resources within the vicinity of the PDO Yard.
Whether the Estimated Time Frame of Remediation is Reasonable	Results of AT123D modeling predict that benzene concentrations in groundwater will decline to less than the MCL of 5 µg/L in just 2 years. This is reasonable compared to the 4 to 12 months predicted for active remediation systems, such as addition of oxygen-releasing compounds, air sparging, or enhanced biodegradation through oxygen and/or nutrient injection.
Whether the Sources of Contamination can be Adequately Controlled	All contaminated soil was excavated to a depth of about 3 to 4 feet during Interim Removal activities. Eight confirmatory soil samples were analyzed for VOCs, SVOCs, and priority pollutant metals to document the source removal. No target analytes, including benzene, were identified in any of the confirmatory soil samples above screening criteria. There is no free-phase product (NAPL) present at the PDO Yard. There is, therefore, no residual source of benzene contamination.
Whether Transformation Products Present a Greater Risk	Methane is a biodegradation product of benzene that has been found at the PDO Yard as evidence that biodegradation is occurring. Methane is an odorless, colorless gas that is physiologically inert and poses no health risk. Methane is a simple asphyxiate; at high concentrations it can supplant oxygen in the air creating an oxygen deficient environment. It is also flammable and has a lower explosive limit in air of 5 percent. Other transformation products formed through subsequent biodegradation of methane include carbon dioxide and water, which pose no health risk.
Whether Active Remediation Measures will Impact the MNA	Other remedial activities at the site, in particular the Interim Removal activities conducted in 1998 to remove contaminated soil, have had a positive impact on the benzene contamination in groundwater by removing the source of contamination. Remediation measures consisting of in-situ chemical oxidation using hydrogen peroxide are proposed for the adjacent PCE plume. However, those measures will not impact the benzene plume because the plumes are present in separate areas and because chemical oxidation also degrades benzene. If any hydrogen peroxide treatment reagent were to drift into the benzene plume area, then the natural microbial population may be temporarily impacted.
Whether Reliable Institutional Controls are Available for Monitoring and Enforcement	The U.S. Government will retain ownership of HAAF, including the area of the PDO Yard, to ensure that monitoring and enforcement of the MNA O&M Plan are completed. Other institutional controls at HAAF include groundwater use restrictions and excavation permits. These controls are reliable for the short-term duration (2 years) for MNA and until the facility is closed.
REASONABLENESS OF REMEDIATION TIMEFRAME	
Comparison to Other Alternatives	Results of AT123D modeling predict that benzene concentrations in groundwater will decline to less than the MCL of 5 µg/L in just 2 years. This is reasonable compared to the 4 to 12 months predicted for active remediation systems, such as air sparging or enhanced biodegradation through oxygen injection.
Balancing of Tradeoffs: Classification, Value of Resource	According to the Pollution Susceptibility Map of Georgia (GDNR 1992), HAAF is located in an average or higher groundwater pollution susceptibility area. Shallow groundwater is not a viable source of drinking water.
Timeframe in Which Aquifer will be Needed	Shallow groundwater is not a viable source of drinking water. The underlying Principal (Floridan) Aquifer is the primary source of drinking water in the vicinity of HAAF. Four water supply wells (Principal Aquifer) are located within a one-mile radius of the PDO Yard. Within the short timeframe of this remediation (2 years), there will be no demand for the affected groundwater resource.

Table E-1. Implementation Checklist for Monitored Natural Attenuation for Benzene[a]
PDO Yard, Hunter Army Airfield, Georgia (continued)

REASONABLENESS OF REMEDIATION TIMEFRAME (CONTINUED)	
Plume Stability Over Time	The benzene plume at the PDO Yard is not increasing in extent, but is shrinking. Results of historical monitoring have shown that benzene concentrations are decreasing at the former source area (MW1-23), and at the edges of the plume (MW02 and MW1-24). Increases in downgradient shallow wells (MW01 and MW06) are consistent with the migration of a slug of contamination toward Lamar Canal. Benzene has not been detected in any of the deep monitoring wells in any historical sampling event.
Detrimental Impacts	The shallow aquifer is not a viable source of drinking water. Benzene contamination will be remediated at all points within the aquifer to less than the MCL of 5 µg/L within 2 years. There will therefore be no long-term detrimental impact to water resources within the vicinity of the PDO Yard.
Uncertainties in Mass or Time Estimates	Chemical, hydrogeologic, and geochemical data are of adequate quality and usability. Data collection and laboratory analysis have been in accordance with approved USACE procedures for assessing data quality, including data validation. Lateral and vertical extent of contamination has been defined adequately to provide accurate estimates of the mass of benzene contamination in groundwater. Time estimates have been made based on AT123D numerical modeling using site-specific chemical, hydrogeologic and geochemical data and a conservative literature-based value for the biodegradation rate of benzene. Uncertainties inherent in these estimates are therefore acceptable. The O&M Plan has identified contingent measures to address uncertainties.
Reliability of Monitoring and Institutional Controls	The U.S. Government will retain ownership of the HAAF, including the area of the PDO Yard, to ensure that monitoring and enforcement of the MNA O&M Plan are completed. Other institutional controls at HAAF include groundwater use restrictions and excavation permits. Because the timeframe for MNA remediation is relatively short (2 years), monitoring and institutional controls can be reliably implemented and will be continued until the facility is closed.
Public Acceptance of Timeframe	The public is provided with an opportunity for review and comment on the CAP in accordance with the Fort Stewart Hazardous Waste Facility Permit. The public will also be provided with an opportunity for review and comment on any substantive changes in the remediation approach or schedule that may arise during implementation of the corrective action.
Provisions for Availability of Adequate Funding	Funding is assured through the U.S. Department of Defense, Environmental Remedial Action (ERA) Program.
REMEDIATION OF SOURCES	
Removal of Contaminated Soil	Not applicable. All contaminated soil was excavated to a depth of about 3 to 4 feet during Interim Removal activities in 1998. There is no remaining source of contamination at the PDO Yard.
Free-Phase NAPL Removal	Not applicable. No free-phase product (NAPL) is present. There is no principal threat waste at the PDO Yard.
Treatment	Not applicable. There is no remaining source.
Principal-Threat Waste Treatment	Not applicable. There is no principal threat waste.
Containment	Not applicable. There is no remaining source.

Table E-1. Implementation Checklist for Monitored Natural Attenuation for Benzene[a]
PDO Yard, Hunter Army Airfield, Georgia (continued)

PERFORMANCE MONITORING AND EVALUATION	
Location	Per Table D-2 of the O&M Plan, 7 shallow and one deep well will be monitored.
Frequency	Per Table D-5 of the O&M Plan, the monitoring frequency will be semiannually during the MNA period. Flexibility for adjusting the monitoring frequency is provided through an analysis of trends and effectiveness of the corrective action as presented in semiannual progress reports.
Type of Samples	• Per Table D-2 of the O&M Plan, samples will be collected of groundwater only. Performance monitoring of surface water is not necessary at the PDO Yard because benzene concentrations in groundwater have been consistently less than their IWQS, and benzene has not been detected in Lamar Canal in historical sampling. Performance monitoring in groundwater will provide sufficient demonstration of natural attenuation for protection of surface waters.
Measurements	Per Table D-2 and Section 6.2 of the O&M Plan, analytical parameters will include BTEX, methane gas, carbon dioxide, nitrate/nitrite, sulfate/sulfide, and total iron. Field parameters will be measured at the time of sampling and will include DO, temperature, Eh, conductivity, and pH.
Design: Demonstrate that Natural Attenuation is Occurring as Expected	Monitoring of the eight existing wells provides suitable measurement of contaminant trends in wells within the plume, upgradient, laterally to the side of the plume, and vertically beneath the plume. Decline in benzene concentrations will demonstrate that degradation is occurring as expected.
Detect Changes (Hydrogeologic, Geochemical, and Microbial)	Presence of elevated methane gas concentrations in wells within the plume (MW01, MW06, and MW1-25) will demonstrate that biodegradation is occurring. Other geochemical parameters listed under "measurements" above will detect changes in the geochemical conditions at the PDO Yard.
Identify Transformation Products	Presence of elevated methane gas concentrations in wells within the plume (MW01, MW06, and MW1-25) will demonstrate that biodegradation is occurring, resulting in methane as a transformation product.
Verify that the Plume is not Expanding	Monitoring of existing wells MW1-24, MW02, MW07, MW08, and MW09 provides suitable measurement of contaminant trends upgradient, laterally to the side of the plume, and vertically beneath the plume to verify that the plume is not expanding.
Verify that There is No Unacceptable Impact to Downgradient Receptors	Monitoring of wells MW1-25 and MW09 located at the banks of Lamar Canal provide suitable measurement of groundwater quality just prior to discharge to verify that there is no unacceptable impact to downgradient receptors in the canal.
Detect New Releases	There is no remaining source so that detection of new releases is not needed. Monitoring of well MW1-23 located adjacent to the former earthen bermed area (former source area) provides suitable detection of any changes in upgradient groundwater conditions.
Demonstrate Effectiveness of Institutional Controls to Protect Receptors	Shallow groundwater is not used as a drinking water supply. Monitoring of wells MW1-25 and MW09 located at the banks of Lamar Canal provide suitable measurement of groundwater quality just prior to discharge to verify that there is no unacceptable impact to downgradient receptors in the canal.
Verify Attainment of Remediation Objectives	Monitoring of the eight existing wells provides suitable measurement of contaminant concentrations in wells within the plume, upgradient, laterally to the side of the plume, and vertically beneath the plume to verify that remediation objectives (MCL of 5 µg/L) have been attained throughout the shallow aquifer.
Duration	Per Table D-5 of the O&M Plan, monitoring will be conducted throughout the MNA period (estimated at 2 years), or until RLs (remediation objectives) are met. Flexibility for adjusting the duration of is provided through an analysis of trends and effectiveness of the corrective action as presented in semiannual progress reports. Extending (or reducing) the duration of monitoring is a contingency remedy to be evaluated as part of the semiannual progress reports.

Table E-1. Implementation Checklist for Monitored Natural Attenuation for Benzene[a]
PDO Yard, Hunter Army Airfield, Georgia (continued)

CONTINGENCY REMEDIES	
Remedy Evaluation	Results of monitoring well sampling and analysis, in particular an analysis of trends in the rate of decline in contaminant concentrations, will be evaluated on a semiannual basis throughout the MNA period. If trends do not match predicted modeled behavior, then contingent remedies will be considered, including: • Modify conceptual site model and/or hydrogeologic model. • Revise the AT123D numerical model to correlate to new data. • Extend (or reduce) the duration of MNA. • Implement active remediation. Specific alternatives to be evaluated at that time include addition of oxygen-releasing compounds, air sparging, or enhanced biodegradation through injection of oxygen and/or nutrients.
Triggers: Concentrations in Soil or Groundwater Show Increase	If benzene concentrations in any given well increase at least 10 percent for two consecutive semiannual sampling events, then implement contingent remedy evaluation.
Near-source Wells Show Increase (New Release)	If benzene concentrations in MW1-23 increase to a level exceeding 10 µg/L, then implement contingent remedy evaluation.
Contaminants are Found Outside the Original Plume Boundary	If benzene is detected in MW1-24, MW02, MW07, MW08, or MW09 (any individual well) at a level exceeding 5 µg/L, then implement contingent remedy evaluation.
Concentrations not Decreasing Sufficiently to Meet Remediation Objectives	If benzene concentrations in MW01, MW06, or MW1-25 (any individual well) exceed the predicted concentration by more than 25 percent for two consecutive semiannual sampling events, then implement contingent remedy evaluation.
Land and/or Groundwater Use has Changed	If land use or groundwater use changes at the PDO Yard or in Lamar Canal, then implement contingent remedy evaluation.

[a]This checklist follows U.S. Environmental Protection Agency guidance as described in Office of Solid Waste and Emergency Response Directive 9200.4-17P (EPA 1999).
AST = aboveground storage tank.
AT123D = Analytical Transient 1-, 2-, 3-Dimensional (model).
bgs = below ground surface.
BTEX = benzene, toluene, ethylbenzene, and total xylenes.
CAP = Corrective Action Plan.
GDNR = Georgia Department of Natural Resources.
IWQS = In-stream Water Quality Standard.
MCL = maximum contaminant level.
MNA = Monitored Natural Attenuation.
NAPL = non-aqueous phase liquid.
O&M = operation and maintenance.
PCE = tetrachloroethene.
RFI = Resource Conservation and Recovery Act (RCRA) Facility Investigation.
SVOC = semivolatile organic compound.
VOC = volatile organic compound.