HYDROGEOLOGIC DATA

E-1 IN-SITU HYDRAULIC CONDUCTIVITY TESTING

E-2 HYDRAULIC GRADIENT AND GROUNDWATER FLOW VELOCITY CALCULATIONS

IN-SITU HYDRAULIC CONDUCTIVITY TESTING

APPENDIX E-1 HYDRAULIC CONDUCTIVITY TEST RESULTS

HLA performed rising head slug tests on monitoring wells installed during the AOC 69W RI in November 1995 and January 1997. This appendix discusses the analytical procedure and presents estimated values of hydraulic conductivity. The test methodology is presented in Subsections 4.8.2 of Volume I of the Fort Devens POP (ABB-ES, 1995a). Field data from all tests were analyzed to estimate hydraulic conductivity using a derivation of the method of Hvorslev (1951)[1] and the method of Bouwer and Rice (1976)[2].

The form of the Hvorslev equation that was used relates the hydraulic conductivity, K, of an unconfined aquifer to the well geometry and the rate of head recovery by:

$$-K = \left[\frac{\mathrm{Log}(H_1) - \mathrm{Log}(H_2)}{t_1 - t_2} \right] \frac{r^2 \ \mathrm{Log}(L / R)}{2L}$$

Parameters in this equation included: r (radius of the well casing), R (radius of the borehole), L (length of the aquifer tested), as well as time (t) and water level (H) data expressed as drawdown. Log values are log base ten. Test data were also analyzed using AQTESOLV™[3], an aquifer test analysis program by Geraghty Miller, Inc. AQTESOLV™ utilizes the Bouwer and Rice method for estimating hydraulic conductivities in unconfined aquifers.

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[1]Hvorslev, M.J., 1951. "Time Lag and Soil Permeability in Groundwater Observations;" U.S. Army Corps of Engineers, Waterways Experiment Station, Bulletin 36; Vicksburg, Mississippi.

[2]Bouwer, H. and R.C. Rice, 1976. A Slug Test Method for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells, Water Resources Research, Vol. 12, No. 3, pp 423-428.

[3]AQTESOLV, 1991 "AQTESOLV, Aquifer Test Solver Version 1.00;" Geraghty and Miller Modeling Group; Reston, VA.

Estimates of hydraulic conductivity for the 15 wells/piezometers tested at AOC 69W range between 2.95×10^{-2} cm/sec and 1.32×10^{-3} cm/sec for the Bouwer and Rice method while the Hvorslev method yields values of 3.76×10^{-3} cm/sec to 9.02×10^{-5} cm/sec. Typically the Bouwer and Rice method provided hydraulic conductivity values which were greater than the values obtained with the Hvorslev equation.

The results of hydraulic conductivity testing are summarized in Table E-1. The data for each test are also provided. The information contained in this Appendix is organized as follows:

1) Table E-1, Summary of In-Situ Hydraulic Conductivity Test Results; input parameters used for AQTESOLV™ analyses;

2) AQTESOLV™ plots with computed hydraulic conductivity values;

3) A table of calculation of hydraulic conductivities using the Hvorslev Equation; and

4) Raw data and plots of data for Hvorslev analyses;

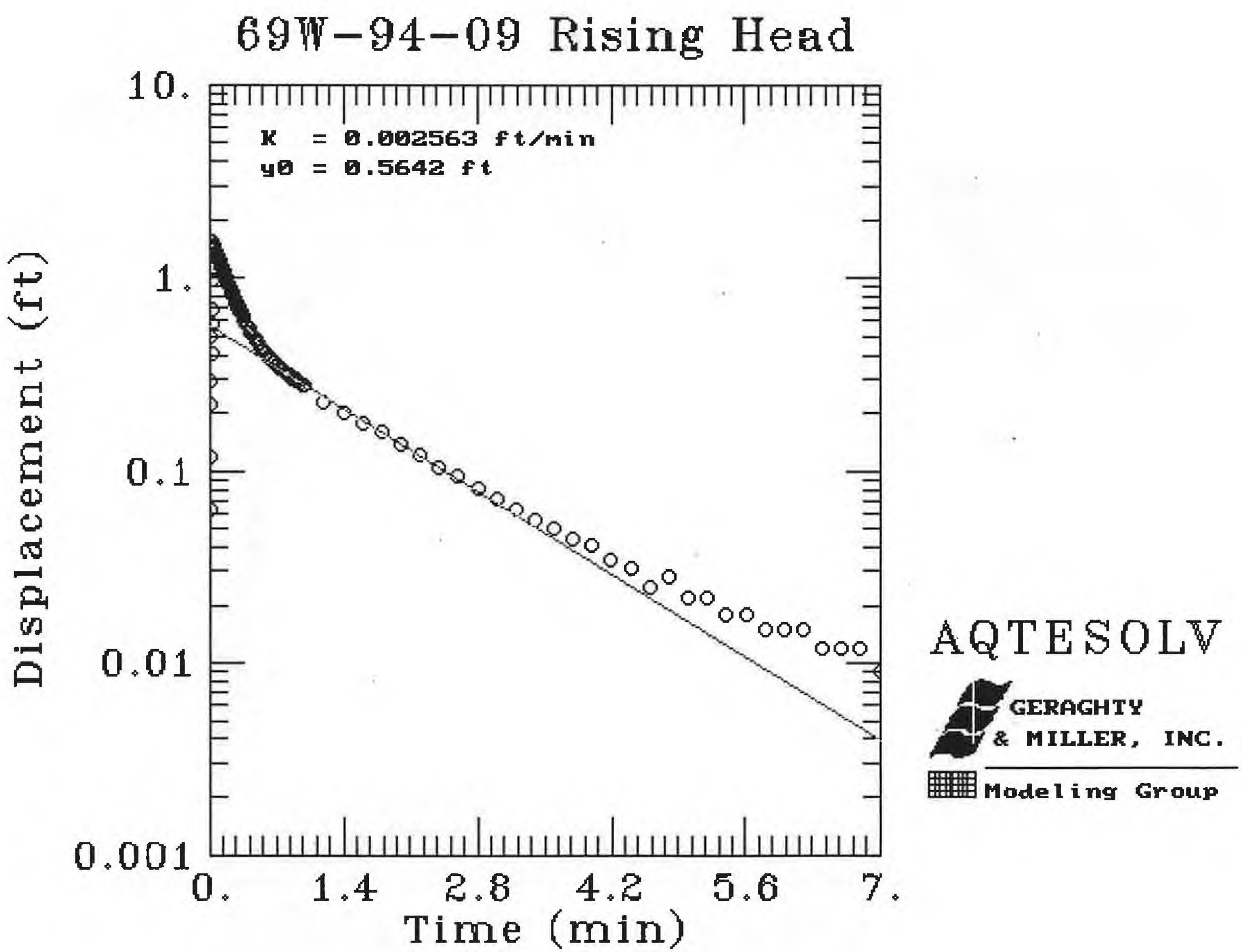
Static water levels in each well were generally referenced to zero with head stress being expressed as a positive change.

TABLE E-1
SUMMARY OF IN-SITU HYDRAULIC CONDUCTIVITY TESTING
AOC 69W

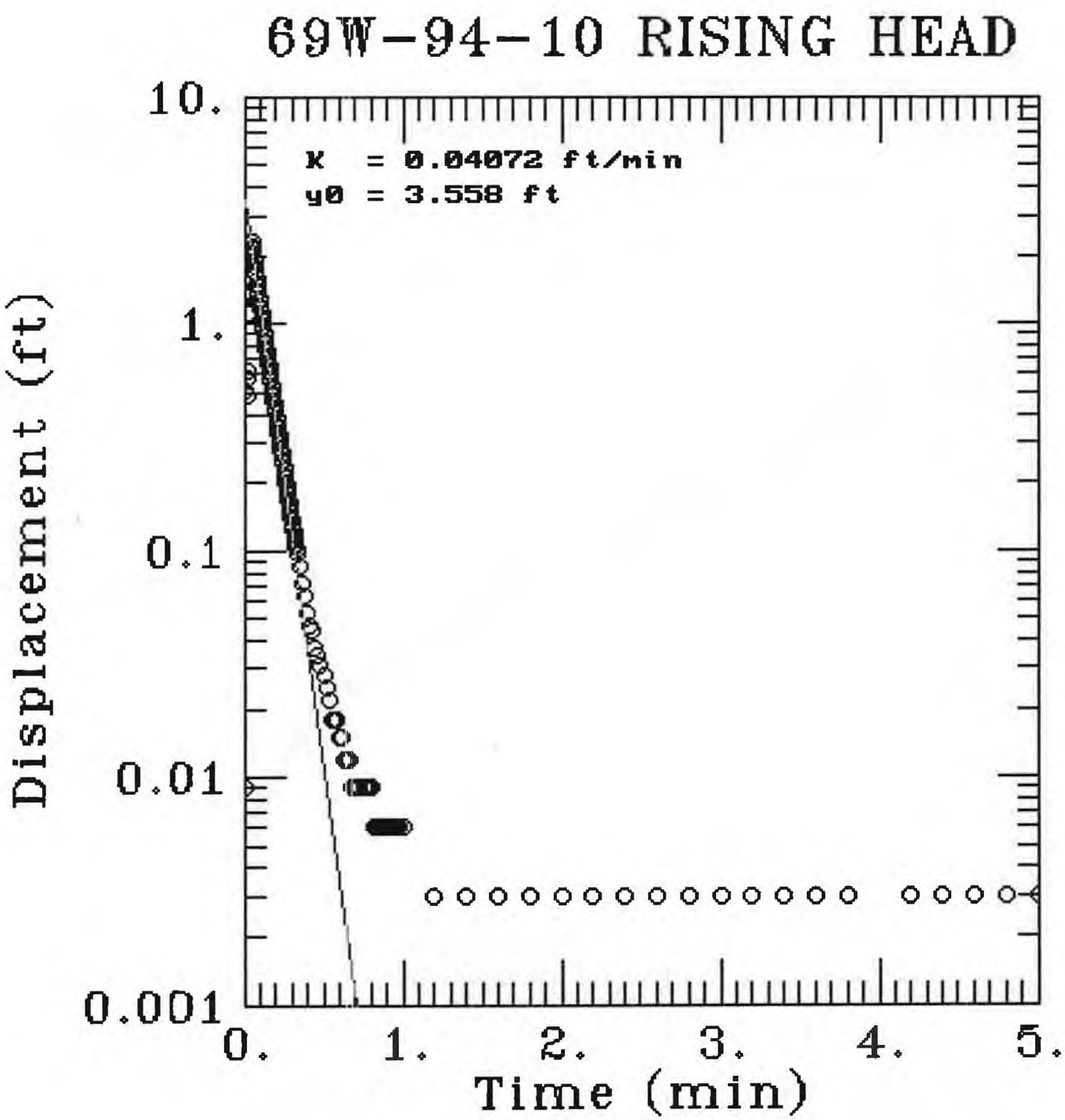
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

									Bouwer and Rice		Hvorslev		
Well ID	Well Diam. (in)	Screen Int. (feet, bgs)	Filter Pack Int. (feet, bgs)	Saturated Height (feet)	Rc (feet)	Rw (feet)	Le (feet)	Hw (feet)	Hydraulic Cond. (ft/min)	Hydraulic Cond. (cm/s)	Hydraulic Cond. (ft/min)	Hydraulic Cond. (cm/s)	Screened Geology (USCS)
69W-94-09	2	3.5 to 13.5	2.5 to 15	6.85	0.17	0.29	8.35	8.35					SP-SM
69W-94-10	2	4.5 to 14.5	3.5 to 15	8.08	0.17	0.29	8.58	8.58	2.60E-03	1.32E-03	1.78E-04	9.02E-05	SW
69W-94-11	4	4.5 to 14.5	3.5 to 15	7.41	0.29	0.46	7.91	7.91	4.10E-02	2.08E-02	2.96E-03	1.50E-03	SP-SM
69W-94-12	2	3 to 13	2.5 to 15	8.26	0.17	0.29	10.26	10.26	3.10E-02	1.57E-02	3.50E-03	1.78E-03	SW
69W-94-13	4	3 to 13	2.5 to 14	9.27	0.29	0.46	10.27	10.27	1.10E-02	5.59E-03	3.14E-03	1.59E-03	SW
69W-94-14	2	3 to 13	2.5 to 13.5	7.62	0.17	0.29	8.12	8.12	5.10E-02	2.59E-02	7.40E-03	3.76E-03	SW
ZWM-95-15X	4	3 to 13	2 to 13.5	9.14	0.29	0.46	9.64	9.64	5.80E-02	2.95E-02	2.72E-03	1.38E-03	SW-GW
ZWM-95-16X	4	6.3 to 16.3	4 to 17	9.06	0.29	0.46	9.76	9.76	5.80E-02	2.95E-02	6.07E-03	3.08E-03	SW-SP
ZWM-95-17X	4	12.2 to 22.2	7 to 22.5	8.75	0.29	0.46	9.05	9.05	1.90E-02	9.65E-03	1.95E-03	9.92E-04	SW-SP
ZWM-95-18X	4	3 to 13	2 to 14	11.65	0.17	0.46	12.65	12.65	3.80E-02	1.93E-02	4.08E-03	2.07E-03	SW-SM
ZWM-96-19X	2	5.8 to 15.8	3.9 to 16	8.6	0.11	0.17	8.8	8.8	5.40E-02	2.74E-02	4.78E-03	2.43E-03	SP-SW-SM
ZWM-96-20X	2	2.8 to 12.8	2.5 to 13	11.21	0.11	0.17	11.41	11.41	8.44E-03	2.74E-02	1.46E-03	7.39E-04	SP
ZWM-96-21X	2	4.8 to 14.8	3.0 to 15.0	8.04	0.11	0.17	8.24	8.24	8.67E-03	2.74E-02	1.44E-03	7.31E-04	SP-SW
									8.84E-03	2.74E-02	1.42E-03	7.24E-04	

Notes:
Data analyzed using AQTESOLV (Bouwer & Rice Solution).
All tests are rising head tests.
Rc = Well casing radius for fully saturated filterpacks and equivalent casing radius which accounts for filterpack resaturation at n=30% for partially saturated filterpacks.
Rw = Radius of borehole.
Le = Saturated length of filterpack.
Hw = Height of Water Column above filterpack bottom.
Saturated Height is height of water column measured in well.
All measurements in feet unless otherwise noted.



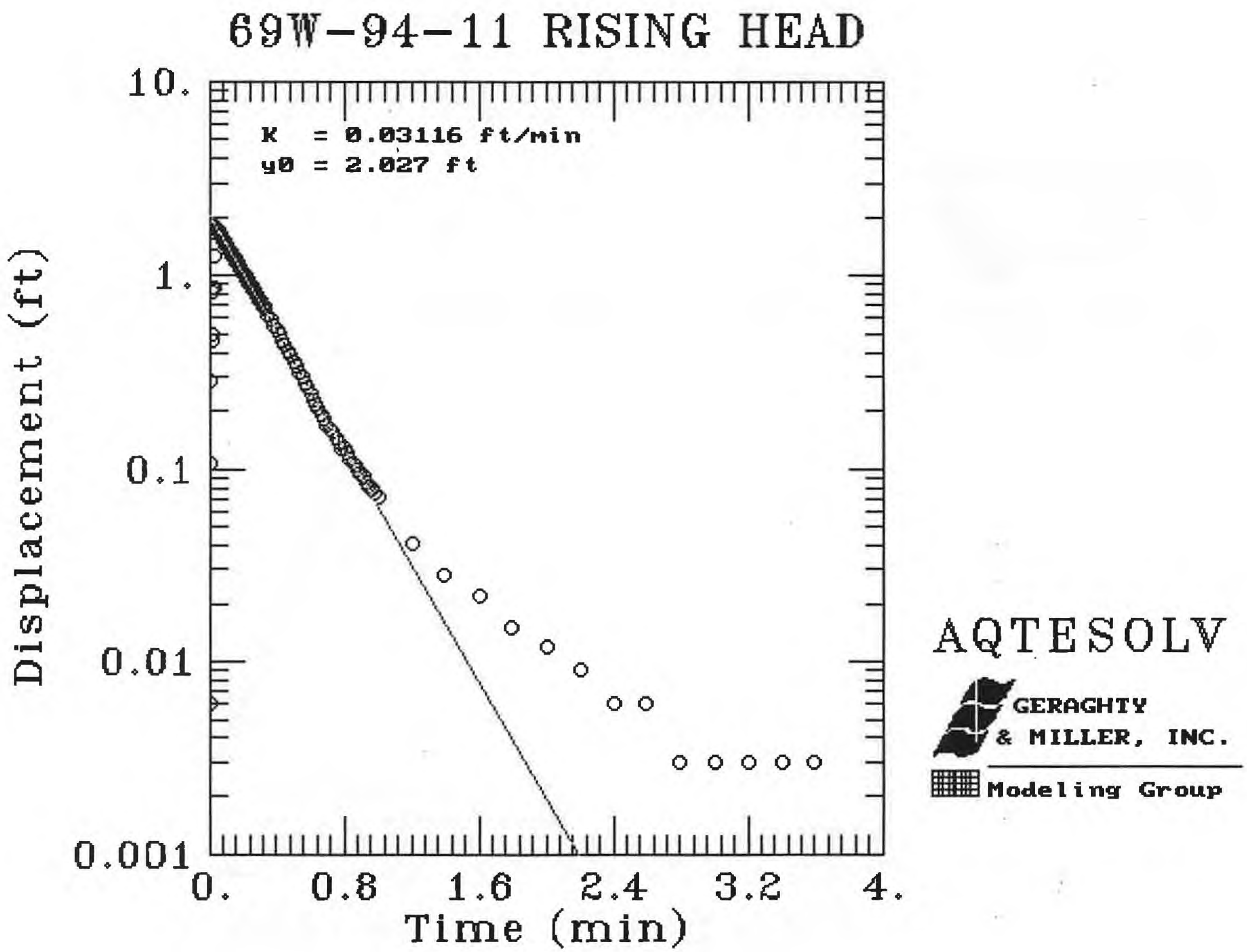
69W-94-09 Rising Head
K = 0.002563 ft/min
y0 = 0.5642 ft
Displacement (ft)
10.
1.
0.1
0.01
0.001
0.
1.4
2.8
4.2
5.6
7.
Time (min)
AQTESOLV
GERAGHTY
& MILLER, INC.
Modeling Group



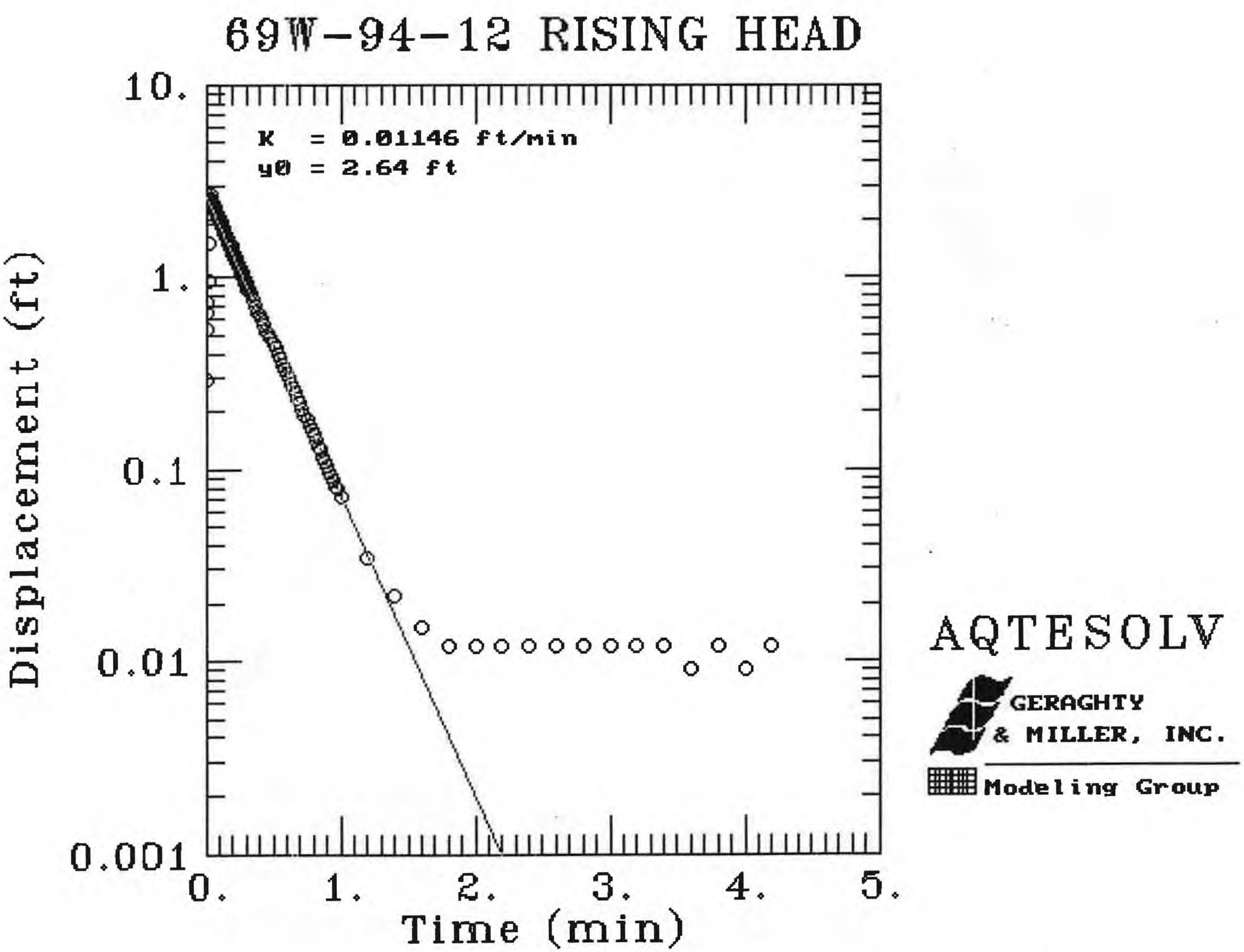
AQTESOLV

GERAGHTY & MILLER, INC.

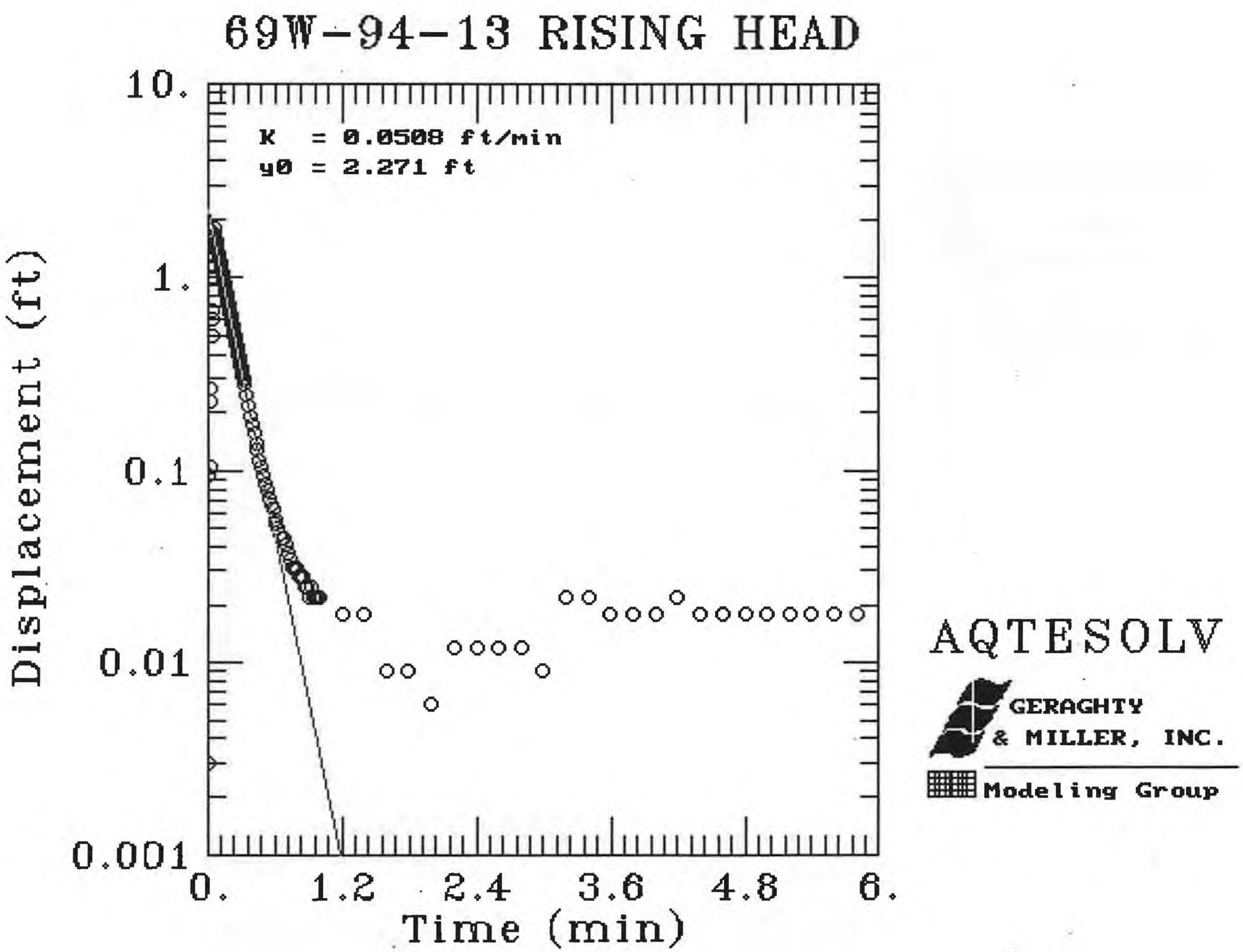
Modeling Group



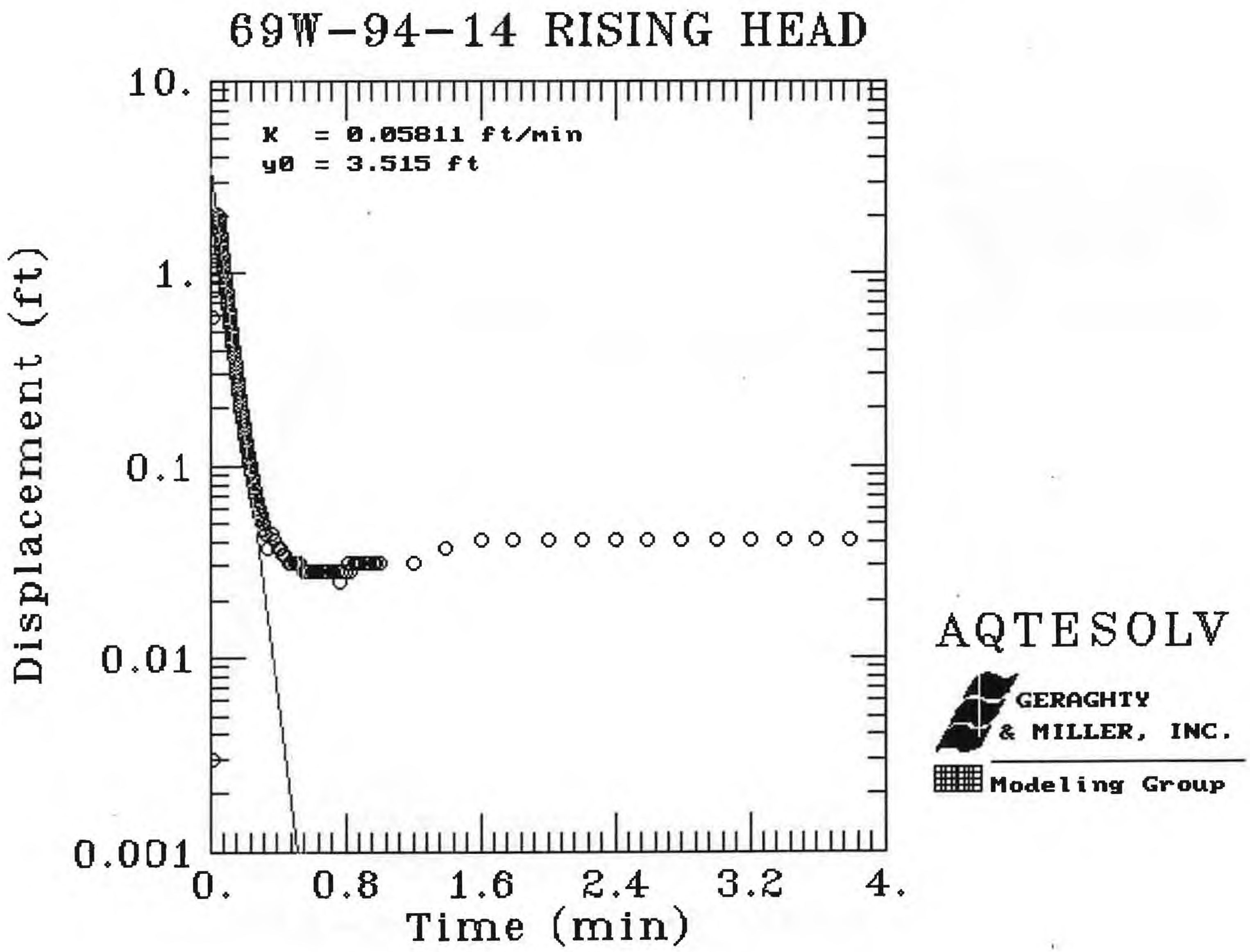
69W-94-11 RISING HEAD
K = 0.03116 ft/min
y0 = 2.027 ft
Displacement (ft)
10.
1.
0.1
0.01
0.001
0.
0.8
1.6
2.4
3.2
4.
Time (min)
AQTESOLV
GERAGHTY
& MILLER, INC.
Modeling Group



69W-94-12 RISING HEAD
K = 0.01146 ft/min
y0 = 2.64 ft
Displacement (ft)
10.
1.
0.1
0.01
0.001
0.
1.
2.
3.
4.
5.
Time (min)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group



69W-94-13 RISING HEAD
K = 0.0508 ft/min
y0 = 2.271 ft
Displacement (ft)
10.
1.
0.1
0.01
0.001
0.
1.2
2.4
3.6
4.8
6.
Time (min)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group


69W-94-14 RISING HEAD
K = 0.05811 ft/min
y0 = 3.515 ft
Displacement (ft)
10.
1.
0.1
0.01
0.001
0.
0.8
1.6
2.4
3.2
4.
Time (min)
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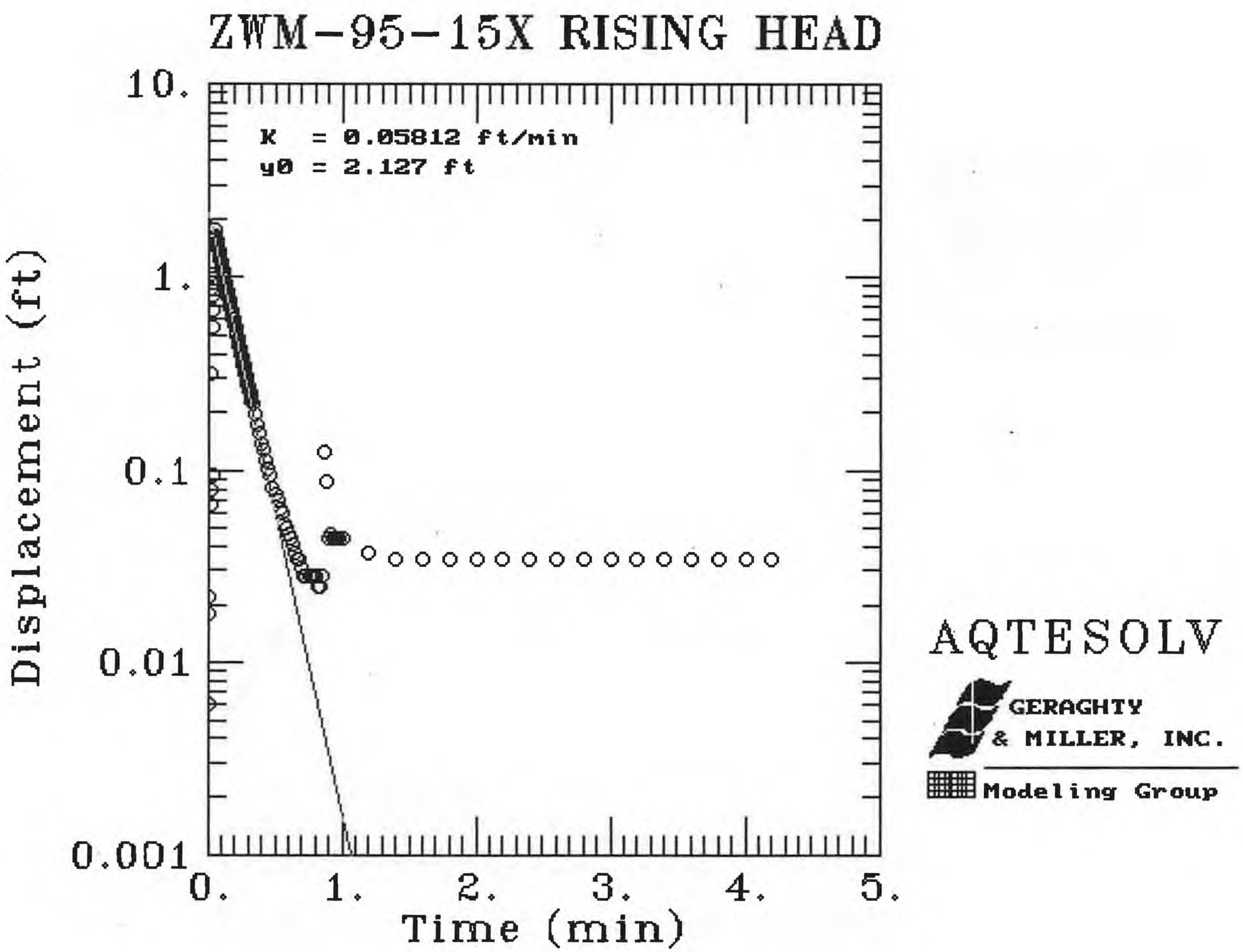
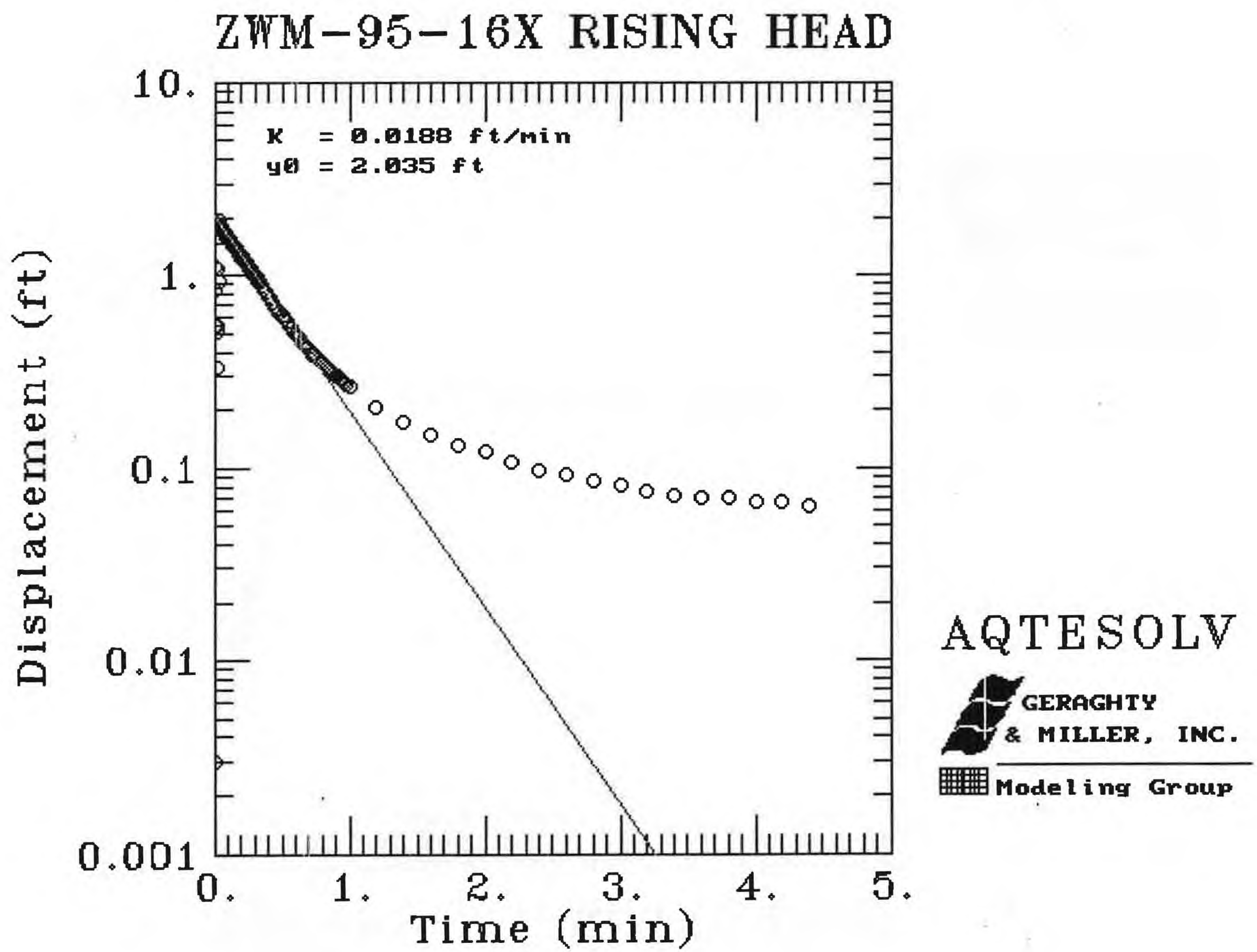
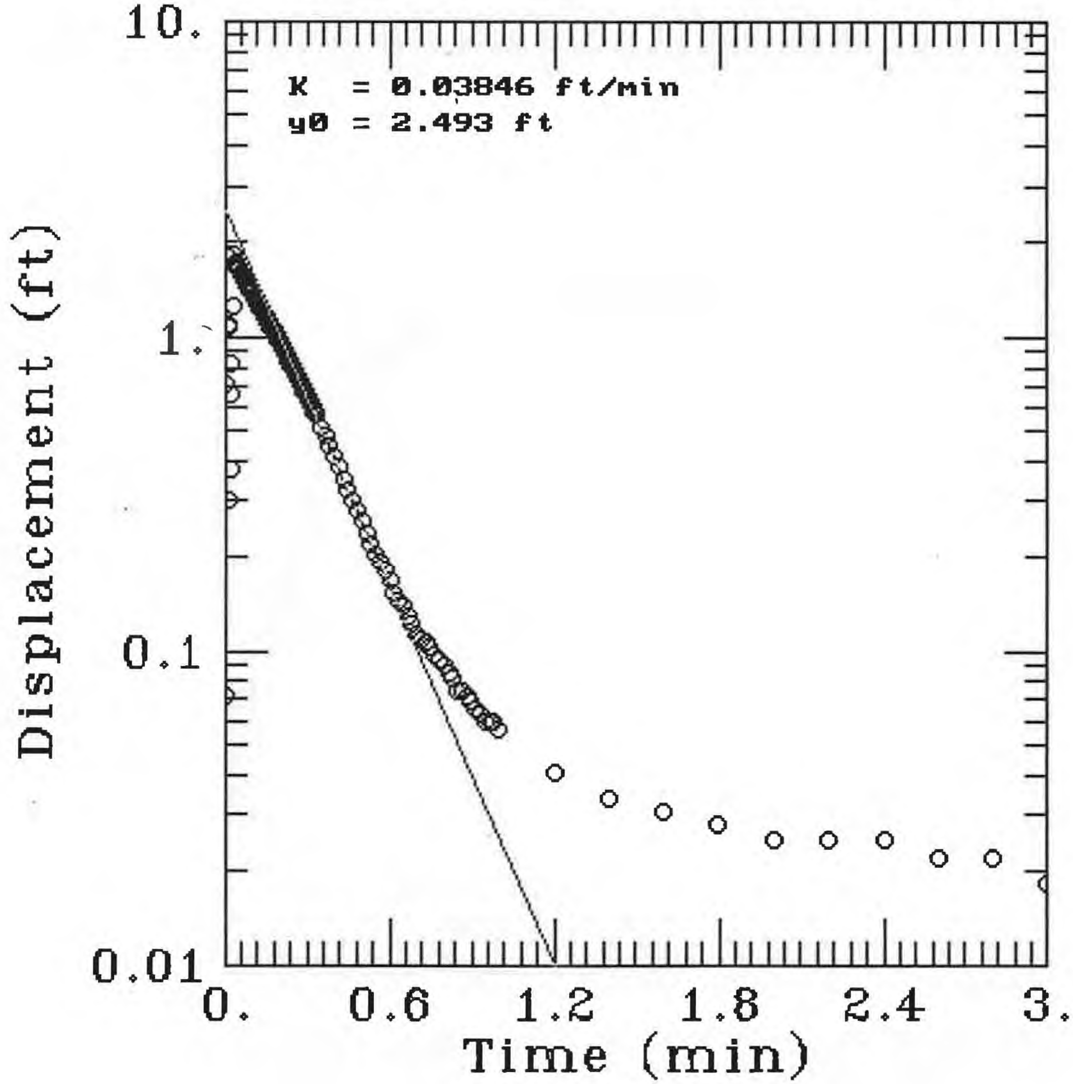


ZWM-95-15X RISING HEAD
K = 0.05812 ft/min
y0 = 2.127 ft
Displacement (ft)
10.
1.
0.1
0.01
0.001
0.
1.
2.
3.
4.
5.
Time (min)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group



ZWM-95-16X RISING HEAD
K = 0.0188 ft/min
y0 = 2.035 ft
Displacement (ft)
10.
1.
0.1
0.01
0.001
0.
1.
2.
3.
4.
5.
Time (min)
AQTESOLV
GERAGHTY
& MILLER, INC.
Modeling Group

ZWM-95-17X RISING HEAD



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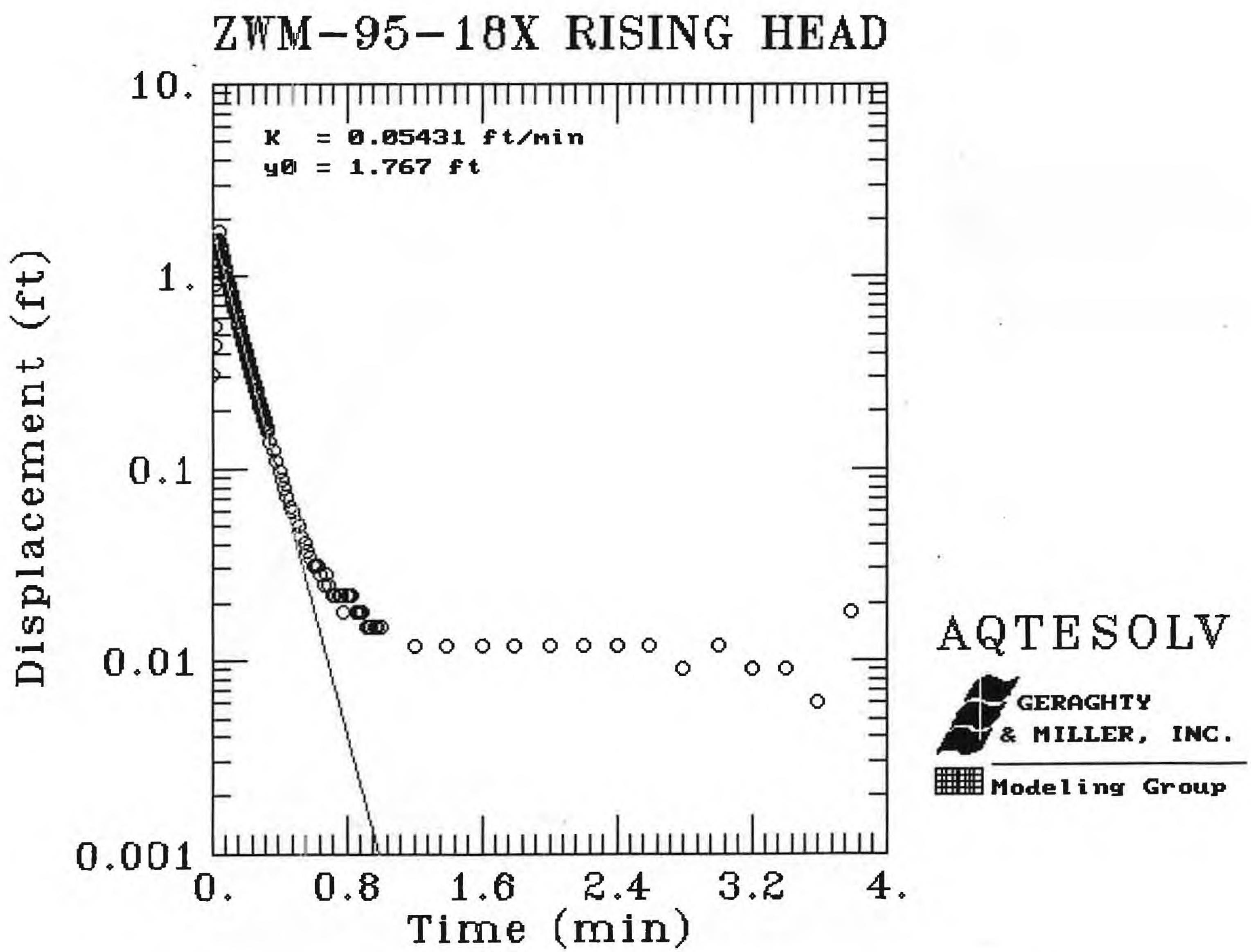
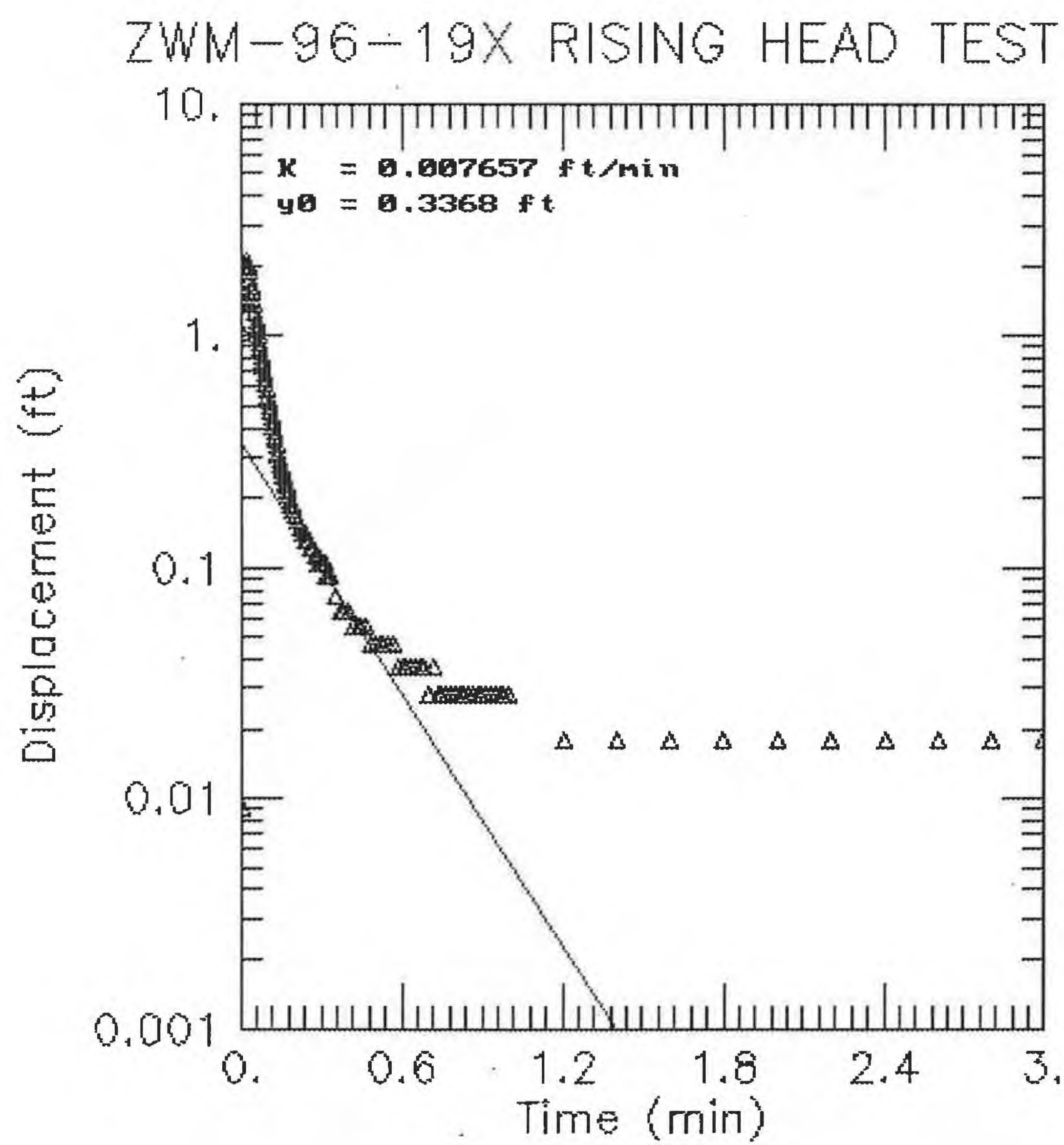
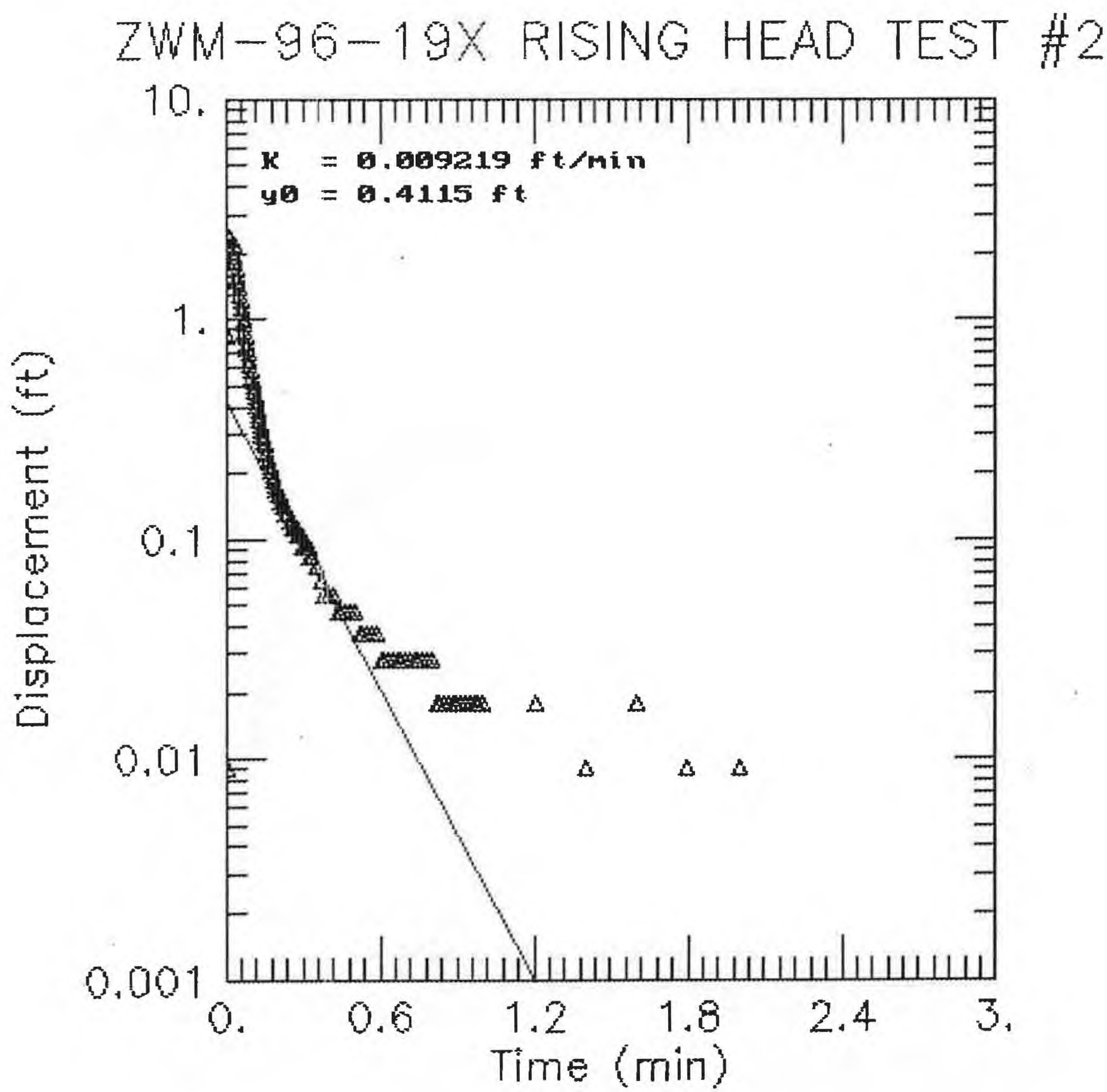
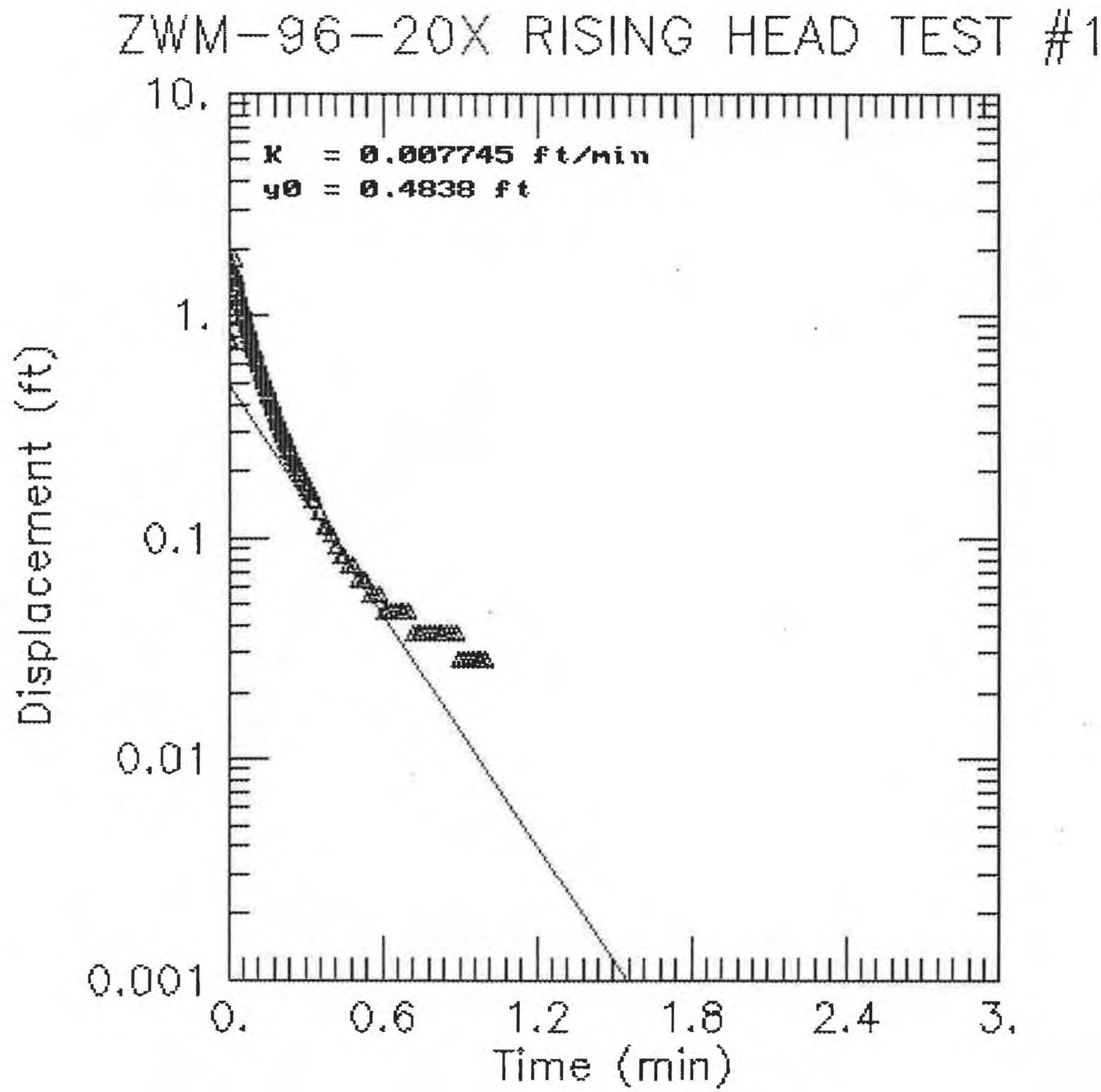
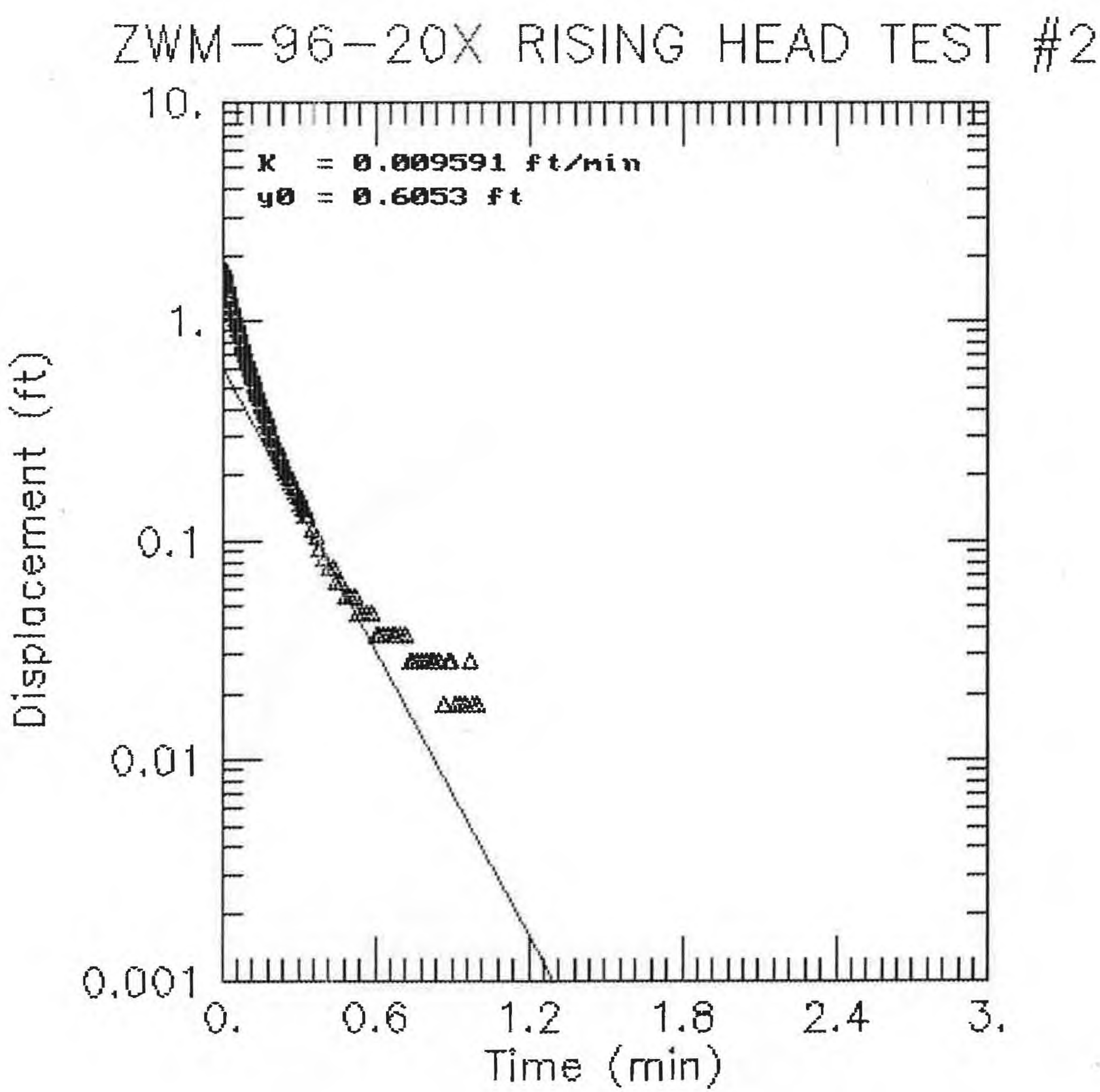
& MILLER, INC.
Modeling Group

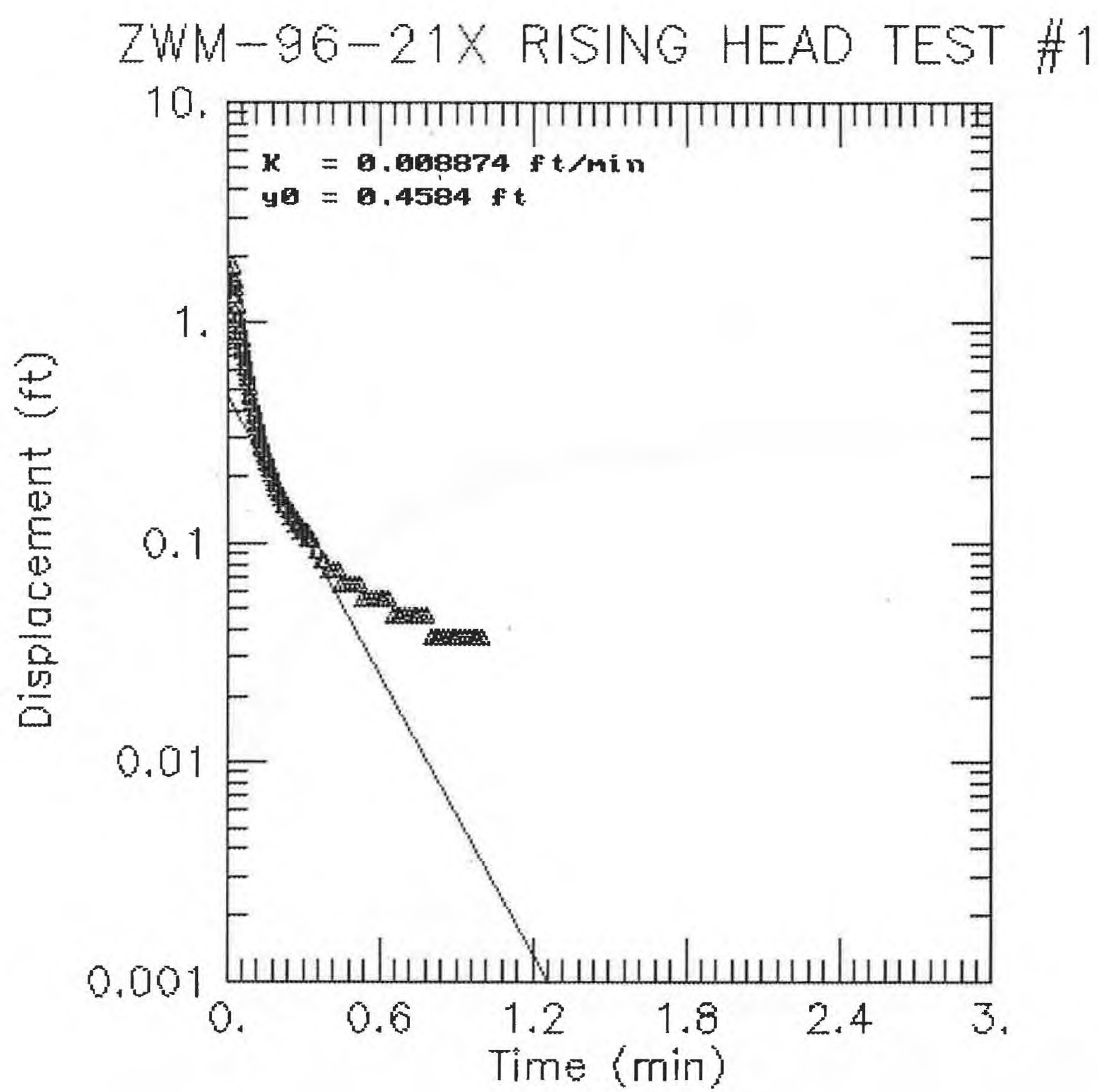

ZWM-95-18X RISING HEAD
K = 0.05431 ft/min
y0 = 1.767 ft
10.
1.
0.1
0.01
0.001
Displacement (ft)
0.
0.8
1.6
2.4
3.2
4.
Time (min)
AQTESOLV
GERAGHTY
& MILLER, INC.
Modeling Group


ZWM-96-19X RISING HEAD TEST #1
K = 0.007657 ft/min
y0 = 0.3368 ft
Displacement (ft)
10.
1.
0.1
0.01
0.001
0.
0.6
1.2
1.8
2.4
3.
Time (min)


ZWM-96-19X RISING HEAD TEST #2
K = 0.009219 ft/min
y0 = 0.4115 ft
Displacement (ft)
10.
1.
0.1
0.01
0.001
0.
0.6
1.2
1.8
2.4
3.
Time (min)

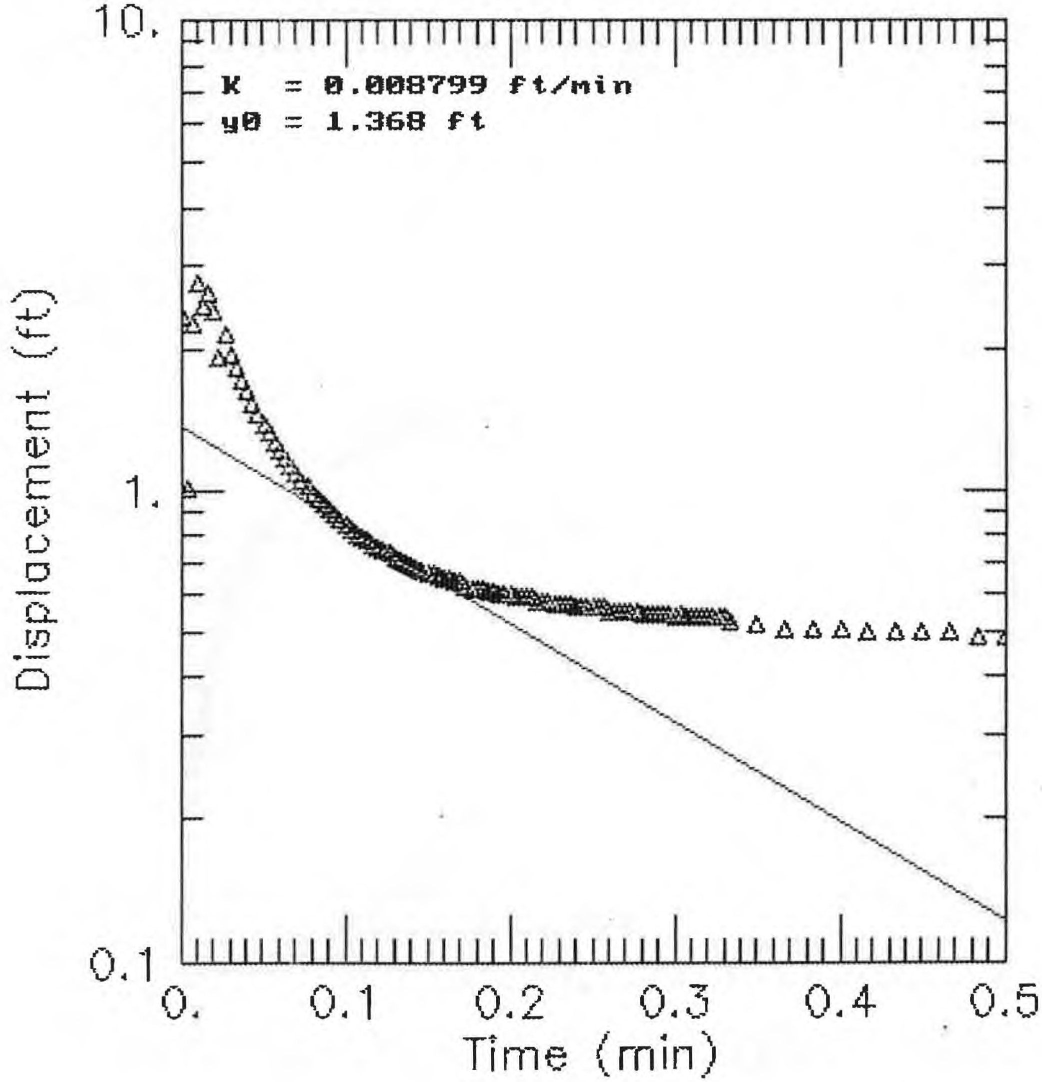

ZWM-96-20X RISING HEAD TEST #1
K = 0.007745 ft/min
y0 = 0.4838 ft
Displacement (ft)
10.
1.
0.1
0.01
0.001
0.
0.6
1.2
1.8
2.4
3.
Time (min)


ZWM-96-20X RISING HEAD TEST #2
K = 0.009591 ft/min
y0 = 0.6053 ft
10.
1.
0.1
0.01
0.001
Displacement (ft)
0.
0.6
1.2
1.8
2.4
3.
Time (min)



ZWM-96-21X RISING HEAD TEST #1
K = 0.008874 ft/min
y0 = 0.4584 ft
Displacement (ft)
10.
1.
0.1
0.01
0.001
0.
0.6
1.2
1.8
2.4
3.
Time (min)

ZWM-96-21X RISING HEAD TEST #2



CALCULATION OF HYDRAULIC CONDUCTIVITIES USING THE HVORSLEV EQUATION
AOC 69W

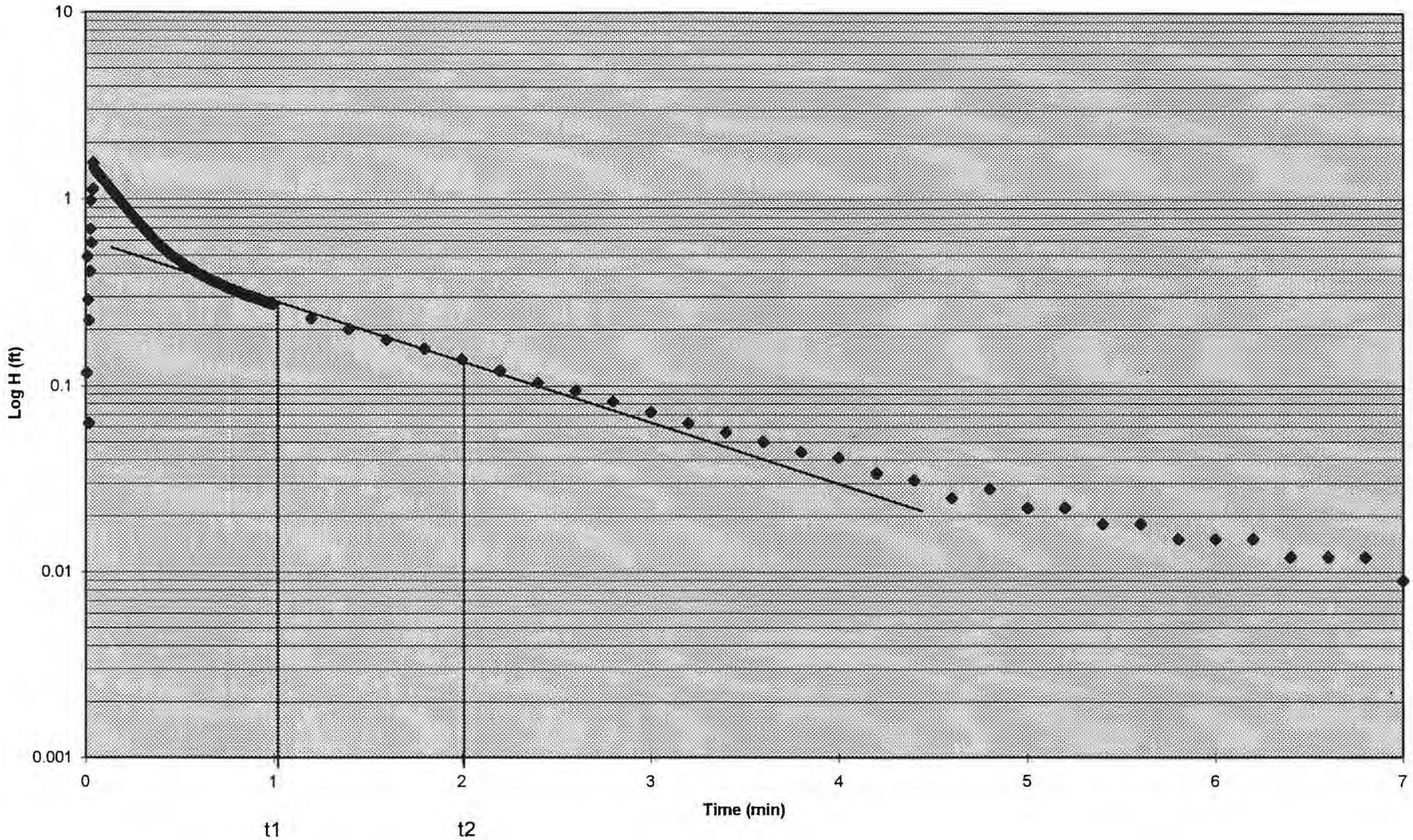
K = -[(LOG Ht1 - LOG Ht2)/(t1 - t2)]{[(r)^2 LOG (L/R)]/2L}

WHERE:
t1 = TIME 1 (MINUTES)
t2 = TIME 2 (MINUTES)
Ht1 = HEAD STRESS AT TIME 1 (FEET)
Ht2 = HEAD STRESS AT TIME 2 (FEET)
r = RADIUS OF WELL CASING (FEET)
R = RADUS OF BOREHOLE (FEET)
L = EFFECTIVE SATURATED LENGTH OF SCREEN (FEET)

											AVERAGE OF MULTIPLE TESTS	
WELL	t1	t2	Ht1	Ht2	r	R	L	TYPE	K (FT/MIN)	K (CM/SEC)	K (FT/MIN)	K (CM/SEC)
69W-94-09	1	2	0.275	0.139	0.08	0.30	8.35	RISING	1.8E-04	9.0E-05		
69W-94-10	0.1	0.15	1.251	0.701	0.08	0.30	8.58	RISING	3.0E-03	1.5E-03		
69W-94-11	0.1	0.5	1.429	0.36	0.17	0.42	7.91	RISING	3.5E-03	1.8E-03		
69W-94-12	0.1	0.6	1.994	0.316	0.17	0.42	10.26	RISING	3.1E-03	1.6E-03		
69W-94-13	0.1	0.4	1.317	0.173	0.17	0.17	10.27	RISING	7.4E-03	3.8E-03		
69W-94-14	0.1	0.4	0.796	0.037	0.08	0.30	8.12	RISING	2.7E-03	1.4E-03		
ZWM-95-15X	0.1	0.4	1.172	0.139	0.17	0.42	9.64	RISING	6.1E-03	3.1E-03		
ZWM-95-16X	0.1	0.4	1.564	0.783	0.17	0.42	9.76	RISING	2.0E-03	9.9E-04		
ZWM-95-17X	0.4	0.6	0.417	0.167	0.17	0.42	9.05	RISING	4.1E-03	2.1E-03		
ZWM-95-18X	0.3	0.5	0.195	0.053	0.17	0.42	12	RISING	4.8E-03	2.4E-03		
ZWM-96-19X[1]	0.2	0.5	0.169	0.046	0.08	0.17	8.8	RISING	1.3E-03	6.5E-04		
ZWM-96-19X[2]	0.2	0.4	0.169	0.056	0.08	0.17	8.8	RISING	1.6E-03	8.3E-04	1.5E-03	7.4E-04
ZWM-96-20X[1]	0.2	0.4	0.319	0.103	0.08	0.17	11.41	RISING	1.4E-03	7.0E-04		
ZWM-96-20X[2]	0.2	0.4	0.291	0.084	0.08	0.17	11.41	RISING	1.5E-03	7.7E-04	1.4E-03	7.3E-04
ZWM-96-21X[1]	0.16	0.2	0.225	0.168	0.08	0.17	8.24	RISING	2.3E-03	1.2E-03		
ZWM-96-21X[2]	0.16	0.2	0.647	0.6	0.08	0.17	8.24	RISING	5.8E-04	3.0E-04	1.4E-03	7.2E-04

NOTES:
1) Rising Head Test #1
2) Rising Head Test #2

69W-94-09 RISING HEAD



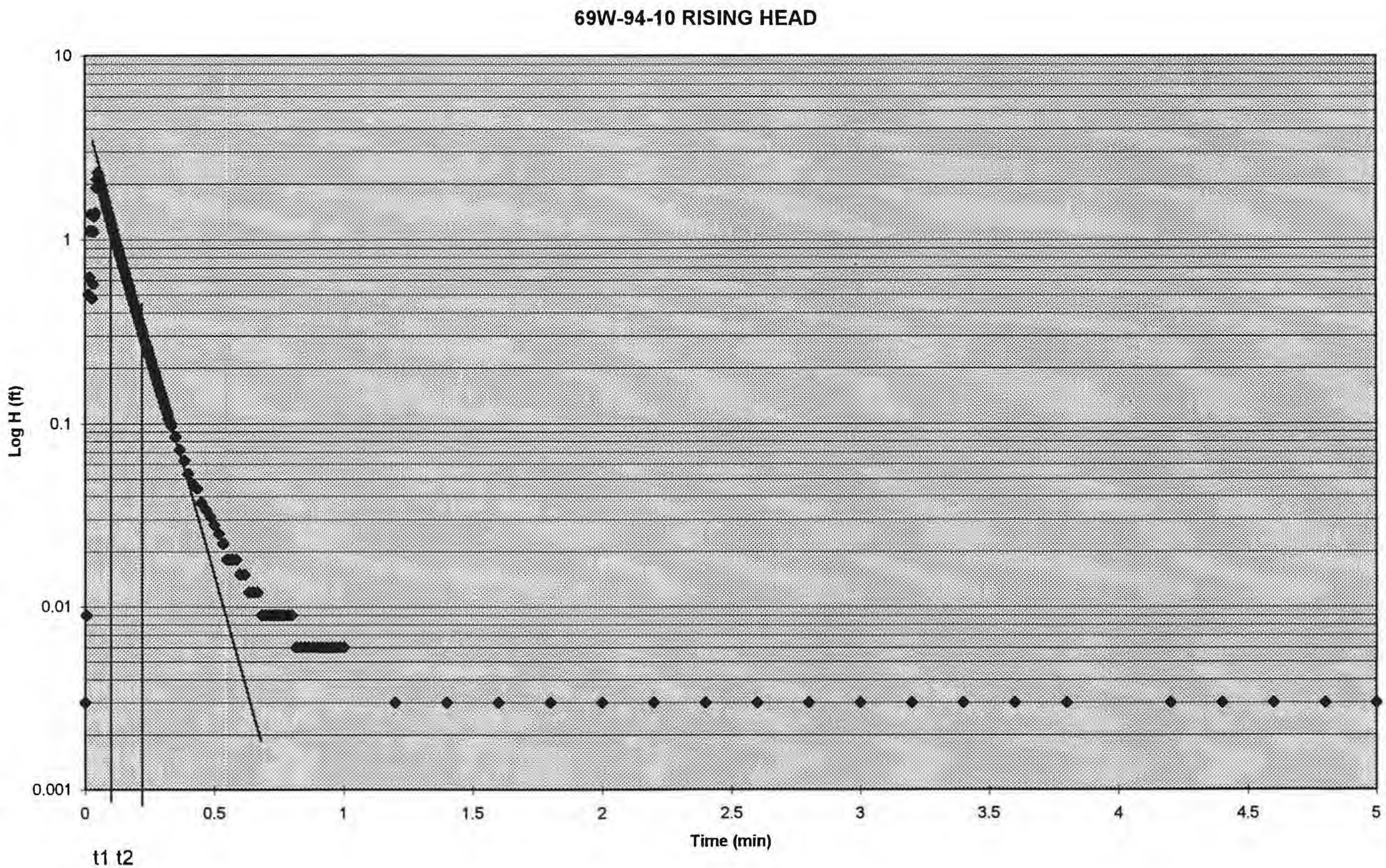
Well ID: 69W-94-09
Test Date: 11/20/95
Test Type: Rising Head
Well Diameter: 0.167 ft.
Boring Diameter: 0.667 ft.
Screened Interval (bgs): 3.5-13.5 ft.
Water Column Height: 6.85 ft.

Time (min)	delta H (ft.)
0.0066	0.117
0.01	0.493
0.0133	0.29
0.0166	0.063
0.02	0.224
0.0233	0.411
0.0266	0.692
0.03	0.986
0.0333	0.585
0.0366	1.122
0.04	1.125
0.0433	1.562
0.0466	1.467
0.05	1.442
0.0533	1.429
0.0566	1.413
0.06	1.397
0.0633	1.382
0.0666	1.372
0.07	1.353
0.0733	1.341
0.0766	1.328
0.08	1.315
0.0833	1.303
0.0866	1.29
0.09	1.28
0.0933	1.265
0.0966	1.255
0.1	1.246
0.1033	1.233
0.1066	1.22
0.11	1.224
0.1133	1.198
0.1166	1.189
0.12	1.176
0.1233	1.167
0.1266	1.154
0.13	1.144
0.1333	1.135
0.1366	1.122
0.14	1.113
0.1433	1.103
0.1466	1.091
0.15	1.081
0.1533	1.072
0.1566	1.062
0.16	1.053
0.1633	1.043
0.1666	1.034
0.17	1.024

Time (min)	delta H (ft.)
0.1733	1.015
0.1766	1.005
0.18	0.996
0.1833	0.986
0.1866	0.977
0.19	0.967
0.1933	0.958
0.1966	0.948
0.2	0.939
0.2033	0.933
0.2066	0.923
0.21	0.914
0.2133	0.907
0.2166	0.898
0.22	0.888
0.2233	0.882
0.2266	0.872
0.23	0.866
0.2333	0.857
0.2366	0.85
0.24	0.841
0.2433	0.834
0.2466	0.825
0.25	0.819
0.2533	0.812
0.2566	0.803
0.26	0.797
0.2633	0.79
0.2666	0.784
0.27	0.774
0.2733	0.768
0.2766	0.762
0.28	0.755
0.2833	0.749
0.2866	0.743
0.29	0.736
0.2933	0.73
0.2966	0.724
0.3	0.717
0.3033	0.711
0.3066	0.705
0.31	0.698
0.3133	0.692
0.3166	0.689
0.32	0.683
0.3233	0.676
0.3266	0.67
0.33	0.667
0.3333	0.661
0.35	0.632

Time (min)	delta H (ft.)					
0.3666	0.607					
0.3833	0.585					
0.4	0.562					
0.4166	0.544					
0.4333	0.525					
0.45	0.509					
0.4666	0.493					
0.4833	0.48					
0.5	0.468					
0.5166	0.455					
0.5333	0.442					
0.55	0.43					
0.5666	0.42					
0.5833	0.411					
0.6	0.401					
0.6166	0.392					
0.6333	0.385					
0.65	0.376					
0.6666	0.37					
0.6833	0.363					
0.7	0.357					
0.7166	0.351					
0.7333	0.344					
0.75	0.338					
0.7666	0.332					
0.7833	0.328					
0.8	0.322					
0.8166	0.319					
0.8333	0.313					
0.85	0.309					
0.8666	0.303					
0.8833	0.3					
0.9	0.297					
0.9166	0.294					
0.9333	0.29					
0.95	0.284					
0.9666	0.281					
0.9833	0.278					
1	0.275					
1.2	0.23					
1.4	0.202					
1.6	0.177					
1.8	0.158					
2	0.139					
2.2	0.12					
2.4	0.104					
2.6	0.094					
2.8	0.082					
3	0.072					
3.2	0.063					

Time (min)	delta H (ft.)					
3.4	0.056					
3.6	0.05					
3.8	0.044					
4	0.041					
4.2	0.034					
4.4	0.031					
4.6	0.025					
4.8	0.028					
5	0.022					
5.2	0.022					
5.4	0.018					
5.6	0.018					
5.8	0.015					
6	0.015					
6.2	0.015					
6.4	0.012					
6.6	0.012					
6.8	0.012					
7	0.009					


69W-94-10 RISING HEAD
10
1
0.1
0.01
0.001
Log H (ft)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time (min)
t1 t2

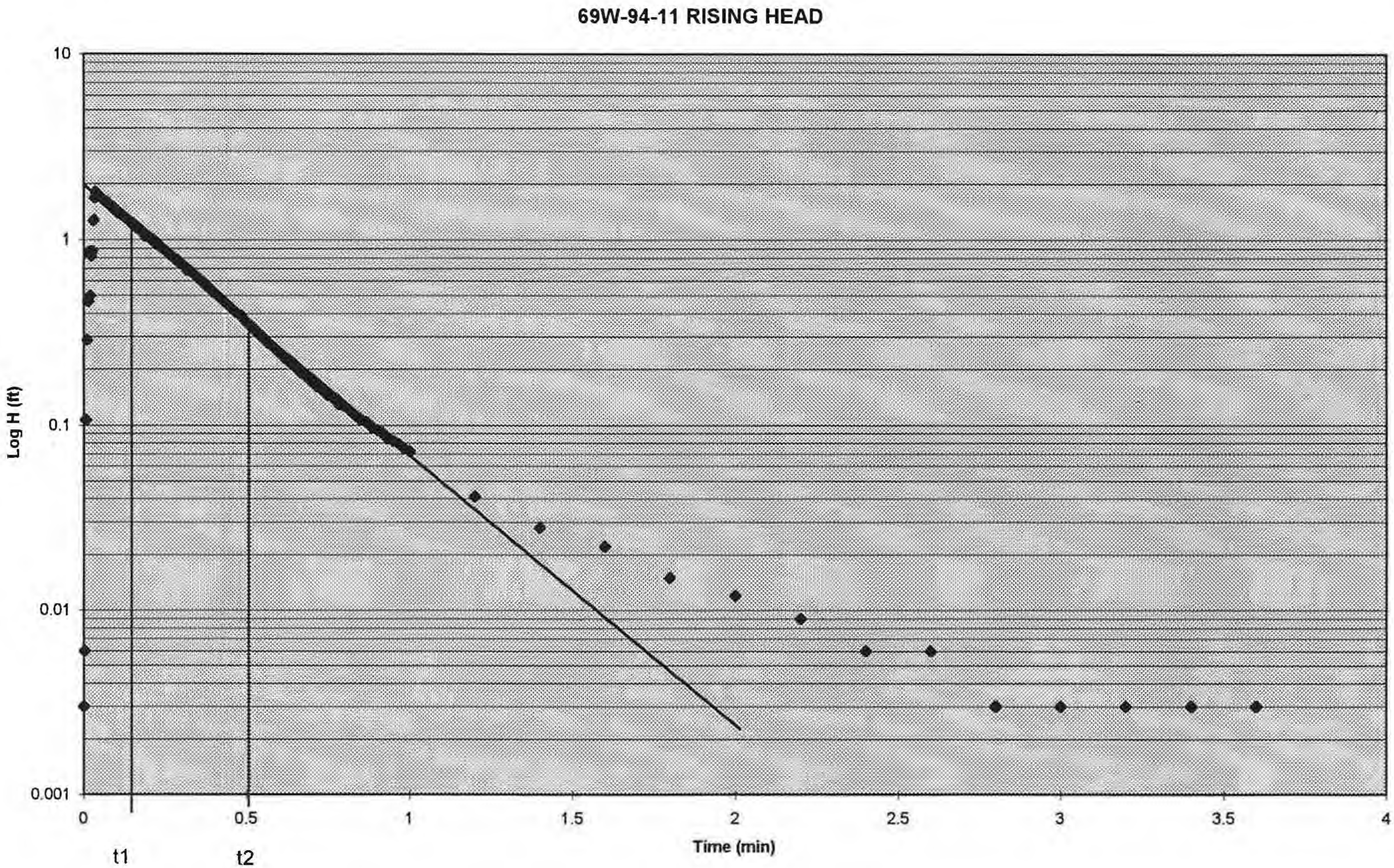
Well ID: 69W-94-10
Test Date: 11/20/95
Test Type: Rising Head
Well Diameter: 0.167 ft.
Boring Diameter: 0.667 ft.
Screened Interval (bgs): 4.5-14.5 ft.
Water Column Height: 8.08 ft.

Time (min)	delta H (ft.)
0	0.003
0.0033	0.009
0.0066	0.009
0.0133	0.505
0.0166	0.625
0.02	1.112
0.0233	1.371
0.0266	0.48
0.03	0.575
0.0333	1.106
0.0366	1.333
0.04	1.39
0.0433	1.899
0.0466	2.111
0.05	2.313
0.0533	2.218
0.0566	2.139
0.06	2.035
0.0633	1.949
0.0666	1.867
0.07	1.795
0.0733	1.719
0.0766	1.649
0.08	1.592
0.0833	1.51
0.0866	1.463
0.09	1.399
0.0933	1.355
0.0966	1.295
0.1	1.251
0.1033	1.2
0.1066	1.156
0.11	1.112
0.1133	1.068
0.1166	1.02
0.12	0.989
0.1233	0.954
0.1266	0.916
0.13	0.881
0.1333	0.846
0.1366	0.818
0.14	0.783
0.1433	0.758
0.1466	0.726
0.15	0.701
0.1533	0.676
0.1566	0.651
0.16	0.625
0.1633	0.6
0.1666	0.578

Time (min)	delta H (ft.)					
0.17	0.559					
0.1733	0.54					
0.1766	0.518					
0.18	0.499					
0.1833	0.483					
0.1866	0.464					
0.19	0.448					
0.1933	0.432					
0.1966	0.413					
0.2	0.401					
0.2033	0.388					
0.2066	0.372					
0.21	0.36					
0.2133	0.347					
0.2166	0.334					
0.22	0.325					
0.2233	0.312					
0.2266	0.3					
0.23	0.284					
0.2333	0.281					
0.2366	0.271					
0.24	0.262					
0.2433	0.252					
0.2466	0.243					
0.25	0.233					
0.2533	0.227					
0.2566	0.218					
0.26	0.211					
0.2633	0.202					
0.2666	0.195					
0.27	0.189					
0.2733	0.183					
0.2766	0.176					
0.28	0.17					
0.2833	0.164					
0.2866	0.158					
0.29	0.151					
0.2933	0.148					
0.2966	0.142					
0.3	0.139					
0.3033	0.132					
0.3066	0.129					
0.31	0.123					
0.3133	0.12					
0.3166	0.116					
0.32	0.113					
0.3233	0.107					
0.3266	0.104					
0.33	0.101					
0.3333	0.097					

Time (min)	delta H (ft.)					
0.35	0.085					
0.3666	0.072					
0.3833	0.063					
0.4	0.053					
0.4166	0.047					
0.4333	0.044					
0.45	0.037					
0.4666	0.034					
0.4833	0.031					
0.5	0.028					
0.5166	0.025					
0.5333	0.022					
0.55	0.018					
0.5666	0.018					
0.5833	0.018					
0.6	0.015					
0.6166	0.015					
0.6333	0.012					
0.65	0.012					
0.6666	0.012					
0.6833	0.009					
0.7	0.009					
0.7166	0.009					
0.7333	0.009					
0.75	0.009					
0.7666	0.009					
0.7833	0.009					
0.8	0.009					
0.8166	0.006					
0.8333	0.006					
0.85	0.006					
0.8666	0.006					
0.8833	0.006					
0.9	0.006					
0.9166	0.006					
0.9333	0.006					
0.95	0.006					
0.9666	0.006					
0.9833	0.006					
1	0.006					
1.2	0.003					
1.4	0.003					
1.6	0.003					
1.8	0.003					
2	0.003					
2.2	0.003					
2.4	0.003					
2.6	0.003					
2.8	0.003					
3	0.003					

Time (min)	delta H (ft.)					
3.2	0.003					
3.4	0.003					
3.6	0.003					
3.8	0.003					
4.2	0.003					
4.4	0.003					
4.6	0.003					
4.8	0.003					
5	0.003					


69W-94-11 RISING HEAD
10
1
0.1
0.01
0.001
Log H (ft)
0
0.5
1
1.5
2
2.5
3
3.5
4
Time (min)
t1
t2

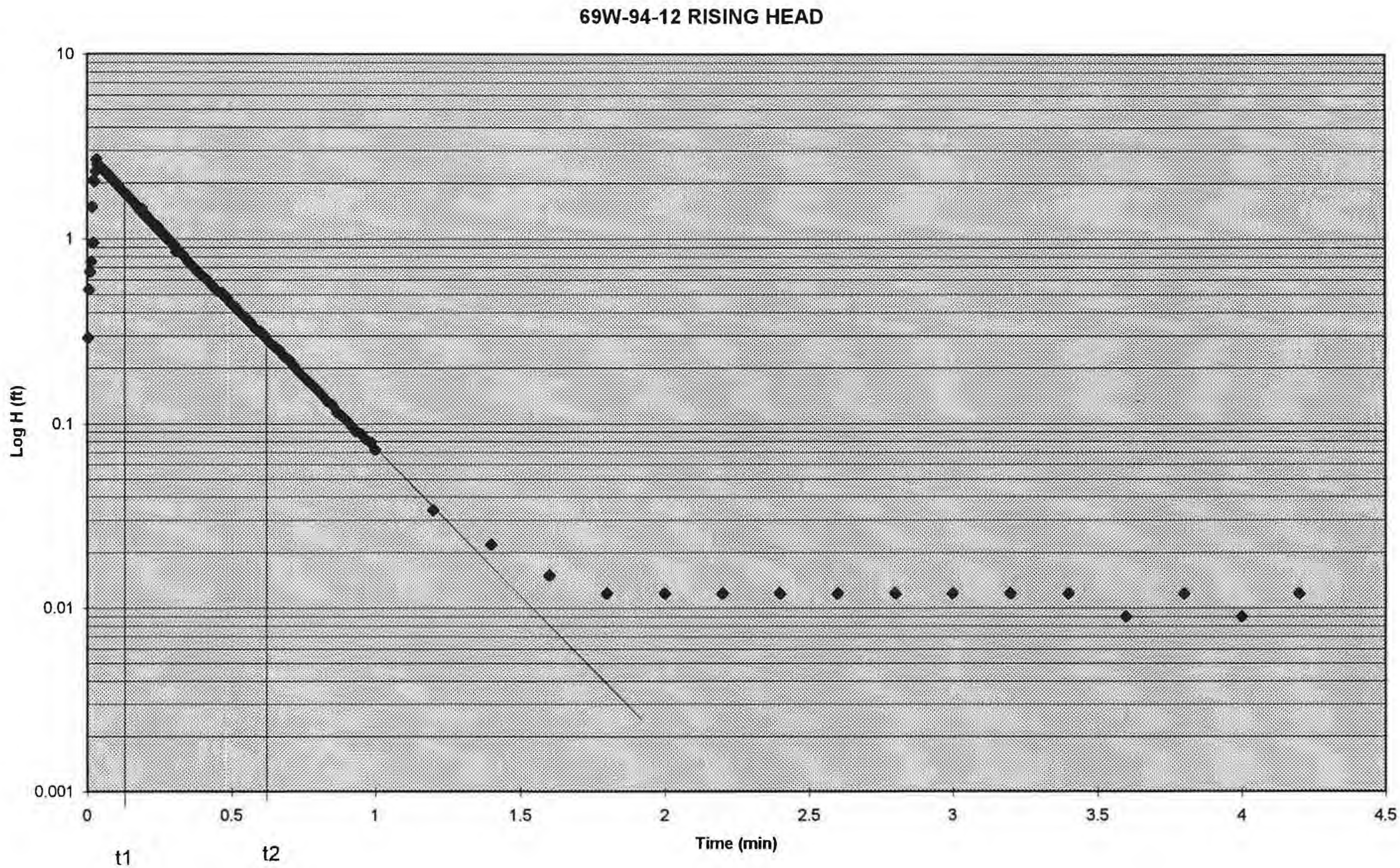
Time (min)	delta H (ft.)
0	0.003
0.0033	0.006
0.0066	0.107
0.01	0.287
0.0133	0.464
0.0166	0.86
0.02	0.499
0.0233	0.819
0.0266	0.869
0.03	1.268
0.0333	1.682
0.0366	1.799
0.04	1.761
0.0433	1.745
0.0466	1.723
0.05	1.698
0.0533	1.682
0.0566	1.663
0.06	1.644
0.0633	1.622
0.0666	1.606
0.07	1.594
0.0733	1.571
0.0766	1.556
0.08	1.53
0.0833	1.515
0.0866	1.496
0.09	1.489
0.0933	1.458
0.0966	1.445
0.1	1.429
0.1033	1.413
0.1066	1.397
0.11	1.388
0.1133	1.375
0.1166	1.366
0.12	1.341
0.1233	1.334
0.1266	1.315
0.13	1.306
0.1333	1.29
0.1366	1.274
0.14	1.261
0.1433	1.246
0.1466	1.233
0.15	1.22
0.1533	1.208
0.1566	1.195
0.16	1.179
0.1633	1.17

Well ID: 69W-94-11
Test Date: 11/20/95
Test Type: Rising Head
Well Diameter: 0.333 ft.
Boring Diameter: 0.833 ft.
Screened Interval (bgs): 4.5-14.5 ft.
Water Column Height: 7.41 ft.

Time (min)	delta H (ft.)					
0.1666	1.157					
0.17	1.144					
0.1733	1.132					
0.1766	1.119					
0.18	1.097					
0.1833	1.097					
0.1866	1.084					
0.19	1.043					
0.1933	1.062					
0.1966	1.046					
0.2	1.04					
0.2033	1.024					
0.2066	1.015					
0.21	0.993					
0.2133	0.996					
0.2166	0.977					
0.22	0.974					
0.2233	0.961					
0.2266	0.948					
0.23	0.939					
0.2333	0.929					
0.2366	0.92					
0.24	0.91					
0.2433	0.901					
0.2466	0.891					
0.25	0.879					
0.2533	0.869					
0.2566	0.86					
0.26	0.85					
0.2633	0.841					
0.2666	0.831					
0.27	0.819					
0.2733	0.816					
0.2766	0.806					
0.28	0.793					
0.2833	0.787					
0.2866	0.778					
0.29	0.771					
0.2933	0.762					
0.2966	0.752					
0.3	0.746					
0.3033	0.736					
0.3066	0.727					
0.31	0.721					
0.3133	0.714					
0.3166	0.705					
0.32	0.686					
0.3233	0.689					
0.3266	0.683					
0.33	0.676					

Time (min)	delta H (ft.)					
0.3333	0.667					
0.35	0.629					
0.3666	0.591					
0.3833	0.556					
0.4	0.521					
0.4166	0.493					
0.4333	0.461					
0.45	0.433					
0.4666	0.408					
0.4833	0.389					
0.5	0.36					
0.5166	0.338					
0.5333	0.316					
0.55	0.297					
0.5666	0.278					
0.5833	0.262					
0.6	0.246					
0.6166	0.23					
0.6333	0.218					
0.65	0.205					
0.6666	0.192					
0.6833	0.183					
0.7	0.17					
0.7166	0.161					
0.7333	0.154					
0.75	0.145					
0.7666	0.139					
0.7833	0.129					
0.8	0.126					
0.8166	0.12					
0.8333	0.113					
0.85	0.107					
0.8666	0.104					
0.8833	0.098					
0.9	0.094					
0.9166	0.091					
0.9333	0.085					
0.95	0.082					
0.9666	0.079					
0.9833	0.075					
1	0.072					
1.2	0.041					
1.4	0.028					
1.6	0.022					
1.8	0.015					
2	0.012					
2.2	0.009					
2.4	0.006					
2.6	0.006					
2.8	0.003					

Time (min)	delta H (ft.)					
3	0.003					
3.2	0.003					
3.4	0.003					
3.6	0.003					


69W-94-12 RISING HEAD
Log H (ft)
10
1
0.1
0.01
0.001
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Time (min)
t1
t2

Time (min)	delta H (ft.)
0.0033	0.293
0.0066	0.534
0.01	0.663
0.0133	0.752
0.0166	1.488
0.02	0.951
0.0233	2.06
0.0266	2.041
0.03	2.306
0.0333	2.689
0.0366	2.521
0.04	2.512
0.0433	2.477
0.0466	2.446
0.05	2.411
0.0533	2.386
0.0566	2.354
0.06	2.322
0.0633	2.291
0.0666	2.262
0.07	2.237
0.0733	2.212
0.0766	2.177
0.08	2.148
0.0833	2.142
0.0866	2.098
0.09	2.069
0.0933	2.047
0.0966	2.019
0.1	1.994
0.1033	1.971
0.1066	1.946
0.11	1.921
0.1133	1.896
0.1166	1.874
0.12	1.848
0.1233	1.823
0.1266	1.801
0.13	1.779
0.1333	1.757
0.1366	1.719
0.14	1.728
0.1433	1.681
0.1466	1.674
0.15	1.643
0.1533	1.627
0.1566	1.602
0.16	1.586
0.1633	1.564
0.1666	1.542

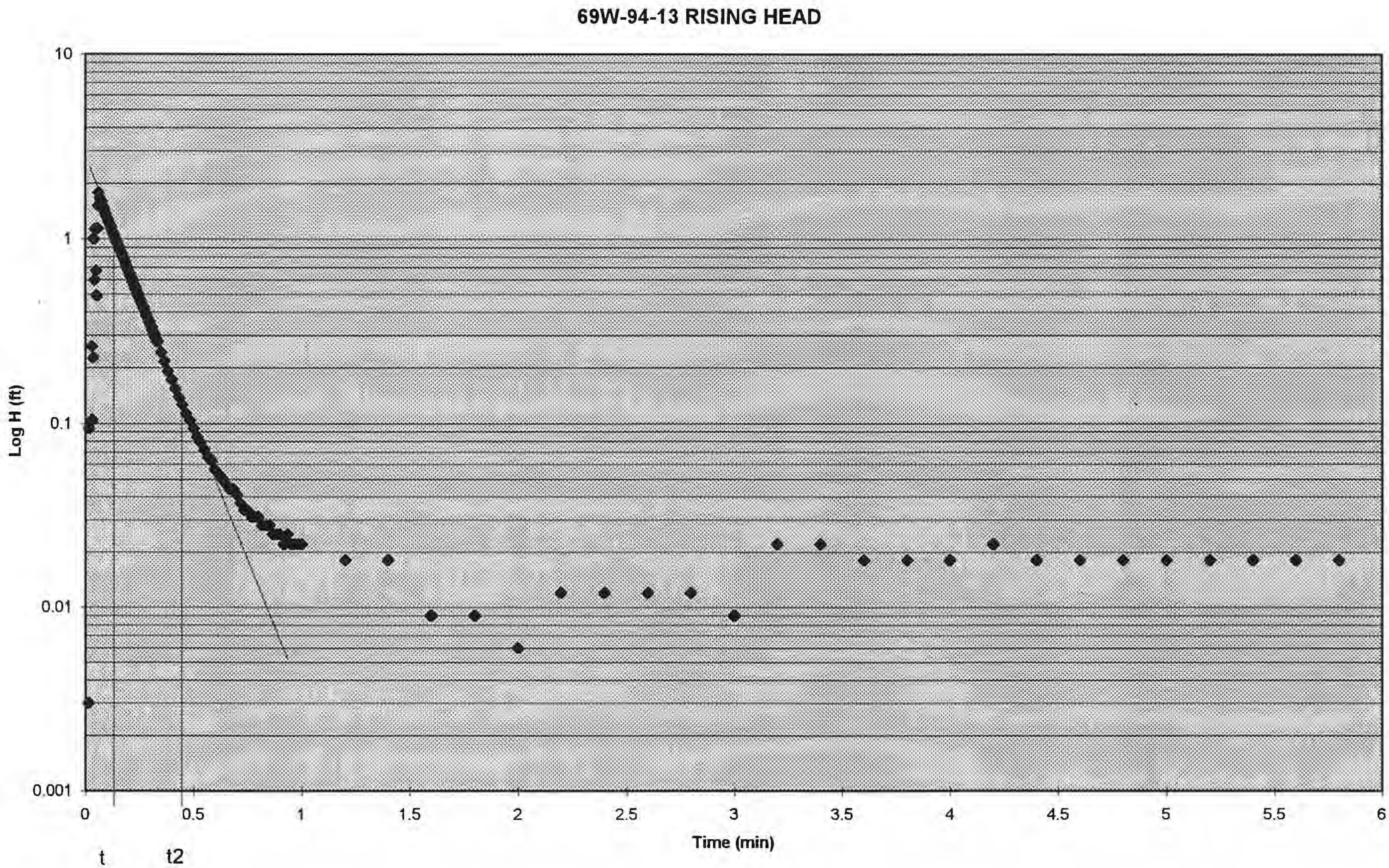
Well ID: 69W-94-12
Test Date: 11/20/95
Test Type: Rising Head
Well Diameter: 0.167 ft.
Boring Diameter: 0.667 ft.
Screened Interval (bgs): 3-13 ft.
Water Column Height: 8.26 ft.

Time (min)	delta H (ft.)					
0.17	1.523					
0.1733	1.504					
0.1766	1.475					
0.18	1.478					
0.1833	1.431					
0.1866	1.434					
0.19	1.45					
0.1933	1.377					
0.1966	1.365					
0.2	1.336					
0.2033	1.343					
0.2066	1.317					
0.21	1.311					
0.2133	1.283					
0.2166	1.264					
0.22	1.248					
0.2233	1.235					
0.2266	1.216					
0.23	1.204					
0.2333	1.185					
0.2366	1.166					
0.24	1.159					
0.2433	1.143					
0.2466	1.159					
0.25	1.106					
0.2533	1.109					
0.2566	1.083					
0.26	1.074					
0.2633	1.058					
0.2666	1.052					
0.27	1.036					
0.2733	1.02					
0.2766	1.011					
0.28	0.998					
0.2833	0.985					
0.2866	0.976					
0.29	0.96					
0.2933	0.948					
0.2966	0.938					
0.3	0.929					
0.3033	0.919					
0.3066	0.894					
0.31	0.856					
0.3133	0.875					
0.3166	0.869					
0.32	0.856					
0.3233	0.846					
0.3266	0.837					
0.33	0.824					
0.3333	0.815					

Time (min)	delta H (ft.)					
0.35	0.758					
0.3666	0.711					
0.3833	0.663					
0.4	0.632					
0.4166	0.6					
0.4333	0.562					
0.45	0.527					
0.4666	0.511					
0.4833	0.48					
0.5	0.448					
0.5166	0.423					
0.5333	0.398					
0.55	0.376					
0.5666	0.353					
0.5833	0.331					
0.6	0.316					
0.6166	0.297					
0.6333	0.278					
0.65	0.262					
0.6666	0.249					
0.6833	0.233					
0.7	0.221					
0.7166	0.205					
0.7333	0.192					
0.75	0.18					
0.7666	0.17					
0.7833	0.161					
0.8	0.151					
0.8166	0.142					
0.8333	0.132					
0.85	0.126					
0.8666	0.116					
0.8833	0.11					
0.9	0.104					
0.9166	0.097					
0.9333	0.091					
0.95	0.088					
0.9666	0.082					
0.9833	0.079					
1	0.072					
1.2	0.034					
1.4	0.022					
1.6	0.015					
1.8	0.012					
2	0.012					
2.2	0.012					
2.4	0.012					
2.6	0.012					
2.8	0.012					
3	0.012					

69W-94-12 RH

Time (min)	delta H (ft.)					
3.2	0.012					
3.4	0.012					
3.6	0.009					
3.8	0.012					
4	0.009					
4.2	0.012					


69W-94-13 RISING HEAD
Log H (ft)
10
1
0.1
0.01
0.001
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
Time (min)
t
t2

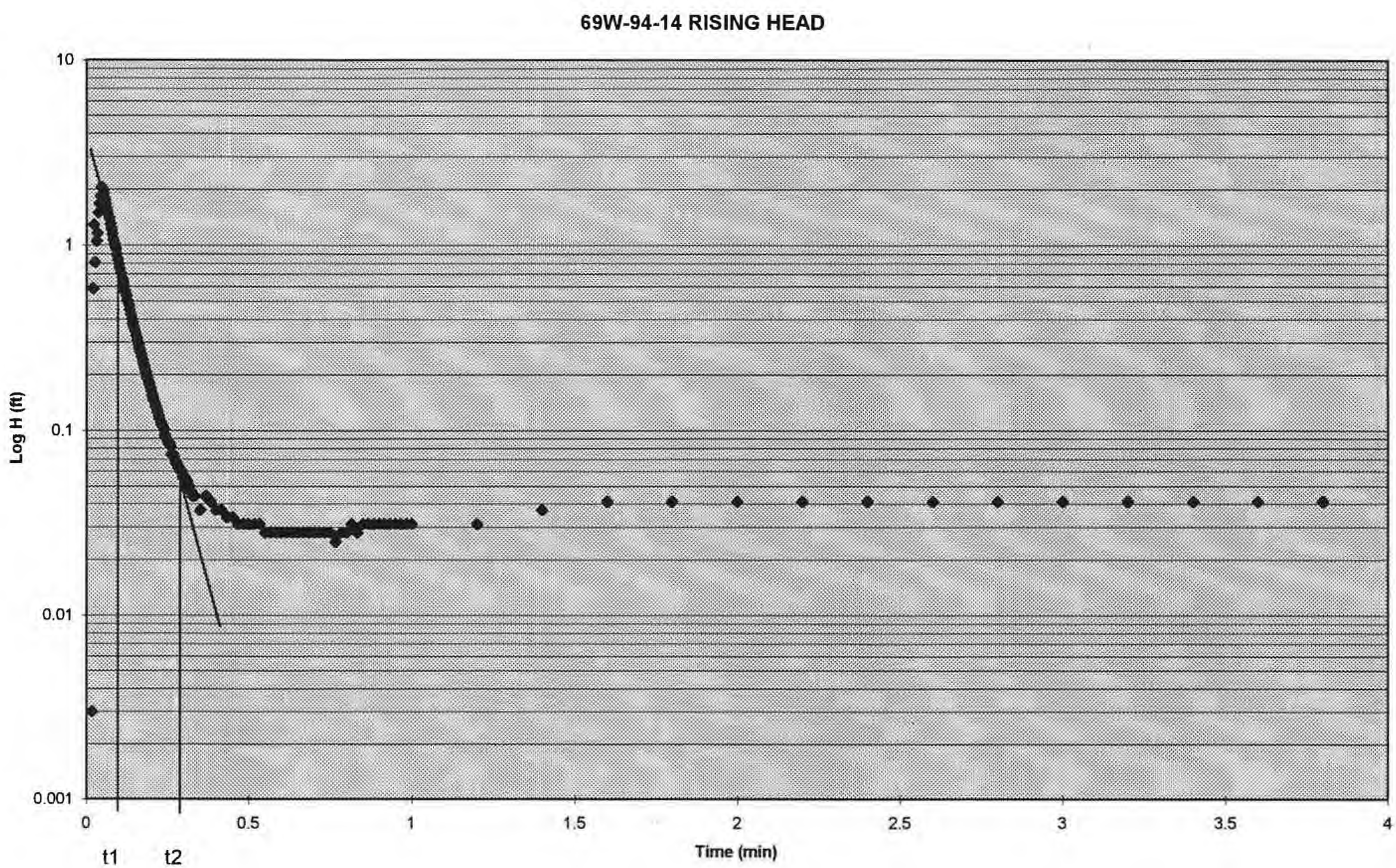
Time (min)	delta H (ft.)
0.0133	0.003
0.0166	0.094
0.03	0.262
0.0333	0.104
0.0366	0.227
0.04	1.004
0.0433	0.6
0.0466	1.128
0.05	0.673
0.0533	0.493
0.0566	1.14
0.06	1.516
0.0633	1.779
0.0666	1.671
0.07	1.633
0.0733	1.595
0.0766	1.551
0.08	1.51
0.0833	1.478
0.0866	1.447
0.09	1.409
0.0933	1.374
0.0966	1.343
0.1	1.317
0.1033	1.283
0.1066	1.251
0.11	1.223
0.1133	1.197
0.1166	1.169
0.12	1.147
0.1233	1.118
0.1266	1.093
0.13	1.071
0.1333	1.049
0.1366	1.027
0.14	1.001
0.1433	0.979
0.1466	0.957
0.15	0.938
0.1533	0.916
0.1566	0.897
0.16	0.878
0.1633	0.862
0.1666	0.843
0.17	0.824
0.1733	0.805
0.1766	0.79
0.18	0.771
0.1833	0.755
0.1866	0.736

Well ID: 69W-94-13
Test Date: 11/20/95
Test Type: Rising Head
Well Diameter: 0.333 ft.
Boring Diameter: 0.833 ft.
Screened Interval (bgs): 3-13 ft.
Water Column Height: 9.27 ft.

Time (min)	delta H (ft.)					
0.19	0.72					
0.1933	0.704					
0.1966	0.688					
0.2	0.673					
0.2033	0.657					
0.2066	0.644					
0.21	0.628					
0.2133	0.616					
0.2166	0.6					
0.22	0.587					
0.2233	0.575					
0.2266	0.562					
0.23	0.549					
0.2333	0.537					
0.2366	0.527					
0.24	0.515					
0.2433	0.502					
0.2466	0.493					
0.25	0.48					
0.2533	0.47					
0.2566	0.461					
0.26	0.448					
0.2633	0.439					
0.2666	0.429					
0.27	0.42					
0.2733	0.414					
0.2766	0.404					
0.28	0.395					
0.2833	0.385					
0.2866	0.376					
0.29	0.369					
0.2933	0.36					
0.2966	0.353					
0.3	0.344					
0.3033	0.338					
0.3066	0.331					
0.31	0.322					
0.3133	0.316					
0.3166	0.309					
0.32	0.303					
0.3233	0.293					
0.3266	0.29					
0.33	0.281					
0.3333	0.278					
0.35	0.243					
0.3666	0.218					
0.3833	0.192					
0.4	0.173					
0.4166	0.154					
0.4333	0.139					

Time (min)	delta H (ft.)					
0.45	0.126					
0.4666	0.113					
0.4833	0.104					
0.5	0.094					
0.5166	0.085					
0.5333	0.079					
0.55	0.072					
0.5666	0.066					
0.5833	0.063					
0.6	0.056					
0.6166	0.053					
0.6333	0.05					
0.65	0.047					
0.6666	0.044					
0.6833	0.044					
0.7	0.041					
0.7166	0.037					
0.7333	0.034					
0.75	0.034					
0.7666	0.031					
0.7833	0.031					
0.8	0.031					
0.8166	0.028					
0.8333	0.028					
0.85	0.028					
0.8666	0.025					
0.8833	0.025					
0.9	0.025					
0.9166	0.022					
0.9333	0.025					
0.95	0.022					
0.9666	0.022					
0.9833	0.022					
1	0.022					
1.2	0.018					
1.4	0.018					
1.6	0.009					
1.8	0.009					
2	0.006					
2.2	0.012					
2.4	0.012					
2.6	0.012					
2.8	0.012					
3	0.009					
3.2	0.022					
3.4	0.022					
3.6	0.018					
3.8	0.018					
4	0.018					
4.2	0.022					

Time (min)	delta H (ft.)					
4.4	0.018					
4.6	0.018					
4.8	0.018					
5	0.018					
5.2	0.018					
5.4	0.018					
5.6	0.018					
5.8	0.018					


69W-94-14 RISING HEAD
Log H (ft)
10
1
0.1
0.01
0.001
0
0.5
1
1.5
2
2.5
3
3.5
4
Time (min)
t1
t2

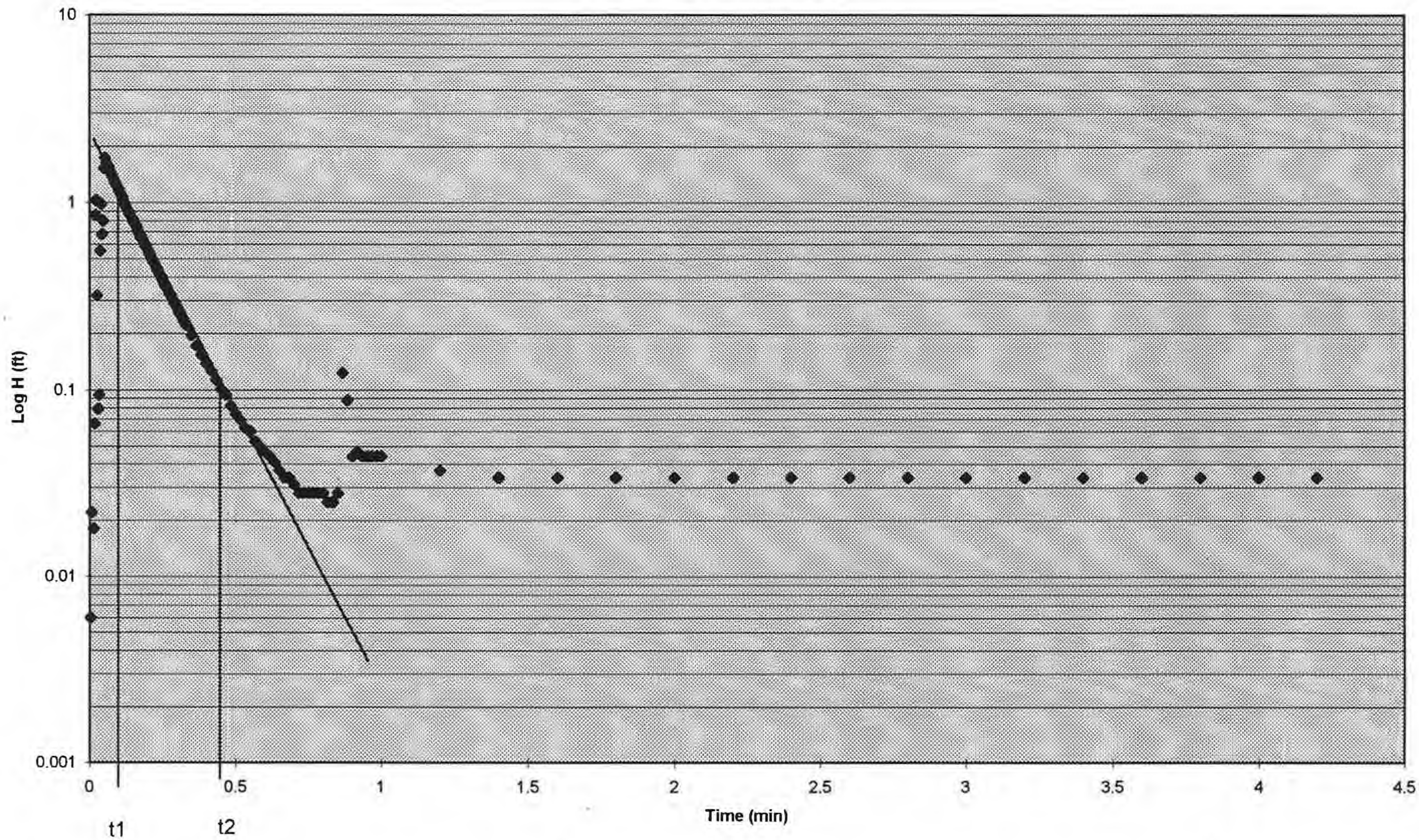
Well ID: 69W-94-14
Test Date: 11/20/95
Test Type: Rising Head
Well Diameter: 0.167 ft.
Boring Diameter: 0.667 ft.
Screened Interval (bgs): 3-13 ft.
Water Column Height: 7.62 ft.

Time (min)	delta H (ft.)
0.0166	0.003
0.02	0.587
0.0233	1.289
0.0266	0.812
0.03	1.055
0.0333	1.159
0.0366	1.491
0.04	1.665
0.0433	1.832
0.0466	2.054
0.05	2.006
0.0533	1.899
0.0566	1.782
0.06	1.668
0.0633	1.57
0.0666	1.472
0.07	1.39
0.0733	1.298
0.0766	1.223
0.08	1.147
0.0833	1.074
0.0866	1.02
0.09	0.957
0.0933	0.897
0.0966	0.843
0.1	0.796
0.1033	0.752
0.1066	0.711
0.11	0.669
0.1133	0.635
0.1166	0.6
0.12	0.565
0.1233	0.537
0.1266	0.505
0.13	0.48
0.1333	0.451
0.1366	0.429
0.14	0.404
0.1433	0.382
0.1466	0.363
0.15	0.344
0.1533	0.325
0.1566	0.309
0.16	0.293
0.1633	0.278
0.1666	0.265
0.17	0.252
0.1733	0.24
0.1766	0.227
0.18	0.218

Time (min)	delta H (ft.)					
0.1833	0.208					
0.1866	0.195					
0.19	0.189					
0.1933	0.18					
0.1966	0.173					
0.2	0.164					
0.2033	0.154					
0.2066	0.148					
0.21	0.142					
0.2133	0.135					
0.2166	0.132					
0.22	0.126					
0.2233	0.12					
0.2266	0.116					
0.23	0.11					
0.2333	0.107					
0.2366	0.104					
0.24	0.101					
0.2433	0.094					
0.2466	0.091					
0.25	0.088					
0.2533	0.085					
0.2566	0.085					
0.26	0.082					
0.2633	0.075					
0.2666	0.075					
0.27	0.072					
0.2733	0.069					
0.2766	0.066					
0.28	0.066					
0.2833	0.063					
0.2866	0.063					
0.29	0.06					
0.2933	0.06					
0.2966	0.056					
0.3	0.056					
0.3033	0.056					
0.3066	0.053					
0.31	0.053					
0.3133	0.05					
0.3166	0.05					
0.32	0.047					
0.3233	0.047					
0.3266	0.044					
0.33	0.044					
0.3333	0.044					
0.35	0.037					
0.3666	0.044					
0.3833	0.041					
0.4	0.037					

Time (min)	delta H (ft.)					
0.4166	0.037					
0.4333	0.034					
0.45	0.034					
0.4666	0.031					
0.4833	0.031					
0.5	0.031					
0.5166	0.031					
0.5333	0.031					
0.55	0.028					
0.5666	0.028					
0.5833	0.028					
0.6	0.028					
0.6166	0.028					
0.6333	0.028					
0.65	0.028					
0.6666	0.028					
0.6833	0.028					
0.7	0.028					
0.7166	0.028					
0.7333	0.028					
0.75	0.028					
0.7666	0.025					
0.7833	0.028					
0.8	0.028					
0.8166	0.031					
0.8333	0.028					
0.85	0.031					
0.8666	0.031					
0.8833	0.031					
0.9	0.031					
0.9166	0.031					
0.9333	0.031					
0.95	0.031					
0.9666	0.031					
0.9833	0.031					
1	0.031					
1.2	0.031					
1.4	0.037					
1.6	0.041					
1.8	0.041					
2	0.041					
2.2	0.041					
2.4	0.041					
2.6	0.041					
2.8	0.041					
3	0.041					
3.2	0.041					
3.4	0.041					
3.6	0.041					
3.8	0.041					

ZWM-95-15X RISING HEAD



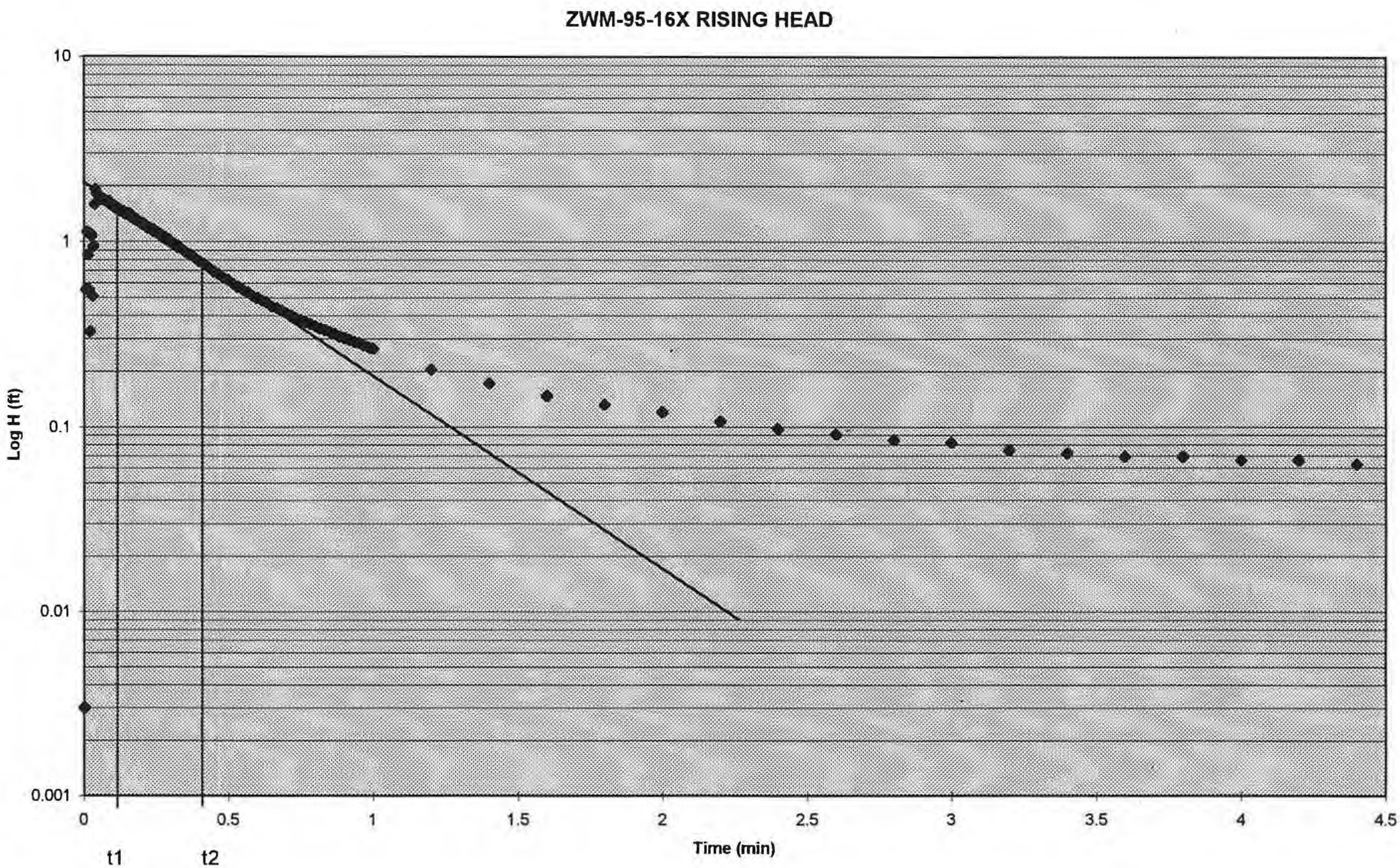
Well ID: ZWM-95-15X
Test Date: 11/20/95
Test Type: Rising Head
Well Diameter: 0.333 ft.
Boring Diameter: 0.833 ft.
Screened Interval (bgs): 3-13 ft.
Water Column Height: 9.14 ft.

Time (min)	delta H (ft.)
0.0033	0.006
0.0066	0.022
0.0133	0.018
0.0166	0.066
0.02	0.859
0.0233	1.027
0.0266	0.319
0.03	0.079
0.0333	0.094
0.0366	0.553
0.04	0.982
0.0433	0.679
0.0466	0.799
0.05	1.52
0.0533	1.734
0.0566	1.63
0.06	1.592
0.0633	1.551
0.0666	1.523
0.07	1.475
0.0733	1.444
0.0766	1.406
0.08	1.368
0.0833	1.324
0.0866	1.292
0.09	1.264
0.0933	1.229
0.0966	1.204
0.1	1.172
0.1033	1.137
0.1066	1.115
0.11	1.087
0.1133	1.049
0.1166	1.02
0.12	0.998
0.1233	0.973
0.1266	0.941
0.13	0.925
0.1333	0.903
0.1366	0.881
0.14	0.856
0.1433	0.84
0.1466	0.824
0.15	0.799
0.1533	0.78
0.1566	0.764
0.16	0.761
0.1633	0.736
0.1666	0.707
0.17	0.692

Time (min)	delta H (ft.)					
0.1733	0.676					
0.1766	0.657					
0.18	0.644					
0.1833	0.632					
0.1866	0.613					
0.19	0.6					
0.1933	0.584					
0.1966	0.571					
0.2	0.559					
0.2033	0.543					
0.2066	0.527					
0.21	0.518					
0.2133	0.505					
0.2166	0.492					
0.22	0.483					
0.2233	0.47					
0.2266	0.458					
0.23	0.448					
0.2333	0.436					
0.2366	0.423					
0.24	0.413					
0.2433	0.407					
0.2466	0.398					
0.25	0.385					
0.2533	0.379					
0.2566	0.369					
0.26	0.36					
0.2633	0.353					
0.2666	0.347					
0.27	0.338					
0.2733	0.328					
0.2766	0.325					
0.28	0.316					
0.2833	0.306					
0.2866	0.3					
0.29	0.29					
0.2933	0.287					
0.2966	0.281					
0.3	0.274					
0.3033	0.274					
0.3066	0.262					
0.31	0.255					
0.3133	0.252					
0.3166	0.246					
0.32	0.24					
0.3233	0.233					
0.3266	0.23					
0.33	0.221					
0.3333	0.221					
0.35	0.195					

Time (min)	delta H (ft.)					
0.3666	0.173					
0.3833	0.154					
0.4	0.139					
0.4166	0.126					
0.4333	0.113					
0.45	0.101					
0.4666	0.094					
0.4833	0.082					
0.5	0.075					
0.5166	0.069					
0.5333	0.063					
0.55	0.06					
0.5666	0.053					
0.5833	0.05					
0.6	0.047					
0.6166	0.044					
0.6333	0.041					
0.65	0.037					
0.6666	0.034					
0.6833	0.034					
0.7	0.031					
0.7166	0.028					
0.7333	0.028					
0.75	0.028					
0.7666	0.028					
0.7833	0.028					
0.8	0.028					
0.8166	0.025					
0.8333	0.025					
0.85	0.028					
0.8666	0.123					
0.8833	0.088					
0.9	0.044					
0.9166	0.047					
0.9333	0.044					
0.95	0.044					
0.9666	0.044					
0.9833	0.044					
1	0.044					
1.2	0.037					
1.4	0.034					
1.6	0.034					
1.8	0.034					
2	0.034					
2.2	0.034					
2.4	0.034					
2.6	0.034					
2.8	0.034					
3	0.034					
3.2	0.034					

Time (min)	delta H (ft.)					
3.4	0.034					
3.6	0.034					
3.8	0.034					
4	0.034					
4.2	0.034					


ZWM-95-16X RISING HEAD
Log H (ft)
10
1
0.1
0.01
0.001
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Time (min)
t1
t2

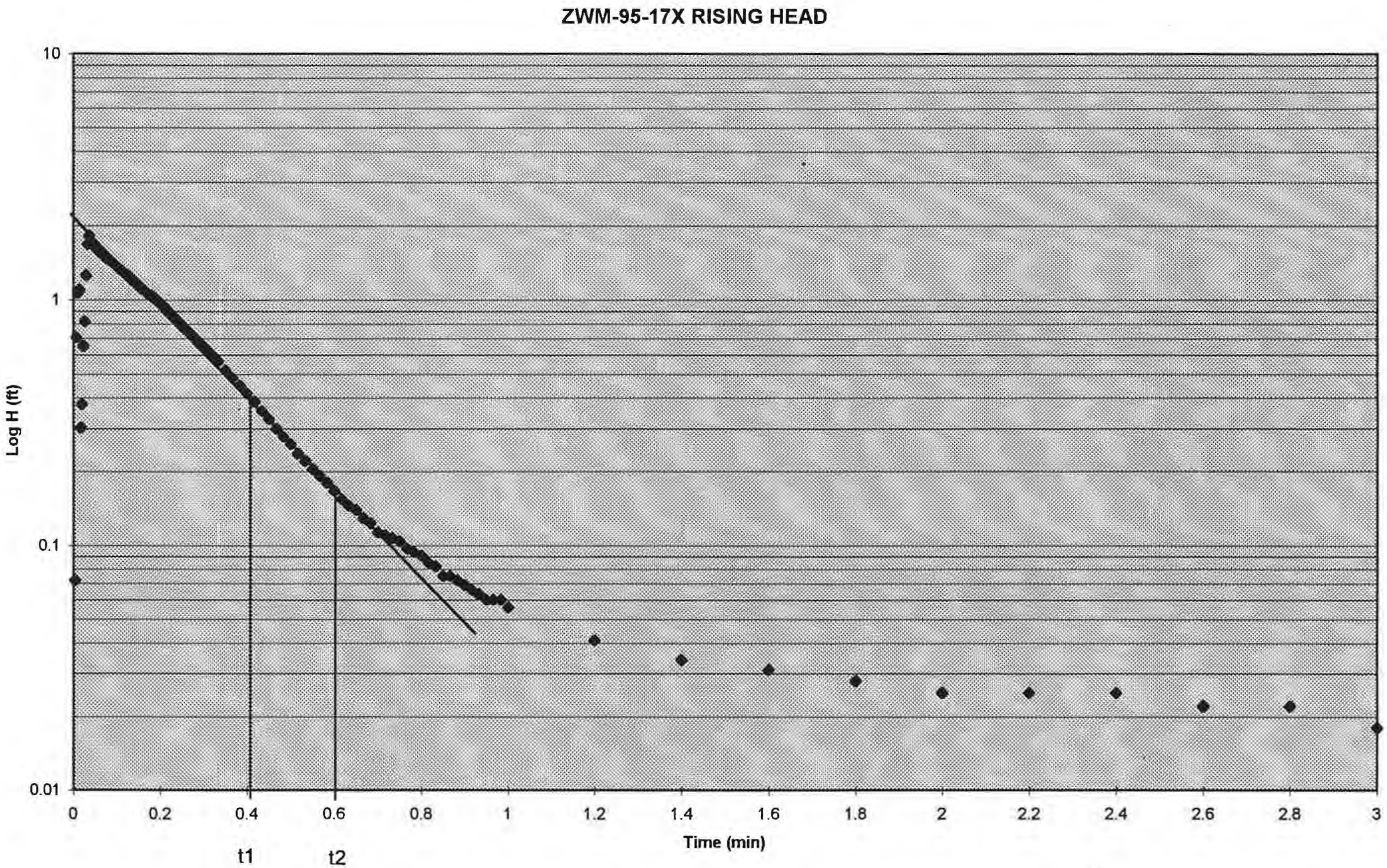
Time (min)	delta H (ft.)
0	0.003
0.0033	0.003
0.0066	0.553
0.01	1.125
0.0133	0.853
0.0166	0.549
0.02	0.328
0.0233	1.09
0.0266	1.071
0.03	0.511
0.0333	0.944
0.0366	1.586
0.04	1.918
0.0433	1.826
0.0466	1.788
0.05	1.772
0.0533	1.76
0.0566	1.725
0.06	1.725
0.0633	1.703
0.0666	1.681
0.07	1.681
0.0733	1.671
0.0766	1.662
0.08	1.643
0.0833	1.646
0.0866	1.646
0.09	1.592
0.0933	1.583
0.0966	1.576
0.1	1.564
0.1033	1.554
0.1066	1.545
0.11	1.51
0.1133	1.532
0.1166	1.507
0.12	1.504
0.1233	1.501
0.1266	1.469
0.13	1.456
0.1333	1.453
0.1366	1.444
0.14	1.441
0.1433	1.415
0.1466	1.422
0.15	1.406
0.1533	1.422
0.1566	1.384
0.16	1.399
0.1633	1.358

Well ID: ZWM-95-16X
Test Date: 11/20/95
Test Type: Rising Head
Well Diameter: 0.333 ft.
Boring Diameter: 0.833 ft.
Screened Interval (bgs): 6.3-16.3 ft.
Water Column Height: 9.06 ft.

Time (min)	delta H (ft.)					
0.1666	1.349					
0.17	1.365					
0.1733	1.336					
0.1766	1.336					
0.18	1.308					
0.1833	1.324					
0.1866	1.295					
0.19	1.286					
0.1933	1.276					
0.1966	1.273					
0.2	1.241					
0.2033	1.254					
0.2066	1.241					
0.21	1.235					
0.2133	1.223					
0.2166	1.213					
0.22	1.204					
0.2233	1.178					
0.2266	1.185					
0.23	1.178					
0.2333	1.169					
0.2366	1.156					
0.24	1.134					
0.2433	1.153					
0.2466	1.131					
0.25	1.125					
0.2533	1.118					
0.2566	1.106					
0.26	1.115					
0.2633	1.087					
0.2666	1.096					
0.27	1.061					
0.2733	1.074					
0.2766	1.046					
0.28	1.052					
0.2833	1.042					
0.2866	1.03					
0.29	1.027					
0.2933	1.017					
0.2966	1.02					
0.3	0.998					
0.3033	0.982					
0.3066	0.992					
0.31	0.979					
0.3133	0.973					
0.3166	0.967					
0.32	0.954					
0.3233	0.948					
0.3266	0.935					
0.33	0.938					

Time (min)	delta H (ft.)					
0.3333	0.929					
0.35	0.891					
0.3666	0.853					
0.3833	0.821					
0.4	0.783					
0.4166	0.755					
0.4333	0.726					
0.45	0.695					
0.4666	0.666					
0.4833	0.641					
0.5	0.625					
0.5166	0.594					
0.5333	0.572					
0.55	0.553					
0.5666	0.534					
0.5833	0.515					
0.6	0.499					
0.6166	0.483					
0.6333	0.47					
0.65	0.448					
0.6666	0.439					
0.6833	0.426					
0.7	0.414					
0.7166	0.401					
0.7333	0.388					
0.75	0.379					
0.7666	0.369					
0.7833	0.36					
0.8	0.35					
0.8166	0.341					
0.8333	0.334					
0.85	0.325					
0.8666	0.319					
0.8833	0.309					
0.9	0.303					
0.9166	0.297					
0.9333	0.29					
0.95	0.284					
0.9666	0.278					
0.9833	0.271					
1	0.265					
1.2	0.205					
1.4	0.173					
1.6	0.148					
1.8	0.132					
2	0.12					
2.2	0.107					
2.4	0.097					
2.6	0.091					
2.8	0.085					

Time (min)	delta H (ft.)					
3	0.082					
3.2	0.075					
3.4	0.072					
3.6	0.069					
3.8	0.069					
4	0.066					
4.2	0.066					
4.4	0.063					



ZWM-95-17X RISING HEAD
10
1
0.1
0.01
Log H (ft)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
Time (min)
t1
t2

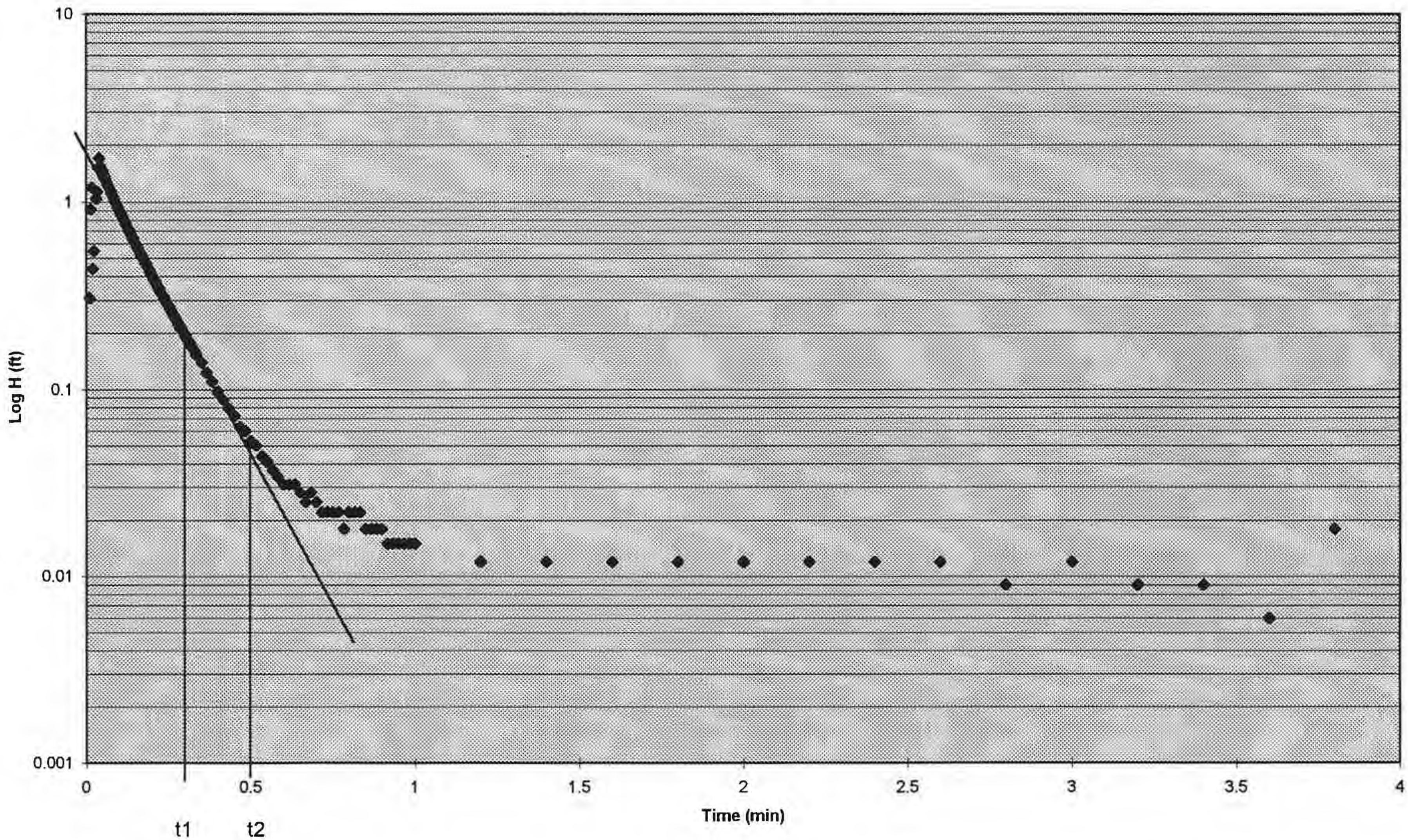
Time (min)	delta H (ft.)
0.0033	0.072
0.0066	0.704
0.01	1.071
0.0133	1.102
0.0166	0.303
0.02	0.376
0.0233	0.651
0.0266	0.821
0.03	1.257
0.0333	1.693
0.0366	1.826
0.04	1.709
0.0433	1.69
0.0466	1.671
0.05	1.64
0.0533	1.624
0.0566	1.599
0.06	1.573
0.0633	1.554
0.0666	1.539
0.07	1.516
0.0733	1.504
0.0766	1.485
0.08	1.469
0.0833	1.456
0.0866	1.441
0.09	1.425
0.0933	1.406
0.0966	1.393
0.1	1.374
0.1033	1.355
0.1066	1.339
0.11	1.324
0.1133	1.314
0.1166	1.295
0.12	1.279
0.1233	1.267
0.1266	1.251
0.13	1.232
0.1333	1.219
0.1366	1.21
0.14	1.194
0.1433	1.181
0.1466	1.162
0.15	1.15
0.1533	1.137
0.1566	1.115
0.16	1.109
0.1633	1.096
0.1666	1.08

Well ID: ZWM-95-17X
Test Date: 11/20/95
Test Type: Rising Head
Well Diameter: 0.333 ft.
Boring Diameter: 0.833 ft.
Screened Interval (bgs): 12.2-22.2 ft.
Water Column Height: 8.75 ft.

Time (min)	delta H (ft.)					
0.17	1.065					
0.1733	1.052					
0.1766	1.046					
0.18	1.046					
0.1833	1.03					
0.1866	1.02					
0.19	1.004					
0.1933	0.995					
0.1966	0.982					
0.2	0.97					
0.2033	0.957					
0.2066	0.948					
0.21	0.941					
0.2133	0.929					
0.2166	0.903					
0.22	0.894					
0.2233	0.881					
0.2266	0.869					
0.23	0.856					
0.2333	0.846					
0.2366	0.834					
0.24	0.824					
0.2433	0.812					
0.2466	0.802					
0.25	0.79					
0.2533	0.78					
0.2566	0.771					
0.26	0.761					
0.2633	0.749					
0.2666	0.739					
0.27	0.73					
0.2733	0.72					
0.2766	0.711					
0.28	0.701					
0.2833	0.692					
0.2866	0.682					
0.29	0.673					
0.2933	0.663					
0.2966	0.654					
0.3	0.647					
0.3033	0.638					
0.3066	0.628					
0.31	0.619					
0.3133	0.609					
0.3166	0.603					
0.32	0.594					
0.3233	0.584					
0.3266	0.578					
0.33	0.572					
0.3333	0.562					

Time (min)	delta H (ft.)					
0.35	0.518					
0.3666	0.483					
0.3833	0.451					
0.4	0.417					
0.4166	0.385					
0.4333	0.353					
0.45	0.328					
0.4666	0.3					
0.4833	0.278					
0.5	0.259					
0.5166	0.237					
0.5333	0.221					
0.55	0.205					
0.5666	0.192					
0.5833	0.18					
0.6	0.167					
0.6166	0.154					
0.6333	0.145					
0.65	0.139					
0.6666	0.129					
0.6833	0.123					
0.7	0.113					
0.7166	0.11					
0.7333	0.107					
0.75	0.104					
0.7666	0.097					
0.7833	0.094					
0.8	0.091					
0.8166	0.085					
0.8333	0.082					
0.85	0.075					
0.8666	0.075					
0.8833	0.072					
0.9	0.069					
0.9166	0.066					
0.9333	0.063					
0.95	0.06					
0.9666	0.06					
0.9833	0.06					
1	0.056					
1.2	0.041					
1.4	0.034					
1.6	0.031					
1.8	0.028					
2	0.025					
2.2	0.025					
2.4	0.025					
2.6	0.022					
2.8	0.022					
3	0.018					

ZWM-95-18X RISING HEAD



Well ID: ZWM-95-18X
Test Date: 11/20/95
Test Type: Rising Head
Well Diameter: 0.333 ft.
Boring Diameter: 0.833 ft.
Screened Interval (bgs): 3-13 ft.
Water Column Height: 11.65 ft.

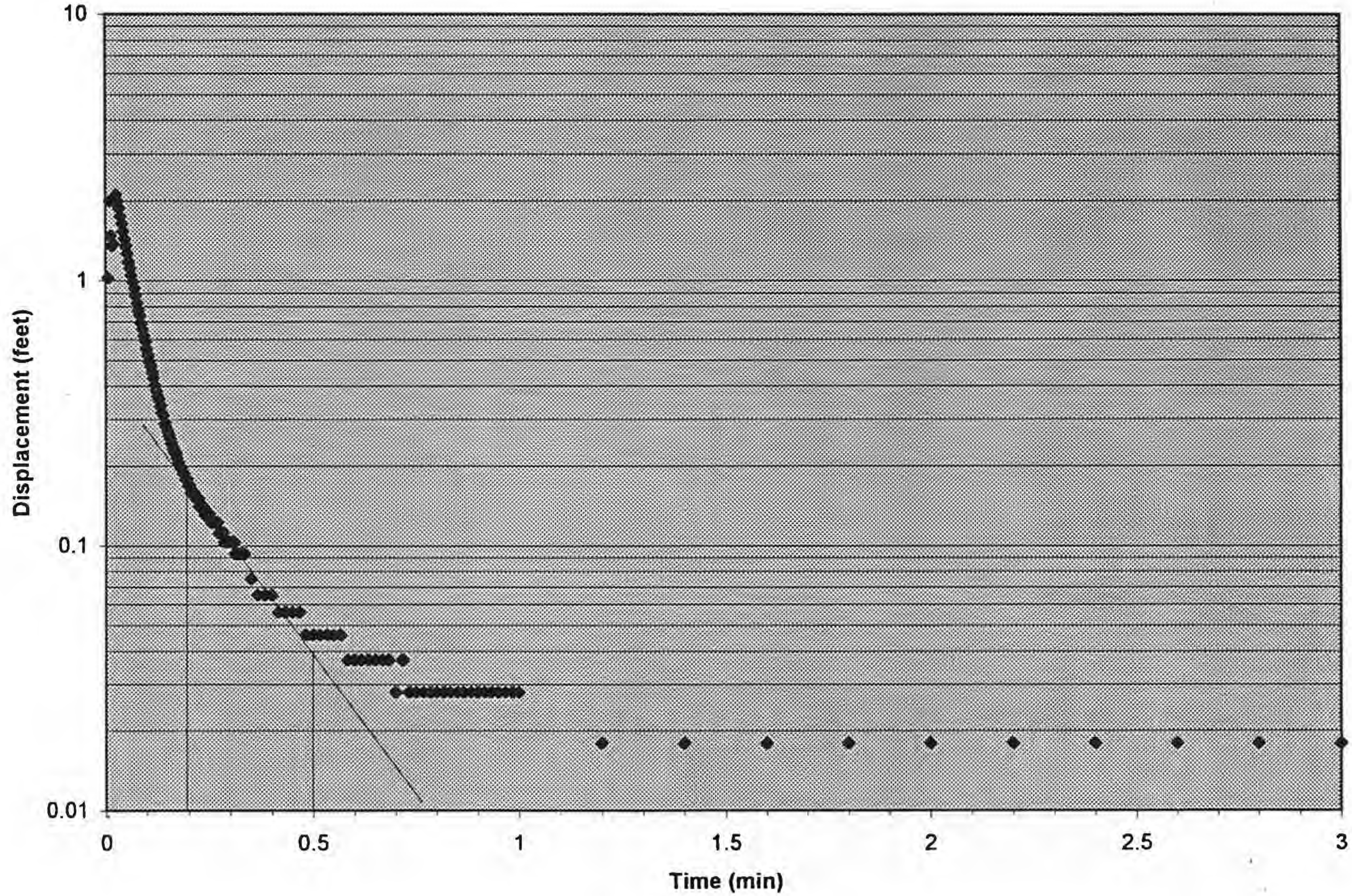
Time (min)	delta H (ft.)
0.01	0.306
0.0133	0.913
0.0166	1.185
0.02	0.439
0.0233	0.546
0.03	1.046
0.0333	1.128
0.0366	1.513
0.04	1.7
0.0433	1.542
0.0466	1.494
0.05	1.441
0.0533	1.396
0.0566	1.352
0.06	1.305
0.0633	1.26
0.0666	1.219
0.07	1.181
0.0733	1.147
0.0766	1.115
0.08	1.08
0.0833	1.049
0.0866	1.017
0.09	0.985
0.0933	0.963
0.0966	0.932
0.1	0.91
0.1033	0.881
0.1066	0.862
0.11	0.834
0.1133	0.812
0.1166	0.79
0.12	0.767
0.1233	0.745
0.1266	0.726
0.13	0.707
0.1333	0.688
0.1366	0.669
0.14	0.651
0.1433	0.635
0.1466	0.616
0.15	0.6
0.1533	0.584
0.1566	0.572
0.16	0.553
0.1633	0.54
0.1666	0.527
0.17	0.511
0.1733	0.499
0.1766	0.486

Time (min)	delta H (ft.)					
0.18	0.474					
0.1833	0.464					
0.1866	0.451					
0.19	0.439					
0.1933	0.426					
0.1966	0.417					
0.2	0.407					
0.2033	0.395					
0.2066	0.385					
0.21	0.376					
0.2133	0.366					
0.2166	0.357					
0.22	0.35					
0.2233	0.341					
0.2266	0.331					
0.23	0.322					
0.2333	0.316					
0.2366	0.309					
0.24	0.3					
0.2433	0.293					
0.2466	0.287					
0.25	0.281					
0.2533	0.271					
0.2566	0.268					
0.26	0.259					
0.2633	0.255					
0.2666	0.249					
0.27	0.243					
0.2733	0.237					
0.2766	0.23					
0.28	0.224					
0.2833	0.221					
0.2866	0.211					
0.29	0.211					
0.2933	0.205					
0.2966	0.202					
0.3	0.195					
0.3033	0.192					
0.3066	0.186					
0.31	0.183					
0.3133	0.18					
0.3166	0.173					
0.32	0.17					
0.3233	0.167					
0.3266	0.164					
0.33	0.161					
0.3333	0.154					
0.35	0.139					
0.3666	0.123					
0.3833	0.11					

Time (min)	delta H (ft.)					
0.4	0.097					
0.4166	0.088					
0.4333	0.079					
0.45	0.072					
0.4666	0.063					
0.4833	0.06					
0.5	0.053					
0.5166	0.05					
0.5333	0.044					
0.55	0.041					
0.5666	0.037					
0.5833	0.034					
0.6	0.031					
0.6166	0.031					
0.6333	0.031					
0.65	0.028					
0.6666	0.025					
0.6833	0.028					
0.7	0.025					
0.7166	0.022					
0.7333	0.022					
0.75	0.022					
0.7666	0.022					
0.7833	0.018					
0.8	0.022					
0.8166	0.022					
0.8333	0.022					
0.85	0.018					
0.8666	0.018					
0.8833	0.018					
0.9	0.018					
0.9166	0.015					
0.9333	0.015					
0.95	0.015					
0.9666	0.015					
0.9833	0.015					
1	0.015					
1.2	0.012					
1.4	0.012					
1.6	0.012					
1.8	0.012					
2	0.012					
2.2	0.012					
2.4	0.012					
2.6	0.012					
2.8	0.009					
3	0.012					
3.2	0.009					
3.4	0.009					
3.6	0.006					

Time (min)	delta H (ft.)					
3.8	0.018					

ZWM-96-19X Rising Head Test #1



ZWM-96-19X Rising Head Test #1

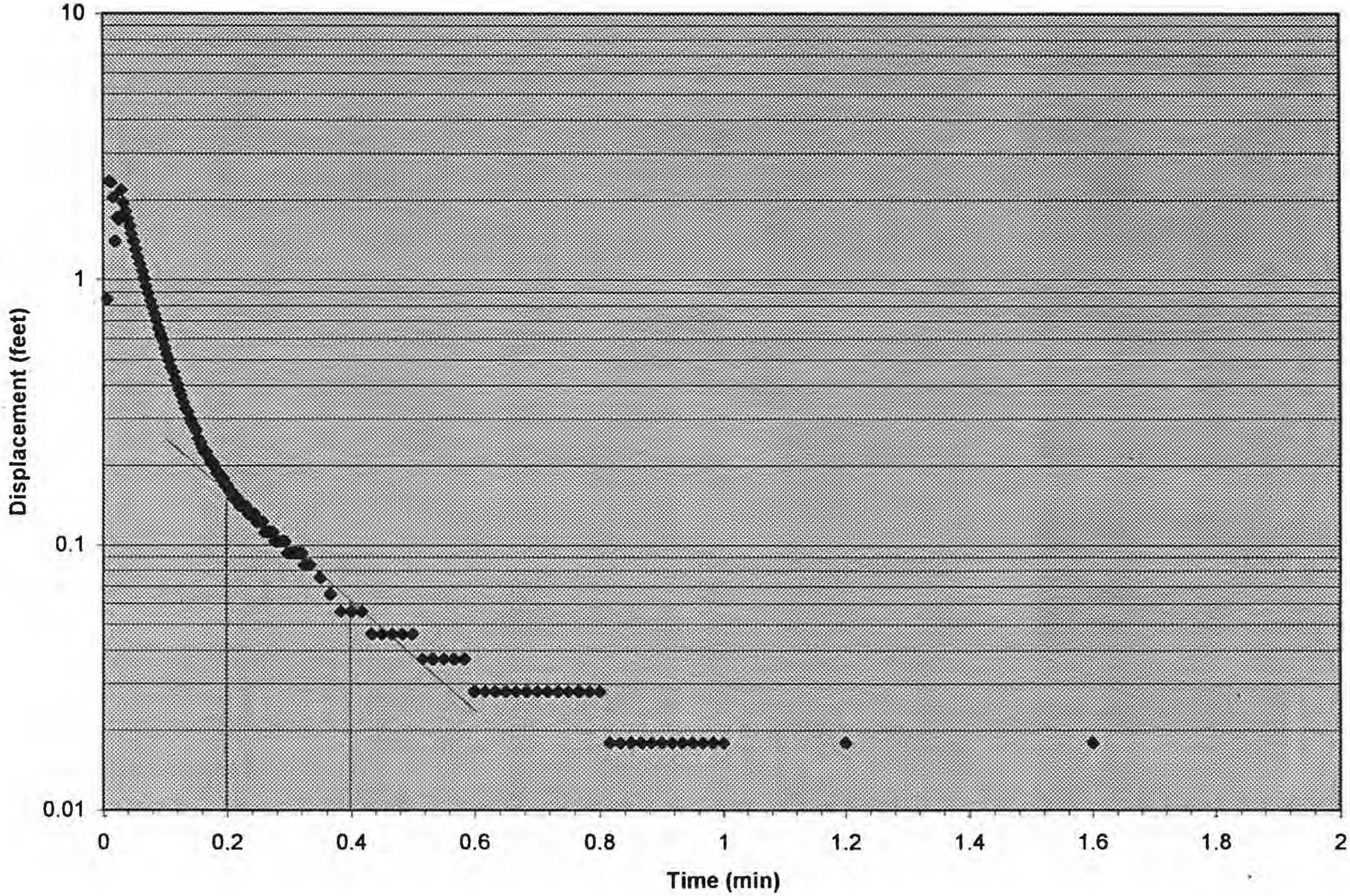
0	0.009
0.0033	0.009
0.0066	1.023
0.01	1.999
0.0133	1.482
0.0166	1.351
0.02	1.379
0.0233	1.999
0.0266	2.111
0.03	1.999
0.0333	1.877
0.0366	1.755
0.04	1.642
0.0433	1.539
0.0466	1.435
0.05	1.351
0.0533	1.267
0.0566	1.182
0.06	1.116
0.0633	1.051
0.0666	0.994
0.07	0.938
0.0733	0.882
0.0766	0.825
0.08	0.779
0.0833	0.741
0.0866	0.694
0.09	0.657
0.0933	0.619
0.0966	0.591
0.1	0.553
0.1033	0.525
0.1066	0.497
0.11	0.478
0.1133	0.45
0.1166	0.431
0.12	0.403
0.1233	0.384
0.1266	0.366
0.13	0.356
0.1333	0.337
0.1366	0.319
0.14	0.309
0.1433	0.29
0.1466	0.281
0.15	0.272
0.1533	0.262
0.1566	0.253
0.16	0.244
0.1633	0.234
0.1666	0.225

max. drawdown = 2.111 - 0.009 = 2.10 ft.

0.17	0.225
0.1733	0.215
0.1766	0.206
0.18	0.197
0.1833	0.197
0.1866	0.187
0.19	0.187
0.1933	0.178
0.1966	0.178
0.2	0.169
0.2033	0.169
0.2066	0.159
0.21	0.159
0.2133	0.159
0.2166	0.15
0.22	0.15
0.2233	0.15
0.2266	0.14
0.23	0.14
0.2333	0.14
0.2366	0.14
0.24	0.131
0.2433	0.131
0.2466	0.131
0.25	0.131
0.2533	0.122
0.2566	0.122
0.26	0.122
0.2633	0.122
0.2666	0.122
0.27	0.122
0.2733	0.112
0.2766	0.112
0.28	0.112
0.2833	0.112
0.2866	0.103
0.29	0.103
0.2933	0.103
0.2966	0.103
0.3	0.103
0.3033	0.103
0.3066	0.103
0.31	0.103
0.3133	0.093
0.3166	0.093
0.32	0.093
0.3233	0.093
0.3266	0.093
0.33	0.093
0.3333	0.093
0.35	0.075

0.3666	0.065
0.3833	0.065
0.4	0.065
0.4166	0.056
0.4333	0.056
0.45	0.056
0.4666	0.056
0.4833	0.046
0.5	0.046
0.5166	0.046
0.5333	0.046
0.55	0.046
0.5666	0.046
0.5833	0.037
0.6	0.037
0.6166	0.037
0.6333	0.037
0.65	0.037
0.6666	0.037
0.6833	0.037
0.7	0.028
0.7166	0.037
0.7333	0.028
0.75	0.028
0.7666	0.028
0.7833	0.028
0.8	0.028
0.8166	0.028
0.8333	0.028
0.85	0.028
0.8666	0.028
0.8833	0.028
0.9	0.028
0.9166	0.028
0.9333	0.028
0.95	0.028
0.9666	0.028
0.9833	0.028
1	0.028
1.2	0.018
1.4	0.018
1.6	0.018
1.8	0.018
2	0.018
2.2	0.018
2.4	0.018
2.6	0.018
2.8	0.018
3	0.018

ZWM-96-19X Rising Head Test #2



ZWM-96-19X Rising Head Test #2

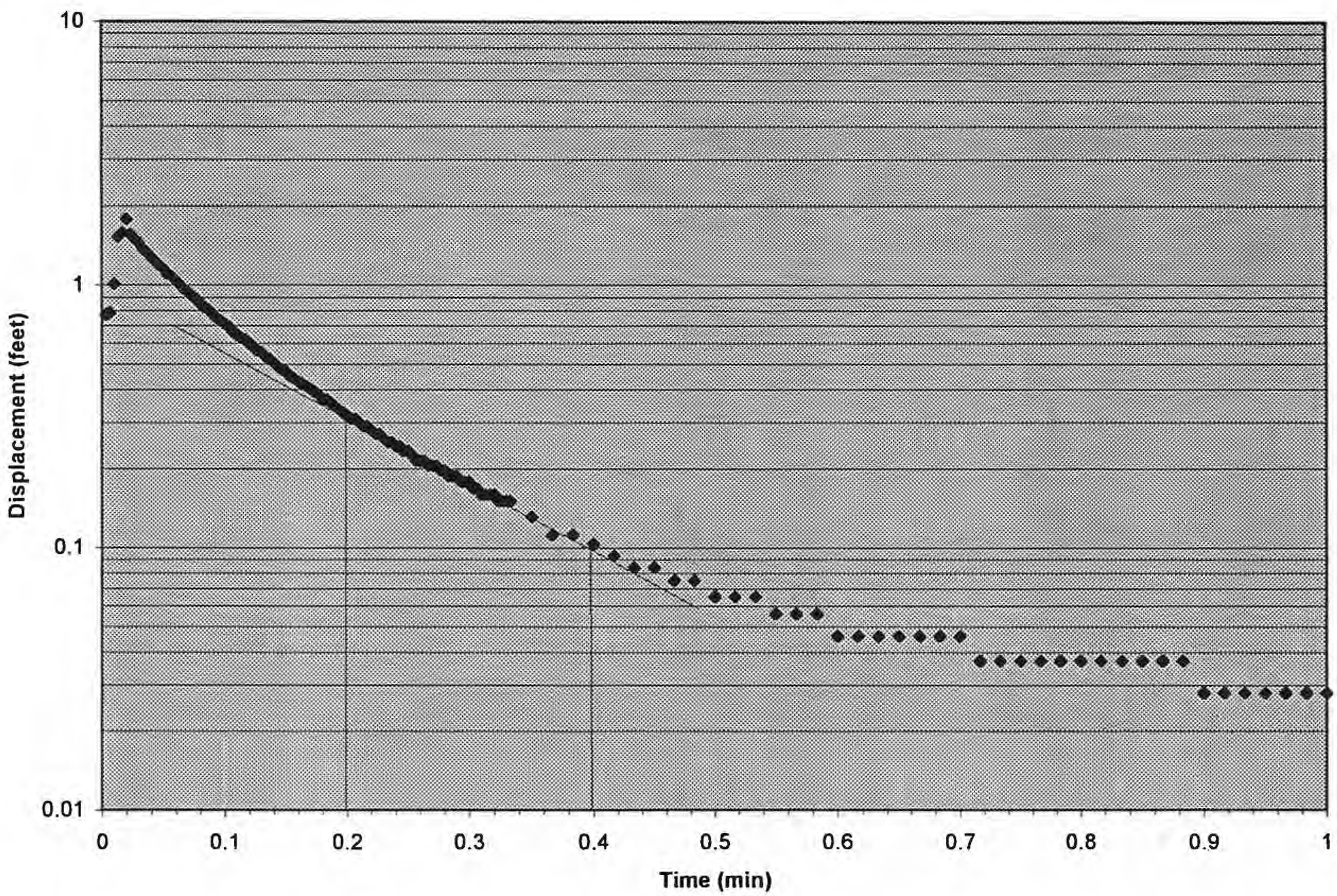
0	0.009
0.0033	0.009
0.0066	0.844
0.01	2.355
0.0133	2.327
0.0166	2.046
0.02	1.398
0.0233	1.717
0.0266	1.689
0.03	2.186
0.0333	1.952
0.0366	1.82
0.04	1.698
0.0433	1.595
0.0466	1.492
0.05	1.398
0.0533	1.304
0.0566	1.22
0.06	1.145
0.0633	1.079
0.0666	1.013
0.07	0.947
0.0733	0.891
0.0766	0.835
0.08	0.788
0.0833	0.741
0.0866	0.703
0.09	0.657
0.0933	0.619
0.0966	0.591
0.1	0.553
0.1033	0.525
0.1066	0.497
0.11	0.469
0.1133	0.45
0.1166	0.422
0.12	0.403
0.1233	0.384
0.1266	0.366
0.13	0.347
0.1333	0.328
0.1366	0.319
0.14	0.3
0.1433	0.29
0.1466	0.281
0.15	0.272
0.1533	0.253
0.1566	0.244
0.16	0.234
0.1633	0.225
0.1666	0.225

max. drawdown = 2.186 - 0.009 = 2.18 ft.

0.17	0.215
0.1733	0.206
0.1766	0.206
0.18	0.197
0.1833	0.187
0.1866	0.187
0.19	0.178
0.1933	0.178
0.1966	0.169
0.2	0.169
0.2033	0.159
0.2066	0.159
0.21	0.15
0.2133	0.15
0.2166	0.15
0.22	0.14
0.2233	0.14
0.2266	0.14
0.23	0.14
0.2333	0.131
0.2366	0.131
0.24	0.131
0.2433	0.131
0.2466	0.122
0.25	0.122
0.2533	0.122
0.2566	0.122
0.26	0.112
0.2633	0.112
0.2666	0.112
0.27	0.112
0.2733	0.112
0.2766	0.103
0.28	0.103
0.2833	0.103
0.2866	0.103
0.29	0.103
0.2933	0.103
0.2966	0.093
0.3	0.093
0.3033	0.093
0.3066	0.093
0.31	0.093
0.3133	0.093
0.3166	0.093
0.32	0.093
0.3233	0.084
0.3266	0.084
0.33	0.084
0.3333	0.084
0.35	0.075

0.3666	0.065
0.3833	0.056
0.4	0.056
0.4166	0.056
0.4333	0.046
0.45	0.046
0.4666	0.046
0.4833	0.046
0.5	0.046
0.5166	0.037
0.5333	0.037
0.55	0.037
0.5666	0.037
0.5833	0.037
0.6	0.028
0.6166	0.028
0.6333	0.028
0.65	0.028
0.6666	0.028
0.6833	0.028
0.7	0.028
0.7166	0.028
0.7333	0.028
0.75	0.028
0.7666	0.028
0.7833	0.028
0.8	0.028
0.8166	0.018
0.8333	0.018
0.85	0.018
0.8666	0.018
0.8833	0.018
0.9	0.018
0.9166	0.018
0.9333	0.018
0.95	0.018
0.9666	0.018
0.9833	0.018
1	0.018
1.2	0.018
1.4	0.009
1.6	0.018
1.8	0.009
2	0.009

ZWM-96-20X Rising Head Test #1



ZWM-96-20X Rising Head Test #1

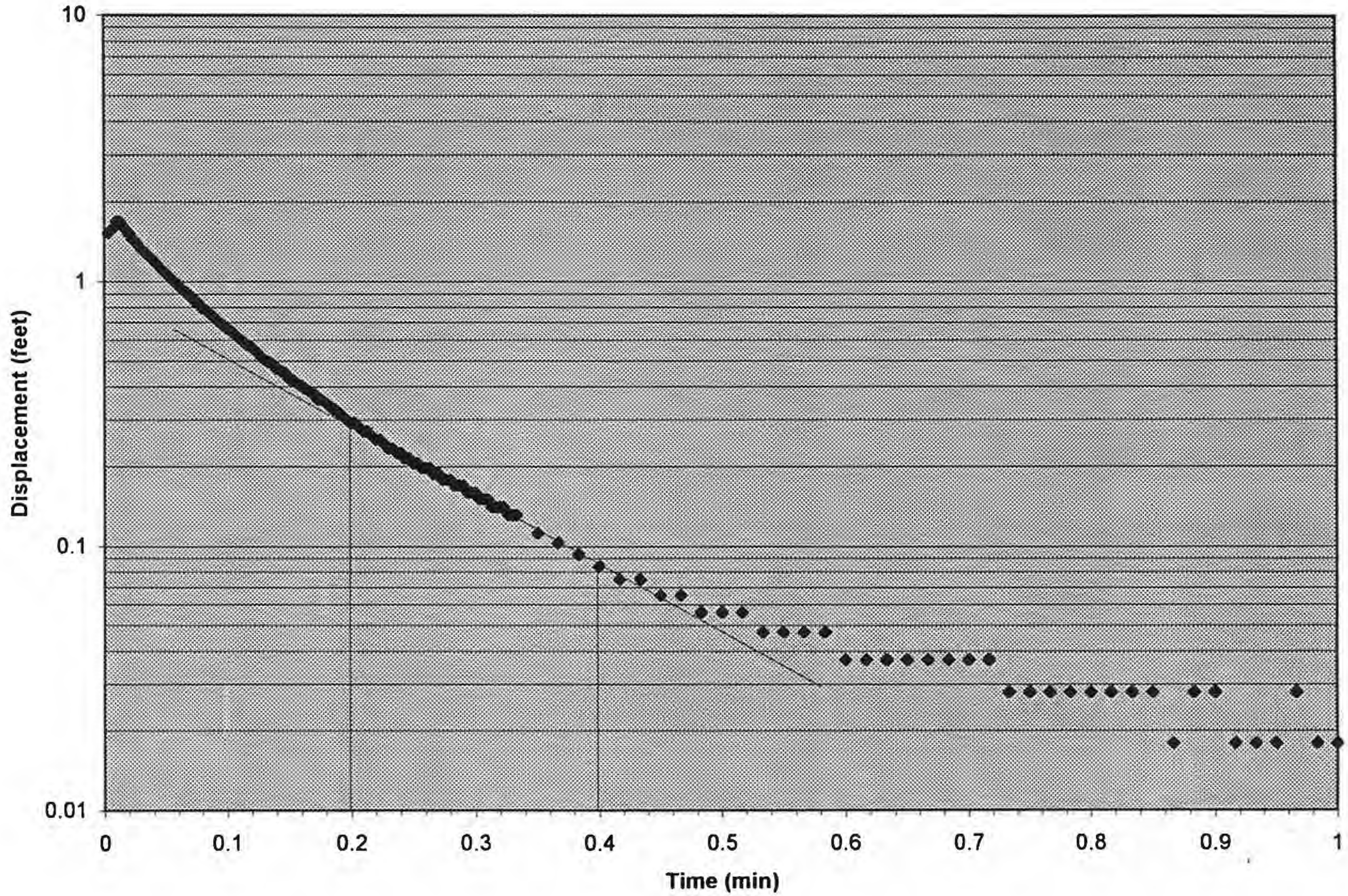
0	0.628
0.0033	0.769
0.0066	0.788
0.01	1.013
0.0133	1.529
0.0166	1.586
0.02	1.783
0.0233	1.567
0.0266	1.501
0.03	1.454
0.0333	1.379
0.0366	1.332
0.04	1.276
0.0433	1.239
0.0466	1.192
0.05	1.154
0.0533	1.107
0.0566	1.079
0.06	1.041
0.0633	1.004
0.0666	0.966
0.07	0.938
0.0733	0.91
0.0766	0.882
0.08	0.854
0.0833	0.825
0.0866	0.807
0.09	0.779
0.0933	0.75
0.0966	0.732
0.1	0.713
0.1033	0.694
0.1066	0.666
0.11	0.647
0.1133	0.628
0.1166	0.619
0.12	0.6
0.1233	0.581
0.1266	0.563
0.13	0.553
0.1333	0.535
0.1366	0.525
0.14	0.506
0.1433	0.488
0.1466	0.478
0.15	0.469
0.1533	0.45
0.1566	0.441
0.16	0.431
0.1633	0.422
0.1666	0.413

max. drawdown = 1.783 - 0.028 = 1.76 ft.

0.17	0.403
0.1733	0.394
0.1766	0.384
0.18	0.366
0.1833	0.366
0.1866	0.356
0.19	0.347
0.1933	0.337
0.1966	0.328
0.2	0.319
0.2033	0.309
0.2066	0.309
0.21	0.3
0.2133	0.29
0.2166	0.29
0.22	0.281
0.2233	0.272
0.2266	0.272
0.23	0.262
0.2333	0.253
0.2366	0.253
0.24	0.244
0.2433	0.244
0.2466	0.234
0.25	0.234
0.2533	0.225
0.2566	0.215
0.26	0.215
0.2633	0.215
0.2666	0.206
0.27	0.206
0.2733	0.206
0.2766	0.197
0.28	0.197
0.2833	0.187
0.2866	0.187
0.29	0.187
0.2933	0.178
0.2966	0.178
0.3	0.178
0.3033	0.168
0.3066	0.168
0.31	0.159
0.3133	0.159
0.3166	0.159
0.32	0.159
0.3233	0.15
0.3266	0.15
0.33	0.15
0.3333	0.15
0.35	0.131

0.3666	0.112
0.3833	0.112
0.4	0.103
0.4166	0.093
0.4333	0.084
0.45	0.084
0.4666	0.075
0.4833	0.075
0.5	0.065
0.5166	0.065
0.5333	0.065
0.55	0.056
0.5666	0.056
0.5833	0.056
0.6	0.046
0.6166	0.046
0.6333	0.046
0.65	0.046
0.6666	0.046
0.6833	0.046
0.7	0.046
0.7166	0.037
0.7333	0.037
0.75	0.037
0.7666	0.037
0.7833	0.037
0.8	0.037
0.8166	0.037
0.8333	0.037
0.85	0.037
0.8666	0.037
0.8833	0.037
0.9	0.028
0.9166	0.028
0.9333	0.028
0.95	0.028
0.9666	0.028
0.9833	0.028
1	0.028

ZWM-96-20X Rising Head Test #2



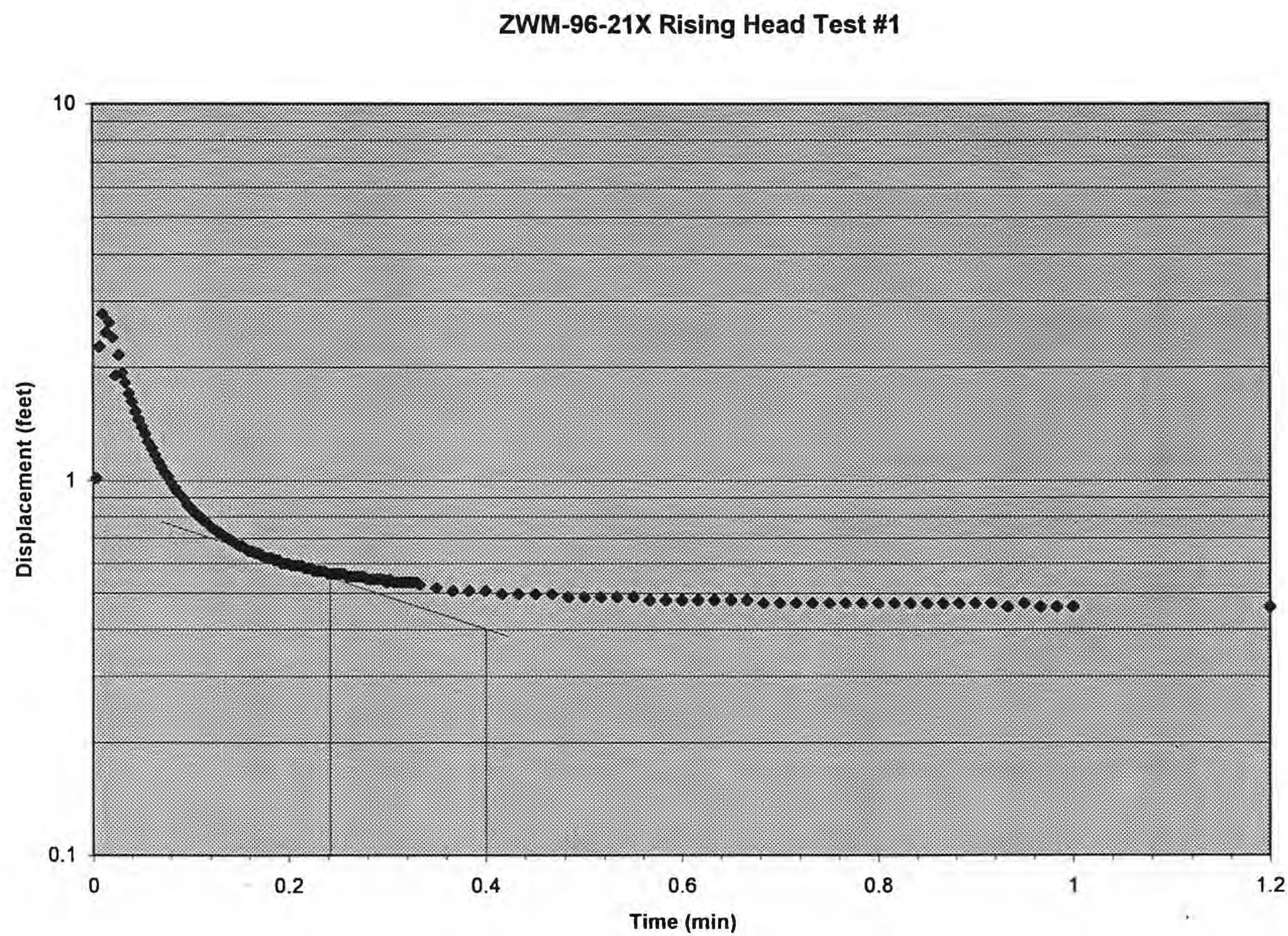
ZWM-96-20X Rising Head Test #2

0	1.107
0.0033	1.529
0.0066	1.576
0.01	1.689
0.0133	1.68
0.0166	1.595
0.02	1.52
0.0233	1.454
0.0266	1.398
0.03	1.332
0.0333	1.295
0.0366	1.248
0.04	1.201
0.0433	1.163
0.0466	1.117
0.05	1.079
0.0533	1.041
0.0566	1.004
0.06	0.976
0.0633	0.938
0.0666	0.91
0.07	0.882
0.0733	0.854
0.0766	0.826
0.08	0.797
0.0833	0.779
0.0866	0.751
0.09	0.732
0.0933	0.704
0.0966	0.685
0.1	0.666
0.1033	0.647
0.1066	0.628
0.11	0.61
0.1133	0.591
0.1166	0.572
0.12	0.563
0.1233	0.544
0.1266	0.525
0.13	0.506
0.1333	0.497
0.1366	0.488
0.14	0.469
0.1433	0.46
0.1466	0.45
0.15	0.431
0.1533	0.422
0.1566	0.413
0.16	0.403
0.1633	0.394
0.1666	0.384

max. drawdown = 1.689 − 0.018 = 1.67 ft.

0.17	0.375
0.1733	0.356
0.1766	0.356
0.18	0.347
0.1833	0.337
0.1866	0.328
0.19	0.319
0.1933	0.309
0.1966	0.3
0.2	0.291
0.2033	0.291
0.2066	0.281
0.21	0.272
0.2133	0.272
0.2166	0.262
0.22	0.253
0.2233	0.253
0.2266	0.244
0.23	0.234
0.2333	0.234
0.2366	0.225
0.24	0.225
0.2433	0.215
0.2466	0.215
0.25	0.206
0.2533	0.206
0.2566	0.197
0.26	0.197
0.2633	0.197
0.2666	0.187
0.27	0.187
0.2733	0.178
0.2766	0.178
0.28	0.178
0.2833	0.169
0.2866	0.169
0.29	0.169
0.2933	0.159
0.2966	0.159
0.3	0.159
0.3033	0.15
0.3066	0.15
0.31	0.15
0.3133	0.14
0.3166	0.14
0.32	0.14
0.3233	0.14
0.3266	0.131
0.33	0.131
0.3333	0.131
0.35	0.112

0.3666	0.103
0.3833	0.093
0.4	0.084
0.4166	0.075
0.4333	0.075
0.45	0.065
0.4666	0.065
0.4833	0.056
0.5	0.056
0.5166	0.056
0.5333	0.047
0.55	0.047
0.5666	0.047
0.5833	0.047
0.6	0.037
0.6166	0.037
0.6333	0.037
0.65	0.037
0.6666	0.037
0.6833	0.037
0.7	0.037
0.7166	0.037
0.7333	0.028
0.75	0.028
0.7666	0.028
0.7833	0.028
0.8	0.028
0.8166	0.028
0.8333	0.028
0.85	0.028
0.8666	0.018
0.8833	0.028
0.9	0.028
0.9166	0.018
0.9333	0.018
0.95	0.018
0.9666	0.028
0.9833	0.018
1	0.018


ZWM-96-21X Rising Head Test #1
10
1
0.1
Displacement (feet)
0
0.2
0.4
0.6
0.8
1
1.2
Time (min)

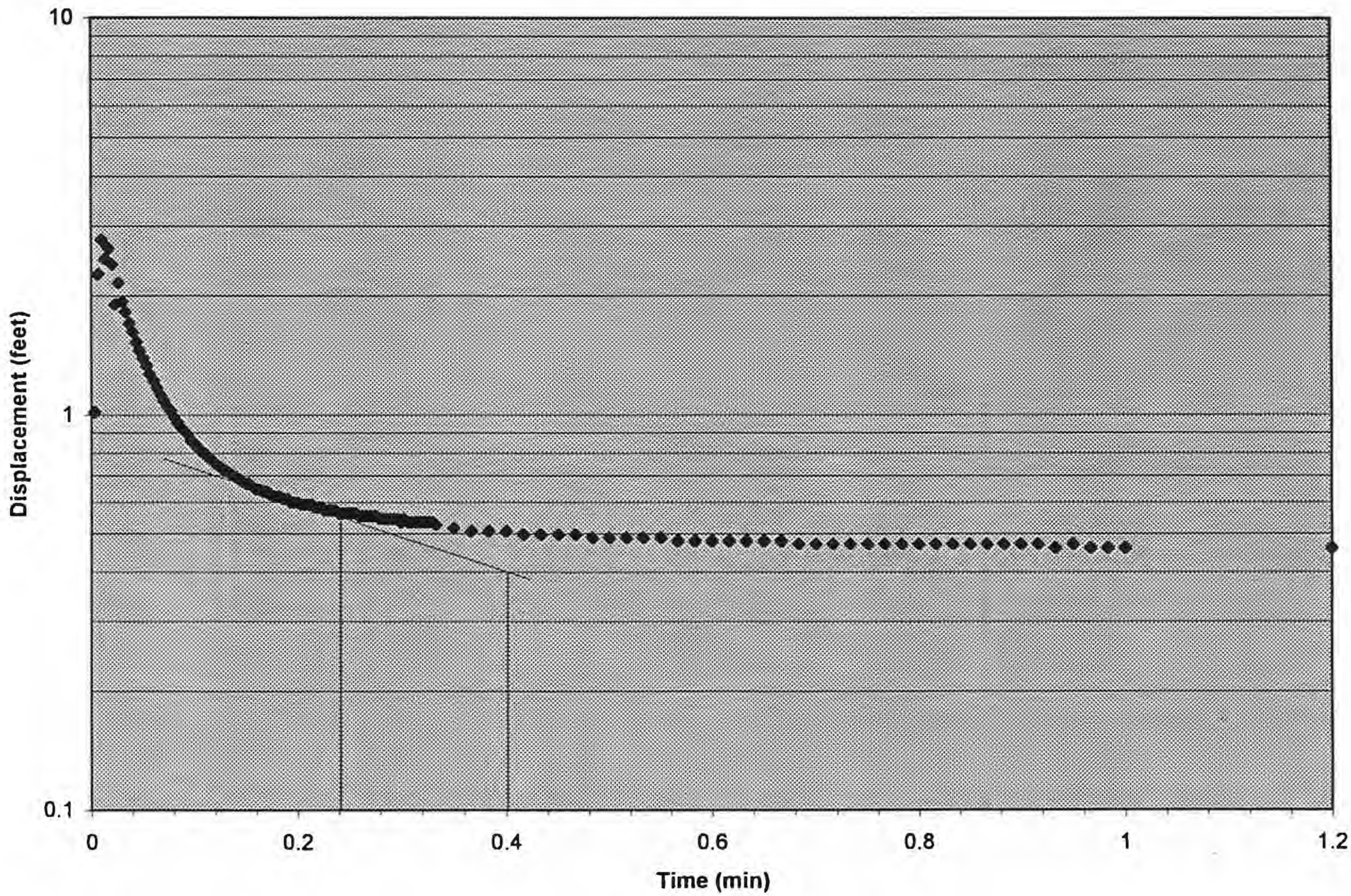
0	0.14
0.0033	0.816
0.0066	1.126
0.01	1.482
0.0133	1.435
0.0166	1.435
0.02	1.567
0.0233	1.773
0.0266	1.783
0.03	1.548
0.0333	1.417
0.0366	1.313
0.04	1.201
0.0433	1.098
0.0466	1.023
0.05	0.957
0.0533	0.9
0.0566	0.844
0.06	0.788
0.0633	0.741
0.0666	0.694
0.07	0.656
0.0733	0.619
0.0766	0.591
0.08	0.563
0.0833	0.534
0.0866	0.506
0.09	0.478
0.0933	0.459
0.0966	0.441
0.1	0.422
0.1033	0.403
0.1066	0.384
0.11	0.375
0.1133	0.356
0.1166	0.347
0.12	0.328
0.1233	0.319
0.1266	0.309
0.13	0.3
0.1333	0.29
0.1366	0.281
0.14	0.272
0.1433	0.262
0.1466	0.253
0.15	0.253
0.1533	0.244
0.1566	0.234
0.16	0.225
0.1633	0.225
0.1666	0.215

max. drawdown = 1.783 - 0.037 = 1.75 ft.

0.17	0.215
0.1733	0.206
0.1766	0.206
0.18	0.197
0.1833	0.197
0.1866	0.187
0.19	0.187
0.1933	0.178
0.1966	0.178
0.2	0.168
0.2033	0.168
0.2066	0.168
0.21	0.159
0.2133	0.159
0.2166	0.159
0.22	0.159
0.2233	0.15
0.2266	0.15
0.23	0.15
0.2333	0.15
0.2366	0.14
0.24	0.14
0.2433	0.14
0.2466	0.14
0.25	0.131
0.2533	0.131
0.2566	0.131
0.26	0.131
0.2633	0.131
0.2666	0.122
0.27	0.122
0.2733	0.122
0.2766	0.122
0.28	0.122
0.2833	0.122
0.2866	0.122
0.29	0.112
0.2933	0.112
0.2966	0.112
0.3	0.112
0.3033	0.112
0.3066	0.112
0.31	0.112
0.3133	0.103
0.3166	0.112
0.32	0.103
0.3233	0.103
0.3266	0.103
0.33	0.103
0.3333	0.103
0.35	0.093

0.3666	0.084
0.3833	0.084
0.4	0.075
0.4166	0.075
0.4333	0.075
0.45	0.065
0.4666	0.065
0.4833	0.065
0.5	0.065
0.5166	0.065
0.5333	0.056
0.55	0.056
0.5666	0.056
0.5833	0.056
0.6	0.056
0.6166	0.056
0.6333	0.056
0.65	0.046
0.6666	0.046
0.6833	0.046
0.7	0.046
0.7166	0.046
0.7333	0.046
0.75	0.046
0.7666	0.046
0.7833	0.046
0.8	0.037
0.8166	0.037
0.8333	0.037
0.85	0.037
0.8666	0.037
0.8833	0.037
0.9	0.037
0.9166	0.037
0.9333	0.037
0.95	0.037
0.9666	0.037
0.9833	0.037
1	0.037

ZWM-96-21X Rising Head Test #2



ZWM-96-21X Rising Head Test #2

0	0.431
0.0033	1.013
0.0066	2.271
0.01	2.768
0.0133	2.477
0.0166	2.637
0.02	2.402
0.0233	1.905
0.0266	2.158
0.03	1.933
0.0333	1.82
0.0366	1.708
0.04	1.623
0.0433	1.529
0.0466	1.454
0.05	1.389
0.0533	1.332
0.0566	1.267
0.06	1.22
0.0633	1.173
0.0666	1.126
0.07	1.088
0.0733	1.051
0.0766	1.023
0.08	0.985
0.0833	0.957
0.0866	0.929
0.09	0.91
0.0933	0.891
0.0966	0.863
0.1	0.844
0.1033	0.825
0.1066	0.807
0.11	0.797
0.1133	0.779
0.1166	0.769
0.12	0.75
0.1233	0.741
0.1266	0.732
0.13	0.722
0.1333	0.713
0.1366	0.703
0.14	0.694
0.1433	0.685
0.1466	0.675
0.15	0.666
0.1533	0.666
0.1566	0.657
0.16	0.647
0.1633	0.647
0.1666	0.638

max. drawdown = 2.768 − 0.431 = 2.34 ft.

0.17	0.638
0.1733	0.628
0.1766	0.619
0.18	0.619
0.1833	0.619
0.1866	0.61
0.19	0.61
0.1933	0.6
0.1966	0.6
0.2	0.6
0.2033	0.591
0.2066	0.591
0.21	0.591
0.2133	0.591
0.2166	0.581
0.22	0.581
0.2233	0.581
0.2266	0.572
0.23	0.572
0.2333	0.572
0.2366	0.572
0.24	0.563
0.2433	0.563
0.2466	0.563
0.25	0.563
0.2533	0.563
0.2566	0.563
0.26	0.553
0.2633	0.553
0.2666	0.553
0.27	0.553
0.2733	0.553
0.2766	0.553
0.28	0.544
0.2833	0.544
0.2866	0.544
0.29	0.544
0.2933	0.544
0.2966	0.544
0.3	0.534
0.3033	0.544
0.3066	0.534
0.31	0.534
0.3133	0.534
0.3166	0.534
0.32	0.534
0.3233	0.534
0.3266	0.534
0.33	0.534
0.3333	0.525
0.35	0.516

0.3666	0.506
0.3833	0.506
0.4	0.506
0.4166	0.497
0.4333	0.497
0.45	0.497
0.4666	0.497
0.4833	0.488
0.5	0.488
0.5166	0.488
0.5333	0.488
0.55	0.488
0.5666	0.478
0.5833	0.478
0.6	0.478
0.6166	0.478
0.6333	0.478
0.65	0.478
0.6666	0.478
0.6833	0.469
0.7	0.469
0.7166	0.469
0.7333	0.469
0.75	0.469
0.7666	0.469
0.7833	0.469
0.8	0.469
0.8166	0.469
0.8333	0.469
0.85	0.469
0.8666	0.469
0.8833	0.469
0.9	0.469
0.9166	0.469
0.9333	0.459
0.95	0.469
0.9666	0.459
0.9833	0.459
1	0.459
1.2	0.459

HYDRAULIC GRADIENT AND GROUNDWATER FLOW VELOCITY CALCULATIONS

HYDRAULIC GRADIENT CALCULATIONS									
AOC 69W									
				December 7, 1995					Horizontal
Distance between wells				Water Levels					Gradient
					δh	/	Dist	=	i
ZWM-95-17X				223.65					
	735	ft			4.08	/	735	=	0.005551
ZWP-95-02X				219.57					
ZWM-95-16X				222.65					
	464	ft			3.18	/	464	=	0.006853
ZWM-95-18X				219.47					
69W--94-10				222.18					
	275	ft			1.6	/	275	=	0.005818
ZWM-95-15X				220.58					
							Average		0.006074
							Geo. Mean		0.00605
							Median		0.00582

HYDRAULIC GRADIENT CALCULATIONS
AOC 69W

Distance between wells			March 26, 1996 Water Levels	δh	/	Dist	=	Horizontal Gradient i
ZWM-95-17X			225.75					
	735	ft		5.45	/	735	=	**0.007415**
ZWP-95-02X			220.3					
ZWM-95-16X			224.45					
	464	ft		4.09	/	464	=	**0.008815**
ZWM-95-18X			220.36					
69W--94-10			223.59					
	275	ft		2.01	/	275	=	**0.007309**
ZWM-95-15X			221.58					
						Average		**0.007846**
						Geo. Mean		**0.00782**
						Median		**0.00741**

HYDRAULIC GRADIENT CALCULATIONS
AOC 69W

Distance between wells			July 23, 1996 Water Levels	δh	/	Dist	=	Horizontal Gradient i
ZWM-95-17X			225.14					
	735	ft		5.02	/	735	=	0.00683
ZWP-95-02X			220.12					
ZWM-95-16X			223.91					
	464	ft		3.84	/	464	=	0.008276
ZWM-95-18X			220.07					
69W--94-10			223.06					
	275	ft		1.82	/	275	=	0.006618
ZWM-95-15X			221.24					
						Average		0.007241
						Geo. Mean		0.00721
						Median		0.00683

HYDRAULIC GRADIENT CALCULATIONS									
AOC 69W									
			January 15,1997					Horizontal	
Distance between wells			Water Levels					Gradient	
				δh	/	Dist	=	i	
ZWM-95-17X			225.95						
	735	ft		5.53	/	735	=	**0.007524**	
ZWP-95-02X			220.42						
ZWM-95-16X			224.5						
	464	ft		4.16	/	464	=	**0.008966**	
ZWM-95-18X			220.34						
69W--94-10			223.6						
	275	ft		2.03	/	275	=	**0.007382**	
ZWM-95-15X			221.57						
						Average		**0.007957**	
						Geo. Mean		**0.00793**	
						Median		**0.00752**	

ESTIMATES OF GROUNDWATER FLOW RATES

$$\bar{V} = \frac{ki}{n}$$

MAXIMUM ESTIMATE

V = Average Linear Velocity
Max K = $3\text{x}10^{-2}$ cm/sec = $5.8\text{x}10^{-2}$ ft/min = 83.5 ft/day
max i = 0.008 ft/ft
n = 0.30

$$\bar{V} = \frac{(83.5\ ft/day)(0.008\ ft/ft)}{0.3} = 2\ ft/day$$

MINIMUM ESTIMATE

Min K = $2.6\text{x}10^{-3}$ ft/min = 3.7 ft/day
min i = 0.006 ft/ft
n = 0.30

$$\bar{V}\ \frac{(3.7\ ft/day)(0.006\ ft/ft)}{0.3} = 0.07\ ft/day$$

GEO. MEAN ESTIMATE

Mean K = $2\text{x}10^{-2}$ ft/min = 28.8 ft/day
mean i = 0.007 ft/ft
n = 0.30

$$\bar{V}\ \frac{(28.8\ ft/day)(0.007\ ft/ft)}{0.3} = 0.7\ ft/day$$

WELL DEVELOPMENT RECORDS

WELL DEVELOPMENT RECORD

Project: Ft. Devens	Well Installation Date:	Project No. 09144-02
Client:	Well Development Date: 10/3/95	Developed by: M. Lounsbury	Checked by:
Well/Site I.D.: ZWM-95-15X	Weather: Sunny 70°	Start Date: 10/3/95	Finish Date: 10/3/95

Well Construction Record Data:

Bottom of Screen ___ ft. — From Ground Surface ☐ From top of Riser ☐

Sediment Sump/Plug ___ ft.

Screen Length 10 ft.

Well Diameter 4 in.

Start Time: 1400 Finish Time: 1515

Fluids Lost During Drilling 0 gal.

Protective Casing Stick-up 2.75 ft. Protective Casing/Well Diff. -0.43 ft.

PID Readings: Ambient Air — ppm; Well Mouth — ppm

Water Levels:

Initial 7.81 ft.

End of Development 7.86 ft.

24 Hrs. After Development 7.72 ft.

Sediment:

Well Depth Before Development 14.14 ft. (from top of PVC)

Well Depth After Development 14.70 ft.

Sediment Depth Removed ~~.56~~ ft. .56

HT of Water Column 6 ft. x ☐ 1.68* ☐ ___ = 1 gal./vol. *For 4" HSA installed wells

Equipment:

☒ Dedicated Submersible Pump
☐ Surge Block
☐ Bailer ☐2" ☐ ___
☐ Grundfos Pump 2" ___ 4" ___

Approximate Recharge Rate 1 gpm

Total Gallons Removed 55 gal.

Well Development Criteria Met:

	yes	no
• Well water clear to unaided eye	☒	☐
• Sediment thickness remaing in well is <1.0% of screen length	☒	☒ note
• Total water removed = a minimum of 5x calculated well volume plus 5x drilling fluid lost	☒	☐

Notes: Very good recharge for well - purge water still slightly silty - almost clear.

End of Well Development Sample (1 pint) Collected? yes ☒ no ☐

Water Parameter Measurments

Record at the start, twice during and at the end of development (minimum):

Time	Volume	Total Gallons	pH	Temp.	Conductivity	Turbidity	Pumping Rate
1400	1	1	6.01	14.7	.295	—	1 gpm.
	2	10	5.88	13.9	.310	~	1 gpm
	3	20	5.77	13.7	.320	94	1 gpm
	4	30	5.68	13.6	.323	80	"
	5	40	5.64	13.5	.328	16	"
1515	6	55	5.62	13.5	1329	—	"

turbidity meter not working

Well Developer's Signature [signature]

ABB Environmental Services, Inc.

9312005S L6

WELL DEVELOPMENT RECORD

Project: Ft. Devens	Well Installation Date:		Project No. 09,44-L
Client:	Well Development Date: 10/2/95	Developed by: M. Lounsbury	Checked by:
Well/Site I.D.: ZWM-95-16X	Weather: Sunny 65°	Start Date: 10/2/95	Finish Date: 10/2/95

Well Construction Record Data:

Bottom of Screen ___ ft. / Sediment Sump/Plug ___ ft. — From Ground Surface ☒ / From top of Riser ☐

Screen Length 10' ft.

Well Diameter 4 in.

Start Time: 8:20 — Finish Time: 940

Fluids Lost During Drilling 0 gal.

Protective Casing Stick-up Flush ft. — Protective Casing/Well Diff. -0.65 ft.

PID Readings: Ambient Air 0 ppm — Well Mouth 3 ppm

Water Levels:

Initial 8.30 ft.

End of Development 14.26 ft.

24 Hrs. After Development 8.61 ft.

HT of Water Column 6 ft. x ☐ 1.68* ☐ ___ = 10 gal./vol. *For 4" HSA installed wells

Sediment:

Well Depth Before Development 14.65 ft. (from top of PVC)

Well Depth After Development 15.60 ft.

Sediment Depth Removed 1 ft.

Equipment:

☒ Dedicated Submersible Pump
☐ Surge Block
☐ Bailer ☐ 2" ☐ ___
☐ Grundfos Pump 2" ___ 4" ___

Approximate Recharge Rate 1 gpm

Total Gallons Removed 55 gal.

Well Development Criteria Met: (yes / no)

- Well water clear to unaided eye — yes ☒
- Sediment thickness remaing in well is <1.0% of screen length — yes ☒
- Total water removed = a minimum of 5x calculated well volume plus 5x drilling fluid lost — yes ☒

Notes: Well recharged Very well, Hear water water running down screen while pumping, Still a Fuel odor to purge water

End of Well Development Sample (1 pint) Collected? yes ☒ no ☐

Water Parameter Measuments

Record at the start, twice during and at the end of development (minimum):

Time	Volume	Total Gallons	pH	Temp.	Conductivity	Turbidity	Pumping Rate
835	0 arrl	1	5.54	16.2	.231	994	1 gal/min
	~~10~~ 1	10	5.94	16.7	.228	999	"
	2	20	6.14	16.8	.228	55	"
	3	30	6.13	16.4	.225	~~0~~ — Almost Clear	"
	4	40	6.16	16.8	.226	— Almost Clear	"
940	5	55	6.14	16.8	.228	— Clear	"

⊗ turbid meter not working properly - well water appeared Clear at the end of Development

Well Developer's Signature [signature]

ABB Environmental Services, Inc.

9312005S L 6

WELL DEVELOPMENT RECORD

Project: Ft. Devens
Well Installation Date:
Project No. 09144-02

Client:
Well Development Date: 10/2/95
Developed by: M. Loundry
Checked by:

Well/Site I.D.: ZWM-95-17X
Weather: Sunny 70°
Start Date: 10/3/95
Finish Date: 10/3/95

Well Construction Record Data:
Well Diameter 4 in.
Start Time: 1110
Finish Time: 1243

Bottom of Screen ___ ft.
Sediment Sump/Plug ___ ft.
Screen Length 10 ft.

]—From Ground Surface ☐ From top of Riser ☐

Fluids Lost During Drilling 0 gal.

Protective Casing Stick-up 2.35 ft. Protective Casing/Well Diff. -0.28 ft.

PID Readings: Ambient Air — ppm; Well Mouth — ppm

Water Levels:
- Initial 17.60 ft.
- End of Development 23.68 ft.
- 24 Hrs. After Development 17.59 ft.

Sediment:
- Well Depth Before Development 23.77 ft. (from top of PVC)
- Well Depth After Development 24.62 ft.
- Sediment Depth Removed ≈1 ft.

HT of Water Column 6 ft. x ☐ 1.68* ☐ ___ = 10 gal./vol. *For 4" HSA installed wells

Equipment:
- ☒ Dedicated Submersible Pump
- ☐ Surge Block
- ☐ Bailer ☐ 2" ☐ ___
- ☐ Grundfos Pump 2" ___ 4" ___

Approximate Recharge Rate 1 gpm
Total Gallons Removed 55 gal.

Well Development Criteria Met:

	yes	no
Well water clear to unaided eye	☒	☐
Sediment thickness remaing in well is <1.0% of screen length	☒	☐
Total water removed = a minimum of 5x calculated well volume plus 5x drilling fluid lost	☒	☐

Notes: Well purged dry, but recharges very well - Still very light Brown Silt in purge water - Barely noticeable.

End of Well Development Sample (1 pint) Collected? yes ☒ no ☐

Water Parameter Measurments

Record at the start, twice during and at the end of development (minimum):

Time	Volume	Total Gallons	pH	Temp.	Conductivity	Turbidity	Pumping Rate
1110	1	1	5.56	13.3	.265	over	1 gpm
	2	10	5.65	12.6	.267	over	1 gpm
	3	20	5.86	12.3	.275	—	1/2 Gpm
	4	30	5.89	12.5	.269	48	1/2 Gpm
	5	40	5.93	12.6	.269	—	1/2 Gpm
1243	6	55	5.90	12.7	.268	—	1/2 Gpm

well purged dry after 30 gals / let recharge and keep purging, recharges well
turbidity not working

Well Developer's Signature [signature]

ABB Environmental Services, Inc.

9312005S L6

WELL DEVELOPMENT RECORD

Project: Ft. Devens	Well Installation Date:	Project No. 09044-02
Client:	Well Development Date: 10/6/95 / Developed by: M Lounsbury	Checked by:
Well/Site I.D.: ZWM-95-18X	Weather: Rain / 60° / Start Date: 10/6/95	Finish Date:
		Start Time: 1055 / Finish Time:

Well Construction Record Data:

Bottom of Screen [ ] ft.
Sediment Sump/Plug [ ] ft.
Screen Length [ ] ft.

From Ground Surface ☐ From top of Riser ☐

Well Diameter 4 in.

Fluids Lost During Drilling [ ] gal.

Protective Casing Stick-up 2.72 ft. Protective Casing/Well Diff. -0.37 ft.

PID Readings: Ambient Air 0 ppm; Well Mouth 0 ppm

Water Levels:
Initial wtr 4.68 ft.
End of Development 4.39 ft.
24 Hrs. After Development 5.17 ft. 10/10/95

HT of Water Column 10 ft. x ☐ 1.68* ☐ ___ = 16 gal./vol. *For 4" HSA installed wells

Sediment:
Well Depth Before Development 15.22 ft.
Well Depth After Development 15.30 ft.
Sediment Depth Removed .08 ft.
(from top of PVC)

Equipment:
☑ Dedicated Submersible Pump
☐ Surge Block
☐ Bailer ☐ 2" ☐ ______
☐ Grundfos Pump 2" ___ 4" ___

Approximate Recharge Rate 1 GPM @ gpm
Total Gallons Removed [ ] gal.

Well Development Criteria Met:

	yes	no
• Well water clear to unaided eye	☑	☐
• Sediment thickness remaing in well is <1.0% of screen length	☑	☐
• Total water removed = a minimum of 5x calculated well volume plus 5x drilling fluid lost	☑	☐

Notes: well recharging very well - not even pumping well down

End of Well Development Sample (1 pint) Collected? yes ☑ no ☐

Water Parameter Measurments

Record at the start, twice during and at the end of development (minimum):

Time	Volume	Total Gallons	pH	Temp.	Conductivity	Turbidity	Pumping Rate
1055	1	1	5.74	13.9	.255	over	@16pm ⊕
	2	16	5.64	13.9	.257	42	"
	3	32	5.69	13.9	.255	18	"
	4	48	5.39	13.9	.266	7	"
	5	64	5.51	13.4	.264	0	"
1200	6	80	5.49	13.8	.272	1	"

Well Developer's Signature [signature]

ABB Environmental Services, Inc.

9312005S L6

WELL DEVELOPMENT RECORD

Project: FORT DEVENS	Well Installation Date: 08/21/96		Project No. 9144.08
Client: US ACE	Well Development Date: 09/10/96	Developed by: CD	Checked by: RKR
Well/Site I.D.: ZWM- ZWM-96-19X (RR)	Weather: DRIZZLE	Start Date: 09/10/96	Finish Date: 09/10/96
Well Construction Record Data:		Start Time: 0830	Finish Time: 08:57

Bottom of Screen 15.8 ft.
Sediment Sump/Plug 16.0 ft.
Screen Length 10 ft.
—From Ground Surface ☑ From top of Riser ☐ CD
Well Diameter 2 in.
Fluids Lost During Drilling — gal.

Protective Casing Stick-up ∅ ft. Protective Casing/Well Diff. 0.44 ft. PID Readings: Ambient Air ∅4 ppm Well Mouth ∅.3 ppm

Water Levels:
Initial 8.45 ft.
End of Development 8.45 ft.
24 Hrs. After Development — ft.

Sediment:
Well Depth Before Development 15.15 ft. (from top of PVC)
Well Depth After Development 15.15 ft.
Sediment Depth Removed ∅ ft.

HT of Water Column 6.7 ft. x ☐ 1.68* ☑ 0.9 = gal./vol. 6 *For 4" HSA installed wells

Equipment:
☑ Dedicated Submersible Pump
☐ Surge Block
☐ Bailer ☐ 2" ☐ ______
☐ Grundfos Pump 2"___ 4"___

Approximate Recharge Rate 1.2 gpm
Total Gallons Removed 32 gal.

Well Development Criteria Met: yes / no
- Well water clear to unaided eye ☑ ☐
- Sediment thickness remaing in well is <1.0% of screen length ☑ ☐
- Total water removed = a minimum of 5x calculated well volume plus 5x drilling fluid lost N/A ☐ ☐

Notes: CONTAINERIZED PURGE WATER DUE TO SHEEN PRESENT ON WATER

End of Well Development Sample (1 pint) Collected? yes ☑ no ☐

Water Parameter Measurments

Record at the start, twice during and at the end of development (minimum):

Time	Volume	Total Gallons	pH	Temp.	Conductivity	Turbidity	REDOX	Pumping Rate
0830	6 gal	6 gal	7.22	15.8	277	455	4.72	1.2 GPM
0840	6 gal	12 gal	6.67	15.4	232	42	546	1.2 GPM
0845	6 gal	18 gal	6.64	15.2	235	22	497	1.2 GPM
0851	6 gal	24 gal	6.56	15.2	233	33	526	1.2 GPM
0857	6 gal	32 gal	6.51	15.2	234	13	562	1.2 GPM

Well Developer's Signature

WELL DEVELOPMENT RECORD
PROJECT OPERATIONS PLAN
FORT DEVENS, MASSACHUSETTS
ABB Environmental Services, Inc.

9312005S L6

WELL DEVELOPMENT RECORD

Project: FT DEVENS	Well Installation Date: 08/02/96		Project No. 9144.08
Client: USACE	Well Development Date: 09/10/96	Developed by: C. DeVogt	Checked by: RRR
Well/Site I.D.: ZMW-96-20X	Weather: OVERCAST / HUMID	Start Date: 09/10/96	Finish Date: 09/10/96
		Start Time: 1333	Finish Time: 1406

Well Construction Record Data:

Bottom of Screen 12.8 ft.
Sediment Sump/Plug 13.0 ft. — From Ground Surface ☑ From top of Riser ☐
Screen Length 10 ft.

Well Diameter 2 in.

Fluids Lost During Drilling 0 gal.

Protective Casing Stick-up Ø ft. Protective Casing/Well Diff. 0.51 ft. PID Readings: Ambient Air 0.0 ppm; Well Mouth 0.0 ppm

Water Levels:

Initial 2.88 ft.
End of Development 2.96 ft.
24 Hrs. After Development —— ft.

Sediment:

Well Depth Before Development 11.72 ft. (from top of PVC)
Well Depth After Development 12.23 ft.
Sediment Depth Removed 0.51 ft.

HT of Water Column 8.84 ft. x ☐ 1.68* ☑ 0.9 = gal./vol. 10 *For 4" HSA installed wells

Equipment:

☑ Dedicated Submersible Pump
☐ Surge Block
☐ Bailer ☐ 2" ☐ ______
☐ Grundfos Pump 2"___ 4"___

Approximate Recharge Rate 1.6 gpm
Total Gallons Removed 50 gal.

Well Development Criteria Met:

	yes	no
• Well water clear to unaided eye	☑	☐
• Sediment thickness remaing in well is <1.0% of screen length	☑	☐
• Total water removed = a minimum of 5x calculated well volume plus 5x drilling fluid lost (NA)	☐	☐

Notes: ______

End of Well Development Sample (1 pint) Collected? yes ☑ no ☐

Water Parameter Measurments

Record at the start, twice during and at the end of development (minimum):

Time	Volume	Total Gallons	pH	Temp.	Conductivity	Turbidity	Redox	Pumping Rate
1333	10 gal	10 gal	6.44	20.5	257	40	3.38	
1341	10 gal	20 gal	6.45	20.0	260	3	3.57	
1349	10 gal	30 gal	6.38	19.8	258	0	3.50	
1357	10 gal	40 gal	6.35	19.7	259	0	3.90	
1405	10 gal	50 gal	6.36	19.6	259	2	3.96	

Well Developer's Signature ______

WELL DEVELOPMENT RECORD
PROJECT OPERATIONS PLAN
FORT DEVENS, MASSACHUSETTS
ABB Environmental Services, Inc.

9312005S L6

WELL DEVELOPMENT RECORD

Project: FT DEVENS	Well Installation Date: 08/26/96		Project No. 9144.08
Client: USACE	Well Development Date: 09/10/96	Developed by: C Daley	Checked by: RRR
Well/Site I.D.: ZWM ~~ZWM~~-96-21X	Weather: OVERCAST / HUMID	Start Date: 09/10/96	Finish Date: 09/10/96
		Start Time: 1040	Finish Time: 1100

Well Construction Record Data:

- Bottom of Screen: 14.8 ft.
- Sediment Sump/Plug: 15.0 ft.
- Screen Length: 10 ft.
- From Ground Surface ☑
- Well Diameter: 2 in.
- From top of Riser ~~TOC~~
- Fluids Lost During Drilling: 0 gal.

Protective Casing Stick-up: Ø ft. Protective Casing/Well Diff.: 0.4 ft. PID Readings: Ambient Air Ø.3 ppm; Well Mouth Ø.3 ppm

Water Levels:

- Initial: 8.10 ft.
- End of Development: 8.10 ft.
- 24 Hrs. After Development: — ft.

Sediment:

- Well Depth Before Development: 14.15 ft. (from top of PVC)
- Well Depth After Development: 14.15 ft.
- Sediment Depth Removed: Ø ft.

HT of Water Column: 6.05 ft. x ☐ 1.68* ☑ 0.9 = gal./vol. 5.8 *For 4" HSA installed wells

Equipment:

- ☑ Dedicated Submersible Pump
- ☐ Surge Block
- ☐ Bailer ☐ 2" ☐ ______
- ☐ Grundfos Pump 2" ___ 4" ___

Approximate Recharge Rate: 1.2 gpm

Total Gallons Removed: 30 gal.

Well Development Criteria Met:

	yes	no
• Well water clear to unaided eye	☑	☐
• Sediment thickness remaing in well is <1.0% of screen length	☑	☐
• Total water removed = a minimum of 5x calculated well volume plus 5x drilling fluid lost (NA)	☐	☐

Notes: CONTAINERIZED PURGED WATER

End of Well Development Sample (1 pint) Collected? yes ☑ no ☐

Water Parameter Measurments

Record at the start, twice during and at the end of development (minimum):

Time	Volume	Total Gallons	pH	Temp.	Conductivity	Turbidity	REDOX	Pumping Rate
1040	6 gal	6 gal	6.69	18.1	194	9	425	1.2 gpm
1045	6 gal	12 gal	6.50	17.6	194	3	443	1.2 gpm
1050	6 gal	18 gal	6.33	17.4	195	1	326	1.2 gpm
1055	6 gal	24 gal	6.25	17.4	198	0	433	1.2 gpm
1100	6 gal	30 gal	6.25	17.2	199	Ø	391	1.2 gpm

Well Developer's Signature: [signature]

WELL DEVELOPMENT RECORD
PROJECT OPERATIONS PLAN
FORT DEVENS, MASSACHUSETTS
ABB Environmental Services, Inc.

9312005S L6

FIELD SAMPLE DATA RECORDS (GROUNDWATER)

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: Rain 45°

LOCATION ACTIVITY: START 1415 END 1530

SITE ID: 69W-94-09X | FIELD SAMPLE NUMBER: MX2W09X3 PP | DATE: 11/2/95 | STUDY AREA (AOC): ~~63AX~~ SSW

WATER LEVEL / WELL DATA

WELL DEPTH: 12.60 FT
WATER DEPTH: 7.71 FT
HEIGHT OF WATER COLUMN: 5 FT

MEASURED FROM: [X] TOP OF WELL [ ] TOP OF CASING

WELL DIAMETER = 2"

[X] x 1.68 gal/ft (4" well) = 5 GAL/VOL
[ ] x ____ gal/ft (well)

PID HEADSPACE READINGS

BREATHING ZONE: — ppm
WELL HEAD: — ppm

PROTECTIVE CASING STICK-UP FROM GROUND: Flush FT

WELL INTEGRITY

	YES	NO
PROTECTIVE CASING SECURE		X
WELL LOCKED		X
PVC WELL CAP PRESENT	X	

POTECTIVE CASINGE/WELL DIFFERENCE: -0.37 FT

PURGE DATA								
VOLUME #	1	2	3	4	5			
GALLONS	5	10	15	20	25			
TEMPERATURE, deg. C	17.4	17.6	17.8	17.8	17.9			
pH units	6.16	6.02	5.98	6.01	5.97			
SPECIFIC CONDUCTIVITY, umho/cm	.244	.244	.242	.242	.241			
TURBIDITY' ntu	563	953	290	1	0			
REDOX (AT COMPLETION OF PURGING)								

SAMPLE OBSERVATION: [ ] CLEAR [X] TURBID [ ] COLORED ____ [ ] ODOR [ ] OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	X	UM18	MS	4C	2- 1L AG	A B CONTROL # 269 P
PEST./PCBS	X	UW19	EC	4C	2- 1L AG	C D
VOC	X	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	X	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	X	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	X	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	X	418.1	C	H2SO4 pH<2	2- 1L AG	M N

[ ] IF MS/MSD COLLECTED
[ ] IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED:
[X] ELECTRIC CONDUCTIVITY PROBE
[ ] FLOAT ACTIVATED
[ ] OTHER ____

PURGING	SAMPLING	
X	X	DEDICATED SUBMIRSABLE PUMP (WHALE)
	X	DEDICATED TEFLON BAILER
	X	IN-LINE FILTER (INORGANICS)
		OTHER ____

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

Alot of Sand and Leaves In well - purged out as much as we could before sampling

SAMPLERS SIGNATURE: [signature]

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: Rain Drizzle, 45° | LOCATION ACTIVITY: START 800 END 845

SITE ID: 69W-94-10X | FIELD SAMPLE NUMBER: MX2W10X3 | DATE: 11/2/95 | STUDY AREA (AOC): ~~63AX~~ 69W

WATER LEVEL / WELL DATA

WELL DEPTH	12.76	FT
WATER DEPTH	7.79	FT
HEIGHT OF WATER COLUMN	5	FT

MEASURED FROM: [X] TOP OF WELL [ ] TOP OF CASING

WELL DIAMETER = 2"

[X] x 1.68 gal/ft (4" well) [ ] x ____ gal/ft (well) = 5 GAL/VOL

PID HEADSPACE READINGS

BREATHING ZONE: — ppm

WELL HEAD: — ppm

PROTECTIVE CASING STICK-UP FROM GROUND: Flush FT

WELL INTEGRITY

	YES	NO
PROTECTIVE CASING SECURE	X	
WELL LOCKED		X
PVC WELL CAP PRESENT	X	

POTECTIVE CASINGE/WELL DIFFERENCE: -0.25 FT

PURGE DATA

VOLUME #	1	2	3	4	5			
GALLONS	5	10	15	20	25			
TEMPERATURE, deg. C	16.8	16.7	17.0	16.9	16.9			
pH units	6.32	6.29	6.27	6.26	6.27			
SPECIFIC CONDUCTIVITY, umho/cm	.304	.311	.296	.302	.298			
TURBIDITY' ntu	32	2	1	5	0			

REDOX (AT COMPLETION OF PURGING) 25.2 - Last purge value

SAMPLE OBSERVATION

[ ] CLEAR
[X] TURBID
[ ] COLORED
[X] ODOR ~ Fuel
[ ] OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	X	UM18	MS	4C	2- 1L AG	A B CONTROL # 271A
PEST./PCBS	X	UW19	EC	4C	2- 1L AG	C D
VOC	X	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	X	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	X	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	X	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	X	418.1	C	H2SO4 pH<2	2- 1L AG	M N

[X] IF MS/MSD COLLECTED
[ ] IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED:

[X] ELECTRIC CONDUCTIVITY PROBE
[ ] FLOAT ACTIVATED
[ ] OTHER ____

PURGING	SAMPLING	
X	X	DEDICATED SUBMIRSABLE PUMP (WHALE)
	X	DEDICATED TEFLON BAILER
	X	IN-LINE FILTER (INORGANICS)
		OTHER ____

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

Purge water Containerized due to Strong fuel odor, Fuel Sheen on purge water - PID - Down

SAMPLERS SIGNATURE Michael H. [signature]

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: CLOUDY, LIGHT SNOW | LOCATION ACTIVITY: START 0940 END 1030

SITE ID: 69W-94-10X | FIELD SAMPLE NUMBER: MXZW10X4 | DATE: 14 FEB 96 | STUDY AREA (AOC): 69

WATER LEVEL / WELL DATA

WELL DEPTH: 12.00 FT
WATER DEPTH: 4.77 FT
HEIGHT OF WATER COLUMN: 7.23 FT

MEASURED FROM: [x] TOP OF WELL [ ] TOP OF CASING

WELL DIAMETER = 2" ID

[ ] x 1.68 gal/ft (4" well) = 5 GAL/VOL
[x] x ___ gal/ft (2" well)

PID HEADSPACE READINGS

BREATHING ZONE: 0 ppm
WELL HEAD: 0 ppm
PROTECTIVE CASING STICK-UP FROM GROUND: (FLUSH) FT

WELL INTEGRITY

	YES	NO
PROTECTIVE CASING SECURE	✓	
WELL LOCKED		✓
PVC WELL CAP PRESENT	✓	

POTECTIVE CASINGE/WELL DIFFERENCE: ___ FT

PURGE DATA

VOLUME #	1	2	3	4	5			
GALLONS	5	10	15	20	25			
TEMPERATURE, deg. C	6.9°	7.8°	8.0°	8.1°	8.2°			
pH units	5.77	5.72	5.72	5.73	5.74			
SPECIFIC CONDUCTIVITY, umho/cm	0.415	0.389	0.372	0.362	0.376			
TURBIDITY' ntu	2	1	1	1	0			
REDOX (AT COMPLETION OF PURGING)		15						

SAMPLE OBSERVATION

[x] CLEAR
[ ] TURBID
[ ] COLORED
[x] ODOR
[ ] OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	✓	UM18	MS	4C	2- 1L AG	A B CONTROL #272
PEST./PCBS	✓	UW19	EC	4C	2- 1L AG	C D
VOC	✓	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	✓	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	✓	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	✓	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	✓	418.1	C	H2SO4 pH<2	1- 1L Poly	M N

[ ] IF MS/MSD COLLECTED
[ ] IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED:
[x] ELECTRIC CONDUCTIVITY PROBE
[ ] FLOAT ACTIVATED
[x] OTHER OIL/WATER INTERFACE PROBE

	PURGING	SAMPLING
DEDICATED SUBMIRSABLE PUMP (WHALE)	✓	✓
DEDICATED TEFLON BAILER		✓
IN-LINE FILTER (INORGANICS)		✓
OTHER ___		

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

- NO PRODUCT IN WELL, STRONG PETROLEUM ODOR -

SAMPLERS SIGNATURE [signature]

PROJECT: USAEC - FT. DEVENS
FIELD SAMPLE NUMBER: MXZW10X5
STUDY AREA/AOC: AOC 69W
SITE ID: 69W-94-10
SITE TYPE: WELL
SAMPLING DATE: 9/30/96-10/1
1106 10/1/96
JOB NUMBER: 9144-08
FILE TYPE: CGW
LOCATION ACTIVITY: START 10:15 END 10:20
WEATHER: Sunny High 60s

WATER LEVEL / WELL DATA

TOP OF WELL / TOP OF CASING: PVC
PROTECTIVE CASING STICK-UP (FROM GROUND): FLUSH FT
PROTECTIVE CASING/WELL DIFF.: FT

WELL DEPTH: 14.54 FT — MEASURED / HISTORICAL
WATER DEPTH: 5.63 FT
HEIGHT OF WATER COLUMN: 8.91 FT
NA GAL/VOL
12 TOTAL GAL PURGED
1.68 gal/ft (4")
___ gal/ft

WELL INTEGRITY: YES NO N/A
PROT. CASING SECURE
CONCRETE COLLAR INTACT
WELL LOCKED
PVC WELL CAP

WELL DIAMETER: 2 INCH / 4 INCH / ___ INCH

11:15
PID READINGS: AMBIENT AIR 0 PPM; WELL MOUTH 0 PPM
18.7 PPM Headspace

START Level 5.82

(Water level)	5.84	5.82	5.81	5.81	5.81	5.81	5.81	5.81	5.81
PURGE DATA — Time	11:17	11:22	1127	1132	1137	1142	11:47	1152	1157
GALLONS	1	1.5	2	2.5	3.0	3.5	4.0	4.5	6.0
PUMPING RATE (GPM)	300 ml/m	300 ml/m	300 ml/m	300 ml/m	100 ml/m	100 ml/m	150 ml/m	200 ml/m	250 ml/m
TEMP, DEG C	18.8	18.7	18.8	18.8	18.8	18.8	18.7	18.8	18.9
pH, UNITS (pH PAPER)	6.48	6.43	6.49	6.46	6.50	6.51	6.50	6.50	6.52
SPECIFIC CONDUCTIVITY, umhos/cm	.371	.357	.347	.339	.332	.326	.321	.317	.315
TURBIDITY, ntu	6	10	6	6	6	1	0	0	0
REDOX (~~@ COMPLETION OF PURGING~~)	38	76	43	44	60	63	188	177	184
D.O.	-0.59	-0.63	-0.54	-0.45	-0.43	-0.42	-0.34	-0.40	-0.36

(Redox Probe IN Cell)

SAMPLE OBSERVATIONS: (ODOr) (Petro)
CLEAR / CLOUDY / COLORED / TURBID / ODOR / OTHER (SEE NOTES)
BACK

EQUIPMENT DOCUMENTATION

PURGING / SAMPLING
PERISTALTIC PUMP — EQUIPMENT ID ISCO #
DEDICATED SUBMERSIBLE PUMP 2" 4" #
BAILER
PVC/SILICON TUBING
IN-LINE/DISPOSABLE FILTER 0.45 um
OTHER

DECON FLUIDS USED: POTABLE WATER; LIQUINOX; STEAM CLEANING
WATER LEVEL EQUIP. USED: ELECTRIC COND. PROBE; PRESSURE TRANSDUCER
NUMBER OF FILTERS USED: 1

Sample Time 1218

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS
VOC	UM20	VP	HCL, 4 DEG C	(4) 60 ML		
SVOC	UM18	MS	4 DEG C	(2) 1 L AG		
PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG		
	UH13					
PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE		
LEAD ONLY	SD20	N	HNO3 TO pH<2			
EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG		
	UW32					
TPHC	418.1	O	H2SO4 TO pH<2	1 L AG		
TOC	415.1	O	H2SO4 TO pH<2	1 L AG		
ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE		
	TT10	C	4 DEG C	1 L P-CUBE		
	310.1	N	HNO3 TO pH<2	1 L P-CUBE		
TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE		
H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE		
		C	4 DEG C	1 L P-CUBE		
		N	HNO3 TO pH<2	1 L P-CUBE		
COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE		

WATer Level when finished 5.75

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

MS/MSD FOR EAL-VPH PARAMETERS

SAMPLED BY: M. ROONEY P. BYRNES
RECEIVED BY: R. RUSTAD

Drummed
4.5 GALS
+ 4.5 + 3 = 12 gallons in Drum

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: cloudy, drizzle, 50°F | LOCATION ACTIVITY: START 1015 END 1120

SITE ID: 69W--94--11X | FIELD SAMPLE NUMBER: MX2W11X3 | DATE: 11/3/95 | STUDY AREA (AOC): AOC 69W

WATER LEVEL / WELL DATA		MEASURED FROM		PID HEADSPACE READINGS		WELL INTEGRITY	YES	NO
WELL DEPTH	14.5 FT	TOP OF WELL		BREATHING ZONE	0 ppm	PROTECTIVE CASING SECURE	X	
WATER DEPTH	7.12 FT	TOP OF CASING	(bgs)	WELL HEAD	12.5 ppm	WELL LOCKED	X	
HEIGHT OF WATER COLUMN	6.5 FT	WELL DIAMETER =	4"			PVC WELL CAP PRESENT	X	
[X] x 1.68 gal/ft (4" well) =	12.2 GAL/VOL			PROTECTIVE CASING STICK-UP FROM GROUND	flush FT	POTECTIVE CASINGE/WELL DIFEERENCE	FT	
[ ] x ____ gal/ft (well)								

PURGE DATA									SAMPLE OBSERVATION
VOLUME #	initial	1	2	3	4	5			
GALLONS	3	12.2	24.4	36.6	48.8	61 gal			[X] CLEAR
TEMPERATURE, deg. C	15.6	16.4	16.5	16.8	16.6	16.5			[ ] TURBID
pH units	6.30	6.35	6.29	6.28	6.30	6.33			[ ] COLORED ____
SPECIFIC CONDUCTIVITY, umho/cm	278	271	283	284	284	283			[X] ODOR
TURBIDITY' ntu	620	10	0	0	0	0			[ ] OTHER (SEE NOTES)
REDOX (AT COMPLETION OF PURGING) *									

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
						CONTROL # 273
SVOCS	X	UM18	MS	4C	2- 1L AG	A B
PEST./PCBS	X	UW19	EC	4C	2- 1L AG	C D
VOC	X	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	X	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	X	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	X	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	X	418.1	C	H2SO4 pH<2	2- 1L AG	M N

[ ] IF MS/MSD COLLECTED

[ ] IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT	PURGING	SAMPLING	
	[ ]	[X]	DEDICATED SUBMIRSABLE PUMP (WHALE)
	[ ]	[X]	DEDICATED TEFLON BAILER
	[ ]	[X]	IN-LINE FILTER (INORGANICS)
	[ ]	[ ]	OTHER ____

WATER LEVEL EQUIPMENT USED:

- [ ] ELECTRIC CONDUCTIVITY PROBE
- [ ] FLOAT ACTIVATED
- [ ] OTHER ____

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

* some pet. odor, but headspace was 4.
* redox meter malfunction - not working properly

SAMPLERS SIGNATURE: F. Dame

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: CLOUDY, LIGHT SNOW, 20's | LOCATION ACTIVITY: START 0817 END 0910

SITE ID: 69W--94--11X | FIELD SAMPLE NUMBER: MXZW11X4 | DATE: 14 FEB 96 | STUDY AREA (AOC): 69

WATER LEVEL / WELL DATA		MEASURED FROM	PID HEADSPACE READINGS		WELL INTEGRITY	YES	NO
WELL DEPTH	12.60 FT	✓ TOP OF WELL	BREATHING ZONE	0 ppm	PROTECTIVE CASING SECURE	✓	
WATER DEPTH	4.15 FT	TOP OF CASING	WELL HEAD	0 ppm	WELL LOCKED		✓
HEIGHT OF WATER COLUMN	8.45 FT	WELL DIAMETER = 4" ID			PVC WELL CAP PRESENT	✓	
✓ x 1.68 gal/ft (4" well) = / x ___ gal/ft (well)	15 GAL/VOL		PROTECTIVE CASING STICK-UP FROM GROUND	(FLUSH) FT	POTECTIVE CASINGE/WELL DIFFERENCE	FT	

PURGE DATA	1	2	3	4	5			
GALLONS	15	30	45	60	75			
TEMPERATURE, deg. C	11.5	11.4	11.2	11.2	11.2			
pH units	5.71	5.66	5.54	5.52	5.50			
SPECIFIC CONDUCTIVITY, umho/cm	0.283	0.253	0.253	0.255	0.254			pw
TURBIDITY' ntu	2	1	0	0	0			
REDOX (AT COMPLETION OF PURGING)								

SAMPLE OBSERVATION: ✓ CLEAR; TURBID; COLORED ___; ODOR; OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	✓	UM18	MS	4C	2- 1L AG	A B CONTROL #274
PEST./PCBS	✓	UW19	EC	4C	2- 1L AG	C D
VOC	✓	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	✓	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	✓	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	✓	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	✓	418.1	C	H2SO4 pH<2	1- 1L Poly	M N

IF MS/MSD COLLECTED
✓ IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED:
- ✓ ELECTRIC CONDUCTIVITY PROBE
- FLOAT ACTIVATED
- OTHER ___

PURGING	SAMPLING	
✓	✓	DEDICATED SUBMIRSABLE PUMP (WHALE)
	✓	DEDICATED TEFLON BAILER
	✓	IN-LINE FILTER (INORGANICS)
		OTHER ___

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

SAMPLERS SIGNATURE [signature]

PROJECT: USAEC - FT. DEVENS	FIELD SAMPLE NUMBER: MXZW11X5	STUDY AREA/AOC: AOC 69W
SITE ID: 69W-94-11	SITE TYPE: WELL	SAMPLING DATE: 9/30/96-10/1/
	JOB NUMBER: 9144-08	FILE TYPE: CGW
LOCATION ACTIVITY: START 10:22 END 10:24		WEATHER: SUNNY HIGH 60'S

Sampled 10/1/96

WATER LEVEL / WELL DATA

WELL DEPTH: 13.17 FT — MEASURED / HISTORICAL

WATER DEPTH: 5.09 FT

HEIGHT OF WATER COLUMN: ~~8.91~~ 8.08 FT

TOP OF WELL / TOP OF CASING / ☒ Top of PVC

PROTECTIVE CASING STICK-UP (FROM GROUND): FLUSH FT

PROTECTIVE CASING/WELL DIFF.: ____ FT

(NA) GAL/VOL

9.75 TOTAL GAL PURGED

WELL INTEGRITY: YES / NO / N/A

- PROT. CASING SECURE
- CONCRETE COLLAR INTACT
- WELL LOCKED
- PVC WELL CAP

WELL DIAMETER: 2 INCH / 4 INCH / ___ INCH

☒ 1.68 gal/ft (4") 4.04 ft from bottom

☐ ___ gal/ft

PID READINGS: AMBIENT AIR 0 PPM; WELL MOUTH 0 PPM

started sampling 12:03

water level	5.22	5.22	5.23	5.24	5.24				
PURGE DATA time ~~VOLUME #~~	11:25	11:35	11:45	11:55	12:00				
GALLONS	1.5	3.0	3.8	5.0	6.0				
PUMPING RATE (ml/min)	390	150	490	490	490				
TEMP, DEG C	17.6	17.6	17.4	17.3	17.4				
pH, UNITS ☐ pH PAPER	6.20	6.20	6.20	6.19	6.19				
SPECIFIC CONDUCTIVITY, umhos/cm	0.260	0.259	0.258	0.259	0.258				
TURBIDITY, ntu	~~100~~ 10 0	0	0	0	0				
REDOX (@ COMPLETION OF PURGING): +/- mv	287	321	329	3.33	331				
D.O.	3.69	3.23	2.80	3.03	2.91				

final water level 5.19 12:30

SAMPLE OBSERVATIONS: ☒ CLEAR ☐ CLOUDY ☐ COLORED ☐ TURBID ☐ ODOR ☐ OTHER (SEE NOTES)

EQUIPMENT DOCUMENTATION

PURGING / SAMPLING

- ☑ ☑ PERISTALTIC PUMP — EQUIPMENT ID ISCO #
- ☑ ☑ DEDICATED SUBMERSIBLE PUMP
- ☐ ☐ BAILER ☐ 2" ☐ 4" #
- ☑ ☑ PVC/SILICON TUBING
- ☐ ☑ IN-LINE/DISPOSABLE FILTER 0.45 μm
- ☐ ☐ OTHER

DECON FLUIDS USED: ☑ POTABLE WATER ☐ LIQUINOX ☐ STEAM CLEANING

NUMBER OF FILTERS USED: 1

WATER LEVEL EQUIP. USED: ☑ ELECTRIC COND. PROBE ☐ PRESSURE TRANSDUCER

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS BOTTLE
						REFER TO SAMP MGMNT SYSTEM
☐ VOC	UM20	VP	HCL, 4 DEG C	(4) 60 ML	☐	
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG	☐	
☐ PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	☐	
	UH13					
☐ PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	☐	
☐ LEAD ONLY	SD20	N	HNO3 TO pH<2		☐	
☐ EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	☐	
	UW32					
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☐	
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☐	
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐	
	TT10	C	4 DEG C	1 L P-CUBE	☐	
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐	
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐	
☐ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☐	
		C	4 DEG C	1 L P-CUBE	☐	
		N	HNO3 TO pH<2	1 L P-CUBE	☐	
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐	

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: M ROONEY P BYRNES

RECEIVED BY: R. RUSTAD

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: Rain 45° PP

LOCATION ACTIVITY: START 1600 END 1645

SITE ID: 69W--94--12X | FIELD SAMPLE NUMBER: MX2W12X3 | DATE: 11/2/95 | STUDY AREA (AOC): 69W

WATER LEVEL / WELL DATA

WELL DEPTH: 15.68 FT

WATER DEPTH: 9.03 FT

HEIGHT OF WATER COLUMN: 6 FT

MEASURED FROM: [ ] TOP OF WELL [ ] TOP OF CASING

WELL DIAMETER = 2"

[X] x 1.68 gal/ft (4" well) = 6 GAL/VOL
[ ] x ____ gal/ft (well)

PID HEADSPACE READINGS

BREATHING ZONE: — ppm

WELL HEAD: — ppm

PROTECTIVE CASING STICK-UP FROM GROUND: 2.7 FT

WELL INTEGRITY

	YES	NO
PROTECTIVE CASING SECURE	X	
WELL LOCKED	X	
PVC WELL CAP PRESENT	X	

POTECTIVE CASINGE/WELL DIFFERENCE: -0.55 FT

PURGE DATA VOLUME #	1	2	3	4	5			
GALLONS	6	12	18	24	30			
TEMPERATURE, deg. C	14.6	14.8	14.7	14.7	14.8			
pH units	6.13	6.02	6.01	6.00	6.00			
SPECIFIC CONDUCTIVITY, umho/cm	.252	.256	.256	.257	.258			
TURBIDITY' ntu	8	1	0	0	2			
REDOX (AT COMPLETION OF PURGING)	359.5 - Last purge volume							

SAMPLE OBSERVATION

[X] CLEAR
[ ] TURBID
[ ] COLORED ____
[ ] ODOR
[ ] OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	X	UM18	MS	4C	2- 1L AG	A B CONTROL # 275 PP
PEST./PCBS	X	UW19	EC	4C	2- 1L AG	C D
VOC	X	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	X	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	X	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	X	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	X	418.1	C	H2SO4 pH<2	2- 1L AG	M N

[ ] IF MS/MSD COLLECTED
[X] IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED:

[X] ELECTRIC CONDUCTIVITY PROBE
[ ] FLOAT ACTIVATED
[ ] OTHER ____

PURGING	SAMPLING	
X	X	DEDICATED SUBMIRSABLE PUMP (WHALE)
	X	DEDICATED TEFLON BAILER
	X	IN-LINE FILTER (INORGANICS)
		OTHER ____

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

SAMPLERS SIGNATURE: Michael H. [signature]

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE	CGW	SITE TYPE	WELL	JOB NUMBER	9144-02

PROJECT	USAEC-FT. DEVENS
WEATHER	CLEAR, 20's
LOCATION ACTIVITY	START 1005 END 1035
SITE ID	69W--94--12X
FIELD SAMPLE NUMBER	MXZW12X4
DATE	13 FEB 95
STUDY AREA (AOC)	69

WATER LEVEL / WELL DATA

WELL DEPTH	14.70 FT
WATER DEPTH	6.38 FT
HEIGHT OF WATER COLUMN	8.32 FT
x 1.68 gal/ft (4" well) / x ___ gal/ft (2" well) =	6 GAL/VOL

MEASURED FROM: [✓] TOP OF WELL [ ] TOP OF CASING

WELL DIAMETER = 2" ID

PID HEADSPACE READINGS

BREATHING ZONE	0 ppm
WELL HEAD	0 ppm
PROTECTIVE CASING STICK-UP FROM GROUND	2.50 FT
POTECTIVE CASINGE/WELL DIFFERENCE	-0.16 FT

WELL INTEGRITY

	YES	NO
PROTECTIVE CASING SECURE	✓	
WELL LOCKED	✓	
PVC WELL CAP PRESENT	✓	

PURGE DATA

VOLUME #	1	2	3	4	5			
GALLONS	6	12	18	24	30			
TEMPERATURE, deg. C	6.1°	6.7°	6.9°	6.7°	6.9°			
pH units	6.02	5.73	5.57	5.53	5.57			
SPECIFIC CONDUCTIVITY, umho/cm	0.220	0.212	0.211	0.208	0.205			
TURBIDITY' ntu	4	0	0	0	0			
REDOX (AT COMPLETION OF PURGING)		215						

SAMPLE OBSERVATION

[✓] CLEAR
[~~✓~~] TURBID
[ ] COLORED ______
[ ] ODOR
[ ] OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	✓	UM18	MS	4C	2- 1L AG	A B CONTROL ~~#280~~ 276
PEST./PCBS	✓	UW19	EC	4C	2- 1L AG	C D
VOC	✓	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	✓	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	✓	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	✓	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	✓	418.1	C	H2SO4 pH<2	1- 1L Poly	M N

[✓] IF MS/MSD COLLECTED
[ ] IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED:

[✓] ELECTRIC CONDUCTIVITY PROBE
[ ] FLOAT ACTIVATED
[ ] OTHER ______

PURGING	SAMPLING	
✓	✓	DEDICATED SUBMIRSABLE PUMP (WHALE)
	✓	DEDICATED TEFLON BAILER
	✓	IN-LINE FILTER (INORGANICS)
		OTHER ______

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

- WATER TURBID DURING 3-5 GALLONS -
- LABELLING ERROR / COLLECTED MS/MSD AT 1130 HRS -

SAMPLERS SIGNATURE [signature]

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE	CGW	SITE TYPE	WELL
JOB NUMBER	9144-02		
PROJECT	USAEC-FT. DEVENS	WEATHER	Rain drizzle - 45°
LOCATION ACTIVITY	START 945	END 1045	
SITE ID	69W-94-13X	FIELD SAMPLE NUMBER	MXZW13X3
DATE	11/2/95	STUDY AREA (AOC)	~~63AX~~ 69W

WATER LEVEL / WELL DATA

WELL DEPTH	15.95 FT	MEASURED FROM	[X] TOP OF WELL [ ] TOP OF CASING
WATER DEPTH	9.03 FT	WELL DIAMETER =	2 inch
HEIGHT OF WATER COLUMN	7 FT		
[X] x 1.68 gal/ft (4" well) = / [ ] x ___ gal/ft (well)	14 GAL/VOL		

PID HEADSPACE READINGS

BREATHING ZONE	— ppm
WELL HEAD	— ppm
PROTECTIVE CASING STICK-UP FROM GROUND	2.7 FT
POTECTIVE CASINGE/WELL DIFFERENCE	-0.25 FT

WELL INTEGRITY

	YES	NO
PROTECTIVE CASING SECURE	X	
WELL LOCKED	X	
PVC WELL CAP PRESENT	X	

PURGE DATA VOLUME #	1	2	3	4	5			
GALLONS	14	28	42	56	70			
TEMPERATURE, deg. C	15.3	15.7	15.9	15.9	14.6			
pH units	6.33	6.26	6.24	6.23	6.23			
SPECIFIC CONDUCTIVITY, umho/cm	.366	.354	.352	.340	.334			
TURBIDITY' ntu	29	3	0	0	6			
REDOX (AT COMPLETION OF PURGING)	455 - Last purge Volume							

SAMPLE OBSERVATION

- [ ] CLEAR
- [X] TURBID
- [ ] COLORED
- [ ] ODOR
- [ ] OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	X	UM18	MS	4C	2- 1L AG	A B CONTROL # 277P
PEST./PCBS	X	UW19	EC	4C	2- 1L AG	C D
VOC	X	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	X	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	X	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	X	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	X	418.1	C	H2SO4 pH<2	2- 1L AG	M N

[ ] IF MS/MSD COLLECTED
[ ] IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED:

- [X] ELECTRIC CONDUCTIVITY PROBE
- [ ] FLOAT ACTIVATED
- [ ] OTHER ________

PURGING	SAMPLING	
X	X	DEDICATED SUBMIRSABLE PUMP (WHALE)
	X	DEDICATED TEFLON BAILER
	X	IN-LINE FILTER (INORGANICS)
		OTHER ________

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

purge water Containerized due to fuel odor - PID - Down

SAMPLERS SIGNATURE [signature]

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: CLEAR, 20's | LOCATION ACTIVITY: START 0830 END 0930

SITE ID: 69W-94-13X | FIELD SAMPLE NUMBER: MXZW13X4 | DATE: 13 FEB 96 | STUDY AREA (AOC): 69

WATER LEVEL / WELL DATA		MEASURED FROM		PID HEADSPACE READINGS		WELL INTEGRITY	YES	NO
WELL DEPTH	5' 21 FT	✓	TOP OF WELL	BREATHING ZONE	0 ppm	PROTECTIVE CASING SECURE	✓	
WATER DEPTH	16.0 FT		TOP OF CASING	WELL HEAD	0 ppm	WELL LOCKED	✓	
HEIGHT OF WATER COLUMN	10.79 FT	WELL DIAMETER =	4" ID			PVC WELL CAP PRESENT	✓	

✓ x 1.68 gal/ft (4" well) = 18 GAL/VOL
☐ x ____ gal/ft (well)

PROTECTIVE CASING STICK-UP FROM GROUND: 2.70 FT

POTECTIVE CASINGE/WELL DIFFERENCE: 0.25 FT

PURGE DATA								
VOLUME #	1	2	3	4	5			
GALLONS	18	36	54	72	90			
TEMPERATURE, deg. C	6.5°	6.0°	6.0°	6.5°	6.4°			
pH units	5.95	6.00	6.10	6.00	5.99			
SPECIFIC CONDUCTIVITY, umho/cm	0.264	0.267	0.263	0.265	0.262			
TURBIDITY' ntu	1	0	0	0	0			
REDOX (AT COMPLETION OF PURGING)		*						

SAMPLE OBSERVATION
- ✓ CLEAR
- ☐ TURBID
- ☐ COLORED ______
- ☐ ODOR
- ✓ OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	✓	UM18	MS	4C	2- 1L AG	A B CONTROL #278
PEST./PCBS	✓	UW19	EC	4C	2- 1L AG	C D
VOC	✓	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	✓	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	✓	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	✓	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	✓	418.1	C	H2SO4 pH<2	1- 1L Poly	M N

☐ IF MS/MSD COLLECTED
☐ IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED:
- ✓ ELECTRIC CONDUCTIVITY PROBE
- ☐ FLOAT ACTIVATED
- ☐ OTHER ______

PURGING	SAMPLING	
✓	✓	DEDICATED SUBMIRSABLE PUMP (WHALE)
	✓	DEDICATED TEFLON BAILER
	✓	IN-LINE FILTER (INORGANICS)
		OTHER ______

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

- WATER TURBID FOR FIRST 5 GALLONS
- DELAY IN TAKING READINGS FOR FIRST VOLUME

* DIDN'T HAVE REDOX METER

SAMPLERS SIGNATURE: [signature]

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: CLOUDY, 20's | LOCATION ACTIVITY: START 1550 END 1615

SITE ID: 69W-94-14X | FIELD SAMPLE NUMBER: MXZW14X4 | DATE: 13 FEB 96 | STUDY AREA (AOC): 69

WATER LEVEL / WELL DATA

WELL DEPTH: 14.0 FT

WATER DEPTH: 6.0 FT

HEIGHT OF WATER COLUMN: 8.0 FT

MEASURED FROM: [x] TOP OF WELL [ ] TOP OF CASING

WELL DIAMETER = 2" ID

[ ] x 1.68 gal/ft (4" well) = 6 GAL/VOL
[x] x ___ gal/ft (2" well)

PID HEADSPACE READINGS

BREATHING ZONE: 0 ppm

WELL HEAD: 0 ppm

PROTECTIVE CASING STICK-UP FROM GROUND: ___ FT

WELL INTEGRITY

	YES	NO
PROTECTIVE CASING SECURE	✓	
WELL LOCKED	✓	
PVC WELL CAP PRESENT	✓	

POTECTIVE CASINGE/WELL DIFFERENCE: ___ FT

PURGE DATA

VOLUME #	1	2	3	4	5			
GALLONS	6	12	18	24	30			
TEMPERATURE, deg. C	4.8°	5.4°	5.5°	5.7°	5.7°			
pH units	5.80	5.74	5.73	5.71	5.72			
SPECIFIC CONDUCTIVITY, umho/cm	0.219	0.221	0.221	0.221	0.221			
TURBIDITY' ntu	0	0	0	0	0			
REDOX (AT COMPLETION OF PURGING)	8							

SAMPLE OBSERVATION: [x] CLEAR [ ] TURBID [ ] COLORED ___ [ ] ODOR [ ] OTHER (SEE NOTES)

SAMPLE PARAMETERS

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	✓	UM18	MS	4C	2- 1L AG	A B CONTROL #280
PEST./PCBS	✓	UW19	EC	4C	2- 1L AG	C D
VOC	✓	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	✓	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	✓	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	✓	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	✓	418.1	C	H2SO4 pH<2	1- 1L Poly	M N

[ ] IF MS/MSD COLLECTED
[ ] IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED:

[x] ELECTRIC CONDUCTIVITY PROBE
[ ] FLOAT ACTIVATED
[ ] OTHER ___

PURGING	SAMPLING	
✓	✓	DEDICATED SUBMIRSABLE PUMP (WHALE)
	✓	DEDICATED TEFLON BAILER
	✓	IN-LINE FILTER (INORGANICS)
		OTHER ___

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

SAMPLERS SIGNATURE: [signature]

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: Rain, 40° | LOCATION ACTIVITY: START 1530 END 1615

SITE ID: 2WM--95--15X | FIELD SAMPLE NUMBER: MX2WL5X1 | DATE: 1/1/95 | STUDY AREA (AOC): 69W

WATER LEVEL / WELL DATA

WELL DEPTH	—	FT
WATER DEPTH	6.81	FT
HEIGHT OF WATER COLUMN	—	FT

MEASURED FROM: [X] TOP OF WELL [ ] TOP OF CASING

WELL DIAMETER = 4"

[X] x 1.68 gal/ft (4" well) = 15 GAL/VOL
[ ] x ____ gal/ft (well)

PID HEADSPACE READINGS

BREATHING ZONE: — ppm
WELL HEAD: — ppm

PROTECTIVE CASING STICK-UP FROM GROUND: 2.6 FT

WELL INTEGRITY

	YES	NO
PROTECTIVE CASING SECURE	X	
WELL LOCKED	X	
PVC WELL CAP PRESENT	X	

POTECTIVE CASINGE/WELL DIFFERENCE: ~0.42 FT

PURGE DATA

VOLUME #	1	2	3	4	5			
GALLONS	15	30	45	60	75			
TEMPERATURE, deg. C	12.4	13.2	13.3	13.2	13.3			
pH units	6.06	5.91	5.89	5.87	5.84			
SPECIFIC CONDUCTIVITY, ~~umho~~ mS/cm	.330	.330	.328	.328	.328			
TURBIDITY' ntu	1	0	0	0	0			

REDOX (AT COMPLETION OF PURGING): 199.5 - LAST Volume

SAMPLE OBSERVATION

[X] CLEAR
[ ] TURBID
[ ] COLORED
[X] ODOR - Fuel
[ ] OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	X	UM18	MS	4C	2- 1L AG	A B CONTROL # 281
PEST./PCBS	X	UW19	EC	4C	2- 1L AG	C D
VOC	X	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	X	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	X	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	X	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	X	418.1	C	H2SO4 pH<2	2- 1L AG	M N

[ ] IF MS/MSD COLLECTED
[ ] IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED:
[X] ELECTRIC CONDUCTIVITY PROBE
[ ] FLOAT ACTIVATED
[ ] OTHER ____

PURGING	SAMPLING	
X	X	DEDICATED SUBMIRSABLE PUMP (WHALE)
	X	DEDICATED TEFLON BAILER
	X	IN-LINE FILTER (INORGANICS)
		OTHER ____

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

PID- Down, well containerized due to Fuel-odor

SAMPLERS SIGNATURE: [signature]

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: CLEAR, 20's | LOCATION ACTIVITY: START 1245 END 1400

SITE ID: ZWM-95-15X | FIELD SAMPLE NUMBER: MXZW15X2 | DATE: 15 FEB 96 | STUDY AREA (AOC): 69

WATER LEVEL / WELL DATA		MEASURED FROM	PID HEADSPACE READINGS		WELL INTEGRITY	YES	NO
WELL DEPTH	14.50 FT	✓ TOP OF WELL	BREATHING ZONE	0 ppm	PROTECTIVE CASING SECURE	✓	
WATER DEPTH	4.43 FT	TOP OF CASING	WELL HEAD	0 ppm	WELL LOCKED	✓	
HEIGHT OF WATER COLUMN	10.07 FT	WELL DIAMETER = 4" ID			PVC WELL CAP PRESENT	✓	

✓ x 1.68 gal/ft (4" well) = 16 GAL/VOL
x ____ gal/ft (well)

PROTECTIVE CASING STICK-UP FROM GROUND: 2.75 FT

POTECTIVE CASINGE/WELL DIFFERENCE: -0.40 FT

PURGE DATA VOLUME #	1	2	3	4	5			
GALLONS	16	32	48	64	80			
TEMPERATURE, deg. C	7.1°	7.9°	8.1°	8.4°	8.5°			
pH units	5.97	5.80	5.80	5.75	5.75			
SPECIFIC CONDUCTIVITY, umho/cm	0.253	0.253	0.254	0.254	0.253			
TURBIDITY' ntu	0	0	0	0	0			RM
REDOX (AT COMPLETION OF PURGING)		89						

SAMPLE OBSERVATION
- ✓ CLEAR
- TURBID
- COLORED ____
- ODOR
- OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	✓	UM18	MS	4C	2- 1L AG	A B CONTROL #282
PEST./PCBS	✓	UW19	EC	4C	2- 1L AG	C D
VOC	✓	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	✓	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	✓	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	✓	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	✓	418.1	C	H2SO4 pH<2	1- 1L Poly	M N

IF MS/MSD COLLECTED

IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED:
- ✓ ELECTRIC CONDUCTIVITY PROBE
- FLOAT ACTIVATED
- OTHER ____

PURGING	SAMPLING	
✓	✓	DEDICATED SUBMIRSABLE PUMP (WHALE)
	✓	DEDICATED TEFLON BAILER
	✓	IN-LINE FILTER (INORGANICS)
		OTHER ____

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

- WATER TURBID AT FIRST, CLEAR AFTER 2 GALLONS

SAMPLERS SIGNATURE [signature]

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: Rain 40° | LOCATION ACTIVITY: START 1345 END 1500

SITE ID: 2WM--95--16X | FIELD SAMPLE NUMBER: MXZW16X1 (PP) | DATE: 11/1/95 | STUDY AREA (AOC): 69W

WATER LEVEL / WELL DATA		MEASURED FROM		PID HEADSPACE READINGS		WELL INTEGRITY	YES	NO
WELL DEPTH	15.32 FT	X	TOP OF WELL	BREATHING ZONE	— ppm	PROTECTIVE CASING SECURE	X	
WATER DEPTH	7.61 FT		TOP OF CASING	WELL HEAD	— ppm	WELL LOCKED		X
HEIGHT OF WATER COLUMN	8 FT	WELL DIAMETER =	4"			PVC WELL CAP PRESENT	X	
[X] x 1.68 gal/ft (4" well) = / [ ] x ___ gal/ft (well)	15 GAL/VOL			PROTECTIVE CASING STICK-UP FROM GROUND	Flush FT	POTECTIVE CASINGE/WELL DIFFERENCE	-0.67 FT	

PURGE DATA	VOLUME #	1	2	3	4	5			
	GALLONS	15	30	45	60	75			
TEMPERATURE, deg. C		15.8	16.0	16.2	16.1	16.1			
pH units		6.55	6.48	6.43	6.43	6.42			
SPECIFIC CONDUCTIVITY, ~~umho~~/cm mS		.284	.273	.270	.269	.267			
TURBIDITY' ntu		4	0	0	0	0			
REDOX (AT COMPLETION OF PURGING)			1864	LAST Volume					

SAMPLE OBSERVATION: [X] CLEAR; [ ] TURBID; [ ] COLORED ____; [ ] ODOR; [ ] OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	X	UM18	MS	4C	2- 1L AG	A B CONTROL # 283 PP
PEST./PCBS	X	UW19	EC	4C	2- 1L AG	C D
VOC	X	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	X	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	X	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	X	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	X	418.1	C	H2SO4 pH<2	2- 1L AG	M N

[ ] IF MS/MSD COLLECTED

[ ] IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED:

- [X] ELECTRIC CONDUCTIVITY PROBE
- [ ] FLOAT ACTIVATED
- [ ] OTHER ____

PURGING	SAMPLING	
X	X	DEDICATED SUBMIRSABLE PUMP (WHALE)
	X	DEDICATED TEFLON BAILER
	X	IN-LINE FILTER (INORGANICS)
		OTHER ____

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

PID-Down, well Containerized due to Strong Fuel odor

SAMPLERS SIGNATURE [signature]

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: CLEAR, 20s | LOCATION ACTIVITY: START 1415 END 1515

SITE ID: ZWM-95-16X | FIELD SAMPLE NUMBER: MXZW16XZ | DATE: 13 FEB 96 | STUDY AREA (AOC): 69

WATER LEVEL / WELL DATA

WELL DEPTH	14.50 FT
WATER DEPTH	4.43 FT
HEIGHT OF WATER COLUMN	10.07 FT
☑ x 1.68 gal/ft (4" well) =	16 GAL/VOL
☐ x ___ gal/ft (well)	

MEASURED FROM: ☑ TOP OF WELL ☐ TOP OF CASING

WELL DIAMETER = 4" ID

PID HEADSPACE READINGS

BREATHING ZONE: 0 ppm

WELL HEAD: 0 ppm

PROTECTIVE CASING STICK-UP FROM GROUND: (FLUSH) FT

WELL INTEGRITY

	YES	NO
PROTECTIVE CASING SECURE	✓	
WELL LOCKED		✓
PVC WELL CAP PRESENT	✓	

POTECTIVE CASINGE/WELL DIFFERENCE: -0.50 FT

PURGE DATA VOLUME #	1	2	3	4	5
GALLONS	16	32	48	64	80
TEMPERATURE, deg. C	7.9°	8.0°	8.4°	8.9°	8.7°
pH units	6.14	6.06	5.95	5.96	5.96
SPECIFIC CONDUCTIVITY, umho/cm	0.190	0.196	0.188	0.190	0.190
TURBIDITY' ntu	77	0	0	0	0
REDOX (AT COMPLETION OF PURGING)	98				

SAMPLE OBSERVATION: ☑ CLEAR ☐ TURBID ☐ COLORED ☐ ODOR ☐ OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	✓	UM18	MS	4C	2- 1L AG	A B CONTROL #284
PEST./PCBS	✓	UW19	EC	4C	2- 1L AG	C D
VOC	✓	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	✓	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	✓	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	✓	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	✓	418.1	C	H2SO4 pH<2	1- 1L Poly	M N

☐ IF MS/MSD COLLECTED ☐ IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED: ☑ ELECTRIC CONDUCTIVITY PROBE ☐ FLOAT ACTIVATED ☐ OTHER ______

PURGING	SAMPLING	
✓	✓	DEDICATED SUBMIRSABLE PUMP (WHALE)
	✓	DEDICATED TEFLON BAILER
	✓	IN-LINE FILTER (INORGANICS)
		OTHER

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

- WATER TURBID AT FIRST (2 GALLONS)
- LEAF INSIDE WELL

SAMPLERS SIGNATURE: Rafael [signature]

1.60

PROJECT	USAEC - FT. DEVENS	FIELD SAMPLE NUMBER	MXZW16X3	STUDY AREA/AOC	AOC 69W
SITE ID	ZW-95-16X	SITE TYPE	WELL	SAMPLING DATE	~~9/30/96~~ 10/1
	9:15 10/1/96	JOB NUMBER	9144.08	FILE TYPE	CGW
LOCATION ACTIVITY	START ~~10:40~~ ~~0900~~ END 1040			WEATHER	SUNNY CLEAR MID 60s

WATER LEVEL / WELL DATA

WELL DEPTH 15.48 FT ☑ MEASURED ☐ HISTORICAL

☐ TOP OF WELL ☒ TOP OF CASING PVC

PROTECTIVE CASING STICK-UP (FROM GROUND) NA FT

PROTECTIVE CASING/WELL DIFF. FT

WATER DEPTH 9.32 FT

NA GAL/VOL

6.5 TOTAL GAL PURGED

HEIGHT OF WATER COLUMN 6.16 FT

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE	☑	☐	☐
CONCRETE COLLAR INTACT	☐	☐	☑
WELL LOCKED	☐	☐	☐
PVC WELL CAP	☑	☐	☐

WELL DIAMETER ☐ 2 INCH ☑ 4 INCH ☐ __ INCH

☑ 1.68 gal/ft (4") 3.02
☐ ____ gal/ft

PID READINGS: AMBIENT AIR 0 PPM WELL MOUTH 0 PPM

PURGE DATA	Level	5.44	5.44	5.44	5.44	5.44	5.44		
Time VOLUME #		9:25	9:30	935	940	0945	950		
GALLONS			3.5	4.0	4.5	5.0	5.3		
(ml/min) PUMPING RATE ~~(GPM)~~		250 ml/m	250 ml	250 ml	250	250 ml/m	250 mL		
TEMP, DEG C		16.3	16.7	16.7	16.7	16.7	16.8		
pH, UNITS ☐ pH PAPER		6.48	6.48	6.49	6.50	6.50	6.50		
SPECIFIC CONDUCTIVITY, umhos/cm		.172	.183	.191	.194	0.196	.195		
TURBIDITY, ntu		0	0	0	0	0	0		
REDOX (~~@ COMPLETION OF PURGING~~):		219	245 mv	246	229	228	230		
D.O.		-0.14	-0.16	-0.22	-0.25	-0.22	-0.24		

SAMPLE OBSERVATIONS
☑ CLEAR
☐ CLOUDY
☐ COLORED ____
☐ TURBID
☐ ODOR
☐ OTHER (SEE NOTES)

Headspace = 0

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
☐	☐	PERISTALTIC PUMP	ISCO # ____
☑	☑	DEDICATED SUBMERSIBLE PUMP	☐ 2" ☐ 4" # ___
☐	☐	BAILER	
☐	☑	PVC/SILICON TUBING	
	☑	IN-LINE/DISPOSABLE FILTER 0.45 um	
☐	☐	OTHER ____	

DECON FLUIDS USED
☑ POTABLE WATER
☐ LIQUINOX
☐ STEAM CLEANING
____

NUMBER OF FILTERS USED 1

WATER LEVEL EQUIP. USED
☑ ELECTRIC COND. PROBE
☐ PRESSURE TRANSDUCER
____

10:00 sample Time

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
☐ VOC	UM20	VP	HCL, 4 DEG C	(4) 60 ML	☐		
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG	☐		
☐ PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	☐		
	UH13						
☐ PAL INORGANICS (see notes)		M	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ LEAD ONLY	SD20	M	HNO3 TO pH<2		☐		
☐ EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	☐		
	UW32						
☑ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☑	514 / 514	
☑ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☑	514	
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐		
	TT10	C	4 DEG C	1 L P-CUBE	☐		
	310.1	M	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐		
☑ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☑	514	
		C	4 DEG C	1 L P-CUBE	☑	514	
		M	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐		
☑ EPH-VPH, Biorem Params					☑	514	

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: M. Rooney
RECEIVED BY: R. Rustad

Redox Cal 242

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: Cloudy, drizzle, 50°F | LOCATION ACTIVITY: START 0745 END 0954

SITE ID: ZWM-95-17X | FIELD SAMPLE NUMBER: MXZW17X1 | DATE: 11/3/95 | STUDY AREA (AOC): AOC 69W

WATER LEVEL / WELL DATA

WELL DEPTH	20.1	FT
WATER DEPTH	17	FT
HEIGHT OF WATER COLUMN	3	FT

MEASURED FROM: [ ] TOP OF WELL [X] TOP OF CASING

WELL DIAMETER = 4"

[X] x 1.68 gal/ft (4" well) = 12.8 GAL/VOL TOTAL
[ ] x ____ gal/ft (well)

PID HEADSPACE READINGS

BREATHING ZONE: 0 ppm
WELL HEAD: 0.2 ppm

PROTECTIVE CASING STICK-UP FROM GROUND: 2.30 FT

POTECTIVE CASINGE/WELL DIFFERENCE: -0.28 FT

WELL INTEGRITY

	YES	NO
PROTECTIVE CASING SECURE	X	
WELL LOCKED	X	
PVC WELL CAP PRESENT	X	

PURGE DATA

VOLUME #	initial	1	2	3	4	5		
GALLONS	3	12.8	25.6	36.4	49.2	64		
TEMPERATURE, deg. C	12°	11.9	11.7	11.7	11.9	12.0		
pH units	6.27	6.51	6.40	6.49	6.56	6.57		
SPECIFIC CONDUCTIVITY, umho/cm	264	257	259	259	260	262		
TURBIDITY' ntu	0	0	0	0	0	0		
REDOX (AT COMPLETION OF PURGING)	*							

SAMPLE OBSERVATION

[X] CLEAR
[ ] TURBID
[ ] COLORED
[ ] ODOR
[ ] OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	X	UM18	MS	4C	2- 1L AG	A, B CONTROL # 285
PEST./PCBS	X	UW19	EC	4C	2- 1L AG	C, D
VOC	X	UM20	VP	HCL,4C	4- 40 ml AG	E, F, G, H
INORGANICS-UNFILTERED	X	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	X	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	X	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	X	418.1	C	H2SO4 pH<2	2- 1L AG	M, N

[ ] IF MS/MSD COLLECTED
[ ] IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED:
[ ] ELECTRIC CONDUCTIVITY PROBE
[ ] FLOAT ACTIVATED
[ ] OTHER ____

	PURGING	SAMPLING
DEDICATED SUBMIRSABLE PUMP (WHALE)		X
DEDICATED TEFLON BAILER		X
IN-LINE FILTER (INORGANICS)		X
OTHER ____		

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

* Redox meter not working — Redox not Taken

SAMPLERS SIGNATURE: D. Dame

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: Partly windy, 30's | LOCATION ACTIVITY: START 1502 END 1630

SITE ID: ZWM-95-17X | FIELD SAMPLE NUMBER: MXZW17X2 | DATE: 12 FEB 95 | STUDY AREA (AOC): 69

WATER LEVEL / WELL DATA		MEASURED FROM		PID HEADSPACE READINGS		WELL INTEGRITY	YES	NO
WELL DEPTH	24.64 FT	✓	TOP OF WELL	BREATHING ZONE	0 ppm	PROTECTIVE CASING SECURE	✓	
WATER DEPTH	13.39 FT		TOP OF CASING	WELL HEAD	0 ppm	WELL LOCKED	✓	
HEIGHT OF WATER COLUMN	11.25 FT	WELL DIAMETER =	4" ID			PVC WELL CAP PRESENT	✓	

☑ x 1.68 gal/ft (4" well) = 20 GAL/VOL
☐ x ____ gal/ft (well)

PROTECTIVE CASING STICK-UP FROM GROUND: 2.24 FT

POTECTIVE CASINGE/WELL DIFFERENCE: - 0.30 FT

PURGE DATA								
VOLUME #	1	2	3	4	5			
GALLONS	20	40	60	80	100			
TEMPERATURE, deg. C	9.9°	10.7°	10.9°	11.0°	11.0°			
pH units	6.17	6.34	6.34	6.35	6.35			
SPECIFIC CONDUCTIVITY, umho/cm	0.258	0.261	0.263	0.259	0.258			
TURBIDITY' ntu	0	0	0	0	0			
REDOX (AT COMPLETION OF PURGING)		210						

RW

SAMPLE OBSERVATION
- ☑ CLEAR
- ☐ TURBID
- ☐ COLORED ____
- ☐ ODOR
- ☐ OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	✓	UM18	MS	4C	2- 1L AG	A B CONTROL #286
PEST./PCBS	✓	UW19	EC	4C	2- 1L AG	C D
VOC	✓	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	✓	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	✓	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	✓	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	✓	418.1	C	H2SO4 pH<2	1- 1L Poly	M N

☐ IF MS/MSD COLLECTED
☐ IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED:
- ☑ ELECTRIC CONDUCTIVITY PROBE
- ☐ FLOAT ACTIVATED
- ☐ OTHER ____

PURGING	SAMPLING	
✓	✓	DEDICATED SUBMIRSABLE PUMP (WHALE)
	✓	DEDICATED TEFLON BAILER
	✓	IN-LINE FILTER (INORGANICS)
		OTHER ____

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

SAMPLERS SIGNATURE: Roland L. Loge

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: Rain, 45° | LOCATION ACTIVITY: START 1100 END 1200

SITE ID: ZWM-95-18X | FIELD SAMPLE NUMBER: MXZW18X1 PP | DATE: 11/2/95 | STUDY AREA (AOC): ~~63AV~~ 69W

WATER LEVEL / WELL DATA		MEASURED FROM	
WELL DEPTH	15.19 FT	[X]	TOP OF WELL
WATER DEPTH	4.78 FT	[ ]	TOP OF CASING
HEIGHT OF WATER COLUMN	10 FT	WELL DIAMETER =	4"

[X] x 1.68 gal/ft (4" well) = 8 GAL/VOL
[ ] x ____ gal/ft (well)

PID HEADSPACE READINGS

- BREATHING ZONE: — ppm
- WELL HEAD: — ppm
- PROTECTIVE CASING STICK-UP FROM GROUND: 2.5 FT

WELL INTEGRITY	YES	NO
PROTECTIVE CASING SECURE	X	
WELL LOCKED	X	
PVC WELL CAP PRESENT	X	

POTECTIVE CASINGE/WELL DIFFERENCE: -0.38 FT

PURGE DATA VOLUME #	1	2	3	4	5			
GALLONS	18	36	54	72	90			
TEMPERATURE, deg. C	13.1	13.3	13.3	13.3	12.7			
pH units	5.87	5.77	5.75	5.67	5.74			
SPECIFIC CONDUCTIVITY, umho/cm	.276	.278	.279	.280	.277			
TURBIDITY' ntu	0	0	0	0	0			
REDOX (AT COMPLETION OF PURGING)	196.5 - LAST Volume							

MHL 11/2/95

SAMPLE OBSERVATION

- [X] CLEAR
- [ ] TURBID
- [ ] COLORED ______
- [ ] ODOR
- [ ] OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	X	UM18	MS	4C	2- 1L AG	A B CONTROL # 287 PP
PEST./PCBS	X	UW19	EC	4C	2- 1L AG	C D
VOC	X	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	X	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	X	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	X	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	X	418.1	C	H2SO4 pH<2	2- 1L AG	M N

[ ] IF MS/MSD COLLECTED
[ ] IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

WATER LEVEL EQUIPMENT USED:

- [X] ELECTRIC CONDUCTIVITY PROBE
- [ ] FLOAT ACTIVATED
- [ ] OTHER ______

PURGING	SAMPLING	
X	X	DEDICATED SUBMIRSABLE PUMP (WHALE)
	X	DEDICATED TEFLON BAILER
	X	IN-LINE FILTER (INORGANICS)
		OTHER ______

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

SAMPLERS SIGNATURE: Michael H. Long

ABB ENVIRONMENTAL SERVICES, INC.

FIELD DATA RECORD - GROUNDWATER

FILE TYPE: CGW | SITE TYPE: WELL | JOB NUMBER: 9144-02

PROJECT: USAEC-FT. DEVENS | WEATHER: Sunny, 40's | LOCATION ACTIVITY: START 1315 END 1420

SITE ID: ZWM--95--18X | FIELD SAMPLE NUMBER: MXZW18X2 | DATE: 12 FEB 96 | STUDY AREA (AOC): 69

WATER LEVEL / WELL DATA

WELL DEPTH	15.0 FT	MEASURED FROM: ✓ TOP OF WELL	
WATER DEPTH	2.75 FT	TOP OF CASING	
HEIGHT OF WATER COLUMN	12.25 FT	WELL DIAMETER = 4" ID	
✓ x 1.68 gal/ft (4" well) =	20 GAL/VOL		
x ____ gal/ft (well)			

PID HEADSPACE READINGS

BREATHING ZONE	0 ppm
WELL HEAD	0 ppm
PROTECTIVE CASING STICK-UP FROM GROUND	2.50 FT
POTECTIVE CASINGE/WELL DIFFERENCE	-1.36 FT

WELL INTEGRITY

	YES	NO
PROTECTIVE CASING SECURE	✓	
WELL LOCKED	✓	
PVC WELL CAP PRESENT	✓	

PURGE DATA

VOLUME #	1	2	3	4	5			
GALLONS	20	40	60	80	100			
TEMPERATURE, deg. C	9.7°	9.6°	9.2°	9.5°	9.3°			
pH units	5.70	5.96	5.94	5.94	5.98			
SPECIFIC CONDUCTIVITY, umho/cm	0.298	0.258	0.239	0.236	0.236			
TURBIDITY' ntu	0	0	0	0	0			
REDOX (AT COMPLETION OF PURGING)	207							

SAMPLE OBSERVATION: ✓ CLEAR; TURBID; COLORED ____; ODOR; OTHER (SEE NOTES)

SAMPLE PARAMETERS	COLLECTED	METHOD #	FRACTION CODE	PRESERVATIVE	VOLUME	SAMPLE BOTTLE NUMBER
SVOCS	✓	UM18	MS	4C	2- 1L AG	A B CONTROL #288
PEST./PCBS	✓	UW19	EC	4C	2- 1L AG	C D
VOC	✓	UM20	VP	HCL,4C	4- 40 ml AG	E F G H
INORGANICS-UNFILTERED	✓	*	N	HNO3 pH<2	1- 1L Poly	I
INORGANICS-FILTERED	✓	*	NF	HNO3 pH<2	1- 1L Poly	J
WATER QUALITY PARAM. / TDS	✓	* 160.1	C	4C	1- 1L Poly	K
			S	H2SO4 pH<2	1- 1L Poly	L
TPHC	✓	418.1	C	H2SO4 pH<2	1- 1L Poly	M N

IF MS/MSD COLLECTED

IF DUPLICATE COLLECTED

SAMPLING EQUIPMENT

	PURGING	SAMPLING	
	✓	✓	DEDICATED SUBMIRSABLE PUMP (WHALE)
		✓	DEDICATED TEFLON BAILER
		✓	IN-LINE FILTER (INORGANICS)
			OTHER ____

WATER LEVEL EQUIPMENT USED:

- ✓ ELECTRIC CONDUCTIVITY PROBE
- FLOAT ACTIVATED
- OTHER ____

NUMBER OF IN-LINE FILTERS USED: 1

Notes: * PAL inorganics: ICP metals (SS10), AS (SD21), SE (SD21), TL (SD09), SB (SD28), PB (SD20), HG (SB01).
Water Quality Parameters: PO4 (TF27), TKN (TF26), NIT (TF22), CL/SO4 (TT10), TSS (160.2), ALK (301.0), HARDNESS.

SAMPLERS SIGNATURE [signature]

PROJECT: USAEC - FT. DEVENS	FIELD SAMPLE NUMBER: MXZW19X1	STUDY AREA/AOC: AOC 69W	
SITE ID: ZWM-96-19X	SITE TYPE: WELL	SAMPLING DATE: 9/30/96	
LOCATION ACTIVITY: START 10:35 END ~~10:37~~ 1437 (RD)	JOB NUMBER: 09144-08	FILE TYPE: CGW	
		WEATHER: Sunny High 60s	

WATER LEVEL / WELL DATA

WELL DEPTH	15.10 FT ☑ MEASURED ☐ HISTORICAL
WATER DEPTH	8.14 FT
HEIGHT OF WATER COLUMN	7.0 FT
GAL/VOL	NA
TOTAL GAL PURGED	13

☐ TOP OF WELL ☒ TOP OF CASING PVC

PROTECTIVE CASING STICK-UP (FROM GROUND): NA FT

PROTECTIVE CASING/WELL DIFF.: FT

WELL INTEGRITY	YES	NO	N/A
PROT. CASING SECURE	☑	☐	☐
CONCRETE COLLAR INTACT	☑	☐	☑
WELL LOCKED	☑	☐	☐
PVC WELL CAP	☑	☐	☐

WELL DIAMETER: ☐ 2 INCH (circled) ☐ ~~4 INCH~~ ☐ ___ INCH

☐ 1.68 gal/ft (4") ☑ 0.7 gal/ft

PID READINGS: AMBIENT AIR 0 PPM WELL MOUTH 0 PPM

	13:00	13:05	13:10	13:15	13:20	13:25	13:30	13:33	
PURGE DATA Drawdown ~~VOLUME #~~ (ft)	8.25	8.29	8.30	8.30	8.30	8.30	8.30	8.30	
GALLONS									
(ml/min) PUMPING RATE ~~(GPM)~~	800	500	500	400	400	330	330	330	
TEMP, DEG C	16.5	16.4	15.9	16.0	16.1	16.1	16.2	16.2	3% = 0.48
pH, UNITS ☐ pH PAPER	6.3	6.28	6.34	6.30	6.31	6.33	6.35	6.34	✓
SPECIFIC CONDUCTIVITY, umhos/cm	0.303	0.301	0.301	0.301	0.301	0.302	0.300	0.301	3% = 0.009
TURBIDITY, ntu	83	24	24	15	10	6	5	0	
~~REDOX (@ COMPLETION OF PURGING): +/- mv~~ D.O.				-0.84	-0.89	-.70	-.79	-0.73	

Started Sampling ~13:40

SAMPLE OBSERVATIONS: ☑ CLEAR ☐ CLOUDY ☐ COLORED ☐ TURBID ☑ ODOR (FUEL) ☐ OTHER (SEE NOTES)

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
☐	☐	PERISTALTIC PUMP	ISCO #
☑	☑	DEDICATED SUBMERSIBLE PUMP	
☐	☐	BAILER	☐ 2" ☐ 4" #
☐	☑	PVC/SILICON TUBING	
	☑	IN-LINE/DISPOSABLE FILTER	0.45 um
☐	☐	OTHER	

DECON FLUIDS USED: ☑ POTABLE WATER ☐ LIQUINOX ☐ STEAM CLEANING ☐

NUMBER OF FILTERS USED: 1

WATER LEVEL EQUIP. USED: ☑ ELECTRIC COND. PROBE ☐ PRESSURE TRANSDUCER ☐

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS BOTTLE
						REFER TO COC-ARF AND SAMPLE MGMNT SYSTEM
☐ VOC	UM20	VP	HCL, 4 DEG C	(4) 60 ML	☐	
☒ ~~SVOC~~ PEST/PCBs (RD)	UM18	MS	4 DEG C	(2) 1 L AG	☒ (RD)	~~510~~ (RD)
	UH02	EC	4 DEG C	(3) 1 L AG		
	UH13					
☐ PAL INORGANICS (see notes)		M	HNO3 TO pH<2	1 L P-CUBE	☐	
☐ LEAD ONLY	SD20	M	HNO3 TO pH<2		☐	
☐ EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	☐	
	UW32					
☑ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☑	510 / 510
☑ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☑	510
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐	
	TT10	C	4 DEG C	1 L P-CUBE	☐	
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐	
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐	
☑ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☑	510
		C	4 DEG C	1 L P-CUBE	☑	510
		N	HNO3 TO pH<2	1 L P-CUBE	☐	
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ	☐	
EPH-VPH, TOTAL AEROBIC HET., T-Fe, D-Fe, CH_4				STERILE	✓	510

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: M. Rooney P. Byrnes

RECEIVED BY: R. Rustad

Duplicate Collected

PROJECT	USAEC - FT. DEVENS	FIELD SAMPLE NUMBER	MXZW20X1	STUDY AREA/AOC	AOC 69W
SITE ID	ZWM-96-20X	SITE TYPE	WELL	SAMPLING DATE	9/30/96
		JOB NUMBER	9144-08	FILE TYPE	CGW
LOCATION ACTIVITY	START 10:30 END 10:34			WEATHER	Sunny High 60s

Sampling 10/1/96

WATER LEVEL / WELL DATA

WELL DEPTH 12.25 FT ☐ MEASURED ☐ HISTORICAL

WATER DEPTH 2.64 FT

HEIGHT OF WATER COLUMN 9.61 FT

☐ TOP OF WELL ☒ TOP OF CASING PVC

PROTECTIVE CASING STICK-UP (FROM GROUND) NA FT

PROTECTIVE CASING/WELL DIFF. FT

NA GAL/VOL

6.8 TOTAL GAL PURGED

WELL INTEGRITY: YES NO N/A
- PROT. CASING SECURE ☑ YES
- CONCRETE COLLAR INTACT ☑ YES
- WELL LOCKED ☑ NO ☑ N/A Flush
- PVC WELL CAP ☑ YES

WELL DIAMETER ☐ 2 INCH ☐ ~~4 INCH~~ ☐ ___ INCH

☐ 1.68 gal/ft (4")
☑ 0.7 gal/ft

PID READINGS: AMBIENT AIR 0 PPM WELL MOUTH 0 PPM

4.8 ft from bottom 9:45 9:52 9:56 10:05 10:10 begin sampling 10:10

PURGE DATA VOLUME #			~~2.5~~		6.8 ~~4.5~~ Total			
DO ~~GALLONS~~	3.65	3.61	3.57	3.65	3.61			
Redox ~~PUMPING RATE (GPM)~~	219		302	319	328			
TEMP, DEG C	19.6	19.7	19.7	19.8	19.8			
pH, UNITS ☐ pH PAPER	6.17	6.21	6.24	6.26	6.28			
SPECIFIC CONDUCTIVITY, umhos/cm	0.323	0.323	0.323	0.323	0.323			
TURBIDITY, ntu	10	10	10	10	10			

SAMPLE OBSERVATIONS
- ☑ CLEAR
- ☐ CLOUDY
- ☐ COLORED ______
- ☐ TURBID
- ☐ ODOR
- ☐ OTHER (SEE NOTES)

Redox probe: 242/241 in ck solution

~~REDOX (@ COMPLETION OF PURGING): ______ +/- mv~~ headspace 0 ppm

EQUIPMENT DOCUMENTATION flow rate Same

PURGING SAMPLING
- ☑ ☐ PERISTALTIC PUMP — EQUIPMENT ID ISCO # ______
- ☐ ☑ DEDICATED SUBMERSIBLE PUMP
- ☐ ☐ BAILER ☐ 2" ☐ 4" # ___
- ☑ ☑ PVC/SILICON TUBING
- ☑ IN-LINE/DISPOSABLE FILTER 0.45 um
- ☐ ☐ OTHER ______

DECON FLUIDS USED
- ☐ POTABLE WATER
- ☐ LIQUINOX
- ☐ STEAM CLEANING
- ______

NUMBER OF FILTERS USED 1

WATER LEVEL EQUIP. USED
- ☑ ELECTRIC COND. PROBE
- ☐ PRESSURE TRANSDUCER
- ______

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
☐ VOC	UM20	VP	HCL, 4 DEG C	(4) 60 ML	☐	___/___/___/___	
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG	☐	___/___/___/___	
☐ PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	☐	___/___/___/___	
	UH13						
☐ PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	☐	___/___/___/___	
☐ LEAD ONLY	SD20	N	HNO3 TO pH<2		☐	___/___/___/___	
☐ EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	☐	___/___/___/___	
	UW32						
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☐	___/___/___/___	
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☐	___/___/___/___	
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐	___/___/___/___	
	TT10	C	4 DEG C	1 L P-CUBE	☐	___/___/___/___	
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐	___/___/___/___	
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐	___/___/___/___	
☐ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☐	___/___/___/___	
		C	4 DEG C	1 L P-CUBE	☐	___/___/___/___	
		N	HNO3 TO pH<2	1 L P-CUBE	☐	___/___/___/___	
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐	___/___/___/___	

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: M. Rooney P. Byrnes

RECEIVED BY: P. Rustad

PROJECT: USAEC - FT. DEVENS
FIELD SAMPLE NUMBER: MXZW21X1
STUDY AREA/AOC: AOC 69W
SITE ID: ZWM-96-21X
SITE TYPE: WELL
SAMPLING DATE: 9/30/96
JOB NUMBER: 9144-08
FILE TYPE: CGW
LOCATION ACTIVITY: START 10:26 END 10:28
WEATHER: SUNNY HIGH 60'S

WATER LEVEL / WELL DATA

☐ TOP OF WELL
☑ TOP OF CASING PVC

PROTECTIVE CASING STICK-UP (FROM GROUND): NA FT

PROTECTIVE CASING/WELL DIFF.: FT

WELL DEPTH: 14.15 FT ☐ MEASURED ☐ HISTORICAL

WATER DEPTH: 7.86 FT

HEIGHT OF WATER COLUMN: 6.29 FT

NA GAL/VOL

7 TOTAL GAL PURGED

☐ 1.68 gal/ft (4")
☑ 0.7 gal/ft

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE	☑	☐	☐
CONCRETE COLLAR INTACT	☐	☐	☑
WELL LOCKED	☐	☐	☐
PVC WELL CAP	☑	☐	☐

WELL DIAMETER: ☑ 2 INCH ☐ 4 INCH ☐ ___ INCH

PID READINGS: AMBIENT AIR 0 PPM; WELL MOUTH 0 PPM

PURGE DATA	15:08	15:15	15:25	15:28	1534	1548		
~~VOLUME #~~ WATER LEVEL	7.88	7.91	7.9	7.91	7.91	7.90		
GALLONS						POST	SAMPLING	
(ml/min) PUMPING RATE ~~(GPM)~~	320	200	160	170	170			
TEMP, DEG C	17.3	17.3	17.5	17.5	17.6			
pH, UNITS ☐ pH PAPER	6.24	6.26	6.27	6.27	6.26			
SPECIFIC CONDUCTIVITY, umhos/cm	0.301	0.302	0.302	0.299	0.297			
TURBIDITY, ntu	36	19	1	2	0			
REDOX (@ COMPLETION OF PURGING):	1.12	0.88 mv	0.88	0.82	0.63			

SAMPLE OBSERVATIONS
☑ CLEAR
☐ CLOUDY
☐ COLORED ________
☐ TURBID
☐ ODOR
☐ OTHER (SEE NOTES)

15:40 Started Sampling

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
☐	☐	PERISTALTIC PUMP	ISCO # ____
☑	☑	DEDICATED SUBMERSIBLE PUMP	
☐	☐	BAILER	☐ 2" ☐ 4" # ___
☐	☐	PVC/SILICON TUBING	
	☑	IN-LINE/DISPOSABLE FILTER	0.45 µm
☐	☐	OTHER ________	

DECON FLUIDS USED
☑ POTABLE WATER
☐ LIQUINOX
☐ STEAM CLEANING
☐ ________

WATER LEVEL EQUIP. USED
☑ ELECTRIC COND. PROBE
☐ PRESSURE TRANSDUCER
☐ ________

NUMBER OF FILTERS USED: 1

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
☐ VOC	UM20	VP	HCL, 4 DEG C	(4) 60 ML	☐	/ / /	
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG	☐	/ / /	
☐ PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	☐	/ / /	
	UH13					/ / /	
☐ PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	☐	/ / /	
☐ LEAD ONLY	SD20	N	HNO3 TO pH<2		☐	/ / /	
☐ EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	☐	/ / /	
	UW32					/ / /	
☑ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☑	512 / 512 / /	
☑ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☐	512 / / /	
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐	/ / /	
	TT10	C	4 DEG C	1 L P-CUBE	☐	/ / /	
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐	/ / /	
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐	/ / /	
☑ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☑	512 / / /	
		C	4 DEG C	1 L P-CUBE	☐	/ / /	
		N	HNO3 TO pH<2	1 L P-CUBE	☐	/ / /	
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐	/ / /	
☑ EPH-VPH, BIOREMEDIATION PARAMS					☑	512 / / /	

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: M. ROONEY, P. BYRNES
RECEIVED BY: R. RUSTAD

PROJECT	USAEC - FT. DEVENS	FIELD SAMPLE NUMBER	MXZW10X6	STUDY AREA/AOC	AOC 69W
SITE ID	69W-94-10	SITE TYPE	WELL	SAMPLING DATE	12/11/97
		JOB NUMBER	9144.03	FILE TYPE	CGW
LOCATION ACTIVITY	START 10⁴⁰ END 12³⁰			WEATHER	25° clear

WATER LEVEL / WELL DATA

☒ TOP OF WELL ☐ TOP OF CASING ________

PROTECTIVE CASING STICK-UP (FROM GROUND) Flush FT

PROTECTIVE CASING/WELL DIFF. — FT

WELL DEPTH 15.00 FT ☒ MEASURED ☐ HISTORICAL

WATER DEPTH 7.79* FT

1.2 gal GAL/VOL

HEIGHT OF WATER COLUMN 7.21 FT

11 TOTAL GAL PURGED

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE	☒	☐	☐
CONCRETE COLLAR INTACT	☒	☐	☐
WELL LOCKED	☒	☐	☐
PVC WELL CAP	☒	☐	☐

WELL DIAMETER ☒ 2 INCH ☐ 4 INCH ☐ ___ INCH

☐ 1.68 gal/ft (4")
☐ ___ gal/ft

PID READINGS: AMBIENT AIR 0.0 PPM WELL MOUTH 7.2 PPM

Purge H_2O = 22.6 ppm (containerized)

* After pump installation

PURGE DATA

VOLUME # / Time	1 / 10³⁵	2 / 11¹⁰	3 / 11²⁰	4 / 11³⁰	5 / 11⁴⁰			
GALLONS	2	5	7	8	10			
(L/min) PUMPING RATE	0.6	0.5	0.3	0.6	0.4			
TEMP, DEG C / drawdown (ft)	9.6 / 0.06	10.8 / 0.08	11.4 / 0.1	11.3 / 0.09	11.2 / 0.08			
pH, UNITS ☐ pH PAPER	7.32	7.75	7.88	7.85	8.02			
SPECIFIC CONDUCTIVITY, umhos/cm	0.404	0.347	0.322	0.316	0.320			
TURBIDITY, ntu / DO (mg/l)	400 / 3.6	6 / 2.0	5 / 1.5	4 / 1.5	3 / 1.1			

REDOX (@ COMPLETION OF PURGING): ______ +/- mv

SAMPLE OBSERVATIONS
☒ CLEAR
☐ CLOUDY
☐ COLORED ________
☐ TURBID
☒ ODOR diesel
☐ OTHER (SEE NOTES)

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
☐	☐	PERISTALTIC PUMP	ISCO # ______
☐	☒	DEDICATED SUBMERSIBLE PUMP	
☐	☐	BAILER	☐ 2" ☐ 4" # ____
☐	☐	PVC/SILICON TUBING	
☐	☐	IN-LINE/DISPOSABLE FILTER	________
☐	☐	OTHER ________	

DECON FLUIDS USED
☒ POTABLE WATER
☒ LIQUINOX
☐ STEAM CLEANING
☐ ________

WATER LEVEL EQUIP. USED
☒ ELECTRIC COND. PROBE
☐ PRESSURE TRANSDUCER
☐ ________

NUMBER OF FILTERS USED ______

12²⁰ Sample time

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
☒ VOC	UM20	VP	HCL, 4 DEG C	(4) 60 ML	☒	1 Sample / 1 MS / 1 MSD /	
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG	☐		
☐ PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	☐		
	UH13						
☐ PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ LEAD ONLY	SD20	N	HNO3 TO pH<2		☐		
☐ EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	☐		
	UW32						
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☐		
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☐		
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐		
	TT10	C	4 DEG C	1 L P-CUBE	☐		
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐		
☐ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☐		
☒ VPH		C	4 DEG C	1 L P-CUBE	☐		
		N	HNO3 TO pH<2	1 L P-CUBE	☐	1 sample / 1 MS / 1 MSD /	
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐		
☒ EPH						2 Samples / 2 MS / 2 MSD /	

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: M. Frandt
RECEIVED BY: ________

PROJECT	USAEC - FT. DEVENS	FIELD SAMPLE NUMBER	MXZW11X6	STUDY AREA/AOC	AOC 69W
SITE ID	69W-94-11	SITE TYPE	WELL	SAMPLING DATE	12/11/97
		JOB NUMBER	7144.03	FILE TYPE	CGW
LOCATION ACTIVITY	START 1230 END 1530			WEATHER	25°, clear

WATER LEVEL / WELL DATA

- WELL DEPTH: 15 FT — [X] MEASURED [ ] HISTORICAL
- WATER DEPTH: 7.13* FT
- HEIGHT OF WATER COLUMN: 7.87 FT
- 13.3 GAL/VOL
- 10 TOTAL GAL PURGED
- [ ] 1.68 gal/ft (4") [ ] ____ gal/ft
- * After pump installed
- [X] TOP OF WELL [ ] TOP OF CASING [ ] ________
- PROTECTIVE CASING STICK-UP (FROM GROUND): Flush FT
- PROTECTIVE CASING/WELL DIFF.: — FT

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE	X		
CONCRETE COLLAR INTACT	X		
WELL LOCKED	X		
PVC WELL CAP	X		

WELL DIAMETER: [ ] 2 INCH [X] 4 INCH [ ] ____ INCH

PID READINGS: AMBIENT AIR 0 PPM; WELL MOUTH 0 PPM

PURGE DATA								
VOLUME # / Time	1 / 1350	2 / 1425	3 / 1430	4 / 1435	5 / 1440	6 / 1450		
GALLONS	0	3.5	4.0	5.0	6.0	8.0		
(l/min) PUMPING RATE (~~GPM~~)	0.4	0.9	0.8	0.8	0.8	0.9		
TEMP, DEG C / drawdown (ft)	12.6 / 0.02	12.3 / 0.02	12.5 / 0.1	12.9 / 0.1	12.9 / 0.1	12.9		
pH, UNITS [ ] pH PAPER	7.66	7.75	7.81	7.84	7.85	7.88		
SPECIFIC CONDUCTIVITY, umhos/cm	0.322	0.311	0.293	0.293	0.280	0.277		
TURBIDITY, ntu / D.O. (mg/l)	0 / 5.2	0 / 5.0	0 / 5.0	0 / 4.8	0 / 4.8	0 / 4.62		

SAMPLE OBSERVATIONS: [X] CLEAR [ ] CLOUDY [ ] COLORED ________ [ ] TURBID [ ] ODOR [ ] OTHER (SEE NOTES)

REDOX (@ COMPLETION OF PURGING): ________ +/- mv

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
[ ]	[ ]	PERISTALTIC PUMP	ISCO # ______
[ ]	[X]	DEDICATED SUBMERSIBLE PUMP	[ ] 2" [ ] 4" # ___
[ ]	[ ]	BAILER	
[ ]	[ ]	PVC/SILICON TUBING	
	[ ]	IN-LINE/DISPOSABLE FILTER ________	
[ ]	[ ]	OTHER ________	

DECON FLUIDS USED: [X] POTABLE WATER [X] LIQUINOX [ ] STEAM CLEANING [ ] ________

WATER LEVEL EQUIP. USED: [X] ELECTRIC COND. PROBE [ ] PRESSURE TRANSDUCER [ ] ________

NUMBER OF FILTERS USED ______

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
[X] VOC — 1515 Sample time	UM20	VP	HCL, 4 DEG C	(4) 60 ML	[X]	2 samples	
[ ] SVOC	UM18	MS	4 DEG C	(2) 1 L AG	[ ]		
[ ] PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	[ ]		
	UH13						
[ ] PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	[ ]		
[ ] LEAD ONLY	SD20	N	HNO3 TO pH<2		[ ]		
[ ] EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	[ ]		
	UW32						
[ ] TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	[ ]		
[ ] TOC	415.1	O	H2SO4 TO pH<2	1 L AG	[ ]		
[ ] ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	[ ]		
[X] EPH	TT10	C	4 DEG C	1 L P-CUBE	[ ]		
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	[ ]	2 samples	
[ ] TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	[ ]		
[ ] H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	[ ]		
[X] VPH		C	4 DEG C	1 L P-CUBE	[ ]		
		N	HNO3 TO pH<2	1 L P-CUBE	[ ]	2 samples	
[ ] COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	[ ]		

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H20 QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: [signature]
RECEIVED BY: ________

PROJECT: USAEC - FT. DEVENS	FIELD SAMPLE NUMBER: MXZW13X5	STUDY AREA/AOC: AOC 69W	
SITE ID: 69W-94-13	SITE TYPE: WELL	SAMPLING DATE: 12-12-97	
	JOB NUMBER: 9144.08	FILE TYPE: CGW	
LOCATION ACTIVITY: START 10:15 END 11:30		WEATHER: High 20's low 3x Overcast	

WATER LEVEL / WELL DATA *8.12 w/ pump in well

- [x] TOP OF PVC WELL
- [ ] TOP OF CASING

PROTECTIVE CASING STICK-UP (FROM GROUND): 2.90 FT

PROTECTIVE CASING/WELL DIFF.: 0.28 FT

WELL DEPTH: 8.10 FT — [x] MEASURED [ ] HISTORICAL

WATER DEPTH: 16.20 FT

~~13.6~~ GAL/VOL — Included Sand pack

HEIGHT OF WATER COLUMN: 8.10 FT

11.75 TOTAL GAL PURGED

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE	[x]	[ ]	[ ]
CONCRETE COLLAR INTACT	[ ]	[ ]	[x]
WELL LOCKED	[x]	[ ]	[ ]
PVC WELL CAP	[x]	[ ]	[ ]

WELL DIAMETER: [ ] 2 INCH [x] 4 INCH [ ] ___ INCH

[ ] 1.68 gal/ft (4")
[ ] ___ gal/ft

PID READINGS: AMBIENT AIR 0 PPM (DUMPED) WELL MOUTH 0 PPM (DUMPED)

water level dropped to 8.21

PURGE DATA									
~~VOLUME #~~ Time	10:15	10:23	10:30	10:35	10:40	10:47	10:56	11:05	11:15
GALLONS	≈1 gal	≈2 gal	≈ 4.0	≈1 gal	≈2.5 gal	≈3.75	≈4.5	≈2.5	≈3.75
l/min PUMPING RATE (lpm)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
TEMP, DEG C / drawdown (ft)	9.8 / 8.21	10.4 / 8.20	10.3 / 8.20	10.0 / 8.22	10.3 / 8.22	10.5 / 8.23	10.6 / 8.23	10.4 / 8.20	10.6 / 8.21
pH, UNITS [ ] pH PAPER	5.85	6.22	6.25	6.22	6.30	6.21	6.35	6.25	6.31
SPECIFIC CONDUCTIVITY, umhos/cm	.315	.273	0.280	.293	0.301	.305	.298	.297	.306
TURBIDITY, ntu / DO (mg/l)	29.8 / 2.5	30 / 0.64	23.3 / 0.86	18.7 / 1.13	15.6 / 0.99	11 / 0.26	9.4 / 0.35	7.1 / 0.86	7.1 / 0.53

SAMPLE OBSERVATIONS: [ ] CLEAR [ ] CLOUDY [ ] COLORED ___ [ ] TURBID [ ] ODOR [ ] OTHER (SEE NOTES)

REDOX (@ COMPLETION OF PURGING): +4.8 +/- mv

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
[ ]	[x]	PERISTALTIC PUMP	ISCO # ___
[ ]	[x]	DEDICATED SUBMERSIBLE PUMP	[ ] 2" [ ] 4" # ___
[ ]	[ ]	BAILER	
[ ]	[ ]	PVC/SILICON TUBING	
[ ]	[ ]	IN-LINE/DISPOSABLE FILTER ___	
[ ]	[ ]	OTHER ___	

DECON FLUIDS USED: [x] POTABLE WATER [ ] LIQUINOX [ ] STEAM CLEANING ___

WATER LEVEL EQUIP. USED: [x] ELECTRIC COND. PROBE [ ] PRESSURE TRANSDUCER ___

NUMBER OF FILTERS USED ___

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
[x] VOC	UM20	VP	HCL, 4 DEG C	~~(4)~~ 3 60 ML	[x]		
[ ] SVOC	UM18	MS	4 DEG C	(2) 1 L AG	[ ]		
[ ] PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	[ ]		
[ ] VPH	UH13		HCL, 4 Deg C	(3) 60 mL	[x]		
[ ] PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	[ ]		
[ ] LEAD ONLY	SD20	N	HNO3 TO pH<2		[ ]		
[ ] EXPLOSIVES	UW19 UW32	LC	4 DEG C	(3) 1 L AG	[ ]		
[ ] TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	[ ]		
[ ] TOC	415.1	O	H2SO4 TO pH<2	1 L AG	[ ]		
[ ] ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	[ ]		
	TT10	C	4 DEG C	1 L P-CUBE	[ ]		
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	[ ]		
[ ] TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	[ ]		
[ ] H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	[ ]		
		C	4 DEG C	1 L P-CUBE	[ ]		
		N	HNO3 TO pH<2	1 L P-CUBE	[ ]		
[ ] COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	[ ]		
[ ] EPH			HCL 4 Deg. C	(2) 1 liter	[x]		

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H20 QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: R.D. Justin / Charles V. Wayman
RECEIVED BY:

Groundwater

PROJECT	USAEC - FT. DEVENS	FIELD SAMPLE NUMBER	MXZW14X5	STUDY AREA/AOC	AOC 69W
SITE ID	69W-94-14	SITE TYPE	WELL	SAMPLING DATE	12/12/97
		JOB NUMBER	9144-98 CHR 8	FILE TYPE	CGW
LOCATION ACTIVITY	START 1145 END 1315			WEATHER	Low 30's Overcast

WATER LEVEL / WELL DATA

☒ TOP OF PVC WELL ☐ TOP OF CASING ☐ ______

PROTECTIVE CASING STICK-UP (FROM GROUND): 2.60± FT

PROTECTIVE CASING/WELL DIFF.: +0.44 FT

WELL DEPTH: 15.18 FT ☑ MEASURED ☐ HISTORICAL

WATER DEPTH: 9.02 FT

HEIGHT OF WATER COLUMN: 6.16 FT

1.0 GAL/VOL

3.9 TOTAL GAL PURGED

☐ 1.68 gal/ft (4")
☐ ___ gal/ft

* excludes sand pack 2" well

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE	☒	☐	☐
CONCRETE COLLAR INTACT	☐	☐	☒
WELL LOCKED	☒	☐	☐
PVC WELL CAP	☒	☐	☐

WELL DIAMETER: ☒ 2 INCH ☐ 4 INCH ☐ ___ INCH

PID READINGS: AMBIENT AIR 0.9 PPM WELL MOUTH 0.9 PPM

* 9.01 Water Depth w/ Pumps submerged

PURGE DATA	Time	1208	1215	1223	1230	1235	1247	1305	
	GALLONS	≈2	≈2.5	≈2.6	≈2.75	≈3.0	≈3.5	≈3.7	
	PUMPING RATE (lpm)	0.22	0.22	0.22	0.22	0.22	0.22	0.22	
TEMP, DEG C / Drawdown (ft)		9.7 / 9.0	9.8 / 9.02	9.8 / 9.02	9.7 / 9.02	9.8 / 9.02	9.3 / 9.02	9.1 / 9.02	
pH, UNITS ☐ pH PAPER		5.91	6.12	5.86	6.12	6.05	5.81	5.93	
SPECIFIC CONDUCTIVITY, umhos/cm		.250	.246	.242	.240	.249	.250	.250	
TURBIDITY, ntu / DO (mg/L)		52.6 / 0.77	32.2 / 2.21	24.4 / 1.27	21.6 / 1.78	19.9 / 2.14	17.7 / 1.53	17.7 / 1.87	

REDOX (@ COMPLETION OF PURGING): +120 +/- mv

SAMPLE OBSERVATIONS
☒ CLEAR
☐ CLOUDY
☐ COLORED ______
☐ TURBID
☐ ODOR
☐ OTHER (SEE NOTES)

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
☐	☐	PERISTALTIC PUMP	ISCO # ______
☐	☑	DEDICATED SUBMERSIBLE PUMP	
☐	☐	BAILER	☐ 2" ☐ 4" # ___
☐	☐	PVC/SILICON TUBING	
☐	☐	IN-LINE/DISPOSABLE FILTER	______
☐	☐	OTHER	______

DECON FLUIDS USED
☑ POTABLE WATER
☐ LIQUINOX
☐ STEAM CLEANING
☐ ______

WATER LEVEL EQUIP. USED
☑ ELECTRIC COND. PROBE
☐ PRESSURE TRANSDUCER
______

NUMBER OF FILTERS USED ______

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
☑ VOC	UM20	VP	HCL, 4 DEG C	~~(4)~~ (3) 60 ML	☑	___/___/___/	
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG	☐	___/___/___/	
☐ PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	☐	___/___/___/	
☑ VPH	~~UH13~~		HCL, 4 Deg C	(3) 60mL	☑	___/___/___/	
☐ PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	☐	___/___/___/	
☐ LEAD ONLY	SD20	N	HNO3 TO pH<2		☐	___/___/___/	
☐ EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	☐	___/___/___/	
	UW32						
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☐	___/___/___/	
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☐	___/___/___/	
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐	___/___/___/	
	TT10	C	4 DEG C	1 L P-CUBE	☐	___/___/___/	
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐	___/___/___/	
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐	___/___/___/	
☐ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☐	___/___/___/	
		C	4 DEG C	1 L P-CUBE	☐	___/___/___/	
		N	HNO3 TO pH<2	1 L P-CUBE	☐	___/___/___/	
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐	___/___/___/	
☑ EPH				(2) 1 Liter Amb	☑	___/___/___/	

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: R.D. [signature] / Charles [signature]
RECEIVED BY: ______

PROJECT: USAEC - FT. DEVENS

SITE ID: ZWM-95-15X

FIELD SAMPLE NUMBER: MXZW15X3

SITE TYPE: WELL

JOB NUMBER: 9144.08

STUDY AREA/AOC: AOC 69W

SAMPLING DATE: 12/12/97

FILE TYPE: CGW

WEATHER: Low 30's slight Overcast Rain.

LOCATION ACTIVITY: START 1330 END 1520

WATER LEVEL / WELL DATA

WELL DEPTH	14.89 FT
WATER DEPTH	6.95 FT
HEIGHT OF WATER COLUMN	7.94 FT

☑ MEASURED ☐ HISTORICAL

☐ TOP OF WELL ☐ TOP OF CASING

5.2 GAL/VOL

5.3 TOTAL GAL PURGED

PROTECTIVE CASING STICK-UP (FROM GROUND): ± 2.75 FT

PROTECTIVE CASING/WELL DIFF.: 0.42 FT

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE	☐	☐	☑
CONCRETE COLLAR INTACT	☐	☐	☐
WELL LOCKED	☑	☐	☐
PVC WELL CAP	☑	☐	☐

WELL DIAMETER: ☐ 2 INCH ☑ 4 INCH ☐ ___ INCH

☐ 1.68 gal/ft (4")
☐ ___ gal/ft

PID READINGS: AMBIENT AIR ___ PPM WELL MOUTH ___ PPM

PURGE DATA

Time ~~VOLUME #~~	1355	1402	1410	1420	1433	1445 (DUMPED)	1455	1505
GALLONS	≈.5	≈1.3	≈2.1	≈2.5	≈3.2	≈4.9	≈.75	≈1
PUMPING RATE (lpm)	.32	.32	.32	.32	.32	.32	.32	.32
TEMP, DEG C / DRAWDOWN (ft)	9.1 / 7.0	9.5 / 7.0	9.5 / 7.0	9.8 / 7.0	9.5 / 7.0	9.6 / 7.0	9.6 / 7.0	9.7 / 7.0
pH, UNITS ☐ pH PAPER	6.41	6.49	6.72	6.26	6.09	6.18	6.19	6.22
SPECIFIC CONDUCTIVITY, umhos/cm	.374	.365	.337	.337	.326	.323	.317	.315
TURBIDITY, ntu / DO mg/L	43.3 / 1.38	43.8 / 1.05	0.00? / 1.34 (2A)	19.1 / 2.13	13.8 / 1.03	10.6 / 1.91	2.54 / 1.04	8.09 / 2.29

REDOX (@ COMPLETION OF PURGING): _______ +/- mv

SAMPLE OBSERVATIONS

☑ CLEAR
☐ CLOUDY
☐ COLORED ________
☐ TURBID
☐ ODOR
☐ OTHER (SEE NOTES)

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
☐	☑	PERISTALTIC PUMP	ISCO # ______
☐	☑	DEDICATED SUBMERSIBLE PUMP	
☐	☐	BAILER	☐ 2" ☐ 4" # ___
☐	☐	PVC/SILICON TUBING	
☐	☐	IN-LINE/DISPOSABLE FILTER	________
☐	☐	OTHER ________	

DECON FLUIDS USED
☑ POTABLE WATER
☐ LIQUINOX
☐ STEAM CLEANING
☐ ________

WATER LEVEL EQUIP. USED
☑ ELECTRIC COND. PROBE
☐ PRESSURE TRANSDUCER
____

NUMBER OF FILTERS USED ______

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
☑ VOC	UM20	VP	HCL, 4 DEG C	(3) 60 ML	☑		
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG	☐		
☐ PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	☐		
☑ VPH	UH13			(2) 60 ml	☑		
☐ PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ LEAD ONLY	SD20	N	HNO3 TO pH<2		☐		
☐ EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	☐		
	UW32						
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☐		
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☐		
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐		
	TT10	C	4 DEG C	1 L P-CUBE	☐		
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐		
☐ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☐		
		C	4 DEG C	1 L P-CUBE	☐		
		N	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐		
☑ EPH				(2) 1 liter	☑		

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: RD [signature] / Charles H. [signature]

RECEIVED BY: ________

PROJECT	USAEC - FT. DEVENS	FIELD SAMPLE NUMBER	MXZW18X3	STUDY AREA/AOC	69W
SITE ID	ZWM-95-18X	SITE TYPE	WELL	SAMPLING DATE	12/16/97
		JOB NUMBER	9144.08	FILE TYPE	CGW
LOCATION ACTIVITY	START 1030 END			WEATHER	clear, 40's

WATER LEVEL / WELL DATA

WELL DEPTH 15.35 FT ☑ MEASURED ☐ HISTORICAL

☑ TOP OF WELL ☐ TOP OF CASING

PROTECTIVE CASING STICK-UP (FROM GROUND) 2.5± FT

PROTECTIVE CASING/WELL DIFF. −0.35 FT

WATER DEPTH 5.05 FT

GAL/VOL

HEIGHT OF WATER COLUMN 10.30 FT

TOTAL GAL PURGED

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE	☑	☐	☐
CONCRETE COLLAR INTACT	☐	☐	☑
WELL LOCKED	☑	☐	☐
PVC WELL CAP	☑	☐	☐

WELL DIAMETER ☐ 2 INCH ☑ 4 INCH ☐ __ INCH

☐ 1.68 gal/ft (4")
☐ ___ gal/ft

PID READINGS: AMBIENT AIR 0.1 PPM WELL MOUTH 0.1 PPM

jar headspace = 0.3 ppm ∴ did not containerize purge H_2O

PURGE DATA								
Time ~~VOLUME #~~	1124	1134	1142	1150	1200			
(eyeball) GALLONS	≈1.8	~2.0	~2.5	~2.8	~3.0			
PUMPING RATE Lpm ~~(GPM)~~	0.26	0.26	0.26	0.16	0.30			
TEMP, DEG C / DRAWDOWN ft	9.8 / 5.12	~~9.6~~ 10.1 / 5.12	10.1 / 5.12	10.3 / 5.12	10.4 / 5.12			
pH, UNITS ☐ pH PAPER	5.69	6.0	6.1	6.06	6.02			
SPECIFIC CONDUCTIVITY, umhos/cm	~~340~~ 307	303	300	299	298			
TURBIDITY, ntu / DO mg/L	0.75 / 3.25	0.60 / 3.23	0.54 / 3.59	.47 / 3.25	.53 / 3.37			

REDOX (@ COMPLETION OF PURGING): 255.2 +/- mv

SAMPLE OBSERVATIONS
☑ CLEAR
☐ CLOUDY
☐ COLORED ____
☐ TURBID
☐ ODOR
☐ OTHER (SEE NOTES)

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
☑	☑	PERISTALTIC PUMP	ISCO # ___
☐	☐	DEDICATED SUBMERSIBLE PUMP	~~2"~~ ☑ 2" ~~2474~~ #
☐	☐	BAILER	
☑	☑	PVC/SILICON TUBING * Bio/organics	
☐	☐	IN-LINE/DISPOSABLE FILTER	
☐	☐	OTHER	

DECON FLUIDS USED
☑ POTABLE WATER
☐ LIQUINOX
☐ STEAM CLEANING
☐

WATER LEVEL EQUIP. USED
☑ ELECTRIC COND. PROBE
☐ PRESSURE TRANSDUCER

NUMBER OF FILTERS USED ___

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
☑ VOC / VPH / EPH	UM20	VP	HCL, 4 DEG C	(4) 60 ML + (2) 1 L AG	☑		
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG	☐		
☐ PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	☐		
	UH13						
☐ PAL INORGANICS (see notes)		M	HNO3 TO pH<2	1 L P-CUBE	☐		
~~☐ LEAD ONLY~~	~~SD20~~	~~M~~	~~HNO3 TO pH<2~~				
☐ EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	☐		
	UW32						
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☐		
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☐		
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐		
	TT10	C	4 DEG C	1 L P-CUBE	☐		
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐		
☐ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☐		
		C	4 DEG C	1 L P-CUBE	☐		
		N	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐		

* Bottles pre-preserved no triple Rinse.

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: C. Lyman / McGrea
RECEIVED BY:

L ÷ 3.785 = gal

start 11 14 30 / 11 15 00 > 480 mL
11 16 30 / 11 17 00 > 260 mL

$$\frac{\pi(2^2)}{12} \times 10.3 \times 7.48 = 80 \text{ gal } (?)$$

Do not go lower than 5.35 ft bgs

PROJECT: USAEC - FT. DEVENS | FIELD SAMPLE NUMBER: MXZW17X3 | STUDY AREA/AOC: 69W

SITE ID: ZWM-95-17X | SITE TYPE: WELL | SAMPLING DATE: 12/16/97

JOB NUMBER: 9144.08 | FILE TYPE: CGW

LOCATION ACTIVITY: START 1320 END 1535 | WEATHER: clear, 40-50°s

WATER LEVEL / WELL DATA

- [x] TOP OF WELL
- [ ] TOP OF CASING

PROTECTIVE CASING STICK-UP (FROM GROUND): 2.4± FT

PROTECTIVE CASING/WELL DIFF.: −0.29 FT

WELL DEPTH: 24.52 FT — [x] MEASURED [ ] HISTORICAL

WATER DEPTH: 16.85 FT

HEIGHT OF WATER COLUMN: 7.67 FT

GAL/VOL:

TOTAL GAL PURGED:

[ ] 1.68 gal/ft (4")
[ ] ____ gal/ft

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE	[x]	[ ]	[ ]
CONCRETE COLLAR INTACT	[ ]	[ ]	[x]
WELL LOCKED	[x]	[ ]	[ ]
PVC WELL CAP	[x]	[ ]	[ ]

WELL DIAMETER: [ ] 2 INCH [x] 4 INCH [ ] ____ INCH

PID READINGS: AMBIENT AIR 0.1 PPM | WELL MOUTH 0.1 PPM | HEAD SPACE PID 0.1 PPM (DID NOT CONTAINERIZE Purge water) (See Note)

PURGE DATA								
Time ~~VOLUME #~~	1352	1400	1410	1420	~~1434~~ 1440	1455	1505	1515
(eyeball) GALLONS	~.5	~1.0	~1.5	~2.0	~4.5	~6.0	~7.0	~7.5
PUMPING RATE LPM ~~(GPM)~~	.30	.30	.26	.27	.27	.30	.30	.30
TEMP, DEG C / Drawdown (ft)	11.1 / 16.93	11.7 / 16.94	11.8 / 16.94	12.2 / 16.94	12.4 / 16.93	12.6 / 16.92	12.6 / 16.91	12.6 / 16.92
pH, UNITS [ ] pH PAPER	6.28	6.29	6.30	6.29	6.28	6.23	6.18	6.20
SPECIFIC CONDUCTIVITY, umhos/cm	298	304	295	297	300	300	299	296
TURBIDITY, ntu / DO (mg/L)	1.61 / 6.09	1.2 / 6.03	.91 / 5.98	0.66 / 6.82	2.65 / 5.83	2.29 / 6.02	1.26 / 5.94	0.83 / 6.12

REDOX (@ COMPLETION OF PURGING): ______ +/- mv

SAMPLE OBSERVATIONS: [ ] CLEAR [ ] CLOUDY [ ] COLORED ____ [ ] TURBID [ ] ODOR [ ] OTHER (SEE NOTES)

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
[ ]	[ ]	PERISTALTIC PUMP	ISCO # ____
[x]	[x]	DEDICATED SUBMERSIBLE PUMP	
[ ]	[ ]	BAILER	[ ] 2" [ ] 4" # ___
[x]	[x]	PVC/~~SILICON~~ TUBING	
	[ ]	IN-LINE/DISPOSABLE FILTER	____
[ ]	[ ]	OTHER	____

DECON FLUIDS USED: [ ] POTABLE WATER [ ] LIQUINOX [ ] STEAM CLEANING [ ] ____

WATER LEVEL EQUIP. USED: [x] ELECTRIC COND. PROBE [ ] PRESSURE TRANSDUCER [ ] ____

NUMBER OF FILTERS USED ____

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
[x] VOC/VPH/EPH/PAH	UM20	VP	HCL, 4 DEG C	(4) ~~60~~ 40 ML + (2) 1L AG	[ ]	/ / /	
[ ] SVOC	UM18	MS	4 DEG C	(2) 1 L AG	[ ]	/ / /	
[ ] PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	[ ]	/ / /	
	UH13					/ / /	
[ ] PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	[ ]	/ / /	
[ ] LEAD ONLY	SD20	N	HNO3 TO pH<2		[ ]	/ / /	
[ ] EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	[ ]	/ / /	
	UW32					/ / /	
[ ] TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	[ ]	/ / /	
[ ] TOC	415.1	O	H2SO4 TO pH<2	1 L AG	[ ]	/ / /	
[ ] ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	[ ]	/ / /	
	TT10	C	4 DEG C	1 L P-CUBE	[ ]	/ / /	
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	[ ]	/ / /	
[ ] TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	[ ]	/ / /	
[ ] H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	[ ]	/ / /	
		C	4 DEG C	1 L P-CUBE	[ ]	/ / /	
		N	HNO3 TO pH<2	1 L P-CUBE	[ ]	/ / /	
[ ] COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	[ ]	/ / /	

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: ____

RECEIVED BY: ____

Collected MS/MSD for VOCs + VPH only

* 1434 – Flow slowed down, moved wire to 1 Resistor block, still too slow (e not pumping water), made a direct connect to battery and Metered water via valve @ the pump hose. end. Collected sample @ 1444, parameters. Emptied Collection bucket.

PROJECT: USAEC - FT. DEVENS | FIELD SAMPLE NUMBER: MXZW20X2 | STUDY AREA/AOC: 69W

SITE ID: 2WM-95-20X | SITE TYPE: WELL | SAMPLING DATE: 12/16/97

JOB NUMBER: 9144.08 | FILE TYPE: CGW

LOCATION ACTIVITY: START 1550 END 1730 | WEATHER: NA (inside scr...

* INSIDE old Boiler ROOM

WATER LEVEL / WELL DATA

WELL DEPTH	12.2	FT
WATER DEPTH	4.9	FT
HEIGHT OF WATER COLUMN	7.3	FT

☑ MEASURED ☐ HISTORICAL

☑ TOP OF WELL ☐ TOP OF CASING

PROTECTIVE CASING STICK-UP (FROM GROUND): 0.0 FT — Flush mount

PROTECTIVE CASING/WELL DIFF.: -0.57 FT

GAL/VOL: ____ TOTAL GAL PURGED: ____

☐ 1.68 gal/ft (4") ☐ ____ gal/ft

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE	☑	☐	☐
CONCRETE COLLAR INTACT	☐	☐	☑
WELL LOCKED	☐	☑	☐
PVC WELL CAP	☑	☐	☐

WELL DIAMETER: ☑ 2 INCH ☐ 4 INCH ☐ ___ INCH

PID READINGS: AMBIENT AIR .4 PPM | WELL MOUTH .4 PPM

PURGE DATA time ~~VOLUME #~~	1614	1620	1631	1641	1653	1701	~~1708~~ 1706	1715
(eyeball) GALLONS	~1.0	~1.5	~2.0	~2.5	~3.2	~3.8	~4.0	~4.5
PUMPING RATE ~~(GPM)~~ LPM	0.34	.33	.33	.40	.40	.22	.22	.22
TEMP, DEG C / drawdown (ft)	12.0 / 4.93	12.2 / 4.94	12.5 / 4.93	12.7 / 4.93	12.4 / 4.93	12.9 / 4.93	13.0 / 4.93	12.9
pH, UNITS ☐ pH PAPER	6.36	6.34	6.29	6.30	6.34	6.31	6.27	6.31
SPECIFIC CONDUCTIVITY, umhos/cm	351	347	346	344	342	345	341	343
TURBIDITY, ntu / DO (mg/L)	13.4 / 3.36	7.5 / 4.24	4.33 / 3.33	2.15 / 3.61	44.0 / 3.71	23.7 / 3.63	9.58 / 3.76	4.13 / 3.36

REDOX (@ COMPLETION OF PURGING): 219.1 +/- mv (See note)

SAMPLE OBSERVATIONS: ☐ CLEAR ☐ CLOUDY ☐ COLORED ____ ☐ TURBID ☐ ODOR ☐ OTHER (SEE NOTES)

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
☑	☑	PERISTALTIC PUMP (NC)	ISCO # ____
☐	☑	DEDICATED SUBMERSIBLE PUMP	
☐	☐	BAILER	☐ 2" ☐ 4" # ___
☑	☑	PVC/~~SILICON~~ TUBING	
☐	☐	IN-LINE/DISPOSABLE FILTER ____	
☐	☐	OTHER ____	

DECON FLUIDS USED: ☑ POTABLE WATER ☐ LIQUINOX ☐ STEAM CLEANING ☐ ____

WATER LEVEL EQUIP. USED: ☑ ELECTRIC COND. PROBE ☐ PRESSURE TRANSDUCER ☐ ____

NUMBER OF FILTERS USED ____

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
☑ VOC/ VPH/EPH/ PAH	UM20	VP	HCL, 4 DEG C	(4) ~~60~~ 40 ML + (2) 1 L AG	☐	/ /	
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG	☐	/ /	
☐ PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	☐	/ /	
	UH13						
☐ PAL INORGANICS (see notes)		M	HNO3 TO pH<2	1 L P-CUBE	☐	/ /	
☐ ~~LEAD ONLY~~	~~SD20~~	~~M~~	~~HNO3 TO pH<2~~		☐	/ /	
☐ EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	☐	/ /	
	UW32						
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☐	/ /	
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☐	/ /	
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐	/ /	
	TT10	C	4 DEG C	1 L P-CUBE	☐	/ /	
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐	/ /	
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐	/ /	
☐ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☐	/ /	
		C	4 DEG C	1 L P-CUBE	☐	/ /	
		N	HNO3 TO pH<2	1 L P-CUBE	☐	/ /	
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐	/ /	

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

Start pumping ~~4:15~~ 4:14 MC

SAMPLED BY: Clyman/ Mroka

RECEIVED BY:

1451 - Power Lost to pump, ? bad connection to battery.

PROJECT: USAEC - FT. DEVENS | FIELD SAMPLE NUMBER: MXZW0904 | STUDY AREA/AOC: 69W

SITE ID: 69W-94-09 | SITE TYPE: WELL | SAMPLING DATE: 12/18/97

JOB NUMBER: 9144.08 | FILE TYPE: CGW

CATION ACTIVITY: START 0845 END 1045 | WEATHER: clear, 30's

WATER LEVEL / WELL DATA

WELL DEPTH: 13.35 FT ☑ MEASURED ☐ HISTORICAL

WATER DEPTH: 7.72 FT

HEIGHT OF WATER COLUMN: 5.63 FT

☐ 1.68 gal/ft (4")
☐ ___ gal/ft

GAL/VOL: | TOTAL GAL PURGED:

☑ TOP OF WELL ☐ TOP OF CASING ☐ ________

PROTECTIVE CASING STICK-UP (FROM GROUND): NA FT

PROTECTIVE CASING/WELL DIFF.: -0.40 FT

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE		☑	
CONCRETE COLLAR INTACT		☑	
WELL LOCKED		☑	
PVC WELL CAP	☑		

WELL DIAMETER: ☑ 2 INCH ☐ 4 INCH ☐ ___ INCH

PID READINGS: AMBIENT AIR 0.1 PPM | WELL MOUTH 0.1 PPM

water - 0.5 ppm

PURGE DATA

PURGE DATA								
Time ~~VOLUME #~~	0943	947	1004	1015	1030			
(eyeball) GALLONS		≈1	2.5	4.045	≈6			
PUMPING RATE (LPM)	0.45	0.26	0.35	0.46	0.35			
TEMP, DEG C / drawdown (ft)	10.1 / 7.58	11.0 / 8.65	/ 8.59	11.5 / 8.8	11.7 / 8.75			
pH, UNITS ☐ pH PAPER	5.95	—	6.27	6.37	6.38			
SPECIFIC CONDUCTIVITY, umhos/cm	238	—	226	223	219			
TURBIDITY, ntu / DO (mg/L)	60 / 3.15		5 / 2.73	3.6 / 2.61	3.25 / 2.42			

REDOX (@ COMPLETION OF PURGING): 225 +/- mv

*adjusted Flow down

SAMPLE OBSERVATIONS
☐ CLEAR
☑ CLOUDY - slight
☐ COLORED ________
☐ TURBID
☐ ODOR
☐ OTHER (SEE NOTES)

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
☐	☐	PERISTALTIC PUMP	ISCO # ________
☑	☑	DEDICATED SUBMERSIBLE PUMP	
☐	☐	BAILER	☐ 2" ☐ 4" # ___
☑	☑	PVC/SILICON TUBING	
	☐	IN-LINE/DISPOSABLE FILTER ________	
☐	☐	OTHER ________	

DECON FLUIDS USED
☑ POTABLE WATER
☐ LIQUINOX
☐ STEAM CLEANING
☐ ________

WATER LEVEL EQUIP. USED
☑ ELECTRIC COND. PROBE
☐ PRESSURE TRANSDUCER
☐ ________

NUMBER OF FILTERS USED ______

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
☑ VOC/VPH/EPH/PAH	UM20	VP	HCL, 4 DEG C	5 40 ~~(4) 60~~ ML + (2) 1 L AG	☐	___/___/___/___	
☐ SVOC	UM18	NS	4 DEG C	(2) 1 L AG	☐	___/___/___/___	
☐ PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	☐	___/___/___/___	
	UH13					___/___/___/___	
☐ PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	☐	___/___/___/___	
☐ LEAD ONLY	SD20	N	HNO3 TO pH<2		☐	___/___/___/___	
☐ EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	☐	___/___/___/___	
	UW32					___/___/___/___	
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☐	___/___/___/___	
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☐	___/___/___/___	
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐	___/___/___/___	
	TT10	C	4 DEG C	1 L P-CUBE	☐	___/___/___/___	
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐	___/___/___/___	
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐	___/___/___/___	
☐ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☐	___/___/___/___	
		C	4 DEG C	1 L P-CUBE	☐	___/___/___/___	
		N	HNO3 TO pH<2	1 L P-CUBE	☐	___/___/___/___	
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐	___/___/___/___	

low Flow protocol

NOTES ~~(1)~~ PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: ________________

RECEIVED BY: ________________

- casing was frozen - lid not flush (like it had been pushed up by flow - inside + outside of casing filled w/ frozen H2O + dirt

PROJECT	USAEC - FT. DEVENS	FIELD SAMPLE NUMBER	MXZW16X4
SITE ID	ZWM-95-18X	STUDY AREA/AOC	69W
		SITE TYPE	WELL
		SAMPLING DATE	12/18/97
		JOB NUMBER	9144.08
		FILE TYPE	CGW
LOCATION ACTIVITY	START 1100 END 1200	WEATHER	clear, 30°s

WATER LEVEL / WELL DATA

- WELL DEPTH: 15.6 FT ☒ MEASURED ☐ HISTORICAL
- WATER DEPTH: 7.58 FT
- HEIGHT OF WATER COLUMN: 8 FT
- ☐ 1.68 gal/ft (4") ☐ ___ gal/ft
- GAL/VOL: ___
- TOTAL GAL PURGED: ___
- ☒ TOP OF WELL ☐ TOP OF CASING ☐ ___
- PROTECTIVE CASING STICK-UP (FROM GROUND): Flush FT
- PROTECTIVE CASING/WELL DIFF.: -.65 FT
- WELL DIAMETER: ☐ 2 INCH ☒ 4 INCH ☐ ___ INCH 4"

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE	X		
CONCRETE COLLAR INTACT	X		
WELL LOCKED		X	
PVC WELL CAP	X		

PID READINGS: AMBIENT AIR 0.9 PPM WELL MOUTH 0.9 PPM jar headspace = 0.9 ppm

PURGE DATA

Time ~~VOLUME #~~	1110	1125	1135	1150				
(roughall) GALLONS	0.3	3	5	6.5-7				
PUMPING RATE (LPM)	~~0.68~~ 0.5	0.5	0.46	0.45				
TEMP, DEG C / drawdown (water level)	11.7 / 7.72	11.7 / 7.8	11.4 / 7.75	11.4				
pH, UNITS ☐ pH PAPER	6.47	6.50	6.59	6.60				
SPECIFIC CONDUCTIVITY, umhos/cm (HORIBA)	215	208	213	213				
TURBIDITY, ntu / D.O	13 / 0.38	3 / 0.60	1.64 / 0.33	2 / 0.40				

REDOX (@ COMPLETION OF PURGING): 10.5 +/- mv Pump placed at 11.0'

Final Turb - 0.68 (With Hach)

SAMPLE OBSERVATIONS: ☒ CLEAR - very ☐ CLOUDY ☐ COLORED ___ ☐ TURBID ☐ ODOR ☐ OTHER (SEE NOTES)

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
☐	☐	PERISTALTIC PUMP	ISCO # ___
☒	☒	DEDICATED SUBMERSIBLE PUMP	- Whale
☐	☐	BAILER	☐ 2" ☐ 4" # ___
☒	☒	PVC/~~SILICON~~ TUBING	
		IN-LINE/DISPOSABLE FILTER ___	
☐	☐	OTHER ___	

DECON FLUIDS USED: ☒ POTABLE WATER ☐ LIQUINOX ☐ STEAM CLEANING ☐ ___

WATER LEVEL EQUIP. USED: ☒ ELECTRIC COND. PROBE ☐ PRESSURE TRANSDUCER ☐ ___

NUMBER OF FILTERS USED ___

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
☒ VOC/VPH/EPH	UM20	VP	HCL, 4 DEG C	6 40 ~~(2) 80~~ ML + (2) 1L AG	☒		
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG	☐		
☐ PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	☐		
	UH13						
☐ PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ LEAD ONLY	SD20	N	HNO3 TO pH<2		☐		
☐ EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	☐		
	UW32						
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☐		
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☐		
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐		
	TT10	C	4 DEG C	1 L P-CUBE	☐		
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐		
☐ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☐		
		C	4 DEG C	1 L P-CUBE	☐		
		N	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐		

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: T Dane / Wirtella

RECEIVED BY: ___

PROJECT: USAEC - FT. DEVENS | FIELD SAMPLE NUMBER: MXZW21X2 | STUDY AREA/AOC: 69W

SITE ID: ZWM-96-21X | SITE TYPE: WELL | SAMPLING DATE: 12/18/97

JOB NUMBER: ~~9188~~ (NR) 9144.08 | FILE TYPE: CGW

CATION ACTIVITY: START 1300 END MOD | WEATHER: clear, 30°s

WATER LEVEL / WELL DATA

WELL DEPTH: 14 FT ☒ MEASURED ☐ HISTORICAL

WATER DEPTH: 10.15 FT

HEIGHT OF WATER COLUMN: ~4 FT

☐ 1.68 gal/ft (4") ☐ ___ gal/ft

GAL/VOL:

TOTAL GAL PURGED:

☒ TOP OF WELL ☐ TOP OF CASING

PROTECTIVE CASING STICK-UP (FROM GROUND): flush FT

PROTECTIVE CASING/WELL DIFF.: -0.41 FT

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE	☒	☐	☐
CONCRETE COLLAR INTACT	☒	☐	☐
WELL LOCKED	☐	☒	☐
PVC WELL CAP	☒	☐	☐

WELL DIAMETER: ☒ 2 INCH ☐ 4 INCH ☐ ___ INCH

PID READINGS: AMBIENT AIR 0.9 PPM | WELL MOUTH 0.9 PPM

PURGE DATA

Time ~~VOLUME #~~	1325	1335	1344	1355				
(eyeball) GALLONS	1	2	3	4				
PUMPING RATE (GPM)	0.44	0.44	0.44	0.44				
TEMP, DEG C / Drawdown (ft.)	12.1 / 10.24	12.5 / 10.23	12.6 / 10.24	12.6				
pH, UNITS ☐ pH PAPER	6.24	6.30	6.33	6.30				
SPECIFIC CONDUCTIVITY, umhos/cm	230	230	231	232				
TURBIDITY, ntu / DO (mg/L)	9.84 / 3.80	2.29 / 4.06	4.98 / 3.79	0.97 / 3.33				

REDOX (@ COMPLETION OF PURGING): 133 +/- mv 3.32

SAMPLE OBSERVATIONS: ☒ CLEAR ☐ CLOUDY ☐ COLORED ___ ☐ TURBID ☐ ODOR ☐ OTHER (SEE NOTES)

0.7 pid (dumped purge)

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
☐	☐	PERISTALTIC PUMP	ISCO # ___
☒	☒	DEDICATED SUBMERSIBLE PUMP	
☐	☐	BAILER	☐ 2" ☐ 4" # ___
☒	☒	PVC/~~SILICON~~ TUBING	
	☐	IN-LINE/DISPOSABLE FILTER ___	
☐	☐	OTHER ___	

DECON FLUIDS USED: ☒ POTABLE WATER ☐ LIQUINOX ☐ STEAM CLEANING ☐ ___

WATER LEVEL EQUIP. USED: ☒ ELECTRIC COND. PROBE ☐ PRESSURE TRANSDUCER ☐ ___

NUMBER OF FILTERS USED ___

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
☒ VOC/EPH/PAH/VPH	UM20	VP	HCL, 4 DEG C	6 ~~(3)~~ 40 ML + (2) 1L AG	☒	___/___/___/	
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG	☐	___/___/___/	
☐ PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	☐	___/___/___/	
	UH13						
☐ PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	☐	___/___/___/	
☐ LEAD ONLY	SD20	N	HNO3 TO pH<2		☐	___/___/___/	
☐ EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	☐	___/___/___/	
	UW32						
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☐	___/___/___/	
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☐	___/___/___/	
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐	___/___/___/	
	TT10	C	4 DEG C	1 L P-CUBE	☐	___/___/___/	
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐	___/___/___/	
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐	___/___/___/	
☐ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☐	___/___/___/	
		C	4 DEG C	1 L P-CUBE	☐	___/___/___/	
		N	HNO3 TO pH<2	1 L P-CUBE	☐	___/___/___/	
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐	___/___/___/	

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: TD JWR

RECEIVED BY: ___

PROJECT	USAEC - FT. DEVENS	FIELD SAMPLE NUMBER	MDZW19X2
SITE ID	ZWM-96-19X	SITE TYPE	WELL
		JOB NUMBER	9144.08
LOCATION ACTIVITY	START 1420 END 1510		

STUDY AREA/AOC: 69W
SAMPLING DATE: 12/18/97
FILE TYPE: CGW
WEATHER: ~~clear, 30s~~ (NM) lrs, sc/NC

WATER LEVEL / WELL DATA

WELL DEPTH 15.2± FT — [x] MEASURED [ ] HISTORICAL
WATER DEPTH 10.42 FT
HEIGHT OF WATER COLUMN ~5 FT
[ ] 1.68 gal/ft (4") [ ] ___ gal/ft

[x] TOP OF WELL [ ] TOP OF CASING

GAL/VOL ___ TOTAL GAL PURGED ___

PROTECTIVE CASING STICK-UP (FROM GROUND) flush FT
PROTECTIVE CASING/WELL DIFF. -0.42 FT

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE			[x]
CONCRETE COLLAR INTACT			
WELL LOCKED		[x]	
PVC WELL CAP	[x]		

WELL DIAMETER [x] 2 INCH [ ] 4 INCH [ ] ___ INCH

PID READINGS: AMBIENT AIR 0.9 PPM WELL MOUTH 0.9 PPM

PURGE DATA

Time ~~VOLUME #~~	1425	1435	1445	1450	1500			
(cycles) GALLONS	0.75	2	3	4	4.5			
PUMPING RATE (GPM)	0.48	0.44	0.44	0.45	0.45			
TEMP, DEG C / Drawdown (ft)	13.9 / 10.53	14.0 / 10.59	14.0 / 10.54	14.2	14.2			
pH, UNITS [ ] pH PAPER	6.37	6.36	6.45	6.45	6.46			
SPECIFIC CONDUCTIVITY, umhos/cm	254	244	244	247	273			
TURBIDITY, ntu / DO (mg/L)	2.66 / 0.62	0.85 / 1.40	0.61 / 2.5	2.63 / 3	/ 1.7			

REDOX (@ COMPLETION OF PURGING): 90 ~~104~~ +/- mv

* adjusted flow

SAMPLE OBSERVATIONS
[x] CLEAR
[ ] CLOUDY
[ ] COLORED ___
[ ] TURBID
[ ] ODOR
[ ] OTHER (SEE NOTES)

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
[ ]	[ ]	PERISTALTIC PUMP	ISCO # ___
[x]	[x]	DEDICATED SUBMERSIBLE PUMP	
[ ]	[ ]	BAILER (NA)	[ ] 2" [ ] 4" # ___
[x]	[x]	~~PVC/SILICON~~ TUBING	
[ ]	[ ]	IN-LINE/DISPOSABLE FILTER ___	
[ ]	[ ]	OTHER ___	

DECON FLUIDS USED
[x] POTABLE WATER
[ ] LIQUINOX
[ ] STEAM CLEANING
[ ] ___

WATER LEVEL EQUIP. USED
[x] ELECTRIC COND. PROBE
[ ] PRESSURE TRANSDUCER
___

NUMBER OF FILTERS USED ___

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
[x] VOC / VPH / EPH / PAH	UM20	VP	HCL, 4 DEG C	6 ~~(4)~~ 40 ~~60~~ ML (2) 1 L AG	[x]	___/___/___/___	
[ ] SVOC	UM18	MS	4 DEG C	(2) 1 L AG	[ ]	___/___/___/___	
[ ] PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	[ ]	___/___/___/___	
	UH13						
[ ] PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	[ ]	___/___/___/___	
[ ] LEAD ONLY	SD20	N	HNO3 TO pH<2		[ ]	___/___/___/___	
[ ] EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	[ ]	___/___/___/___	
	UW32						
[ ] TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	[ ]	___/___/___/___	
[ ] TOC	415.1	O	H2SO4 TO pH<2	1 L AG	[ ]	___/___/___/___	
[ ] ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	[ ]	___/___/___/___	
	TT10	C	4 DEG C	1 L P-CUBE	[ ]	___/___/___/___	
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	[ ]	___/___/___/___	
[ ] TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	[ ]	___/___/___/___	
[ ] H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	[ ]	___/___/___/___	
		C	4 DEG C	1 L P-CUBE	[ ]	___/___/___/___	
		N	HNO3 TO pH<2	1 L P-CUBE	[ ]	___/___/___/___	
[ ] COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	[ ]	___/___/___/___	

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: TD/WR
RECEIVED BY: ___

- Collected a duplicate CMD

PROJECT	USAEC - FT. DEVENS	FIELD SAMPLE NUMBER	MXZW12X5
SITE ID	~~ZWM~~-94-12X 69W	SITE TYPE	WELL
		JOB NUMBER	9144.08
LOCATION ACTIVITY	START 0800 END 0915		
STUDY AREA/AOC	69W	SAMPLING DATE	12/19/97
FILE TYPE	CGW	WEATHER	overcast, 40°s

WATER LEVEL / WELL DATA

WELL DEPTH 13.25 FT [x] MEASURED [ ] HISTORICAL

WATER DEPTH 7.27 FT

HEIGHT OF WATER COLUMN ~6 FT

[ ] 1.68 gal/ft (4") [ ] ___ gal/ft

[x] TOP OF WELL [ ] TOP OF CASING [ ] ______

GAL/VOL ______ TOTAL GAL PURGED ______

PROTECTIVE CASING STICK-UP (FROM GROUND) flush FT

PROTECTIVE CASING/WELL DIFF. -0.44 FT

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE	[x]	[ ]	[ ]
CONCRETE COLLAR INTACT	[ ]	[ ]	[x]
WELL LOCKED	[ ]	[x]	[ ]
PVC WELL CAP	[x]	[ ]	[ ]

WELL DIAMETER [ ] 2 INCH [x] 4 INCH [ ] ___ INCH

PID READINGS: AMBIENT AIR 0.0 PPM WELL MOUTH 0.0 PPM jar headspace = 0 ppm ∴ did not containerize purge H₂O

PURGE DATA								
Time ~~VOLUME #~~	0820	0830	0837	0850				
(eyeball) GALLONS	0.5	1	3	4				
PUMPING RATE (GPM)	0.50	0.50	0.50	0.48				
TEMP, DEG C / Drawdown (ft)	11.9 / 7.30	12.1 / 7.30	11.8 / 7.30	12.1 / 7.36				
pH, UNITS [ ] pH PAPER	5.92	6.00	6.05	6.04				
SPECIFIC CONDUCTIVITY, umhos/cm	323	310	305	303				
TURBIDITY, ntu / DO (mg/L)	0.47 / ~~4.47~~	0.43 / 4.43	0.35 / 4.38	0.2 / 4.35				

REDOX (@ COMPLETION OF PURGING): @4.48 +/- mV → Redox = 226.1 mV Zobell soln check = 253 @ 5°C

SAMPLE OBSERVATIONS

[x] CLEAR
[ ] CLOUDY
[ ] COLORED ______
[ ] TURBID
[ ] ODOR
[ ] OTHER (SEE NOTES)

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING		EQUIPMENT ID
[x] (NR)	[x]	PERISTALTIC PUMP	ISCO # ______
[x]	[x]	DEDICATED SUBMERSIBLE PUMP	[ ] 2" [ ] 4" # ___
[x]	[ ]	BAILER	
[x]	[x]	PVC/~~SILICON~~ TUBING	
	[ ]	IN-LINE/DISPOSABLE FILTER ______	
[ ]	[ ]	OTHER ______	

DECON FLUIDS USED
[x] POTABLE WATER
[ ] LIQUINOX
[ ] STEAM CLEANING
[ ] ______

NUMBER OF FILTERS USED ______

WATER LEVEL EQUIP. USED
[x] ELECTRIC COND. PROBE
[ ] PRESSURE TRANSDUCER
______

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
[x] VOC/VPH/EPH/PAH *	UM20	VP	HCL, 4 DEG C	6 40 ~~(4) 60~~ ML + (2) 1 L AG	[x]	/ / /	
[ ] SVOC	UM18	MS	4 DEG C	(2) 1 L AG	[ ]	/ / /	
[ ] PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	[ ]	/ / /	
	UH13					/ / /	
[ ] PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	[ ]	/ / /	
[ ] LEAD ONLY	SD20	N	HNO3 TO pH<2		[ ]	/ / /	
[ ] EXPLOSIVES	UW19	EC	4 DEG C	(3) 1 L AG	[ ]	/ / /	
	UW32					/ / /	
[ ] TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	[ ]	/ / /	
[ ] TOC	415.1	O	H2SO4 TO pH<2	1 L AG	[ ]	/ / /	
[ ] ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	[ ]	/ / /	
	TT10	C	4 DEG C	1 L P-CUBE	[ ]	/ / /	
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	[ ]	/ / /	
[ ] TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	[ ]	/ / /	
[ ] H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	[ ]	/ / /	
		C	4 DEG C	1 L P-CUBE	[ ]	/ / /	
		N	HNO3 TO pH<2	1 L P-CUBE	[ ]	/ / /	
[ ] COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	[ ]	/ / /	

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: TD/NR
RECEIVED BY: ______

* – collected extra VPH/VOC for potential MS/MSD if required by Woods Hole

– collected (2) extra EPH if replicate required

SURVEY DATA

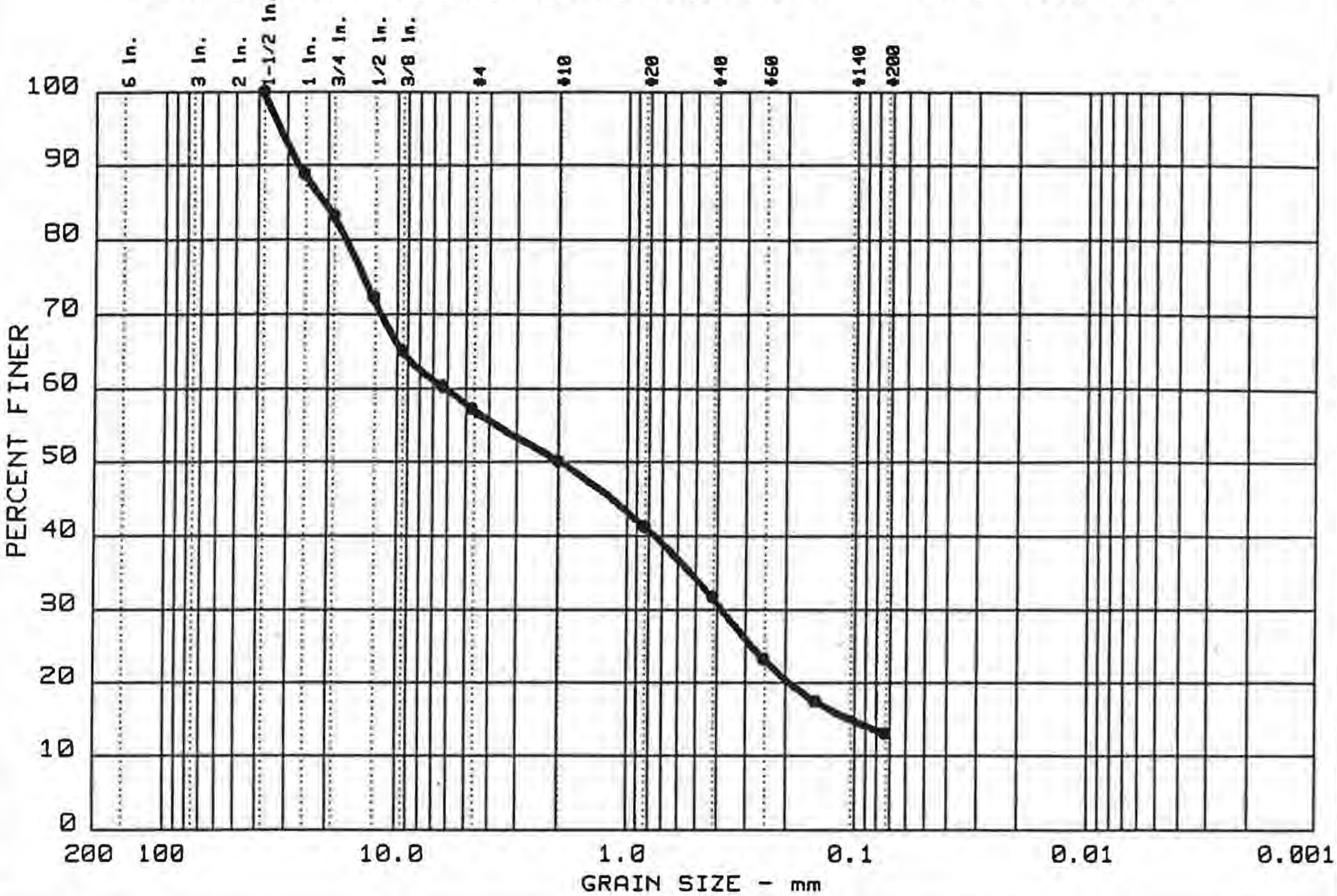
TABLE H-1
MONITORING WELL AND PIEZOMETER DATA
AOC 69W

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

WELL	NORTH	EAST	TOP OF PVC	GROUND ELEVATION
69W-94-09	564499	571261	228.4	228.67
69W-94-10	564499	571163	227.99	228.24
69W-94-11	564553	571198	227.33	227.74
69W-94-12	564619	571215	228.94	226.45
69W-94-13	564610	571147	227.79	225.3
69W-94-14	564704	571088	228.02	225.53
ZWM-95-15X	564735.06	571021.88	225.81	222.94
ZWM-95-16X	564474.81	571257.09	228.38	229.01
ZWM-95-17X	564209.73	571369.71	238.63	236.07
ZWM-95-18X	564869.16	571013.25	222.95	220.73
ZWM-96-19X	564414.93	571174.03	231.11	231.53
ZWM-96-20X	564409.95	571294.75	225.99	226.49
ZWM-96-21X	564391.42	571187.79	230.93	231.17
ZWP-95-01X	564617.99	570952.94	226.84	224.43
ZWP-95-02X	564819.87	570959.78	223.63	220.71

GEOTECHNICAL DATA (GRAIN SIZE)

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	42.8	44.2	13.0		GM-SM		

SIEVE inches size	PERCENT FINER ●		
1.5	100.0		
1	88.8		
0.75	83.2		
0.5	72.2		
0.375	65.1		
0.25	60.2		
	GRAIN SIZE		
D_{60}	6.17		
D_{30}	0.38		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	57.2		
10	50.1		
20	41.2		
40	31.8		
60	23.3		
100	17.4		
200	13.0		

Sample information:
● ZWM-96-19X
F to C Gvly F to C SAND; Lttl Si.

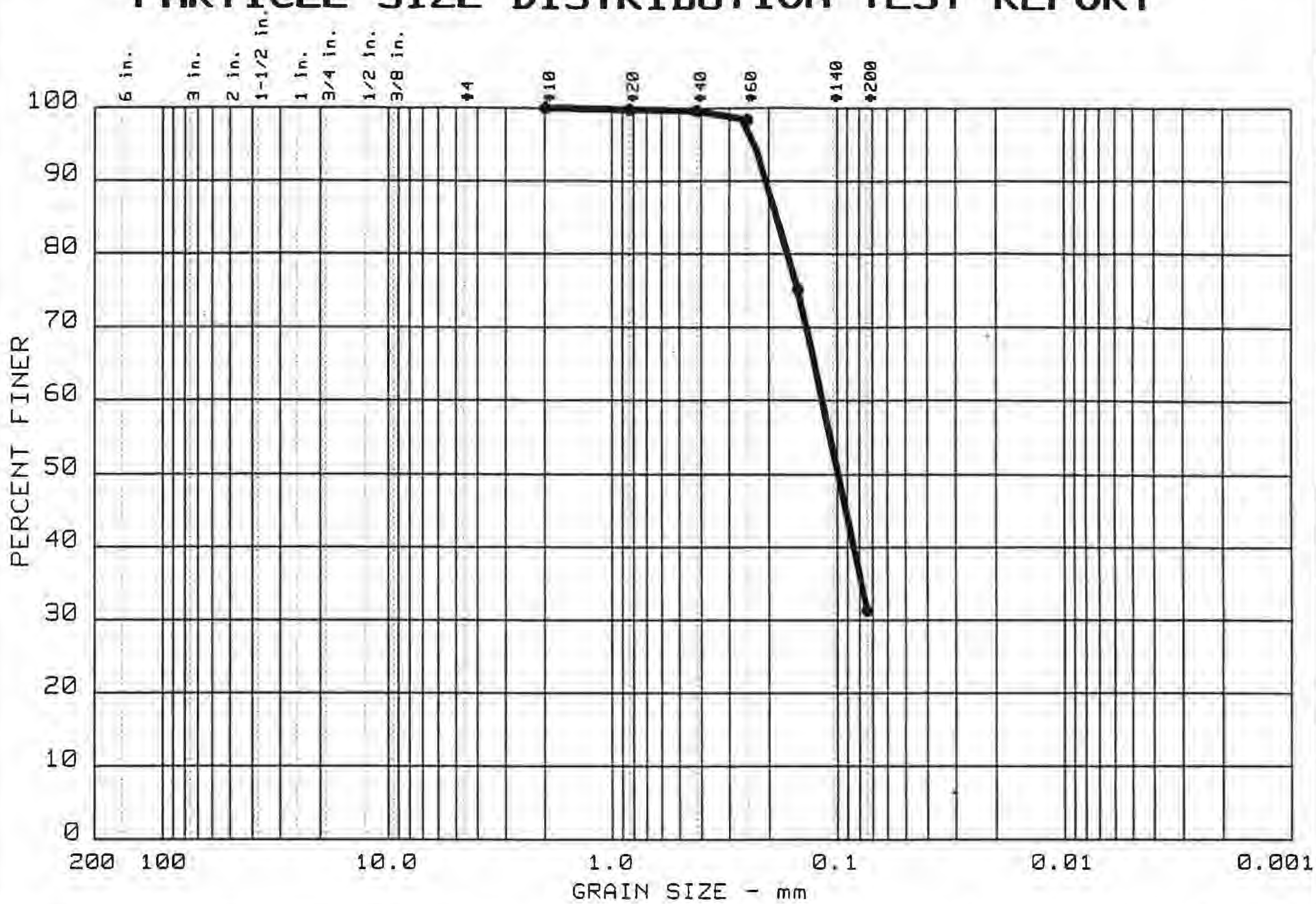
Remarks:
SIEVE ANALYSIS

ABB Environmental Services, Inc.

Project No.: 9144.08
Project: FORT DEVENS

Date: 10\10\96 Data Sheet No. 5

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.0	68.7	31.3		SM		

SIEVE inches size	PERCENT FINER ●		
	GRAIN SIZE		
D_{60}	0.12		
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
10	100.0		
20	99.8		
40	99.6		
60	98.4		
100	75.1		
200	31.3		

Sample information:
● ZWM-96-20X
F SAND; Sm Si; Tr M Sa.

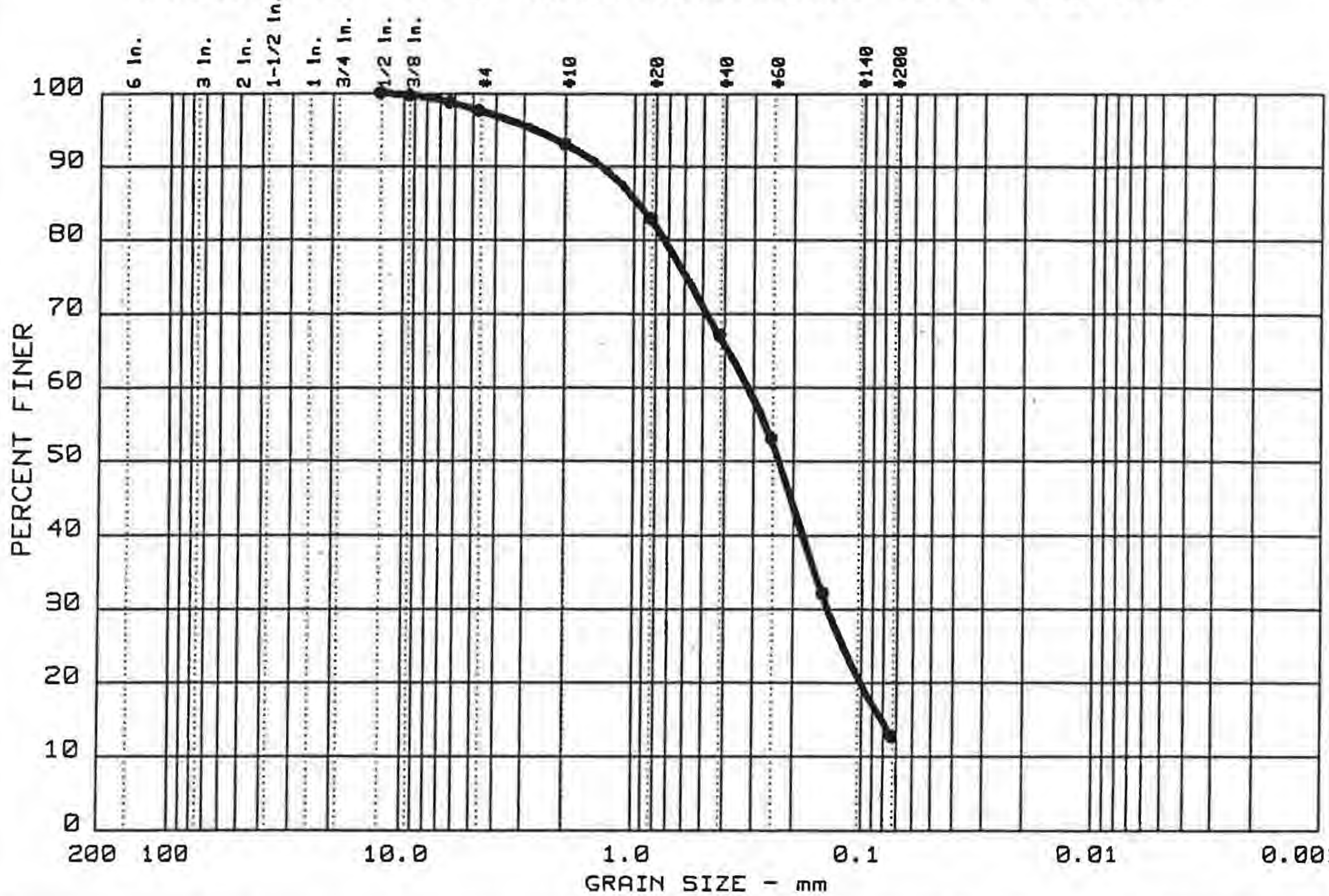
Remarks:
SIEVE ANALYSIS

ABB Environmental Services, Inc.

Project No.: 09144.08
Project: FORT DEVENS

Date: 10/10/96 Data Sheet No. 21

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	2.4	84.9	12.7		SW		

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
0.375	99.8		
0.25	98.7		
	GRAIN SIZE		
D_{60}	0.31		
D_{30}	0.14		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	97.6		
10	93.1		
20	82.9		
40	67.1		
60	53.0		
100	32.2		
200	12.8		

Sample information:
● ZWM-96-21X
F to C SAND; Lttl Si;
Tr F Gvl.

Remarks:
SIEVE ANALYSIS

ABB Environmental Services, Inc.

Project No.: 9144.08
Project: FORT DEVENS
Date: 10/10/96
Data Sheet No. 5

PROJECT ANALYTE LIST

APPENDIX J
PROJECT ANALYTE LIST

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

TEST NAME	PARAMETER NAME	SOIL		WATER	
		CRL	UNIT	CRL	UNIT
PAL INORGANICS					
AL	ALUMINUM	2.35	ug/g	141	ug/l
SB	ANTIMONY	0.109	ug/g	3.03	ug/l
AS	ARSENIC	0.25	ug/g	2.54	ug/l
BA	BARIUM	5.18	ug/g	5	ug/l
BE	BERYLLIUM	0.5	ug/g	5	ug/l
CD	CADMIUM	0.7	ug/g	4.01	ug/l
CA	CALCIUM	100	ug/g	500	ug/l
CR	CHROMIUM	4.05	ug/g	6.02	ug/l
CO	COBALT	1.42	ug/g	25	ug/l
CU	COPPER	0.965	ug/g	8.09	ug/l
FE	IRON	3.68	ug/g	38.8	ug/l
PB	LEAD	0.177	ug/g	1.26	ug/l
MG	MAGNESIUM	100	ug/g	500	ug/l
MN	MANGANESE	2.05	ug/g	2.75	ug/l
HG	MERCURY	0.05	ug/g	0.243	ug/l
NI	NICKEL	1.71	ug/g	34.3	ug/l
K	POTASSIUM	100	ug/g	375	ug/l
SE	SELENIUM	0.25	ug/g	3.02	ug/l

continued

APPENDIX J
PROJECT ANALYTE LIST

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

TEST NAME	PARAMETER NAME	SOIL		WATER	
		CRL	UNIT	CRL	UNIT
AG	SILVER	0.589	ug/g	4.6	ug/l
NA	SODIUM	100	ug/g	500	ug/l
TL	THALLIUM	0.319	ug/g	6.99	ug/l
V	VANADIUM	3.39	ug/g	11	ug/l
ZN	ZINC	8.03	ug/g	21	ug/l
PAL EXPLOSIVES					
135TNB	1,3,5-TRINITROBENZENE	0.488	ug/g	0.449	ug/l
13DNB	1,3-DINITROBENZENE	0.496	ug/g	0.611	ug/l
246TNT	2,4,6-TRINITROTOLUENE	0.456	ug/g	0.635	ug/l
24DNT	2,4-DINITROTOLUENE	0.424	ug/g	0.0637	ug/l
26DNT	2,6-DINITROTOLUENE	0.524	ug/g	0.0738	ug/l
HMX	CYCLOTETRAMETHYLENETETRANITRAMINE	0.666	ug/g	1.21	ug/l
NB	NITROBENZENE	2.41	ug/g	0.645	ug/l
RDX	CYCLONITE	0.587	ug/g	1.17	ug/l
TETRYL	NITRAMINE	0.731	ug/g	1.56	ug/l
NG	NITROGLYCERINE	4	ug/g	10	ug/l
PETN	PENTAERYTHRITOL TETRANITRATE	4	ug/g	20	ug/l

continued

APPENDIX J
PROJECT ANALYTE LIST

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

TEST NAME	PARAMETER NAME	SOIL		WATER	
		CRL	UNIT	CRL	UNIT
PAL ANIONS/CATIONS					
HCO3	BICARBONATE	NA		NA	ug/l
CL	CHLORIDE	NA		2,120	ug/l
SO4	SULFATE	NA		10,000	ug/l
NO3	NITRATE	NA		10	ug/l
CA	CALCIUM	NA		500	ug/l
K	POTASSIUM	NA		375	ug/l
MG	MAGNESIUM	NA		500	ug/l
PAL WATER QUALITY PARAMETERS					
CL	CHLORIDES	NA		2,120	ug/l
N2KJEL	TOTAL NITROGEN	NA		183	ug/l
NIT	NO3-N	NA		10	ug/l
SO4	SULFATES	NA		10,000	ug/l
TPO4	TOTAL PHOSPHORUS	NA		13.3	ug/l
--	HARDNESS	NA		NA	ug/l
ALK	ALKALINITY	NA		NA	ug/l
TSS	TOTAL SUSPENDED SOLIDS	NA		NA	ug/l
DO	DISSOLVED OXYGEN	NA		NA	ug/l

continued

APPENDIX J
PROJECT ANALYTE LIST

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

TEST NAME	PARAMETER NAME	SOIL		WATER	
		CRL	UNIT	CRL	UNIT
PAL ORGANICS VOLATILE COMPOUNDS					
111TCE	1,1,1-TRICHLOROETHANE	0.0044	ug/g	0.5	ug/l
112TCE	1,1,2-TRICHLOROETHANE	0.0054	ug/g	1.2	ug/l
11DCE	1,1-DICHLOROETHYLENE/ 1,1-DICHLOROETHENE	0.0039	ug/g	0.5	ug/l
11DCLE	1,1-DICHLOROETHANE	0.0023	ug/g	0.68	ug/l
12DCE	1,2-DICHLOROETHYLENES, TOTAL (CIS AND TRANS ISOMERS)	0.003	ug/g	0.5	ug/l
12DCLE	1,2-DICHLOROETHANE	0.0017	ug/g	0.5	ug/l
12DCLP	1,2-DICHLOROPROPANE	0.0029	ug/g	0.5	ug/l
ACET	ACETONE	0.017	ug/g	13	ug/l
BRDCLM	BROMODICHLOROMETHANE	0.0029	ug/g	0.59	ug/l
C2H3CL	CHLOROETHENE/VINYL CHLORIDE	0.0062	ug/g	2.6	ug/l
C2H5CL	CHLOROETHANE	0.012	ug/g	1.9	ug/l
C6H6	BENZENE	0.0015	ug/g	0.5	ug/l
CCL4	CARBON TETRACHLORIDE	0.007	ug/g	0.5	ug/l
CH2CL2	METHYLENE CHLORIDE	0.012	ug/g	2.3	ug/l
CH3BR	BROMOMETHANE	0.0057	ug/g	5.8	ug/l
CH3CL	CHLOROMETHANE	0.0088	ug/g	3.2	ug/l

continued

APPENDIX J
PROJECT ANALYTE LIST

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

TEST NAME	PARAMETER NAME	SOIL		WATER	
		CRL	UNIT	CRL	UNIT
CHBR3	BROMOFORM	0.0069	ug/g	2.6	ug/l
C13DCP	CIS-1,3-DICHLOROPROPYLENE C+S-1,3-DICHLOROPROPENE	0.0032	ug/g	0.58	ug/l
CHCL3	CHLOROFORM	0.00087	ug/g	0.5	ug/l
CL2CH2	DICHLOROMETHANE	12	ug/g	2.3	ug/l
CLC6H5	CHLOROBENZENE	0.00086	ug/g	0.5	ug/l
CS2	CARBON DISULFIDE	0.0044	ug/g	0.5	ug/l
DBRCLM	DIBROMOCHLOROMETHANE	0.0031	ug/g	0.67	ug/l
ETC6H5	ETHYLBENZENE	0.0017	ug/g	0.5	ug/l
MEC6H5	TOLUENE	0.00078	ug/g	0.5	ug/l
MEK	METHYLETHYL KETONE/2-BUTANONE	0.07	ug/g	6.4	ug/l
MIBK	METHYLISOBUTYL KETONE	0.027	ug/g	3	ug/l
MNBK	METHYL-N-BUTYL KETONE/2-HEXANONE	0.032	ug/g	3.6	ug/l
STYR	STYRENE	0.0026	ug/g	0.5	ug/l
T13DCP	TRANS-1,3-DICHLOROPROPENE	0.0028	ug/g	0.7	ug/l
TCLEA	1,1,2,2-TETRACHLOROETHANE	0.0024	ug/g	0.51	ug/l
TCLEE	TETRACHLOROETHYLENE/ TETRACHLOROETHENE	0.00081	ug/g	1.6	ug/l

APPENDIX J
PROJECT ANALYTE LIST

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

TEST NAME	PARAMETER NAME	SOIL		WATER	
		CRL	UNIT	CRL	UNIT
TRCLE	TRICHLOROTHYLENE/TRICHLOROETHENE	0.0028	ug/g	0.5	ug/l
TXYLEN	XYLENES, TOTAL COMBINED	1.5	ug/g	0.84	ug/l
PAL ORGANICS SEMIVOLATILE COMPOUNDS					
124TCB	1,2,4-TRICHLOROBENZENE	0.04	ug/g	1.8	ug/l
12DCLB	1,2-DICHLOROBENEZENE	0.11	ug/g	1.7	ug/l
13DCLB	1,3-DICHLOROBENZENE	0.13	ug/g	1.7	ug/l
14DCLB	1,4-DICHLOROBENZENE	0.098	ug/g	1.7	ug/l
245TCP	2,4,5-TRICHLOROPHENOL	0.1	ug/g	5.2	ug/l
246TCP	2,4,6-TRICHLOROPHENOL	0.17	ug/g	13	ug/l
24DCLP	2,4-DICHLOROPHENOL	0.18	ug/g	2.9	ug/l
24DMPN	2,4-DIMETHYLPHENOL	0.69	ug/g	5.8	ug/l
24DNP	2,4-DINITROPHENOL	1.2	ug/g	21	ug/l
24DNT	2,4-DINITROTOLUENE	0.14	ug/g	4.5	ug/l
26DNT	2,6-DINITROTOLUENE	0.085	ug/g	0.79	ug/l
2CLP	2-CHLOROPHENOL	0.06	ug/g	0.99	ug/l
2CNAP	2-CHLORONAPHTHALENE	0.036	ug/g	0.5	ug/l
2MNAP	2-METHYLNAPHTHALENE	0.049	ug/g	1.7	ug/l
2MP	2-METHYLPHENOL/2-CRESOL	0.029	ug/g	3.9	ug/l

APPENDIX J
PROJECT ANALYTE LIST

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

TEST NAME	PARAMETER NAME	SOIL		WATER	
		CRL	UNIT	CRL	UNIT
2NANIL	2-NITROANILINE	0.062	ug/g	4.3	ug/l
2NP	2-NITROPHENOL	0.14	ug/g	3.7	ug/l
33DCBD	3,3'-DICHLOROBENZIDINE	6.3	ug/g	12	ug/l
3NANIL	3-NITROANILINE	0.45	ug/g	4.9	ug/l
46DN2C	4,6-DINITRO-2-CRESOL/ METHYL-4,6-DINITROPHENOL	0.55	ug/g	17	ug/l
4BRPPE	4-BROMOPHENYLPHENYL ETHER	0.033	ug/g	4.2	ug/l
4CANIL	4-CHLOROANILINE	0.81	ug/g	7.3	ug/l
4CL3C	4-CHLORO-3-CRESOL/ 3-METHYL-4-CHLOROPHENOL	0.095	ug/g	4	ug/l
4CLPPE	4-CHLOROPHENYLPHENYL ETHER	0.033	ug/g	5.1	ug/l
4MP	4-METHYLPHENOL/4-CRESOL	0.24	ug/g	0.52	ug/l
4NANIL	4-NITROANILINE	0.41	ug/g	5.2	ug/l
4NP	4-NITROPHENOL	1.4	ug/g	12	ug/l
ANAPNE	ACENAPHTHENE	0.036	ug/g	1.7	ug/l
ANAPYL	ACENAPHTHYLENE	0.033	ug/g	0.5	ug/l
ANTRC	ANTHRACENE	0.033	ug/g	0.5	ug/l
B2CEXM	BIS (2-CHLOROETHOXY) METHANE	0.059	ug/g	1.5	ug/l
B2CIPE	BIS (2-CHLOROISOPROPYL) ETHER	0.2	ug/g	5.3	ug/l

continued

APPENDIX J
PROJECT ANALYTE LIST

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

TEST NAME	PARAMETER NAME	SOIL		WATER	
		CRL	UNIT	CRL	UNIT
B2CLEE	BIS (2-CHLOROETHYL) ETHER/ 2,2-OXYBIS(1-CHLOROPROPANE)	0.033	ug/g	1.9	ug/l
B2EHP	BIS (2-ETHYLHEXYL) PHTHALATE	0.62	ug/g	4.8	ug/l
BAANTR	BENZO [A] ANTHRACENE	0.17	ug/g	1.6	ug/l
BAPYR	BENZO [A] PYRENE	0.25	ug/g	4.7	ug/l
BBFANT	BENZO [B] FLUORANTHENE	0.21	ug/g	5.4	ug/l
BBZP	BUTYLBENZYL PHTHALATE	0.17	ug/g	3.4	ug/l
BGHIPY	BENZO [G,H,I] PERYLENE	0.25	ug/g	6.1	ug/l
BKFANT	BENZO [K] FLUORANTHENE	0.066	ug/g	0.87	ug/l
BZALC	BENZYL ALCOHOL	0.19	ug/g	0.72	ug/l
CARBAZ	CARBAZOLE	No certified limit		No certified limit	
CHRY	CHRYSENE	0.12	ug/g	2.4	ug/l
CL6BZ	HEXACHLOROBENZENE	0.033	ug/g	1.6	ug/l
CL6CP	HEXACHLOROCYCLOPNTADIENE	6.2	ug/g	8.6	ug/l
CL6ET	HEXACHLOROETHANE	0.15	ug/g	1.5	ug/l
DBAHA	DIBENZ [A,H] ANTHRACENE	0.21	ug/g	6.5	ug/l
DBZFUR	DIBENZOFURAN	0.035	ug/g	1.7	ug/l
DEP	DIETHYL PHTHALATE	0.24	ug/g	2	ug/l
DMP	DIMETHYL PHTHALATE	0.17	ug/g	1.5	ug/l

continued

APPENDIX J
PROJECT ANALYTE LIST

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

TEST NAME	PARAMETER NAME	SOIL		WATER	
		CRL	UNIT	CRL	UNIT
DNBP	DI-N-BUTYL PHTHALATE	0.061	ug/g	3.7	ug/l
DNOP	DI-N-OCTYL PHTHALATE	0.19	ug/g	15	ug/l
FANT	FLUORANTHENE	0.068	ug/g	3.3	ug/l
FLRENE	FLUORENE	0.033	ug/g	3.7	ug/l
HCBD	HEXACHLOROBUTADIENE	0.23	ug/g	3.4	ug/l
ICDPYR	INDENO [1,2,3-C,D] PYRENE	0.29	ug/g	8.6	ug/l
ISOPHR	ISOPHORONE	0.033	ug/g	4.8	ug/l
NAP	NAPHTHALENE	0.037	ug/g	0.5	ug/l
NB	NITROBENZENE	0.045	ug/g	0.5	ug/l
NNDNPA	N-NITROSO DI-N-PROPYLAMINE	0.2	ug/g	4.4	ug/l
NNDPA	N-NITROSO DIPHENYLAMINE	0.19	ug/g	3	ug/l
PCP	PENTACHLOROPHENOL	1.3	ug/g	18	ug/l
PHANTR	PHENANTHRENE	0.033	ug/g	0.5	ug/l
PHENOL	PHENOL	0.11	ug/g	9.2	ug/l
PYR	PYRENE	0.033	ug/g	2.8	ug/l
PAL ORGANICS PESTICIDES AND PCBS					
ABHC	ALPHA-BENZENEHEXACHLORIDE/ ALPHA-HEXACHLOROCYCLOHEXANE	0.00907	ug/g	0.0385	ug/l
ACLDAN	ALPHA CHLORDANE	0.005	ug/g	0.075	ug/l

APPENDIX J
PROJECT ANALYTE LIST

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

TEST NAME	PARAMETER NAME	SOIL		WATER	
		CRL	UNIT	CRL	UNIT
AENSLF	ALPHA-ENDOSULFAN/ENDOSULFAN I	0.00602	ug/g	0.023	ug/l
ALDRN	ALDRIN	0.00729	ug/g	0.0918	ug/l
BBHC	BETA-BENZENEHEXACHLORIDE/ BETA-HEXACHLOROCYCLOHEXANE	0.00257	ug/g	0.024	ug/l
BENSLF	BETA-ENDOSULFAN/ENDOSULFAN II	0.00663	ug/g	0.023	ug/l
DBHC	DELTA-BENZENEHEXACHLORIDE/ DELTA-HEXACHLOROCYCLOHEXANE	0.00555	ug/g	0.0293	ug/l
DLDRN	DIELDRIN	0.00629	ug/g	0.024	ug/l
ENDRN	ENDRIN	0.00657	ug/g	0.0238	ug/l
ENDRNA	ENDRIN ALDEHYDE	0.024	ug/g	0.0285	ug/l
ENDRNK	ENDRIN KETONE	Not certified		Not certified	
ESFS04	ENDOSULFAN SULFATE	0.00763	ug/g	0.0786	ug/l
GCLDAN	GAMA-CHLORDANE	0.005	ug/g	0.075	ug/l
HPCL	HEPTACHLOR	0.00618	ug/g	0.0423	ug/l
HPCLE	HEPTACHLOR EPOXIDE	0.0062	ug/g	0.0245	ug/l
LIN	LINDANE/GAMMA-BENZENEHEXACHLORIDE/ GAMMA-HEXACHLOROCYCLOHEXANE	0.00638	ug/g	0.0507	ug/l
MEXCLR	METHOXYCHLOR	0.0711	ug/g	0.057	ug/l
PCB016	PCB 1016	0.0666	ug/g	0.16	ug/l
PCB221	PCB 1221	0.0666	ug/g	0.16	ug/l

continued

APPENDIX J
PROJECT ANALYTE LIST

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

TEST NAME	PARAMETER NAME	SOIL		WATER	
		CRL	UNIT	CRL	UNIT
PCB232	PCB 1232	0.0666	ug/g	0.16	ug/l
PCB242	PCB 1242	0.0804	ug/g	0.19	ug/l
PCB248	PCB 1248	0.0804	ug/g	0.19	ug/l
PCB254	PCB 1254	0.0804	ug/g	0.19	ug/l
PCB260	PCB 1260	0.0804	ug/g	0.19	ug/l
PPDDD	2,2-BIS (PARA-CHLOROPHENYL)-1,1DICHLOROETHANE	0.00826	ug/g	0.0233	ug/l
PPDDE	2,2-BIS (PARA-CHLOROPHENYL)-1,1-DICHLOROETHENE	0.00765	ug/g	0.027	ug/l
PPDDT	2,2-BIS (PARA-CHLOROPHENYL)-1,1,1-TRICHLOROETHANE	0.00707	ug/g	0.034	ug/l
TXPHEN	TOXAPHENE	0.444	ug/g	1.35	ug/l

Notes:

CRL = Certified Reporting Limit
NA = Not Applicable

CALCULATION OF BACKGROUND CONCENTRATIONS

TABLE K-1
AOC 69W

REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SOIL		GROUNDWATER	
Analyte	Concentration µg/g	Analyte	Concentration µg/L
Aluminum	18000	Aluminum	6870
Antimony	0.5	Antimony	3.03
Arsenic	19	Arsenic	10.5
Barium	54	Barium	39.6
Beryllium	0.81	Beryllium	5
Cadmium	1.28	Cadmium	4.01
Calcium	810	Calcium	14700
Chromium	33	Chromium	14.7
Cobalt	4.7	Cobalt	25
Copper	13.5	Copper	8.09
Iron	18000	Iron	9100
Lead	48	Lead	4.25
Magnesium	5500	Magnesium	3480
Manganese	380	Manganese	291
Mercury	--	Mercury	0.243
Nickel	14.6	Nickel	34.3
Potassium	2400	Potassium	2370
Selenium	--	Selenium	3.02
Silver	0.086	Silver	4.6
Sodium	131	Sodium	10800
Thallium	--	Thallium	6.99
Vanadium	32.3	Vanadium	11
Zinc	43.9	Zinc	21.1

U.S. Army
Environmental
Center

Remedial Investigations Report Functional Area II Volume IV of IV Appendices

Fort Devens, Massachusetts

August 1994
Contract No. DAAA15-90-D-0012
Delivery Order No. 0003
ELIN A009

Prepared for:
Commander
U.S. Army Environmental Center
Aberdeen Proving Ground, Maryland 21010-5401

Prepared by:
ecology and environment, inc.
1700 North Moore Street
Arlington, Virginia 22209

Printed on Recycled Paper

Final

287R11.PM4

APPENDIX K

BACKGROUND DATA RATIONALE

INTRODUCTION

On 10 September 1993, representatives from Ecology and Environment, Inc. (E & E), Arthur D. Little (ADL), ABB Engineering Services (ABB), and the U.S. Army Environmental Center (USAEC) met at ADL's office in Cambridge, MA to discuss methods for determining background concentrations of organic and inorganic analytes in groundwater, soil, sediment, and surface water at Fort Devens. The objective of the meeting was to initiate the development of a uniform set of background values that could be used by all contractors to identify organic and inorganic contamination at the base. This appendix summarizes the current background values being used for this report, incorporating data from all available sources.

Appendix K is divided into three sections based on matrix. The sections are:

- Section K1: Background Concentrations of Inorganic Analytes in Sediment;
- Section K2: Background Concentrations of Inorganic Analytes in Soil and Background Concentrations of Organic Analytes in soil; and
- Section K3: Background Concentrations of Inorganic Analytes in Surface Water.

Background concentration ranges for inorganic analytes in each matrix were determined from designated background samples collected at Fort Devens. The background sediment database was augmented with regional data from the peer-reviewed scientific literature. The background surface-water database was augmented with additional surface-water samples from IRDMIS.

There are no background data for groundwater on a regional scale from areas known to be unaffected by human activity. Wells that are upgradient of specific sites, such as 32M-92-01X at the DRMO Yard, have been compared with on-site wells.

SECTION K2

Background Concentrations of Inorganic Analytes in Soil

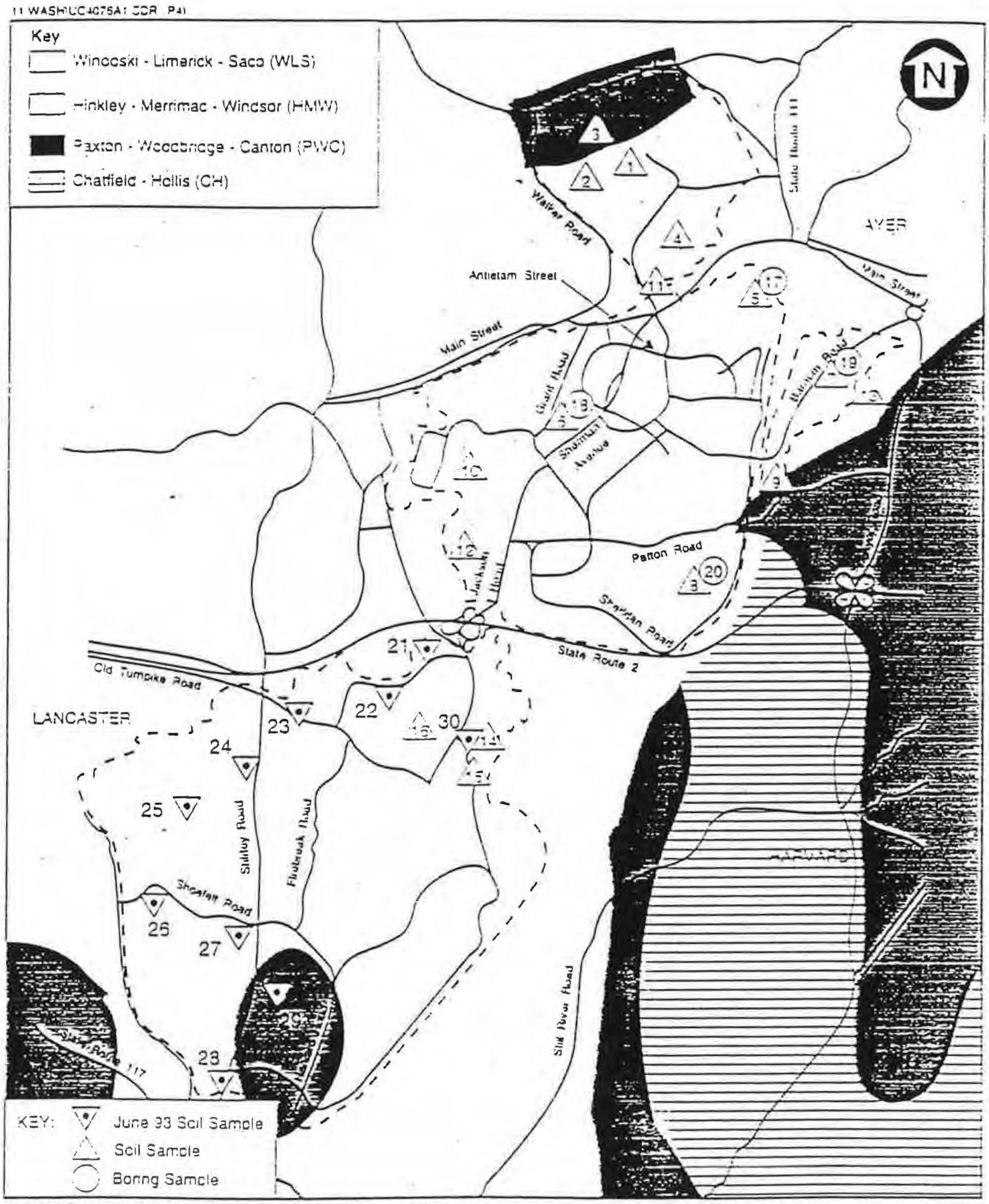
Background soil samples for inorganic analytes were collected in August 1991, October 1992, and June 1993. Thirty-three samples in all were collected. The samples were collected from all three of the major soil associations on the base and from each of Main Post, North Post, and South Post. Sample locations are shown in Figure K2-1. Note that no AOCs occur on the fourth soil association mapped, which lies outside the present boundaries of the facility. The background soil samples were all collected from sites that were, as far as could be determined visually, undisturbed, that were at least 50 feet from any road and at least 300 feet from any known or suspected Study Area. In most cases the distance was greater, especially in South Post.

Table K2-1 is the background database for inorganic analytes in soil. Sampling date, post, and soil association are listed for the samples. There are two columns in the table for each analyte: one column for the measured concentration and one for notes. The note column indicates which data points were entered as one-half the LOD and which are outliers. For calculation purposes, values that appeared in IRDMIS as less than the LOD were converted to one-half the LOD. Outliers were identified by the method of Dixon or Grubbs as described by Sokal and Rohlf (1981), graphically, or by judgment. Dixon's test is valid for sample sizes of 3 to 25. Grubbs' test was used for sample sizes greater than 25.

Grubbs' method was applied to the data for the following sixteen analytes: aluminum, arsenic, barium, cadmium, calcium, chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, sodium, vanadium, and zinc. Dixon's test for outliers was applied to the data for beryllium, cobalt, and selenium after omitting 10 samples for beryllium, 10 samples for cobalt, and 20 samples for selenium that were reported as less than the LOD, but that had unusually high LODs. For example, 10 samples had a reported cobalt concentration of < 14 mg/kg (see Table K2-1); this LOD is greater than the highest measured value for cobalt of 4.69 mg/kg.

Outliers for mercury were determined graphically. A normal probability plot showed the mercury data to be bimodally distributed; the four values in the upper cluster were judged to be outliers (see Table K2-1). Silver was detected in only two background soil samples; the "detects" were judged to be outliers (see Table K2-1). In all, 35 outliers were identified in the background soil database.

Table K2-2 lists concentration ranges for inorganic analytes for the Fort Devens background soil database, excluding outliers. Inorganic analyte levels in AOC samples were compared with the maximum of the background range; exceedances were considered site-related contamination. For comparison, Table K2-2 also lists concentration ranges for inorganic analytes in uncontaminated soils of the eastern United States. For all analytes, the maximum concentration in the Fort Devens background database lies within the range for the eastern United States, usually toward the low end of the range. This suggests that comparing



SOURCE: USDA.SCS Soils Survey Worcester County NE Part.

Legend —— Road – – – Installation Boundary

Scale in miles 1 3/4 1/2 1/4 0

Figure K2-1 BACKGROUND SAMPLING SITES FOR SOIL

TABLE K2-1. BACKGROUND DATABASE FOR INORGANIC ANALYTES IN SOIL AT FORT DEVENS. ALL VALUES ARE mg/kg.

SAMP_ID$	DATE$	POST$	ASSOC$	TYPE$	AL	ALNOTE$	SB	SBNOTE$	AS	ASNOTE$	BA	BANOTE$	BE	BENOTE$	CD	CDNOTE$	CA	CANOTE$	CR	CRNOTE$
SOIL-01	AUG91	NORTH	HMW	AREA	6400		1.71	1/2 LOD	9.6		14.2		0.119		0.212	1/2 LOD	610		7.11	
SOIL-02	AUG91	NORTH	HMW	AREA	14000		17	1/2 LOD	13		35		0.126		0.212	1/2 LOD	610		11.1	
SOIL-03	AUG91	NORTH	HWC	AREA	12000		1.71	1/2 LOD	9.3		14.5		0.039		0.212	1/2 LOD	330		7.57	
SOIL-04	AUG91	NORTH	WLS	AREA	8800		1.71	1/2 LOD	9.4		14.2		0.141		0.212	1/2 LOD	630		10.2	
SOIL-05	AUG91	MAIN	HMW	AREA	9900		1.71	1/2 LOD	12		15.5		0.124		0.212	1/2 LOD	430		8.2	
SOIL-06	AUG91	MAIN	HMW	AREA	13000		1.71	1/2 LOD	32	OUTLIER	11.5	1/2 LOD	0.108		1.28		710		30.3	
SOIL-07	AUG91	MAIN	HMW	AREA	12000		1.71	1/2 LOD	15		36		0.133		1.06		1400	OUTLIER	29	
SOIL-08	AUG91	MAIN	HMW	AREA	2500	1/2 LOD	1.71	1/2 LOD	15		15.6		0.142		0.212	1/2/LOD	310		9.59	
SOIL-09	AUG91	MAIN	HWC	AREA	24000	OUTLIER	17	1/2 LOD	25	OUTLIER	54		0.335		1.06		650	1/2 LOD	56.5	OUTLIER
SOIL-10	AUG91	MAIN	WLS	AREA	8500		17	1/2 LOD	14		11.5	1/2 LOD	0.390	1/2 LOD	2.1	1/2 LOD	2100	OUTLIER	19.5	1/2 LOD
SOIL-11	AUG91	MAIN	WLS	AREA	11000		1.71	1/2 LOD	13		52		0.350		4.48	OUTLIER	2800	OUTLIER	27.1	
SOIL-12	AUG91	MAIN	WLS	AREA	7400		1.71	1/2 LOD	7.1		12.9		0.172		0.212	1/2 LOD	810		6.02	
SOIL-13	AUG91	MAIN	HMW	AREA	18000		1.71	1/2 LOD	28	OUTLIER	67.2	OUTLIER	0.672		3.52	OUTLIER	1500	1/2 LOD	33	
SOIL-14	AUG91	SOUTH	WLS	AREA	6900		1.71	1/2 LOD	11		16.6		0.146		0.212	1/2 LOD	740		13.8	
SOIL-15	AUG91	SOUTH	WLS	AREA	8000		1.71	1/2 LOD	4.6		16.2		0.145		0.212	1/2 LOD	144		1.95	1/2 LOD
SOIL-16	AUG91	SOUTH	HWC	AREA	13000		1.71	1/2 LOD	11		46		0.533		0.212	1/2 LOD	720		12.5	
SOIL-17	AUG91	MAIN	HMW	HOLE	4300		1.71	1/2 LOD	9.5		9.67		0.039	1/2 LOD	0.212	1/2 LOD	350		7.71	
SOIL-18	AUG91	MAIN	HMW	HOLE	11000		1.71	1/2 LOD	99	OUTLIER	29		0.039		0.212	1/2 LOD	650		39.5	OUTLIER
SOIL-19	AUG91	MAIN	HMW	HOLE	7100		1.71	1/2 LOD	11		14.2		0.104		0.212	1/2 LOD	710		14.1	
SOIL-20	AUG91	MAIN	HMW	HOLE	7100		1.71	1/2 LOD	19		31		0.188		0.212	1/2 LOD	810		9.25	
BKS-21	JUN93	SOUTH	HWC	AREA	7800		0.25	1/2 LOD	7.03		21.4		0.25	1/2 LOD	0.602		250	1/2 LOD	7.13	
BKS-22	JUN93	SOUTH	HWC	AREA	9600		0.25	1/2 LOD	7.8		15		0.25	1/2 LOD	0.647		250	1/2 LOD	10.6	
BKS-23	JUN93	SOUTH	HMW	AREA	9800		0.25	1/2 LOD	11.0		11.8		0.25	1/2 LOD	0.551		250	1/2 LOD	10.4	
BKS-24	JUN93	SOUTH	HMW	AREA	7400		0.25	1/2 LOD	14.4		12.3		0.25	1/2 LOD	1.21		250	1/2 LOD	12.5	
BKS-25	JUN93	SOUTH	HMW	AREA	387		0.25	1/2 LOD	6.04		2.5	1/2 LOD	0.25	1/2 LOD	0.25	1/2 LOD	250	1/2 LOD	1.0	1/2 LOD
BKS-26	JUN93	SOUTH	HMW	AREA	1800		0.25	1/2 LOD	8.31		2.5	1/2 LOD	0.25	1/2 LOD	0.25	1/2 LOD	250	1/2 LOD	2.67	
BKS-27	JUN93	SOUTH	HMW	AREA	797		0.25	1/2 LOD	5.19		2.5	1/2 LOD	0.25	1/2 LOD	0.25	1/2 LOD	250	1/2 LOD	1.0	1/2 LOD
BKS-28	JUN93	SOUTH	WLS	AREA	398		0.25	1/2 LOD	2.06		2.5	1/2 LOD	0.25	1/2 LOD	0.25	1/2 LOD	250	1/2 LOD	1.0	1/2 LOD
BKS-29	JUN93	SOUTH	HWC	AREA	1460		0.25	1/2 LOD	8.04		2.5	1/2 LOD	0.25	1/2 LOD	0.25	1/2 LOD	250	1/2 LOD	1.0	1/2 LOD
BKS-30	JUN93	SOUTH	WLS	AREA	603		0.25	1/2 LOD	3.3		2.5	1/2 LOD	0.25	1/2 LOD	0.25	1/2 LOD	250	1/2 LOD	1.0	1/2 LOD
25S-92-12X	OCT92	SOUTH			2920		0.55	1/2 LOD	3.17		18		0.25	1/2 LOD	0.35	1/2 LOD	50	1/2 LOD	2.03	1/2 LOD
25S-92-13X	OCT92	SOUTH			11400		0.55	1/2 LOD	7.87		28		0.81		0.35	1/2 LOD	50	1/2 LOD	9.43	
26S-92-10X	OCT92	SOUTH			7380		0.55	1/2 LOD	10.7		30.1		0.698		0.35	1/2 LOD	50	1/2 LOD	9.09	

TABLE K2-1. CONTINUED.

SAMP_ID$	DATE$	POST$	ASSOC$	TYPE$	K	KNOTE$	SE	SENOTE$	AG	AGNOTE$	NA	NANOTE$	V	VNOTE$	ZN	ZNNOTE$
SOIL-01	AUG91	NORTH	IMW	AREA	620		2.88	1/2 LOD	0.043	1/2 LOD	26	1/2 LOD	7.57		16.5	
SOIL-02	AUG91	NORTH	IMW	AREA	660		2.88	1/2 LOD	0.043	1/2 LOD	58.6		16.6		27.7	
SOIL-03	AUG91	NORTH	IWC	AREA	530		2.88	1/2 LOD	0.043	1/2 LOD	26	1/2 LOD	17.9		14.6	
SOIL-04	AUG91	NORTH	WLS	AREA	314		2.88	1/2 LOD	0.043	1/2 LOD	26	1/2 LOD	11.7		13.6	
SOIL-05	AUG91	MAIN	IMW	AREA	470		2.88	1/2 LOD	0.043	1/2 LOD	71.2		7.91		14.7	
SOIL-06	AUG91	MAIN	IMW	AREA	1100		2.88	1/2 LOD	0.208	OUTLIER	79.8		32.3		40	1/2 LOD
SOIL-07	AUG91	MAIN	IMW	AREA	1700		2.88	1/2 LOD	0.043	1/2 LOD	117		23.4		40	1/2 LOD
SOIL-08	AUG91	MAIN	IMW	AREA	630		2.88	1/2 LOD	0.043	1/2 LOD	26	1/2 LOD	8.03		13.2	
SOIL-09	AUG91	MAIN	IWC	AREA	2400		2.88	1/2 LOD	0.043	1/2 LOD	85.8		44.3	OUTLIER	130	OUTLIER
SOIL-10	AUG91	MAIN	WLS	AREA	990		2.88	1/2 LOD	0.043	1/2 LOD	680	OUTLIER	6.5	1/2 LOD	40	1/2 LOD
SOIL-11	AUG91	MAIN	WLS	AREA	1100		2.88	1/2 LOD	0.582	OUTLIER	123		18.1		40	1/2 LOD
SOIL-12	AUG91	MAIN	WLS	AREA	600		2.88	1/2 LOD	0.043	1/2 LOD	26	1/2 LOD	16.3		17.7	
SOIL-13	AUG91	MAIN	IMW	AREA	2200		2.88	1/2 LOD	0.043	1/2 LOD	231		46.6	OUTLIER	40	1/2 LOD
SOIL-14	AUG91	SOUTH	WLS	AREA	700		2.88	1/2 LOD	0.043	1/2 LOD	100		13.8		22.2	
SOIL-15	AUG91	SOUTH	WLS	AREA	248		2.88	1/2 LOD	0.043	1/2 LOD	26	1/2 LOD	6.19		11.7	
SOIL-16	AUG91	SOUTH	IWC	AREA	2400		2.88	1/2 LOD	0.043	1/2 LOD	130		17.5		23.4	
SOIL-17	AUG91	MAIN	IMW	BORE	590		2.88	1/2 LOD	0.043	1/2 LOD	57.5		6.12		11.2	
SOIL-18	AUG91	MAIN	IMW	BORE	1700		2.88	1/2 LOD	0.043	1/2 LOD	124		22.8		40	1/2 LOD
SOIL-19	AUG91	MAIN	IMW	BORE	880		2.88	1/2 LOD	0.043	1/2 LOD	86.7		9.89		14.2	
SOIL-20	AUG91	MAIN	IMW	BORE	1000		2.88	1/2 LOD	0.043	1/2 LOD	93.9		7.2		13.5	
HKS-21	JUN93	SOUTH	IWC	AREA	341		0.1	1/2 LOD	0.1	1/2 LOD	100	1/2 LOD	10.5		43.9	
HKS-22	JUN93	SOUTH	IWC	AREA	100	1/2 LOD	0.1	1/2 LOD	0.1	1/2 LOD	100	1/2 LOD	11.4		32.3	
HKS-23	JUN93	SOUTH	IMW	AREA	100	1/2 LOD	0.1	1/2 LOD	0.1	1/2 LOD	100	1/2 LOD	10.5		28.7	
HKS-24	JUN93	SOUTH	IMW	AREA	100	1/2 LOD	0.603		0.1	1/2 LOD	100	1/2 LOD	28.5		35.2	
HKS-25	JUN93	SOUTH	IMW	AREA	100	1/2 LOD	0.279		0.1	1/2 LOD	100	1/2 LOD	1.0	1/2 LOD	3.69	
HKS-26	JUN93	SOUTH	IMW	AREA	100	1/2 LOD	0.489		0.1	1/2 LOD	100	1/2 LOD	1.0	1/2 LOD	5.26	
HKS-27	JUN93	SOUTH	IMW	AREA	100	1/2 LOD	0.388		0.1	1/2 LOD	100	1/2 LOD	1.0	1/2 LOD	5.33	
HKS-28	JUN93	SOUTH	WLS	AREA	100	1/2 LOD	0.246		0.1	1/2 LOD	100	1/2 LOD	1.0	1/2 LOD	3.52	
HKS-29	JUN93	SOUTH	IWC	AREA	100	1/2 LOD	0.33		0.1	1/2 LOD	100	1/2 LOD	3.3		7.8	
HKS-30	JUN93	SOUTH	WLS	AREA	100	1/2 LOD	0.1	1/2 LOD	0.1	1/2 LOD	100	1/2 LOD	1.0	1/2 LOD	4.87	
25S-92-12X	OCT92	SOUTH			215	UK	0.601		0.29	1/2 LOD	208		4.7		4.015	1/2 LOD
25S-92-13X	OCT92	SOUTH			260	UK	1.23	OUTLIER	0.29	1/2 LOD	191		13.3		25.3	
26S-92-10X	OCT92	SOUTH			143	UJ	0.992		0.29	1/2 LOD	234		19.8		33.3	

Table K2-3

PESTICIDE CONCENTRATION RANGES
FORT DEVENS MAIN POST SITE INVESTIGATION

Compounds	Total Samples	Total Detects	Minimum Detect	Maximum Detect	Average	95th Percentile (3)	Approximate Range of Detection Limits (2)
Soils							
Chlordane	241	1	0.136	0.136	0.136	-	0.04 - 1
p,p'-DDD	719 (1)	40	0.004	6.6	0.53	2.85	0.003 - 0.27
p,p'-DDE	726 (1)	70	0.003	2.7	0.10	0.76	0.003 - 0.31
p,p'-DDT	727 (1)	148	0.004	5.6	0.25	1.53	0.004 - 0.41
Sediments							
Chlordane	97	0	-	-	-	-	0.016 - 1
p,p'-DDD	444	77	0.008	6.2	0.39	2.25	0.008 - 2
p,p'-DDE	449	81	0.003	1.3	0.092	0.44	0.004 - 2
p,p'-DDT	449	50	0.009	15	0.42	4.66	0.004 - 2

* Composite of results from multiple data sets of Level III data for non-entomology shop locations at Main, South, and North Posts, Fort Devens, Massachusetts.

All results in mg/kg (ppm).

(1) Sample set with higher detection limit of three removed from data set (total of six samples).
(2) Only includes detection limits for results reported in database as "LT".
(3) 95th percentile formula - mean + (2 x standard deviations) for all detected results.

Source: ADL 1993.

GROUNDWATER BACKGROUND CONCENTRATIONS
REPRESENTATIVE SAMPLES
FORT DEVENS, MASSACHUSETTS

MONITORING WELL	LOCATION	TOTAL SUSPENDED SOLIDS (ug/L)	ALUMINUM (ug/L)
G6M-92-09X	NORTH POST	37,000	230
G6M-92-11X	NORTH POST	53,000	1,920
WWTMW-01	NORTH POST	20,000	2,330
WWTMW-13	NORTH POST	30,000	3,150
WWTMW-14	NORTH POST	25,000	9,130
G3M-92-01X	MAIN POST	<4,000	71
13M-92-01X	MAIN POST	–	7,270
12M-92-01X	SOUTH POST	–	179
27M-92-04X	SOUTH POST	–	8,700
28M-92-01X	SOUTH POST	–	2,280

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05-Mar-93

INORGANIC ANALYTES IN WATER
FORT DEVENS, MASSACHUSETTS

DATA		CALCULATIONS	
ALUMINUM			
MONITORING WELL	CONCENTRATION (ug/L)		
G3M-92-01X	71	Minimum -	71
12M-92-01X	179	Maximum -	9140
G6M-92-09X	230	Mean -	3527
G6M-92-11X	1920	95th %ile -	6874
28M-92-01X	2280	Background Concentration -	6870
WWTMW-01	2330		
WWTMW-13	3150		
13M-92-01X	7270		
27M-92-04X	8700		
WWTMW-14	9140		
ANTIMONY			
MONITORING WELL	CONCENTRATION (ug/L)		
WWTMW-14	1.52	Minimum -	1.52
WWTMW-13	1.52	Maximum -	1.52
WWTMW-01	1.52	Mean -	1.52
G6M-92-11X	1.52	95th %ile -	NA
G6M-92-09X	1.52	Background Concentration -	3.03 *
G3M-92-01X	1.52		
28M-92-01X	1.52		
27M-92-04X	1.52		
13M-92-01X	1.52		
12M-92-01X	1.52		
ARESNIC			
MONITORING WELL	CONCENTRATION (ug/L)		
G6M-92-11X	1.27	Minimum -	1.27
12M-92-01X	1.27	Maximum -	15.20
G6M-92-09X	1.27	Mean -	5.65
G3M-92-01X	1.77	95th %ile -	10.5
28M-92-01X	3.94	Background Concentration -	10.5
WWTMW-13	5.39		
WWTMW-01	9.81		
13M-92-01X	10.9		
WWTMW-14	15.2		
27M-92-04X	32.3 **		
BARIUM			
MONITORING WELL	CONCENTRATION (ug/L)		
12M-92-01X	2.5	Minimum -	2.5
G6M-92-09X	7.6	Maximum -	52.0
G3M-92-01X	10.7	Mean -	22.6
WWTMW-01	12.4	95th %ile -	39.6
28M-92-01X	14.4	Background Concentration -	39.6
G6M-92-11X	16.1		
WWTMW-13	19.5		
13M-92-01X	44.5		
WWTMW-14	46.3		
27M-92-04X	52.0		

* Method Detection Limit
** Likely Statistical Outlier

INORGANIC ANALYTES IN WATER
FORT DEVENS, MASSACHUSETTS

DATA		CALCULATIONS	
BERYLLIUM			
MONITORING WELL	CONCENTRATION (ug/L)		
G3M-92-01X	2.50	Minimum –	2.50
12M-92-01X	2.50	Maximum –	2.50
G6M-92-09X	2.50	Mean –	2.50
G6M-92-11X	2.50	95th %ile –	NA
28M-92-01X	2.50	Background Concentration –	5.00 *
WWTMW-01	2.50		
WWTMW-13	2.50		
13M-92-01X	2.50		
27M-92-04X	2.50		
WWTMW-14	2.50		
CADMIUM			
MONITORING WELL	CONCENTRATION (ug/L)		
WWTMW-14	2.01	Minimum –	2.01
WWTMW-13	2.01	Maximum –	2.01
WWTMW-01	2.01	Mean –	2.01
G6M-92-11X	2.01	95th %ile –	NA
G6M-92-09X	2.01	Background Concentration –	4.01 *
G3M-92-01X	2.01		
28M-92-01X	2.01		
27M-92-04X	2.01		
13M-92-01X	2.01		
12M-92-01X	2.01		
CALCIUM			
MONITORING WELL	CONCENTRATION (ug/L)		
12M-92-01X	179	Minimum –	179
28M-92-01X	1910	Maximum –	23200
WWTMW-14	2490	Mean –	7801
WWTMW-13	3280	95th %ile –	14747
G6M-92-11X	5780	Background Concentration –	14700
WWTMW-01	6940		
G3M-92-01X	7710		
27M-92-04X	8820		
G6M-92-09X	17700		
13M-92-01X	23200		
CHROMIUM			
MONITORING WELL	CONCENTRATION (ug/L)		
G3M-92-01X	3.01	Minimum –	3.0
G6M-92-09X	3.01	Maximum –	18.7
28M-92-01X	3.01	Mean –	8.7
12M-92-01X	3.01	95th %ile –	14.7
WWTMW-01	6.04	Background Concentration –	14.7
G6M-92-11X	6.36		
WWTMW-13	10.1		
27M-92-04X	16.4		
13M-92-01X	16.9		
WWTMW-14	18.7		

* Method Detection Limit

** Likely Statistical Outlier

INORGANIC ANALYTES IN WATER
FORT DEVENS, MASSACHUSETTS

DATA		CALCULATIONS	
COBALT			
MONITORING WELL	CONCENTRATION (ug/L)		
G3M-92-01X	12.5	Minimum –	12.5
12M-92-01X	12.5	Maximum –	12.5
G6M-92-09X	12.5	Mean –	12.5
G6M-92-11X	12.5	95th %ile –	NA
28M-92-01X	12.5	Background Concentration –	25.0 *
WWTMW-01	12.5		
WWTMW-13	12.5		
13M-92-01X	12.5		
27M-92-04X	12.5		
WWTMW-14	12.5		
COPPER			
MONITORING WELL	CONCENTRATION (ug/L)		
G3M-92-01X	4.05	Minimum –	4.05
WWTMW-14	4.05	Maximum –	6.52
28M-92-01X	4.05	Mean –	4.36
WWTMW-01	4.05	95th %ile –	5.2
G6M-92-09X	4.05	Background Concentration –	8.09 *
12M-92-01X	4.05		
G6M-92-11X	4.05		
WWTMW-13	6.52		
13M-92-01X	18.60 **		
27M-92-04X	19.00 **		
IRON			
MONITORING WELL	CONCENTRATION (ug/L)		
G3M-92-01X	171	Minimum –	171
G6M-92-09X	331	Maximum –	12900
12M-92-01X	373	Mean –	4611
G6M-92-11X	2390	95th %ile –	9104
28M-92-01X	2410	Background Concentration –	9100
WWTMW-01	3250		
WWTMW-13	3830		
WWTMW-14	9250		
27M-92-04X	11200		
13M-92-01X	12900		
LEAD			
MONITORING WELL	CONCENTRATION (ug/L)		
G6M-92-09X	0.65	Minimum –	0.65
WWTMW-01	2.00	Maximum –	5.70
28M-92-01X	2.17	Mean –	2.81
G3M-92-01X	2.30	95th %ile –	4.25
G6M-92-11X	2.30	Background Concentration –	4.25
WWTMW-13	3.10		
12M-92-01X	4.23		
WWTMW-14	5.70		
13M-92-01X	12.10 **		
27M-92-04X	12.40 **		

* Method Detection Limit

** Likely Statistical Outlier

INORGANIC ANALYTES IN WATER
FORT DEVENS, MASSACHUSETTS

DATA		CALCULATIONS	
MAGNESIUM			
MONITORING WELL	CONCENTRATION (ug/L)		
28M-92-01X	693	Minimum -	693
G6M-92-11X	857	Maximum -	4500
G3M-92-01X	1000		
WWTMW-13	1390	Mean -	2157
G6M-92-09X	1600		
WWTMW-01	1900	95th %ile -	3477
WWTMW-14	1970		
27M-92-04X	3550	Background	
12M-92-01X	4110	Concentration -	3480
13M-92-01X	4500		
MANGANESE			
MONITORING WELL	CONCENTRATION (ug/L)		
G6M-92-09X	23.4	Minimum -	23.40
12M-92-01X	69.9	Maximum -	486.00
WWTMW-01	77.7		
28M-92-01X	86.4	Mean -	156.93
G6M-92-11X	102		
WWTMW-13	107	95th %ile -	290.7
13M-92-01X	227		
WWTMW-14	233	Background	
G3M-92-01X	486	Concentration -	291
27M-92-04X	1110 **		
MERCURY			
MONITORING WELL	CONCENTRATION (ug/L)		
WWTMW-01	0.12	Minimum -	0.12
G3M-92-01X	0.12	Maximum -	0.70
12M-92-01X	0.12		
13M-92-01X	0.12	Mean -	0.18
WWTMW-14	0.12		
28M-92-01X	0.12	95th %ile -	0.35
G6M-92-11X	0.12		
G6M-92-09X	0.12	Background	
27M-92-04X	0.12	Concentration -	0.243 *
WWTMW-13	0.70		
NICKEL			
MONITORING WELL	CONCENTRATION (ug/L)		
G6M-92-09X	17.2	Minimum -	17.20
WWTMW-01	17.2	Maximum -	17.20
28M-92-01X	17.2		
G3M-92-01X	17.2	Mean -	17.20
G6M-92-11X	17.2		
WWTMW-13	17.2	95th %ile -	NA
12M-92-01X	17.2		
WWTMW-14	17.2	Background	
13M-92-01X	17.2	Concentration -	34.3 *
27M-92-04X	17.2		

* - Method Detection Limit
** Likely Statistical Outlier

INORGANIC ANALYTES IN WATER
FORT DEVENS, MASSACHUSETTS

DATA / CALCULATIONS

POTASSIUM

MONITORING WELL	CONCENTRATION (ug/L)	CALCULATIONS	
28M-92-01X	461	Minimum –	461
G6M-92-11X	645	Maximum –	2790
WWTMW-13	1080	Mean –	1644
G3M-92-01X	1450	95th %ile –	2370
12M-92-01X	1500	Background Concentration –	2370
WWTMW-01	1980		
WWTMW-14	1980		
G6M-92-09X	1980		
13M-92-01X	2570		
27M-92-04X	2790		

SELENIUM

MONITORING WELL	CONCENTRATION (ug/L)	CALCULATIONS	
G6M-92-09X	1.51	Minimum –	1.51
12M-92-01X	1.51	Maximum –	1.51
WWTMW-01	1.51	Mean –	1.51
28M-92-01X	1.51	95th %ile –	NA
G6M-92-11X	1.51	Background Concentration –	3.02 *
WWTMW-13	1.51		
13M-92-01X	1.51		
WWTMW-14	1.51		
G3M-92-01X	1.51		
27M-92-04X	1.51		

SILVER

MONITORING WELL	CONCENTRATION (ug/L)	CALCULATIONS	
WWTMW-01	2.30	Minimum –	2.30
G3M-92-01X	2.30	Maximum –	2.30
12M-92-01X	2.30	Mean –	2.30
13M-92-01X	2.30	95th %ile –	NA
WWTMW-14	2.30	Background Concentration –	4.60 *
28M-92-01X	2.30		
G6M-92-11X	2.30		
G6M-92-09X	2.30		
27M-92-04X	2.30		
WWTMW-13	2.30		

SODIUM

MONITORING WELL	CONCENTRATION (ug/L)	CALCULATIONS	
28M-92-01X	1380	Minimum –	1380
G6M-92-09X	2000	Maximum –	18000
WWTMW-14	2100	Mean –	5771
G6M-92-11X	2430	95th %ile –	10841
27M-92-04X	3070	Background Concentration –	10800
12M-92-01X	4250		
WWTMW-13	4610		
G3M-92-01X	8570		
WWTMW-01	11300		
13M-92-01X	18000		

* Method Detection Limit
** Likely Statistical Outlier

INORGANIC ANALYTES IN WATER
FORT DEVENS, MASSACHUSETTS

DATA		CALCULATIONS	
THALLIUM			
MONITORING WELL	CONCENTRATION (ug/L)		
		Minimum –	3.50
28M–92–01X	3.50		
G6M–92–11X	3.50	Maximum –	3.50
WWTMW–13	3.50		
G3M–92–01X	3.50	Mean –	3.50
12M–92–01X	3.50		
WWTMW–01	3.50	95th %ile –	3.50
WWTMW–14	3.50		
G6M–92–09X	3.50	Background	
13M–92–01X	3.50	Concentration –	6.99
27M–92–04X	3.50		
VANADIUM			
MONITORING WELL	CONCENTRATION (ug/L)		
		Minimum –	5.50
G6M–92–09X	5.50		
12M–92–01X	5.50	Maximum –	14.50
WWTMW–01	5.50		
28M–92–01X	5.50	Mean –	7.13
G6M–92–11X	5.50		
WWTMW–13	5.50	95th %ile –	10.41
13M–92–01X	5.50		
G3M–92–01X	5.50	Background	
27M–92–04X	12.8	Concentration –	11.0 *
WWTMW–14	14.5		
ZINC			
MONITORING WELL	CONCENTRATION (ug/L)		
		Minimum –	10.6
WWTMW–13	10.6		
G6M–92–09X	10.6	Maximum –	47.0
WWTMW–01	10.6		
28M–92–01X	10.6	Mean –	20.5
G6M–92–11X	10.6		
G3M–92–01X	10.6	95th %ile –	34.9
WWTMW–14	32.0		
27M–92–04X	41.7	Background	
12M–92–01X	47.0	Concentration –	21.1 *
13M–92–01X	78.5 **		

* Method Detection Limit

** Likely Statistical Outlier

OFF-SITE ANALYTICAL LABORATORY DATA

INDOOR AIR QUALITY REPORT

December 25, 1997

PN: 9144.03

Mr. Mark Applebee
U.S. Army Corps of Engineers
New England District
424 Trapelo Road, Building 112 S
Waltham, MA 02254

SUBJECT: Contract No. DACA31-94-D-0061
Task Order No. 0001
Draft Supplemental Air Sampling Report
AOC 69W - Devens Elementary School

INTRODUCTION

ABB Environmental Services, Inc., (ABB-ES) was directed to perform supplemental indoor air sampling at Area of Contamination (AOC) 69W, Devens Elementary School. The work augmented activities already completed in accordance with the Remedial Investigation/Feasibility Study (RI/FS) Final Task Order Work Plan for AOC 69W, submitted in January 1996, and the Final RI/FS Task Order Workplan Addendum submitted dated August 28, 1996.

ABB-ES is conducting the RI/FS under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at AOC 69W at Devens in central Massachusetts, for the U.S. Army. Devens is located approximately 35 miles northwest of the city of Boston, within the towns of Ayer and Shirley (Middlesex County) and Harvard and Lancaster (Worcester County), and occupies approximately 9,280 acres of land area (Figure 1).

AOC 69W is located in the northwest portion of the former Main Post, in the corner of Antietam and MacArthur Streets (Figure 1). The site is comprised of an unoccupied elementary school, an associated parking lot, and surrounding grassy area. Groundwater flow in the vicinity of the school is to the north-northwest towards Willow Brook. Depth to groundwater at the site varies from approximately 10 feet at the school to less than 2 feet as one approaches the brook.

Fuel oil contamination is present in subsurface soils at the site as a result of No. 2 fuel oil releases in 1972 and 1978. The assumed source of these leaks was damaged piping near or within the footprint of the current school. Results of previous investigative activities indicated the presence of petroleum contamination in subsurface soil primarily at the water table, adjacent to and downgradient of the school's foundation. In addition, soil and groundwater contamination were detected directly beneath the school in the immediate vicinity of the new boiler room.

Because of concerns that these contaminants (in a vapor phase) could be migrating into the school, air monitoring was conducted in the school in 1996 to evaluate whether contaminants in the soil and groundwater were impacting indoor air quality. The results of the air monitoring

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effort were presented in a draft report entitled, "Draft Air Sampling Results, AOC 69W", dated November 13, 1996. Results of the sampling indicated the presence of various VOCs; however, due to excessive breakthrough on the TENAX sampling tubes, quantification of contaminant concentrations was inconclusive. As a result, the Army requested that supplemental sampling be performed in the building.

The objective of the supplemental air sampling was to determine if fuel-related contaminants in soil and groundwater adjacent to and beneath the school were impacting air quality within the school, and if they were, to determine if contaminant levels in the school present an unacceptable health risk to potential occupants of the building. This report presents the results of the recent air sampling event. These results will be incorporated into the Remedial Investigation/Feasibility Study report to be prepared for the site.

METHODOLOGY

The supplemental air sampling was conducted in general accordance with procedures set forth in the "Final Remedial Investigation/Feasibility Study Workplan Addendum for Supplemental Air Sampling, Devens Elementary School" dated October 1997.

On Tuesday, October 14, 1997, personnel visited the site and collected a headspace sample from the groundwater monitoring well in the new boiler room. The screened portion of this well spans the water table, and a portion of the screen is open to the unsaturated zone. The headspace sample collected from this well therefore comprises soil vapor from immediately above the water table. The sample was analyzed to confirm the fingerprint of the soil vapor contamination. This sample was submitted for expedited analysis, and the results were used to confirm/refine the analyte list presented in the workplan. Based on these sample results, tetrachloroethylene and acetone were added to the target analyte list.

While at the site, field personnel opened school doors and windows and operated the air handling system to ventilate the building. These procedures were instituted to approximate normal school operation. On October 14, sampling personnel also removed potential sources of volatile contaminants from the school, including such things as cleaners, gasoline cans, paint cans, and solvents. Pilot lights on kitchen stoves were observed to be off. The interior doors of the two boiler rooms were sealed off from the rest of the school by taping them closed. This was done to segregate the rooms from the remainder of the school and minimize the effects of the obvious non-spill related oil in the boiler rooms resulting from normal operation of the heating system.

The windows remained open for 4 days, and were closed on Friday, October 17. The windows remained closed until and throughout Monday, October 20 (when the indoor air sampling was conducted). Keeping the building closed was designed to approximate the school condition during an inactive period (e.g., weekend).

Sampling was performed on Monday, October 20, 1997, with windows and doors closed and the air handling systems off. This protocol was expected to represent the anticipated general worst-case scenario with respect to air quality. Conditions are considered analogous to those likely to be encountered in the school upon opening after being empty for a weekend. While at the site, the depth to groundwater in the three wells within the school were measured.

A total of 12 air samples were collected in and around the school on October 20, 1997. Air samples were collected in Summa canisters at locations outlined in the Final Work Plan and as illustrated on Figure 2 of this report. Canisters were supplied by ENSR Air Toxic Specialty Laboratory, Acton, Massachusetts. Each canister was pre-cleaned and leak tested by the laboratory prior to use. Please refer to Attachment A for the canister cleaning records.

The air flow into each canister was pre-set by ENSR to allow each canister to fill over an eight hour time period with a final canister pressure of approximately -6 to-8 inches mercury. The air flow was checked at the start of each sample using a Mass Flow Meter and adjusted as necessary. All final canister pressures were acceptable except for Canister B239 (ZWA-97-04X), which had a final pressure of 0 inches Hg. This sample's duplicate, ZWA-97-03X (Canister A210), had an acceptable final pressure of -8 inches Hg.

The weather conditions on the day of the survey were sunny with the wind out of the northeast at approximately 5-10 miles per hour. The temperature was between 50°-60°F.

The air samples were delivered to ENSR on the day following their collection. The samples were analyzed by ENSR under the guidelines of EPA TO-14 Gas Chromatography-Mass Spectrometry (GC-MS) technique. Complete laboratory analytical results are included in Attachment XXX, and are summarized on Table 1. The laboratory did not report results for tetradecane, 1-Methylnaphthalene, 2-Methylnaphthalene, and naphthalene because these compounds could not be satisfactorily recovered from the canisters.

RESULTS

Groundwater - The depth to groundwater in the three wells located within the school building was measured on October 21, 1997, during air sampling. The depth to groundwater and elevation of the groundwater surface determined that day are as follows:

WELL ID	DEPTH TO GROUNDWATER (FT)	GROUNDWATER ELEV. (FT ABOVE MSL)
ZWM-96-19X	10.28	220.83
ZWM-96-20X	4.80	221.19
ZWM-96-21X	9.96	220.97

The water levels recorded in the wells were lower by one to two feet than in the one previous measurement event conducted in these three wells. recorded in the one previous water level round

Analytical Results - The analytical results are summarized on Table 1 and the full laboratory reports are included in Attachment 1.

Acetone, toluene, and xylene were detected in one or more of the quality control blank samples, and so their respective results have been qualified (with a "B" on Table 1) in the majority of samples in which these compounds were detected.

The well headspace sample (ZWA-97-09X) collected on October 14, 1997, indicated the presence of tetrachloroethylene [360 micrograms per cubic meter ($\mu g/m^3$)] and acetone (210B $\mu g/m^3$) in soil gas from beneath the new boiler room. Acetone was detected in the blank sample, and so is not believed to be a site contaminant. Tetrachloroethylene was not detected in any other air samples, including those collected from the dirt-floored crawlspace beneath the kitchen and cafeteria (i.e., those samples most likely to be affected by subsurface contamination).

Both samples collected from the crawlspace beneath the kitchen (ZWA-97-06X) and the cafeteria (ZWA-97-05X) contained toluene (150B and 13B $\mu g/m^3$, respectively) and acetone (81B and 38B $\mu g/m^3$, respectively). The sample from beneath the kitchen also contained xylene (18.3B $\mu g/m^3$), octane 5.5 ($\mu g/m^3$), and ethylbenzene (5.2 $\mu g/m^3$).

The three outdoor background samples, ZWA-97-11X, -12X, and 13X, contained toluene and acetone (qualified; also detected in the blank). Xylene was detected (qualified) in ZWA-97-11X, but not in the other two outdoor background samples. The indoor background sample, ZWA-97-07X, contained eight compounds, including the three qualified compounds toluene, xylene, and acetone, as well as 2-Methylheptane (7.2 $\mu g/m^3$), 3-Methylheptane (8.9 $\mu g/m^3$), ethylbenzene (9.9 $\mu g/m^3$), nonane (5 $\mu g/m^3$), and octane (9.1 $\mu g/m^3$). This indoor background sample contained all compounds detected in samples from the site.

Samples from within the school contained from 3 compounds (ZWA-97-08X, a sample from the room adjacent to the new boiler room) to 8 compounds (ZWA-97-03X, a sample from a room near the old boiler room in the northeast corner of the school). In general, compound concentrations were consistent throughout the school, and were of the same magnitude as those in the indoor background sample.

CONCLUSIONS

Based on a review of the air sampling data, it appears that contaminants historically detected in soil and groundwater from the vicinity of the school are not contributing in a measurable fashion to air quality within the school. The following information supports this conclusion:

1) Air samples were analyzed for: a) compounds detected previously in groundwater and soil from beneath the site, and b): volatile compounds that are likely present in weathered No. 2 Fuel Oil. It should be noted that the target analytes so identified are typical constituents of cleaning solutions, lubricants, paints and other petroleum-derived products, some of which had been stored in the school before their removal from the school prior to sampling.

2) The air (soil vapor) sample collected from the groundwater monitoring well in the new boiler room did not contain any of the target analytes. Therefore, contaminants previously identified in the subsurface soils and groundwater and volatile compounds that are likely present in weathered No. 2 Fuel Oil do not appear to be contributing measurably to soil vapor quality.

3) If contaminants previously detected beneath the school in groundwater, soil, and soil vapor were migrating into the school, it is reasonable to assume that the preferential migration pathway would be through the crawlspace (with its dirt floor) and thence into the school. However, fewer compounds were detected in the crawlspace samples than in other samples from within the school, including the indoor background sample. In addition, concentrations of compounds in the crawlspace samples were comparable to or less than their respective concentrations in samples from elsewhere in the school. The crawlspace samples were also consistent with the three outdoor background samples. Based on this information, the crawlspace does not appear to be a contributing pathway of contaminants into the school.

The data gathered during this investigation will be included in the remedial investigation currently being prepared for the AOC 69W.

Please feel free to call me if you have any questions regarding this report.

Sincerely,

ABB ENVIRONMENTAL SERVICES, INC.

Alan J. Fillip

Alan Fillip
Senior Project Manager

Attachments

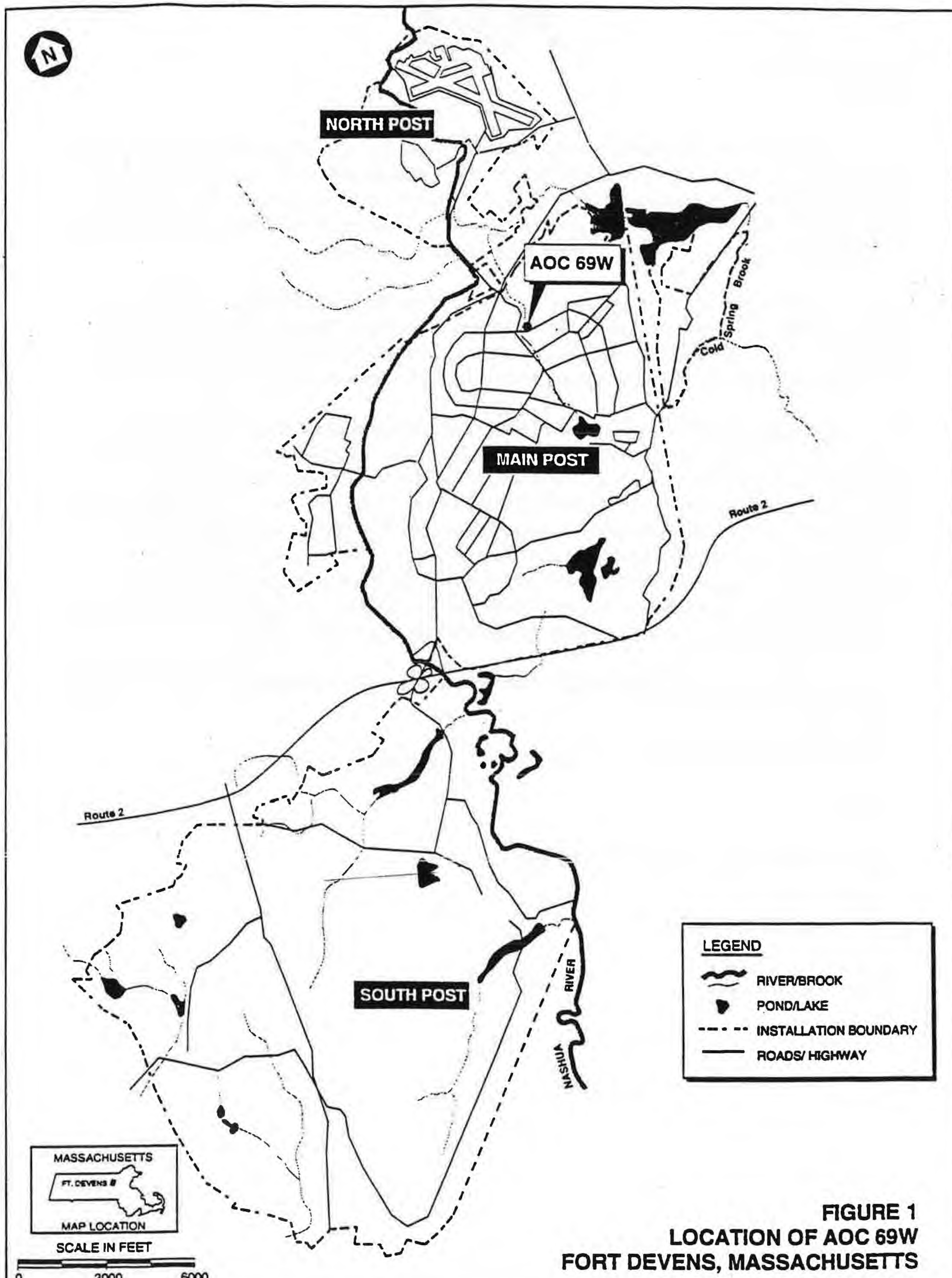

FIGURE 1
LOCATION OF AOC 69W
FORT DEVENS, MASSACHUSETTS

ABB Environmental Services, Inc.

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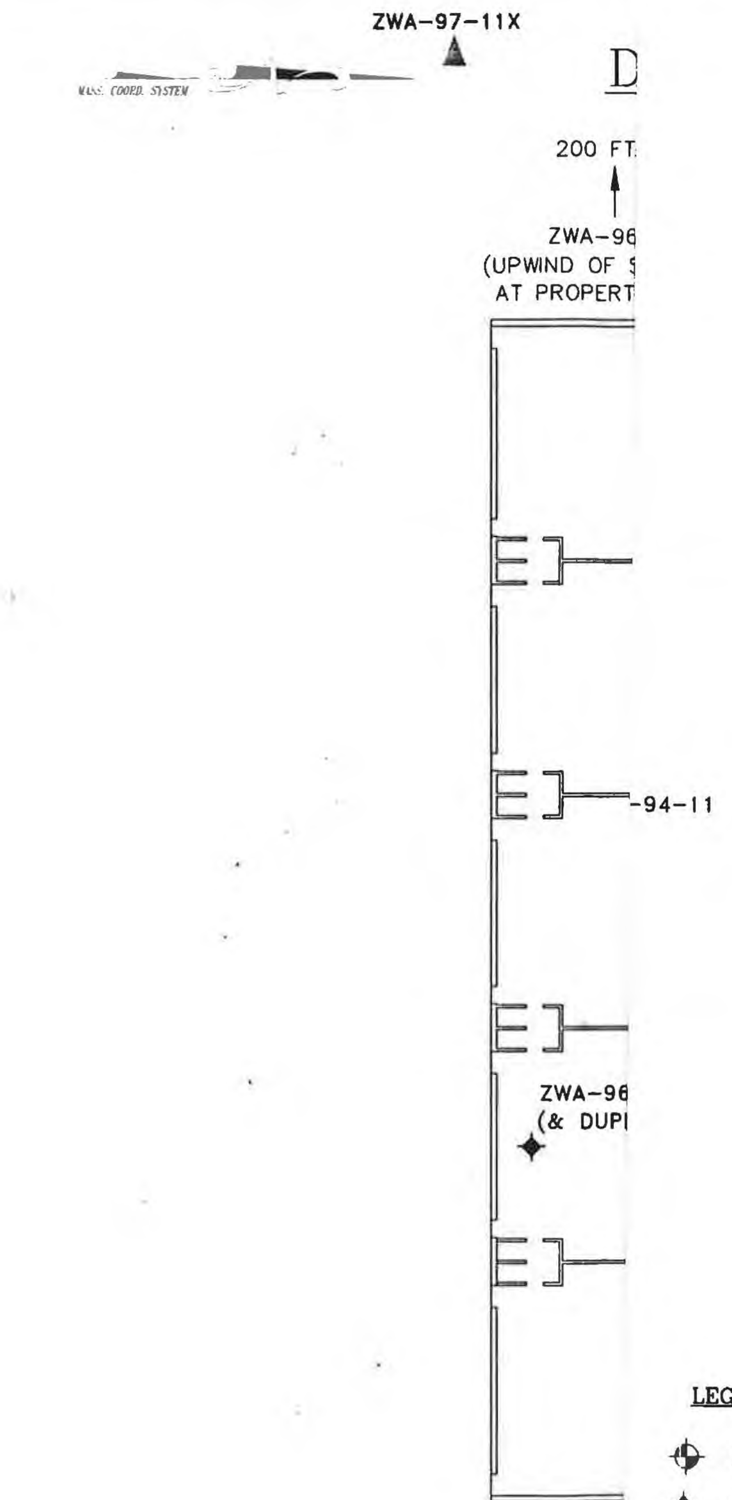

LEGEND

- EXISTING MONITORING WELL LOCATION
- FORMER AIR SAMPLE LOCATION (1996)
- EXISTING BORING LOCATION
- AIR SAMPLING LOCATION (OCTOBER 1997)

0 200 400 800 FEET

SCALE: 1"=400'

J:\9144-01\914493A.DWG 10/24/97

FIGURE 2
SAMPLE LOCATIONS
SUPPLEMENTAL AIR SAMPLING
AOC 69W
FORT DEVENS, MA

ABB Environmental Services, Inc.

TABLE 1
AOC 69W - DEVENS ELEMENTARY SCHOOL
INDOOR AIR QUALITY AIR SAMPLE RESULTS
DEVENS, MASSACHUSETTS

Site ID: Canister: Location: COMPOUND	ZWA-97-01X A230 Classroom N of new boiler room	ZWA-97-02X A209 Kitchen/ Cafeteria	ZWA-97-03X A210 1st Classr'm NE Wing	ZWA-97-04X B239 -03X Duplicate	ZWA-97-05X 70 Crawl space near old boiler room	ZWA-97-06X B237 Crawl space under kitchen	ZWA-97-07X B246 SW classr'm (indoor backgrnd)	Inhalation Toxicity Value (ug/m3)
1,2,4 Trimethylbenzene	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	180
1,3,5 Trimethylbenzene	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	180
2-Methylheptane	8	< 4.4	19	6.3	< 4.4	< 4.4	7.2	200
3-Methylheptane	< 4.4	< 4.4	8.7	< 4.4	< 4.4	< 4.4	8.9	200
Decane	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	2000
Dodecane	< 22	< 22	< 22	< 22	< 22	< 22	< 22	2000
Ethylbenzene	7.9	470	27	7.6	< 4.4	5.2	9.9	1000
Methyl tert-butly Ether	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	3000
Nonane	< 4.4	< 4.4	7.2	< 4.4	< 4.4	< 4.4	5	2000
Octane	< 4.4	< 4.4	21	8.4	< 4.4	5.5	9.1	200
Toluene	260 B	72 B	1000 B	350 B	13 B	150 B	36 B	400
Xylene	30.4 B	< 8.8	92 B	28.1 BJ	< 8.8	18.3 BJ	34.8 B	310
Acetone	470 B	200 B	82 B	54 B	38 B	81 B	30 B	---
Tetrachloroethylene	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	---

Site ID: Canister: Location: COMPOUND	ZWA-97-08X A211 Classr'm S of new boiler room	ZWA-97-09X 92 Boiler room well head sample	ZWA-97-10X 62 NW classroom	ZWA-97-11X A207 Front parking lot downwind (bkgrnd)	ZWA-97-12X A221 Near wells upwind (bkgrnd)	ZWA-97-13X B233 Playground upwind (backgrnd)	Inhalation Toxicity Value (ug/m3)
1,2,4 Trimethylbenzene	< 4.4	< 22	< 4.4	< 4.4	< 4.4	< 4.4	180
1,3,5 Trimethylbenzene	< 4.4	< 22	< 4.4	< 4.4	< 4.4	< 4.4	180
2-Methylheptane	< 4.4	< NA	5.2	< 4.4	< 4.4	< 4.4	200
3-Methylheptane	< 4.4	< NA	< 4.4	< 4.4	< 4.4	< 4.4	200
Decane	< 4.4	< NA	< 4.4	< 4.4	< 4.4	< 4.4	2000
Dodecane	< 22	< NA	< 22	< 22	< 22	< 22	2000
Ethylbenzene	< 4.3 J	< 22	< 2.8 J	< 3.2 J	< 4.4	< 4.4	1000
Methyl tert-butly Ether	< 4.4	< NA	< 4.4	< 4.4	< 4.4	< 4.4	3000
Nonane	< 4.4	< NA	< 4.4	< 4.4	< 4.4	< 4.4	2000
Octane	< 4.4	< NA	< 4.4	< 4.4	< 4.4	< 4.4	200
Toluene	70 B	< 22	82 B	63 B	38 B	19 B	400
Xylene	17.1 J	< 44	8	8.2 B	< 8.8	< 8.8	310
Acetone	54 B	210 B	52 B	440 B	27 B	31 B	—
Tetrachloroethylene	< 4.4	360	< 4.4	< 4.4	< 4.4	< 4.4	—

Notes: < = Less than certified reporting limits

B - Analyte found in blank; J - Estimated value, below detection limit

NA - Not analyzed

ATTACHMENT A

SAMPLING AND LABORATORY REPORTS

Devens Elementary School
Summa Canister Sampling Summary
Survey Date: October 20, 1997

Sample No.	Canister	Location	Start Time	Start Pressure	End Time	End Pressure
ZWA-97-08X	A211	Class, left of entrance	10:45	-26	18:33	-6
ZWA-97-10X	62	Class, corner room	10:46	-27	18:32	-8
ZWA-97-01X	A230	Class, across from new boiler room	10:47	-20	16:50	-7
ZWA-97-02X	A209	Cafeteria	10:48	-29	17:27	-6
ZWA-97-03X	A210	Class, far end of school	10:49	-28	18:07	-8
ZWA-97-04X	B239	Same as above (duplicate)	10:50	-30	18:07	0*
ZWA-97-07X	B246	Class, right of entrance	10:52	-30	17:25	-7
ZWA-97-11X	A207	Front parking lot, downwind	10:53	-20	18:47	-7
ZWA-97-12X	A221	Near wells, upwind	10:55	-30	18:55	-8
ZWA-97-13X	B233	Playground, upwind	10:56	-30	18:56	-9
ZWA-97-06X	B237	Crawl space, under kitchen	10:45	-22	18:02	-8
ZWA-97-05X	70	Crawl space, near old boiler room	10:49	-30	18:27	-7
	99	Trip blank				
ZWA-97-09X	92**	Well sample	10:01	-24	11:01	-7

* At 17:25 gauge reading was -12

** Sample collected on 10/14/97

ENSR Consulting and Engineering
Air Toxics Specialty Laboratory

ENSR
Air Toxics Specialty Laboratory
42 Nagog Park
Acton, MA 01720

DATE: October 29, 1997

TO: Bob Cashins
Cashins and Associates, Inc.
80 Main Street
Reading, MA 01867

Re.: Volatile Organic Analysis of SUMMA® canister sample by Gas Chromatography/Mass Spectrometry (GC/MS)

LAB ID #: 970145

ANALYTICAL PROCEDURE:

One SUMMA® canister sample was analyzed under the guidelines of EPA TO-14, Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using SUMMA® Passivated Canister Sampling and Gas Chromatography (GC) Analysis.

A Hewlett Packard 5890 gas chromatograph equipped with a Hewlett Packard 5970 mass selective detector (MSD) was employed for the analysis. An ENTECH 2000 automatic concentrator was utilized for sample pre-concentration.

Twenty and 100 mL aliquots were drawn from the sample, concentrated at -150°C and then transferred to the GC/MSD for the analysis. The operating conditions of the GC/MSD are listed in Table 1.

GC/MSD calibration was performed with SUMMA® canister standards prepared for each target VOC. Four canister standards of concentrations ranging from 4.44 ng/L to 222 ng/L were prepared using a purging-transferring technique. Six point calibrations were generated using the standards.

No problems were encountered during sample login.

QUALITY CONTROL:

1. A laboratory blank was analyzed in the same manner as the sample. Target analytes detected in the laboratory blank have been flagged "B" when detected in the samples.

2. The SUMMA® canister was cleaned on September 22, 1997. It was certified clean by GC/MS analysis of one canister from the batch (canister #51).

3. Duplicate analysis was performed on the sample.

4. The sample chromatogram was searched for additional peaks not found in the normal TO-14 list of analytes. A compound eluting at 20.85 minutes was tenatively identified as 1,1,2,3-tetramethylcyclohaxane. This compound was present at an estimated concentration of 120 ng/L or 21 ppbV.

ANOMALIES:

1. The mass spectrometer shut off after 3.0 minutes of analysis when the sample was analyzed at full volume (500 mL). Analysis of 20 mL of the sample prevented this problem. Additionally, 100 mL of the samples were analyzed with the mass spectrometer collecting data after 4.5 minutes of analysis. The following compounds elute prior to 4.5 minutes and have a higher detection limit based on the 20 mL volume of sample analyzed: dichlorodifluoromethane; chloromethane; freon 114; vinyl chloride; 1,3-butadiene.

Date Samples Received by the Laboratory: 10/14/97

Date Analysis Started: 10/15/97

DATA_RPT\970145\GC_MS.RPT

TABLE 1

GC/MSD Operating Conditions

Instrument	Hewlett Packard 5890 GC
	Hewlett Packard 5970 MSD
Injector Temperature	250°C
Column	Rtx-1 60 m Capillary
Parameters	0.53mm ID, 7.0μm df
Carrier gas	UHP Helium
Flow rate	10 cc/min
Auxiliary flow rate	20 cc/min
Detector	Mass Selective detector
Temperature	280°C
Temperature program	Initial Temp.: 50°C
	Hold: 3.0 min
	Ramping Rate: 8.0°C/min
	Final Temp.: 200°C
System Computer	HP 1000 CPU
Data System	RTE/6

ENSR AIR TOXICS SPECIALTY LABORATORY
ANALYTICAL SUMMARY OF RESULTS

Client: Cashins
Lab ID #: 970145

Sample ID	Lab Blank				Lab Blank				Canister #92			
Date Sampled	NA				NA				10/14/97			
Date Analyzed	10/15/97				10/17/97				10/16/97 & 10/17/97			
Compound	ng/L		ppb		ng/L		ppb		ng/L		ppb	
Acetone	17	B	7.2	B	25		10		210	~~B~~ UJ	87	~~B~~ UJ
2-Butanone	4.4	U	1.5	U	4.4	U	1.5	U	22	U	7.4	U
Dichlorodifluoromethane	4.4	U	0.88	U	4.4	U	0.88	U	110	U	22	U
Chloromethane	4.4	U	2.1	U	4.4	U	2.1	U	110	U	53	U
Freon 114	4.4	U	0.62	U	4.4	U	0.62	U	110	U	16	U
Vinyl chloride	4.4	U	1.7	U	4.4	U	1.7	U	110	U	43	U
1,3-Butadiene	4.4	U	2.0	U	4.4	U	2.0	U	110	U	49	U
Bromomethane	4.4	U	1.1	U	4.4	U	1.1	U	22	U	5.6	U
Chloroethane	4.4	U	1.7	U	4.4	U	1.7	U	22	U	8.3	U
Trichlorofluoromethane	4.4	U	0.78	U	4.4	U	0.78	U	22	U	3.9	U
1,1-Dichloroethylene	4.4	U	1.1	U	4.4	U	1.1	U	22	U	5.5	U
Methylene chloride	4.4	U	1.3	U	4.4	U	1.3	U	22	U	6.3	U
Freon 113	4.4	U	0.57	U	4.4	U	0.6	U	22	U	2.8	U
1,1-Dichloroethane	4.4	U	1.1	U	4.4	U	1.1	U	22	U	5.4	U
trans-1,2-Dichloroethylene	4.4	U	1.1	U	4.4	U	1.1	U	22	U	5.5	U
cis-1,2-Dichloroethylene	4.4	U	1.1	U	4.4	U	1.1	U	22	U	5.5	U
Chloroform	4.4	U	0.89	U	4.4	U	0.9	U	22	U	4.5	U
1,2-Dichloroethane	4.4	U	1.1	U	4.4	U	1.1	U	22	U	5.4	U
Trichloroethylene	4.4	U	0.81	U	4.4	U	0.81	U	22	U	4.1	U
1,1,1-Trichloroethane	4.4	U	0.80	U	4.4	U	0.80	U	22	U	4.0	U
Benzene	4.4	U	1.4	U	4	U	1.4	U	22	U	6.8	U
Carbon tetrachloride	4.4	U	0.69	U	4.4	U	0.7	U	22	U	3.5	U
1,2-Dichloropropane	4.4	U	0.95	U	4.4	U	0.9	U	22	U	4.7	U
cis-1,3-Dichloropropene	4.4	U	0.96	U	4.4	U	1.0	U	22	U	4.8	U
4-Methyl-2-pentanone	4.4	U	1.1	U	4.4	U	1.1	U	22	U	5.3	U
trans-1,3-Dichloropropene	4.4	U	0.96	U	4.4	U	1.0	U	22	U	4.8	U
1,1,2-Trichloroethane	4.4	U	0.80	U	4.4	U	0.8	U	22	U	4.0	U
Toluene	4.4	U	1.2	U	4	U	1	U	22	U	5.8	U
1,2-Dibromoethane	4.4	U	0.57	U	4.4	U	0.6	U	22	U	2.8	U
Tetrachloroethylene	4.4	U	0.64	U	4.4	U	0.6	U	360		52	
Chlorobenzene	4.4	U	0.95	U	4.4	U	0.9	U	22	U	4.7	U
Ethylbenzene	4.4	U	1.0	U	4.4	U	1.0	U	22	U	5.0	U
p- & m-Xylenes	4.4	U	1.0	U	4.4	U	1.0	U	22	U	5.0	U
Styrene	4.4	U	1.0	U	4.4	U	1.0	U	22	U	5.1	U
1,1,2,2-Tetrachloroethane	4.4	U	0.64	U	4.4	U	0.6	U	22	U	3.2	U
o-Xylene	4.4	U	1.0	U	4.4	U	1.0	U	22	U	5.0	U
4-Ethyltoluene	4.4	U	0.89	U	4.4	U	0.9	U	22	U	4.4	U
1,3,5-Trimethylbenzene	4.4	U	0.89	U	4.4	U	0.9	U	22	U	4.4	U
Benzyl chloride	4.4	U	0.84	U	4.4	U	0.8	U	22	U	4.2	U
1,2,4-Trimethylbenzene	4.4	U	0.89	U	4.4	U	0.9	U	22	U	4.4	U
1,3-Dichlorobenzene	4.4	U	0.73	U	4.4	U	0.7	U	22	U	3.6	U
1,4-Dichlorobenzene	11	U	1.8	U	11	U	1.8	U	56	U	9.1	U
1,2-Dichlorobenzene	11	U	1.8	U	11	U	1.8	U	56	U	9.1	U
1,2,4-Trichlorobenzene	11	U	1.5	U	11	U	1.5	U	56	U	7.4	U
Hexachlorobutadiene	11	U	1.0	U	11	U	1.0	U	56	U	5.1	U

U = undetected at specified detection limit
J = estimated value, below the detection limit
E = estimated value, exceeds calibration range
B = analyte found in blank(s)

ENSR AIR TOXICS SPECIALTY LABORATORY
QUALITY CONTROL RESULTS - DUPLICATES

Client: Cashins
Lab ID #: 970145

Sample ID	Canister 92		Duplicate		
Date Sampled	10/14/97		10/14/97		
Date Analyzed	10/15/97 & 10/17/97		10/15/97 & 10/17/97		
Compound	**ng/L**	**ppb**	**ng/L**	**ppb**	**RPD**
Acetone	210 ~~B~~ UJ	87 ~~B~~ UJ	300 ~~B~~ UJ	130 ~~B~~ UJ	~~40~~ NA
2-Butanone	22 U	7.4 U	22 U	7.4 U	NC
Dichlorodifluoromethane	110 U	22 U	110 U	22 U	NC
Chloromethane	110 U	53 U	110 U	53 U	NC
Freon 114	110 U	16 U	110 U	16 U	NC
Vinyl chloride	110 U	43 U	110 U	43 U	NC
1,3-Butadiene	110 U	49 U	110 U	49 U	NC
Bromomethane	110 U	28 U	110 U	28 U	NC
Chloroethane	22 U	8.3 U	22 U	8.3 U	NC
Trichlorofluoromethane	22 U	3.9 U	22 U	3.9 U	NC
1,1-Dichloroethylene	22 U	5.5 U	22 U	5.5 U	NC
Methylene chloride	22 U	6.3 U	22 U	6.3 U	NC
Freon 113	22 U	2.8 U	22 U	2.8 U	NC
1,1-Dichloroethane	22 U	5.4 U	22 U	5.4 U	NC
trans-1,2-Dichloroethylene	22 U	5.5 U	22 U	5.5 U	NC
cis-1,2-Dichloroethylene	22 U	5.5 U	22 U	5.5 U	NC
Chloroform	22 U	4.5 U	22 U	4.5 U	NC
1,2-Dichloroethane	22 U	5.4 U	22 U	5.4 U	NC
Trichloroethylene	22 U	4.1 U	22 U	4.1 U	NC
1,1,1-Trichloroethane	22 U	4.0 U	22 U	4.0 U	NC
Benzene	22 U	6.8 U	22 U	6.8 U	NC
Carbon tetrachloride	22 U	3.5 U	22 U	3.5 U	NC
1,2-Dichloropropane	22 U	4.7 U	22 U	4.7 U	NC
cis-1,3-Dichloropropene	22 U	4.8 U	22 U	4.8 U	NC
4-Methyl-2-pentanone	22 U	5.3 U	22 U	5.3 U	NC
trans-1,3-Dichloropropene	22 U	4.8 U	22 U	4.8 U	NC
1,1,2-Trichloroethane	22 U	4.0 U	22 U	4.0 U	NC
Toluene	22 U	5.8 U	22 U	6 U	NC
1,2-Dibromoethane	22 U	2.8 U	22 U	2.8 U	NC
Tetrachloroethylene	360	52	320	46	12
Chlorobenzene	22 U	4.7 U	22 U	4.7 U	NC
Ethylbenzene	22 U	5.0 U	22 U	5.0 U	NC
p- & m-Xylenes	22 U	5.0 U	22 U	5.0 U	NC
Styrene	22 U	5.1 U	22 U	5.1 U	NC
1,1,2,2-Tetrachloroethane	22 U	3.2 U	22 U	3.2 U	NC
o-Xylene	22 U	5.0 U	22 U	5.0 U	NC
4-Ethyltoluene	22 U	4.4 U	22 U	4.4 U	NC
1,3,5-Trimethylbenzene	22 U	4.4 U	22 U	4.4 U	NC
Benzyl chloride	22 U	4.2 U	22 U	4.2 U	NC
1,2,4-Trimethylbenzene	22 U	4.4 U	22 U	4.4 U	NC
1,3-Dichlorobenzene	22 U	3.6 U	22 U	3.6 U	NC
1,4-Dichlorobenzene	56 U	9.1 U	56 U	9.1 U	NC
1,2-Dichlorobenzene	56 U	9.1 U	56 U	9.1 U	NC
1,2,4-Trichlorobenzene	56 U	7.4 U	56 U	7.4 U	NC
Hexachlorobutadiene	56 U	5.1 U	56 U	5.1 U	NC

U = undetected at specified detection limit
J = estimated value, below the detection limit

E = estimated value, exceeds calibration range
B = analyte found in blank(s)

RPD = relative percent difference
NC = not calculable

M901376

ENSR

CHAIN OF CUSTODY RECORD

Page 1 of 2

Client/Project Name: Cashins & Assoc.

Project Number: 1347

Sampler: (Print Name) /Affiliation: ROBERT CASHINS

Signature: [signature]

Project Location: FORT DEVENS ELEMENTARY SCHOOL

Field Logbook No.:

Chain of Custody Tape No.:

Send Results/Report to: [illegible] Cashins fax [illegible]

Analysis Requested: FINGERPRINT COMPOUNDS

	Field Sample No./Identification	Date	Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid; Sludge, Etc.)	Preservative	Field Filtered	FINGERPRINT COMPOUNDS						Lab I.D.	Remarks
✓1.	A 211	10/20/97			X	SUMMA	AIR	NONE	N	X							
✓2	[illegible]				X	"	"	"	"	X							
✓3	[illegible]				X	"	"	"	"	X							
✓4	[illegible]	[illegible]			X	"	"	"	"	X							
✓5	[illegible]	[illegible]			X	"	"	"	"	X							
✓6	[illegible]				X	"	"	"	"	X							
✓7	B 140				X	"	"	"	"	X							
✓	[illegible]				X	"	"	"	"	X							
✓	[illegible]				X	"	"	"	"	X							
✓	[illegible]	[illegible]			X	"	"	"	"	X							

Relinquished by: (Print Name)	Date/Time	Received by: (Print Name)	Date/Time
ROBERT CASHINS Signature: [signature]	Date: 10/21/97 Time: 2:30 PM	[illegible] Veccarlee Signature: [signature]	Date: [illegible] Time: 2:5[illegible]
LARRY LAFRANCE Signature: [signature]	Date: 10/21/97 Time: 15:20	Signature:	Date: Time:
Signature:	Date: Time:	Signature:	Date: Time:

Analytical Laboratory (Destination):

Serial No.

M901376

ENSR

CHAIN OF CUSTODY RECORD

Client/Project Name: Cashins & [illegible]

Project Location: FORT DEVINS ELEMENTARY SCHOOL

Project Number: 1347

Field Logbook No.:

Sampler: (Print Name) /Affiliation: ROBERT CASHINS

Signature: [signature]

Chain of Custody Tape No.:

Send Results/Report to: [illegible]

Analysis Requested: FLUORPAINT COMPOUNDS

	Field Sample No./ Identification	Date 10/20/97	Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid, Sludge, Etc.)	Preservative	Field Filtered	FLUORPAINT COMPOUNDS						Lab I.D.	Remarks
V 1	[illegible]7				X	SUMMA	AIR	NONE	N	X							
V 2	70				X	"	"	"	"	X							
V 17	trip blank		99		X	"	"	"	"	X							

Relinquished by: (Print Name)	Date / Time	Received by: (Print Name)	Date / Time
ROBERT CASHINS; Signature: [signature]	Date: 10/21/97; Time: 2:30 PM	[illegible]; Signature: [illegible]	Date: [illegible]; Time: [illegible]
LARRY PLATRAME; Signature: [signature]	Date: 10/21/97; Time: 13:28	Signature:	Date: ; Time:
Signature:	Date: ; Time:	Signature:	Date: ; Time:

Analytical Laboratory (Destination):

Serial No.

132-0200

ENSR

ENSR Consulting and Engineering
Air Toxics Specialty Laboratory

SUMMA® CANISTER CLEANING RECORDS

Can #	Date Cleaned	Date Shipped	Project	Lab Task Number	Date Received	Comment (QC Data File)
A210	10/15/97	10-17-97 29"Hg	Cashing	970152	10/22/97	
A211		29"Hg				B635
B237		29"Hg				
B239		30"Hg				
A207		28"Hg				
B246		28"Hg				
~~A203~~	MD	29"Hg				
A221		30"Hg				
B233		30"Hg				
A230	10/16/97	10-17 30"Hg	Cashins	970150	10/22/97	B636
A209		29"Hg				
70		28"Hg				
99		30"Hg				
62		30"Hg				
94		10-2 29"Hg	MWRA	970158	10/30/97	
41		29"Hg				
A203		10-2 30"Hg	MWRA	970158	10/30/97	
A202	10-27	10-29 Hg	Bay State	970160	10/31/97	QC(B645)
A208		30"Hg		970163	11/2/97	
A210		29"Hg		970160	10/31/97	
111		30"Hg		970160	10/31/97	
25		28"Hg		970163	11/2/97	
41		30"Hg		970160	10/31/97	
A219		30"Hg		970160	10/31/97	
B735		30"Hg		— —	——	

\LAB\LAB_FORM\CAN_CLEN.WP

ENSR Consulting and Engineering
Air Toxics Specialty Laboratory

ENSR
Air Toxics Specialty Laboratory
42 Nagog Park
Acton, MA 01720

DATE: November 17, 1997

TO: Bob Cashins
Cashins and Associates

Re.: Volatile Organic Analysis of SUMMA® canister and tedlar bag samples by Gas Chromatography/Mass Spectrometry (GC/MS)

LAB ID #: 970152

ANALYTICAL PROCEDURE:

Thirteen SUMMA® canister samples were analyzed under the guidelines of EPA TO-14, Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using SUMMA® Passivated Canister Sampling and Gas Chromatography (GC) Analysis.

A Hewlett Packard 5890 gas chromatograph equipped with a Hewlett Packard 5970 mass selective detector (MSD) was employed for the analysis. An ENTECH 2000 automatic concentrator was utilized for sample pre-concentration.

A 500 mL aliquot was drawn from the samples, concentrated at -150°C and then transferred to the GC/MSD for the analysis. The operating conditions of the GC/MSD are listed in Table 1.

GC/MSD calibration was performed with SUMMA® canister standards prepared for each target VOC. Four canister standards of concentrations ranging from 4.44 ng/L to 222 ng/L were prepared using a purging-transferring technique. Four to six point calibrations were generated using the standards.

No problems were encountered during sample login or analysis.

QUALITY CONTROL:

1. A laboratory blank was analyzed in the same manner as the sample. Target analytes detected in the laboratory blank have been flagged "B" when also detected in samples.

2. The SUMMA® canisters were cleaned on October 17, 1997. They were certified clean by GC/MS analysis of one canister from each batch (canisters #A210 and #A230).

3. Duplicate analysis was performed on canister #B246.

4. Several compounds, listed below, were determined to be unrecoverable from the canisters. The laboratory was unable to analyze for these compounds and they have been omitted from the sample report.
   Tetradecane
   Naphthalene
   2-Methylnaphthalene
   1-Methylnaphthalene

Date Samples Received by the Laboratory: 10/22/97

Date Analysis Started: 11/11/97

DATA_RPT\970152\GC_MS.RPT

TABLE 1

GC/MSD Operating Conditions

Instrument	Hewlett Packard 5890 GC
	Hewlett Packard 5970 MSD
Injector Temperature	250°C
Column	Rtx-1 60 m Capillary
Parameters	0.53mm ID, 7.0μm df
Carrier gas	UHP Helium
Flow rate	10 cc/min
Auxiliary flow rate	20 cc/min
Detector	Mass Selective detector
Temperature	280°C
Temperature program	Initial Temp.: 50°C
	Hold: 3.0 min
	Ramping Rate: 8.0°C/min
	Final Temp.: 200°C
System Computer	HP 1000 CPU
Data System	RTE/6

ENSR AIR TOXICS SPECIALTY LABORATORY
ANALYTICAL SUMMARY OF RESULTS

Client: Cashins and Associates
Lab ID #: 970152

Sample ID	Can. # 99		Can # A211		Can #62		Can #A230	
Date Sampled	10/20/97		10/20/97		10/20/97		10/20/97	
Date Analyzed	11/11/97		11/12/97		11/12/97		11/11 & 11/12/97	
Compound	**ng/L**	**ppb**	**ng/L**	**ppb**	**ng/L**	**ppb**	**ng/L**	**ppb**
Acetone	10 ~~JB~~ u	4.0 ~~JB~~ u	54 ~~B~~ u	22 ~~B~~ u	52 ~~B~~ u	21 ~~B~~ u	470 ~~B~~	200 ~~B~~
Methyl-tert-butyl-ether	4.4 UJ	1.2 UJ	4.4 UJ	1.2 UJ	4.4 UJ	1.2 UJ	4.4 UJ	1.2 UJ
2-Methylheptane	4.4 U	0.93 U	4.4 U	0.93 U	5.2	1.1	8.0	1.68
3-Methylheptane	4.4 U	0.93 U	4.4 U	0.93 U	4.4 U	0.93 U	4.4 U	0.93 U
Octane	4.4 U	0.93 U	4.4 U	0.93 U	4.4 U	0.93 U	4.4 U	0.93 U
Nonane	4.4 U	0.83 U	4.4 U	0.83 U	4.4 U	0.83 U	4.4 U	0.83 U
Decane	4.4 U	0.75 U	4.4 U	0.75 U	4.4 U	0.75 U	4.4 U	0.75 U
Dedecane	22 UJ	3.1 UJ	22 UJ	3.1 UJ	22 UJ	3.1 UJ	22 UJ	3.1 UJ
Toluene	13 ~~B~~	3.3 ~~B~~	70 ~~B~~	18 ~~B~~	82 ~~B~~	21 ~~B~~	260 ~~B~~	66 ~~B~~
Tetrachloroethylene	4.4 U	0.64 U	4.4 U	0.64 U	4.4 U	0.64 U	4.4 U	0.64 U
Ethylbenzene	4.4 U	1.0 U	4.3 J	1.0 J	2.8 J	0.63 J	7.9	1.8
p- & m-Xylenes	4.4 U	1.0 U	13	2.9	8.0	1.8	25 ~~B~~	5.6 ~~B~~
o-Xylene	4.4 U	1.0 U	4.1 J	0.92 J	4.4 U	1.0 U	5.4	1.2
4-Ethyltoluene	4.4 U	0.89 U	4.4 U	0.89 U	4.4 U	0.89 U	4.4 U	0.89 U
1,3,5-Trimethylbenzene	4.4 UJ	0.39 UJ	4.4 UJ	0.89 UJ	4.4 UJ	0.89 UJ	4.4 UJ	0.89 UJ
1,2,4-Trimethylbenzene	4.4 UJ	0.89 UJ	4.4 UJ	0.89 UJ	4.4 UJ	0.89 UJ	4.4 UJ	0.89 UJ

Sample ID	Can #A209		Can # A210		Can # B239		Can #B248	
Date Sampled	10/20/97		10/20/97		10/20/97		10/20/97	
Date Analyzed	11/11 & 11/12/97		11/11 & 11/12/97		11/11 & 11/12/97		11/11 & 11/12/97	
Compound	ng/L	ppb	ng/L	ppb	ng/L	ppb	ng/L	ppb
Acetone	200 ~~B~~ u	83 ~~B~~ u	82 ~~B~~ u	34 ~~B~~ u	54 ~~B~~ u	R 22 ~~B~~ u	R 30 ~~B~~ u	12 ~~B~~ u
Methyl-tert-butyl-ether	4.4 UJ	1.2 UJ	4.4 UJ	1.2 UJ	4.4 U	1.2 U	4.4 UJ	1.2 UJ
2-Methylheptane	4.4 U	0.93 U	19	4.0	6.3	1.3	7.2	1.5
3-Methylheptane	4.4 U	0.93 U	8.7	1.8	4.4 U	0.33 U	8.9	1.9
Octane	4.4 U	0.93 U	21	4.5	8.4	1.8	9.1	1.9
Nonane	4.4 U	0.83 U	7.2	1.3	4.4 U	0.83 U	5.0	0.93
Decane	4.4 UJ	0.75 UJ	4.4 UJ	0.75 UJ	4.4 U	0.75 U	4.4 UJ	0.75 UJ
Dedecane	22 U	3.1 U	22 U	3.1 U	22 U	3.1 U	22 U	3.1 U
Toluene	72 ~~B~~	19 ~~B~~	1000 B	270 ~~B~~	350 B	92 B	36 ~~B~~ u	9.3 ~~B~~ u
Tetrachloroethylene	4.4 U	0.64 U	4.4 U	0.64 U	4.4 U	0.64 U	4.4 U	0.64 U
Ethylbenzene	470	110	27	6.1	7.6	1.7	9.9	2.2
p- & m-Xylenes	4.4 U	1.0 U	75 ~~B~~	17 B	24 ~~B~~	5.4 ~~B~~	29 ~~B~~	6.6 ~~B~~
o-Xylene	4.4 U	1.0 U	17	3.8	4.1 J	0.93 J	5.8	1.32
4-Ethyltoluene	4.4 U	0.89 U	4.4 U	0.89 U	4.4 U	0.89 U	4.4 U	0.89 U
1,3,5-Trimethylbenzene	4.4 UJ	0.89 UJ	4.4 UJ	0.89 UJ	4.4 U	0.89 U	4.4 UJ	0.89 UJ
1,2,4-Trimethylbenzene	4.4 UJ	0.89 UJ	4.4 UJ	0.89 UJ	4.4 U	0.89 U	4.4 UJ	0.89 UJ

U = undetected at specified detection limit
J = estimated value, below the detection limit
E = estimated value, exceeds calibration range
B = analyte found in blank(s)

ENSR AIR TOXICS SPECIALTY LABORATORY
ANALYTICAL SUMMARY OF RESULTS

Client: Cashins and Associates
Lab ID #: 970152

Sample ID	Can. # A207		Can # A221		Can #B233		Can #B237	
Date Sampled	10/20/97		10/20/97		10/20/97		10/20/97	
Date Analyzed	11/11 & 11/12/97		11/11/97		11/11/97		11/11/97	
Compound	ng/L	ppb	ng/L	ppb	ng/L	ppb	ng/L	ppb
Acetone	440 u ~~B~~	190 u ~~B~~	27 u ~~B~~	11 u ~~B~~	31 u ~~B~~	13 u ~~B~~	81 u ~~B~~	34 u ~~B~~
Methyl-tert-butyl-ether	4.4 UJ	1.2 UJ	4.4 UJ	1.2 UJ	4.4 UJ	1.2 UJ	4.4 UJ	1.2 UJ
2-Methylheptane	4.4 U	0.93 U	4.4 U	0.93 U	4.4 U	0.93 U	4.4 U	0.93 U
3-Methylheptane	4.4 U	0.93 U	4.4 U	0.93 U	4.4 U	0.93 U	4.4 U	0.93 U
Octane	4.4 U	0.93 U	4.4 U	0.93 U	4.4 U	0.93 U	5.5	1.2
Nonane	4.4 U	0.83 U	4.4 U	0.83 U	4.4 U	0.83 U	4.4 U	0.83 U
Decane	4.4 U	0.75 U	4.4 U	0.75 U	4.4 U	0.75 U	4.4 U	0.75 U
Dedecane	22 UJ	3.1 UJ	22 UJ	3.1 UJ	22 UJ	3.1 UJ	22 UJ	3.1 UJ
Toluene	63 ~~B~~	16 ~~B~~	38 u ~~B~~	9.8 u ~~B~~	19 u ~~B~~	5.0 u ~~B~~	150 ~~B~~	38 ~~B~~
Tetrachloroethylene	4.4 U	0.64 U	4.4 U	0.64 U	4.4 U	0.64 U	4.4 U	0.64 U
Ethylbenzene	3.2 J	0.72 J	4.4 U	1.0 U	4.4 U	1.0 U	5.2	1.2
p- & m-Xylenes	8.2 u ~~B~~	1.9 u ~~B~~	4.4 U	1.0 U	4.4 U	1.0 U	15 u ~~B~~	3.4 u ~~B~~
o-Xylene	4.4 U	1.0 U	4.4 U	1.0 U	4.4 U	1.0 U	3.3 J	0.74 J
4-Ethyltoluene	4.4 U	0.89 U	4.4 U	0.89 U	4.4 U	0.89 U	4.4 U	0.89 U
1,3,5-Trimethylbenzene	4.4 UJ	0.89 UJ	4.4 UJ	0.89 UJ	4.4 UJ	0.89 UJ	4.4 UJ	0.89 UJ
1,2,4-Trimethylbenzene	4.4 UJ	0.89 UJ	4.4 UJ	0.89 UJ	4.4 UJ	0.89 UJ	4.4 UJ	0.89 UJ

Sample ID	Can. # 70	
Date Sampled	10/20/97	
Date Analyzed	11/11/97	
Compound	ng/L	ppb
Acetone	38 u ~~B~~	16 u ~~B~~
Methyl-tert-butyl-ether	4.4 UJ	1.2 UJ
2-Methylheptane	4.4 U	0.93 U
3-Methylheptane	4.4 U	0.93 U
Octane	4.4 U	0.93 U
Nonane	4.4 U	0.83 U
Decane	4.4 UJ	0.75 UJ
Dedecane	22 U	3.1 U
Toluene	13 u ~~B~~	3.5 u ~~B~~
Tetrachloroethylene	4.4 U	0.64 U
Ethylbenzene	4.4 U	1.0 U
p- & m-Xylenes	4.4 U	1.0 U
o-Xylene	4.4 U	1.0 U
4-Ethyltoluene	4.4 U	0.89 U
1,3,5-Trimethylbenzene	4.4 UJ	0.89 UJ
1,2,4-Trimethylbenzene	4.4 UJ	0.89 UJ

U = undetected at specified detection limit
J = estimated value, below the detection limit
E = estimated value, exceeds calibration range
B = analyte found in blank(s)

ENSR AIR TOXICS SPECIALTY LABORATORY
QUALITY CONTROL RESULTS - BLANKS

Client: Cashins and Associates
Lab ID #: 970152

Sample ID	Lab Blank				Lab Blank			
Date Sampled	N/A				N/A			
Date Analyzed	11/11/97				11/12/97			
Compound	ng/L		ppb		ng/L		ppb	
Acetone	24		9.9		8.0	J	3.3	J
Methyl-tert-butyl-ether	4.4	U	1.2	U	4.4	U	1.2	U
2-Methylheptane	4.4	U	0.93	U	4.4	U	0.93	U
3-Methylheptane	4.4	U	0.93	U	4.4	U	0.93	U
Octane	4.4	U	0.93	U	4.4	U	0.93	U
Nonane	4.4	U	0.83	U	4.4	U	0.83	U
Decane	4.4	U	0.75	U	4.4	U	0.75	U
Dedecane	22	U	3.1	U	22	U	3.1	U
Toluene	11		2.8		5.1		1.3	
Tetrachloroethylene	4.4	U	0.64	U	4.4	U	0.64	U
Ethylbenzene	4.4	U	1.0	U	4.4	U	1.0	U
p- & m-Xylenes	5.0		1.1		4.4	U	1.0	U
o-Xylene	4.4	U	1.0	U	4.4	U	1.0	U
4-Ethyltoluene	4.4	U	0.89	U	4.4	U	0.89	U
1,3,5-Trimethylbenzene	4.4	U	0.89	U	4.4	U	0.89	U
1,2,4-Trimethylbenzene	4.4	U	0.89	U	4.4	U	0.89	U

U = undetected at specified detection limit
J = estimated value, below the detection limit

ENSR AIR TOXICS SPECIALTY LABORATORY
QUALITY CONTROL RESULTS - DUPLICATES

Client: Cashins and Associates
Lab ID #: 970152

Sample ID	Can #B246		Duplicate		
Date Sampled	10/20/97		10/20/97		
Date Analyzed	11/11 & 11/12/97		11/11 & 11/12/97		
Compound	**ng/L**	**ppb**	**ng/L**	**ppb**	**RPD**
Acetone	30 u ~~B~~	12 u ~~B~~	23 u ~~B~~	9.7 u ~~B~~	~~26~~ NA
Methyl-tert-butyl-ether	4.4 UJ	1.2 UJ	4.4 UJ	1.2 UJ	NC
2-Methylheptane	7.2	1.5	8.2	1.7	13
3-Methylheptane	8.9	1.9	10.1	2.1	13
Octane	9.1	1.9	8.4	1.8	8.9
Nonane	5.0	0.93	4.6	0.86	7.5
Decane	4.4 UJ	0.75 UJ	4.4 UJ	0.75 UJ	NC
Dedecane	22 U	3.1 U	22 U	3.1 U	NC
Toluene	36 u ~~B~~	9.3 u ~~B~~	31 u ~~B~~	8.1 u ~~B~~	~~14~~ NA
Tetrachloroethylene	4.4 U	0.64 U	4.4 U	0.64 U	NC
Ethylbenzene	9.9	2.2	8.6	1.9	14
p- & m-Xylenes	29 ~~B~~	6.6 ~~B~~	28 ~~B~~	6.3 ~~B~~	4.9
o-Xylene	5.8	1.3	5.5	1.2	6.0
4-Ethyltoluene	4.4 U	0.89 U	4.4 U	0.89 U	NC
1,3,5-Trimethylbenzene	4.4 UJ	0.89 UJ	4.4 UJ	0.89 UJ	NC
1,2,4-Trimethylbenzene	4.4 UJ	0.89 UJ	4.4 UJ	0.89 UJ	NC

U = undetected at specified detection limit
J = estimated value, below the detection limit

E = estimated value, exceeds calibration range
B = analyte found in blank(s)

RPD = relative percent difference
NC = not calculable

SAMPLE LOG-IN & RECEIPT CHECKLIST

Client/Proj #: Cashins & Associates

Project Mgr: L Wong

Lab Pool #: 97D156

Inspected & Logged in by: M. L. Tilston

Date Time: 12/22/97 9:30

Sample Matrix	Number of Samples	Analysis Requested	Analyze by (date)	Storage Location
Canister	13	TO-14 org. spec. list.	1/3/97	GCMS lab.

Circle the appropriate response:

1) Shipped / Hand delivered

2) COC present / not present on receipt

3) COC Tape present / not present on shipping container NA

4) Samples broken / leaking / intact on receipt

5) Samples ambient / chilled on receipt

6) Samples preserved correctly / incorrectly / none recommended

7) Received within / outside holding time

8) COC tapes present / not present on samples

9) Discrepancies / NO discrepancies noted between COCs and samples

Additional Comments:

1 0119

M901376

ENSR

CHAIN OF CUSTODY RECORD

Page 1 of 2

Client/Project Name: Cashins & Assoc.

Project Location: FORT DEVENS ELEMENTARY SCHOOL

Project Number: 1347

Field Logbook No

Sampler (Print Name)/Affiliation: ROBERT CASHINS

Chain of Custody Tape No

Signature: [signature] 10/20

Send Results/Report to: Bob Cashins fax: (617) 944-4082

Analysis Requested: FINGERPRINT COMPOUNDS

Field Sample No / Identification	Date	Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid, Sludge, Etc)	Preservative	Field Filtered	FINGERPRINT COMPOUNDS						Lab ID	Remarks
A 211 class	10/20/97			X	SUMMA	AIR	NONE	N	X							
6.2				X	"	"	"	"	X							
A 230 class				X	"	"	"	"	X							
A 209 cafeteria				X	"	"	"	"	X							
A 210 class				X	"	"	"	"	X							
B 234				X	"	"	"	"	X							
B 246 class				X	"	"	"	"	X							
A 207				X	"	"	"	"	X							
A 221				X	"	"	"	"	X							
B 233 playground				X	"	"	"	"	X							

Relinquished by	Date / Time	Received by	Date / Time
(Print Name) ROBERT CASHINS; Signature [signature]	Date: 10/21/97; Time: 2:30 PM	(Print Name) Evelina Vaccaglia; Signature: [signature]	Date: 10/21/97; Time: 2:50
received (Print Name) LARRY LAFRANCE; Signature [signature]	Date: 10/21/97; Time: 15:28	(Print Name) Michelle Littleton; Signature [signature]	Date: 10/22/97; Time: 9:30
(Print Name); Signature	Date; Time	(Print Name); Signature	Date; Time

Analytical Laboratory (Destination):

Serial No

10102

M901176

ENSR

CHAIN OF CUSTODY RECORD

Page 2 of 2

Client/Project Name: Cushing & Assoc	Project Location: FORT DEVENS ELEMENTARY SCHOOL
Project Number: 1347	Field Logbook No
Sampler (Print Name)/Affiliation: ROBERT CASHINS	Chain of Custody Tape No
Signature: [signature] 10/20	Send Results/Report to: Bob Cushing fax (617)944-4082

Analysis Requested: FINGERPRINT COMPOUNDS

	Field Sample No./Identification	Date	Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid, Sludge, Etc.)	Preservative	Field Filtered	FINGERPRINT COMPOUNDS						Lab I.D.	Remarks
...11	B 237 water kitchen	10/22/97			X	SUMMA	AIR	NONE	N	X							
...12	70 old lib. Corr...				X	"	"	"	"	X							
...13	top Clark		99		X	"	"	"	"	X							

Relinquished by (Print Name)	Date	Received by (Print Name)	Date	Analytical Laboratory (Destination)
ROBERT CASHINS Signature: [signature]	10/21/97 Time: 2:30 PM	[illegible] Signature: [signature]	10/21 Time: 2:30	
Received / Relinquished by: LARRY PLAFRANCE Signature: [signature]	10/21/97 Time: 15:28	Michelle Littleton Signature: [signature]	10/22/97 Time: 9:30	
Relinquished by (Print Name) Signature	Date Time	Received by (Print Name) Signature	Date Time	Serial No

CTOT

SOIL REMOVAL ACTION REPORT

AREA OF CONTAMINATION (AOC) 69W

(DEVENS ELEMENTARY SCHOOL)

DEVENS, MASSACHUSETTS

REMOVAL ACTION REPORT

Contract No. DACW33-95-D-0004,

Delivery Order No. 0004

DCN No. VRA-052998-AAKV

APRIL 1998

Prepared for

U. S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 Virginia Road
Concord, Massachusetts 01742-2751

Prepared by

Roy F. Weston, Inc.
One Wall Street, Manchester, NH. 03103

Work Order No. 03886-118-204-0910

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EXECUTIVE SUMMARY

The purpose of this report is to document the activities conducted as part of a time-critical removal action in accordance with the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of 1980, as amended, for Area of Contamination (AOC) 69W (former Fort Devens Elementary School), Devens, Massachusetts.

AOC 69W is located on the northern portion of the Main Post of the former Fort Devens near the northeast corner of the intersection of MacArthur Avenue and Antietam Streets. AOC 69W is comprised of the former Fort Devens Elementary School (Building 215) and the associated parking lot and adjacent lawn extending approximately 300 feet northwest to Willow Brook, which runs along MacArthur Avenue in Devens, MA.

The Elementary School building was originally constructed in 1951, and an addition to the building was constructed in 1972. The old section of the building was heated by using oil stored in a 10,000 gallon Underground Storage Tank (UST) that was located in what is now the courtyard of the school building. This UST was removed in 1972, and a new 10,000 gallon UST was installed under the parking lot on the north side of the new section of the building. The new UST supplied heating oil for the entire school building. There are two boiler rooms, one each in the old and new sections of the building.

A review of historical records and a series of personal interviews, conducted by ABB Environmental Services, Inc. during the Remedial Investigation at the site, indicated that there have been two separate releases of fuel oil at AOC 69W, the first in 1972 and the second in 1978.

Field and analytical data indicated two areas of fuel-related soil contamination at AOC 69W. The larger area of contamination extended from the new boiler room located in the northwest corner of the school building, to a 250-gallon underground concrete vault, located in a wooded area near Willow Brook, approximately 300 feet northwest of the school. This contamination is attributed to the 1972 release of fuel oil from piping between the existing 10,000-gallon underground storage tank (UST) and the newer boiler room in the northwest corner of the Elementary School.

The 1972 fuel oil release was due to a crimp in the piping which ran from the new 10,000 gallon UST to the new boiler room. It has been estimated that approximately 7,000 to 8,000 gallons of fuel oil were released into soil and groundwater prior to repair of the piping. The exact location of the release is unknown; however, contaminant distributions suggest that the release was in the vicinity of the newer boiler room.

As a result of the release, a "skimmer system" was installed in 1972 to remove oil from the source area and presumably from near surface soils in the grassy area north of the school. According to historical reports, the "skimmer system" was constructed with a pipeline from the northwest corner boiler room to an underground concrete vault situated near Willow Brook. The concrete vault collected oil water and was pumped out approximately every three months. Sometime after 1986, the concrete vault was filled with crushed stone.

The other identified area of soil contamination was located adjacent to the northeast corner of the school building, outside of the original boiler room. This contamination has been attributed to the 1978 release of fuel oil due to ruptured piping near the old boiler room. An excavation at the time of the release revealed fuel oil emanating from beneath the school. Between 7,000 to 8,000 gallons of fuel oil were estimated to have been released to soil and groundwater during this incident. Following this spill, it is reported that approximately 2,600 gallons of residual oil were pumped from the underground concrete vault.

In accordance with 40 CFR Section 300.415 of the National Contingency Plan, an Action Memorandum was prepared by WESTON® to perform a removal action at AOC 69W. The Action Memorandum called for the removal of the existing 10,000 gallon UST, approximately 1200 cubic yards of petroleum-contaminated soil from a hot spot adjacent to the UST location, the underground piping from the "skimmer system", and the underground concrete vault. The Action Memorandum was reviewed and approved by the Massachusetts Department of Environmental Protection and the United States Environmental Protection Agency during December 1997.

A time-critical removal action was conducted during January 1998 and February 1998, according to procedures outlined in the approved Action Memorandum. This action included the removal of the existing 10,000 gallon UST, 660 gallons of tank sludge and oily water from the UST, the underground concrete vault, approximately 375 linear feet of clay pipe leading to the concrete vault, and approximately 3,500 cubic yards of petroleum-contaminated soils from the parking lot and the grassy area north of the Elementary School building. The original estimate of the volume of petroleum-contaminated soil of 1,200 cubic yards was exceeded substantially due to the presence of a larger area of subsurface contamination than originally expected based on available subsurface data. Additionally, approximately 1,900 gallons of oily water were pumped from the groundwater surface in the open excavation to remove the oily sheen present on the groundwater at the conclusion of excavation activities.

The excavated soils were field-screened using a Non-dispersive Infrared Spectrometer (NDIR) to determine the levels of Total Petroleum Hydrocarbon (TPH) contamination in the soil. Field screening samples were taken at a frequency of one sample for approximately every 15 to 20 cubic yards of excavated material. A field screening goal of 1,000 ppm TPH was used as a criterion to segregate excavated soils. Soils that showed concentrations above 1,000 ppm via the NDIR, as well as soils showing heavy staining or a strong petroleum odor were set aside as contaminated and staged separately.

During the removal action, the contaminated soils were staged in a temporary soil staging area prepared on the east side of the Elementary School. The staging area was prepared by laying two layers of 8-mil polyethylene sheets on the ground, with a berm around the staging area. The contaminated soil stockpile was covered with waterproof tarps as a shield from rain and snow, and to prevent migration of contamination from the stockpile into adjacent areas. The contaminated soils were sampled at a frequency of one sample per 100 cubic yards and characterized for disposal. Subsequent to the conclusion of the removal action, the contaminated soils were transported to the Central Soil Storage Facility at Devens, MA. and staged for future disposal.

1. PURPOSE

The purpose of this Removal Action Report is to document the remedial activities conducted at Area of Contamination (AOC) 69W (former Fort Devens Elementary School), at Devens, MA in accordance with the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of 1980, as amended. Removal actions included the removal and disposal of a 10,000 gallon Underground Storage Tank (UST), removal and disposal of approximately 660 gallons of oily water and tank bottoms present in the UST, removal of an underground concrete vault (approximate size 700 gallons), approximately 375 linear feet of underground clay pipe, approximately 3,500 cubic yards of petroleum-contaminated soils, and disposal of approximately 1,900 gallons of oily water from the excavation area.

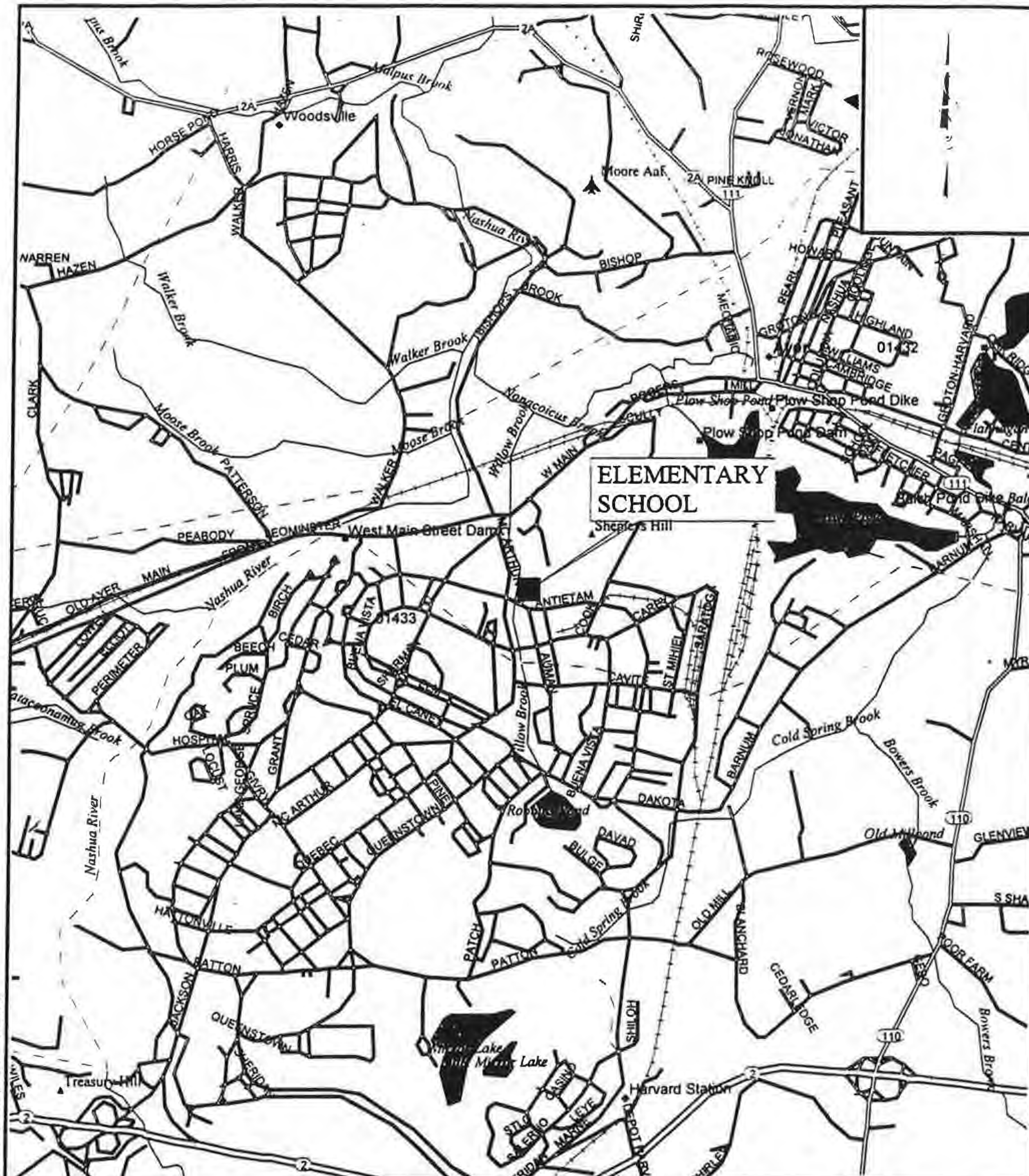
2. SITE CONDITIONS AND BACKGROUND

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) states that a removal action may be conducted at a site where a threat to human health and welfare or the environment is established. An appropriate removal action is taken to abate, minimize, stabilize, mitigate, or eliminate the release or threat of release at the site. The following paragraphs describe Devens (formerly called Fort Devens) and the conditions of the soils at the former Fort Devens Elementary School site (hereafter referred to as AOC 69W).

2.1 SITE DESCRIPTION

AOC 69W is located on the northern portion of the Main Post of the former Fort Devens (hereafter called Devens), near the northeast corner of MacArthur Avenue and Antietam St. (Figure 2-1). Devens is located within the towns of Ayer, Harvard, Lancaster, and Shirley, Massachusetts, and comprises approximately 9,280 acres. Devens was used for a variety of U.S. military training missions from 1917 until 1996. In 1991 the installation was selected for cessation of operations and closure under Public Law 101-510, the Base Realignment and Closure (BRAC) Act of 1990. On 21 December 1989, Fort Devens was placed on the National Priorities List (NPL) pursuant to CERCLA.

According to the Draft Remedial Investigation (RI) Report for AOC 69W prepared by ABB Environmental Services, Inc. (ABB-ES May 1997), various historical site plans for the former Fort Devens Elementary School indicated that heating oil for the Elementary School was provided by a 10,000 gallon UST located in what is now the school courtyard. In 1972, a new section of the building was added to the school resulting in the current configuration of the building. As part of the addition, a new boiler room was added to complement the existing boiler. The 10,000 gallon UST, located in what is now the courtyard, and associated piping were removed and a new 10,000 gallon UST was installed under the parking lot on the north side of the school (Figure 2-2). A review of historical records and a series of personal interviews, conducted by ABB during the Draft RI Report, indicated that



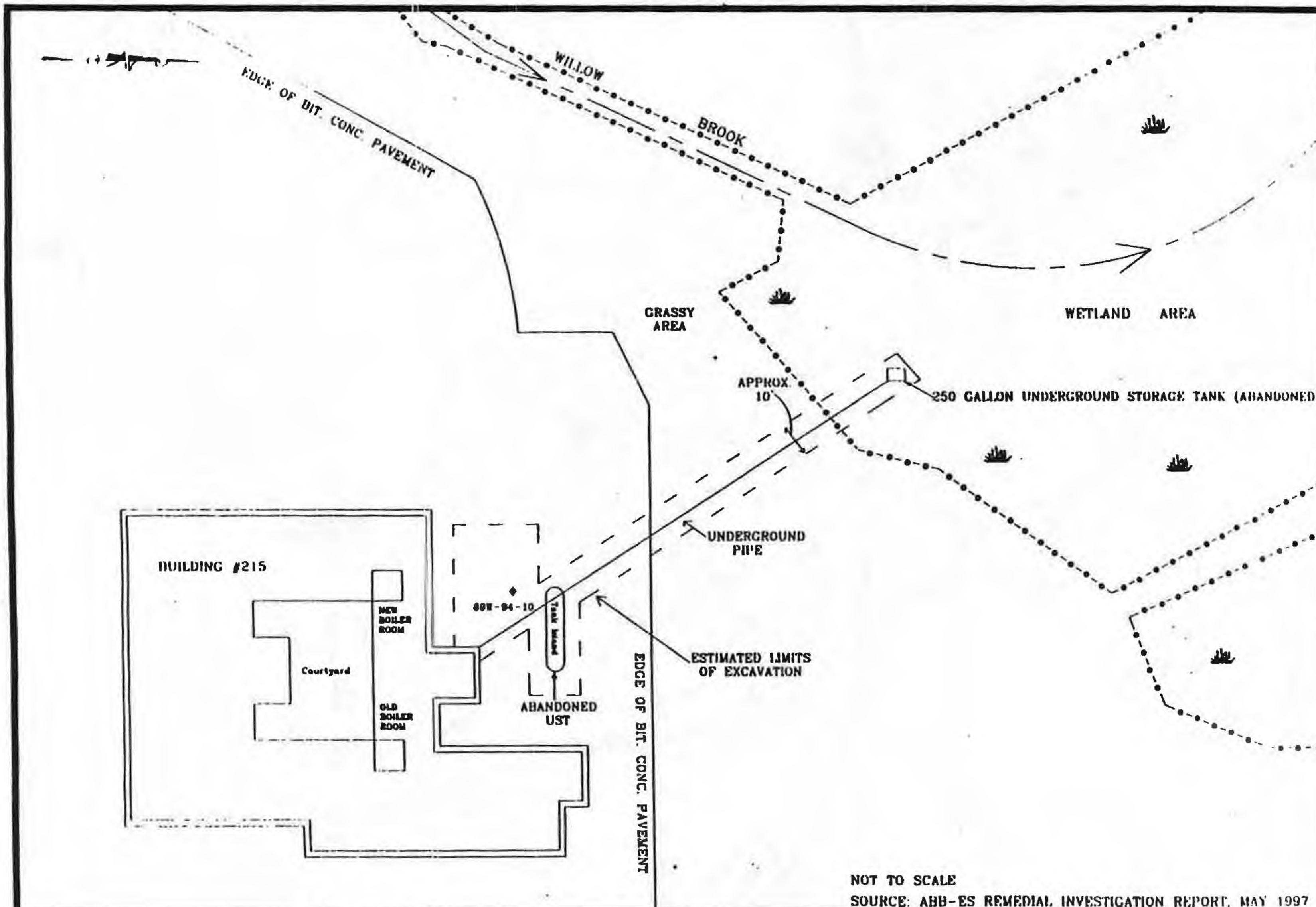
AREA OF CONTAMINATION 69W
ELEMENTARY SCHOOL
DEVENS, MASSACHUSETTS

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

SITE LOCATION

WESTON
MANAGERS DESIGNERS/CONSULTANTS
MANCHESTER NEW HAMPSHIRE

DRAWN D.C.C.
DATE NOV 97
FIGURE NO. 2-1



SITE SKETCH	AREA OF CONTAMINATION 69W ELEMENTARY SCHOOL DEVENS, MASSACHUSETTS	FIGURE 2-2 WESTON

there have been two separate releases of fuel oil at AOC 69W, the first in 1972 and the second in 1978 (ABB-ES, May 1997).

The 1972 fuel oil release was due to a crimp in the piping which ran from the new 10,000 gallon UST to the new boiler room. It has been estimated that approximately 7,000 to 8,000 gallons of fuel oil were released into soil and groundwater prior to repair of the piping. The exact location of the release is unknown; however, contaminant distributions suggest that the release was in the vicinity of the newer boiler room.

As a result of the fuel oil release, a "skimmer system" was installed next to the UST in either late 1972 or early 1973. The nature and exact location of the system were unclear; however, some evidence suggested that the system was essentially a french drain. It was believed that the system was connected to, or possibly comprised of, a pipe buried approximately three feet below ground surface extending from the vicinity of the UST to a buried concrete vault located approximately 250 feet to the northwest. The concrete vault collected oily water and was pumped out approximately every three months. Sometime after 1986, the concrete vault was filled with crushed rock.

The 1978 fuel oil release resulted from a failed piping connection from fuel oil pipes leading to the old boiler room. Approximately 7,000 to 8,000 gallons of fuel oil were released into soil and groundwater during the 1978 incident. A large area was excavated on the north side of the school adjacent to the loading dock in an attempt to locate the source of the release. Reports indicate that the excavation collected residual oil for one month before the damaged piping was found and replaced. Shortly after the release an oily sheen was reported in Willow Brook and the associated wetlands to the north of the school. Following the spill, 2,600 gallons of residual oil were pumped from the concrete vault.

The decision to remove the existing 10,000 gallon UST, the 250 gallon concrete vault and associated piping and petroleum-contaminated soil, thereby removing the source of the contamination in the soil and groundwater at AOC 69W, was documented in the Action

Memorandum for AOC 69W, which was approved by MADEP and USEPA in December 1997.

2.2 OTHER ACTIONS TO DATE

Previous actions at AOC 69W are discussed in detail in reports compiled by ABB-ES (ABB-ES, May 1997). A brief summary of the actions taken to date is provided below.

2.2.1 Arthur D. Little, Inc. AREE 69 Evaluation (AREE 69W)

In July of 1993, Arthur D. Little, Inc. (ADL) investigated the former Fort Devens Elementary School, which at that time was designated as Area Requiring Environmental Evaluation (AREE) 69W. The investigation was conducted as part of the basewide AREE 69 (Past Spill Sites) evaluation. The investigation focused on the 1978 fuel oil release and was comprised of a document review and site visit. The study concluded that there was a potential for fuel oil contamination in the soil and groundwater (ADL, 1995)

Further investigation was performed by ADL at AREE 69W from March through June of 1994. The investigation involved sampling, field screening, and laboratory analysis of surface soil, subsurface soil, groundwater, surface water, and sediment, and a geophysical survey to locate subsurface utilities.

2.2.1.1 Surface Soil

Soil samples were collected at depths between 0 and 1 foot below ground surface (bgs), from the north and northwest areas of the parking lot of the Elementary School, and were field screened for total petroleum hydrocarbons (TPHC) and for benzene, toluene, ethylbenzene and xylene (BTEX). The sample with the highest TPHC concentration was sent for offsite analyses for TPHC, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), inorganic compounds and total organic carbon (TOC).

TPHC field screening results ranged from 9.5 parts per million (ppm) to 131 ppm. The highest concentration was detected in a sample collected approximately 150 feet northwest of the UST, in the vicinity of the pipeline connected to the concrete vault. No BTEX concentrations were detected during field screening. Offsite laboratory analyses did not detect compounds at concentrations exceeding then current Massachusetts Contingency Plan (MCP) Method 1 S-1/GW-1 Standards. Carcinogenic polycyclic aromatic hydrocarbons (cPAHs) detected in the surface soils at the site consisted of benzo(a)anthracene and chrysene at a combined concentration of 0.29 ppm (ABB-ES, May 1997).

2.2.1.2 Subsurface Soil

As part of the ADL subsurface investigation, soil samples were collected during the installation of groundwater monitoring wells and during a Geoprobe® investigation at the site. During the first round of Geoprobe sampling, the subsurface samples were collected from 0 to 2 feet bgs and from 3 to 5 feet bgs at 16 locations and were field screened for TPHC and BTEX. Of the 32 samples analyzed in the field, three samples exhibiting the highest TPHC concentrations and one sample with the lowest TPHC concentration, were submitted for laboratory analysis of Project Analyte List (PAL) VOCs, PAL SVOCs, TPHC, PAL inorganics and Total Organic Carbon (TOC) analysis. During the second Geoprobe sampling round, nine additional locations were investigated. Subsurface soil samples were collected from a depth of 3 to 5 feet bgs and field screened for TPHC.

Subsurface soil samples were collected at depth intervals of 0 to 2 feet, 2 to 4 feet, and 11 to 13 feet bgs during the monitoring well installation effort. These samples were screened in the field for TPHC and BTEX. The samples from the 2 to 4 and 4 to 6 foot depth intervals were submitted for laboratory analysis of TPHC, PAL VOCs, PAL SVOCs, PAL inorganics, and TOC analysis.

TPHC concentrations in soils collected with the Geoprobe® and from monitoring well soil borings ranged from 7.5 ppm to 15,500 ppm at varying depths. The maximum TPH concentration was detected in the vicinity of the UST, at a depth between 3 to 5 feet bgs.

SVOC analytical results from the samples collected at depths greater than 2 feet bgs indicated benzo(b)fluoranthene at concentrations exceeding the Massachusetts Department of Environmental Protection (MADEP) Massachusetts Contingency Plan (MCP) S-2/GW-1 Standards. Benzo(b)fluoranthene was detected at 0.75 ppm, adjacent to the northern side of the UST, at a depth between 3 to 5 feet bgs.

ABB concluded that based on the field screening and laboratory analysis results, TPHC and cPAH soil contamination appeared to be concentrated in the area of the existing UST (the presumed source area), and may have migrated downgradient towards Willow Brook (ABB-ES, May 1997).

2.2.1.3 Groundwater

Groundwater samples were collected from each Geoprobe location and from the six newly installed groundwater monitoring wells. Sixteen groundwater samples were collected during the first Geoprobe sampling round and were field screened for TPHC and BTEX. Filtered and non-filtered groundwater samples collected during the second Geoprobe sampling round were field screened for TPHC.

Field screening results from the 25 Geoprobe groundwater samples indicated that TPHC was present in groundwater. BTEX was not detected. Five sample locations from the first Geoprobe sampling round exhibiting the highest field screening TPHC concentrations were resampled and submitted to the laboratory for analysis of PAL VOCs, PAL SVOCs, TPHC and water quality parameters. No samples from the second Geoprobe sampling round were sent for laboratory analysis. Results indicated that TPHC, inorganic analytes (arsenic, lead, antimony, beryllium, chromium, and nickel), and organic compounds (1,1-dichloroethene, benzene, carbon tetrachloride, chloroform, tetrachloroethene, trichloroethene, 2-methyl naphthalene, and naphthalene) were detected at concentrations exceeding MCP Method 1 GW-1 Standards. Most of these exceedances occurred at locations in the vicinity and downgradient of the UST. No cPAHs were detected in the Geoprobe groundwater samples.

The six monitoring wells installed at the site confirmed the results of the Geoprobe® investigation. Groundwater samples were submitted for analysis of TPHC, PAL VOCs, PAL SVOCs, unfiltered inorganics and water quality parameters. Results indicated that TPHC, arsenic, beryllium, cadmium, chromium, lead, nickel, 2-methyl naphthalene, acenaphthene, and naphthalene were detected at concentrations exceeding MCP Method 1 GW-1 Standards. No cPAHs were detected in the groundwater samples.

Groundwater sample results indicate that the area around the UST has the greatest number of compounds exceeding MCP Standards. Groundwater northwest of the UST was also found to have elevated concentrations of inorganics and TPHC, suggesting that contaminants have potentially migrated downgradient of the UST location.

2.2.1.4 Surface Water and Sediment

Surface water and sediment samples were collected from two locations in Willow Brook. One sample location was placed in line with the inferred plume migration pathway indicated by the Geoprobe survey, and the other was placed upstream of this area. Samples were analyzed for TPHC, PAL VOCs, PAL SVOCs, unfiltered inorganics, and water quality parameters.

The results indicated the presence of cPAHs in both sediment samples, and TPHC in one sample. Specifically, the cPAHs benzo(a)anthracene, chrysene, benzo(b)fluoranthene, and benzo(k)fluoranthene were detected. Total cPAHs in the upstream sample barely exceeded 7.0 ppm. Total cPAHs in the downstream sample were an order of magnitude less than the clean-up values. Other PAHs and metals were detected in both samples.

TPHC and cPAHs were not detected in surface water samples.

2.2.2 Remedial Investigation by ABB-ES

2.2.2.1 RI Field Analytical Soil Results.

Soil samples were collected during the RI in 1995 and 1996 from TerraProbe^{SM} points, soil borings, and test pits. Soil samples were subjected to on-site analysis for BTEX, select VOCs, gasoline range organics (GRO), and TPHC. Select samples were also analyzed for diesel range organics (DRO). Soil samples were generally collected from near ground surface, a midpoint, and the water table as exploration conditions allowed. Selected soil samples were also subjected to off-site laboratory analyses for PAL VOCs, SVOCs, inorganics, and TPHC.

In general, on-site analyses detected VOCs and TPHCs in a number of soil samples. The majority of the VOC detections were the petroleum-related compounds toluene, chlorobenzene, ethylbenzene, and xylenes. The highest detected total and individual concentrations of these compounds were found within 50 feet south and southwest of the UST. However, none of these compound concentrations exceeded the applicable MCP S-1/GW-1 regulatory standards.

The maximum detected TPHCs concentration was 7,700 ppm at 6 feet bgs approximately 50 feet southwest of the UST. The most significant detections (i.e., in excess of 500 ppm) were located in the area of the underground "skimmer system" which leads from the school to the 250 gallon underground vault located approximately 300 feet to the northwest. The "skimmer system" that was installed in 1972 may have acted as a conduit for migration of TPHC soil contamination.

2.2.2.2 RI Off-Site Analytical Soils Results.

Selected soil samples from the 1995 RI work were subjected to laboratory analysis to provide off-site confirmation of the on-site analysis. Analyses were performed for PAL VOCs, SVOCs, inorganics, and TPHC.

Arsenic, beryllium, calcium, cobalt, copper, iron, magnesium, manganese, mercury, nickel, selenium, sodium, and zinc were detected at levels in excess of established Devens background concentrations. The greatest number of exceedances were observed at depths ranging from 4 to 7 feet bgs along the downgradient pathway from the UST to Willow Brook.

Detected VOCs were comprised primarily of the fuel related compounds toluene, ethylbenzene, and xylene (TEX). The maximum observed concentration of total TEX was 0.48 ppm (ethylbenzene and xylenes only) at 7 feet bgs in the vicinity of the UST. A number of SVOCs were identified in both surficial and subsurface soils at AOC 69W. The highest observed concentrations of the PAHs were observed in subsurface soils immediately adjacent to the school building near the new boiler room and in surficial soils in the grassy area north of the school. These SVOC concentrations were shown to be coincident with the pipe leading from the school to the concrete vault.

TPHC were detected in seventeen of the samples collected for off-site analysis. The TPHC concentration was 14,400 ppm at 7 feet bgs, approximately 50 feet south of the UST. The remainder of the TPHC concentrations in excess of 500 ppm were primarily located between 5 to 7 feet bgs (the varying depth to groundwater) along the pipeline from the new boiler room to the concrete vault.

In August of 1996, additional investigation was conducted involving installation of soil borings/monitoring wells in the school courtyard and inside each boiler room. One soil boring and one monitoring well were installed in the school courtyard and a monitoring well was installed in each of the school's two boiler rooms. A total of nine soil samples were collected from these explorations and analyzed at off-site laboratories for extractable petroleum hydrocarbons (EPH) and volatile petroleum hydrocarbons (VPH) parameters, TPHC, and TOC for the screened interval of the monitoring wells.

Analysis for EPH/VPH yielded one detection. The 9 feet bgs sample from the boring advanced in the new boiler room yielded a concentration of 560 ppm for the n-C 9 to n-C 18 range aliphatics and 110 ppm for the n-C 19 to n-C 36 range aliphatics. Aromatics in the n-C 10 to n-C 22 range were identified at 120 ppm. None of the targeted PAHs were detected above the laboratory reporting limits. VPH analysis showed the same sample to contain VPH compounds including 270 ppb for the n-C 5 to n-C 8 aliphatic range, 8,300 ppb for the n-C 9 to n-C 12 aliphatics, and 3,500 ppb for the n-C 9 to n-C 10 aromatics. None of the targeted VOCs were detected above laboratory reporting limits.

Two of the nine soil samples contained detectable levels of TPHC. The 9 feet bgs sample from the new boiler room boring contained 1,740 ppm of TPHC and the sample collected from the courtyard boring at 6 feet bgs indicated a TPH concentration of 57.5 ppm.

2.2.2.3 RI Groundwater Results

Groundwater sampling and analysis for the RI included field analytical testing of water samples collected from TerraProbe^{SM} borings in 1995 as well as the off-site laboratory analysis for three rounds of RI groundwater sampling (two rounds in conjunction with the 1995 field effort and one round of low-flow sampling as part of the 1996 field effort).

2.2.2.4 RI Field Analytical Groundwater Results.

A total of 29 groundwater samples were collected from the TerraProbe^{SM} points and analyzed in the field for BTEX, select VOCs, and GRO for select samples.

Seven samples contained one or more of the fuel related contaminants chlorobenzene, ethylbenzene, and xylenes. The majority of detections were from TerraProbes^{SM} adjacent to the north side of the school building. The highest observed concentrations were ethylbenzene at 73 ppb and xylene at 120 ppb from the same groundwater sample. Concentrations were generally in the low part-per-billion range (<50 ppb).

2.2.2.5 RI Groundwater Off-Site Laboratory Analytical Sample Results.

Two rounds of groundwater sampling were conducted on all 10 of the on-site monitoring wells in 1995 and 1996, except for one (69W-94-09) which was destroyed by a snow plow between Rounds 1 and 2. Groundwater samples were analyzed for PAL VOCs, SVOCs, total and filtered PAL inorganics, pesticides/PCBs, TPHC, TDS, and water quality parameters.

Several inorganic analytes were detected above the calculated Devens background concentrations in groundwater. Arsenic, calcium, iron, manganese, potassium, and sodium were detected above background in the filtered samples. All of the above inorganic analytes, as well as copper, were detected above background in one or more of the unfiltered samples. The greatest numbers of background exceedances, in both Rounds 1 and 2, were observed in samples from monitoring wells 69W-94-10 and 69W-94-13, located approximately 25 feet southwest and 100 feet north of the UST, respectively. These were also the only wells to have inorganics concentrations in excess of Maximum Contaminant Levels (MCLs). The arsenic was believed, by ABB-ES, to be due to reducing conditions in the aquifer and the reducing conditions are attributed to the aerobic degradation of the fuel oil contamination.

VOCs were observed in these samples at total concentrations of 20 ppb or less. SVOC compounds were detected at a maximum concentration of 1,380 ppb in Round 1 and 1,500 ppb in Round 2. None of the Rounds 1 or 2 groundwater samples contained detectable levels of PCBs. Monitoring well 69W-94-10 was the only location to contain TPHCs in both Rounds 1 and 2 (159,000 ppb and 228,000 ppb respectively). TPHC detections in other samples were at significantly lower levels during these two rounds (maximum 1,960 ppb).

A third round of groundwater samples were collected from six monitoring wells as part of the 1996 field effort to delineate potential source areas. The monitoring wells were sampled following USEPA low-flow (minimum stress) purging and sampling protocols (USEPA, 1996). Sampled wells included the three newly installed courtyard and boiler room monitoring wells as well as the existing monitoring wells three of the six existing wells. Groundwater samples were analyzed for EPH/VPH, TPHC (method 418.1), water quality parameters, TDS, and TOC.

Three of the monitoring wells contained measurable levels of VPH. Monitoring well 69W-94-10 exhibited the highest concentration of total VPH. The total VPH concentration consisted of 17 ppb of the n-C 5 to n-C 8 aliphatics, 550 ppb of the n-C 9 to n-C 12 aliphatics, and 790 ppb of the n-C 9 to n-C 10 aromatic range. This sample also contained the only detections of targeted VOCs: 35 ppb of ethylbenzene and 94 ppb of naphthalene.

EPH compounds were detected in monitoring well 69W-94-10 only. Total EPH compound concentrations were comprised of 590 ppb of the n-C 9 to n-C 18 range aliphatics and 710 ppb of the n-C 10 to n-C 22 range aromatics. Targeted PAH (SVOC) analytes consisted of 89 ppb of 2-methylnaphthalene, 45 ppb of naphthalene, and 15 ppb of acenaphthene. TPHCs were below detection limits in all of the Round 3 samples.

3. PROJECT PLANS AND FIELD ACTIVITIES

3.1 PREPARATION OF PLANS

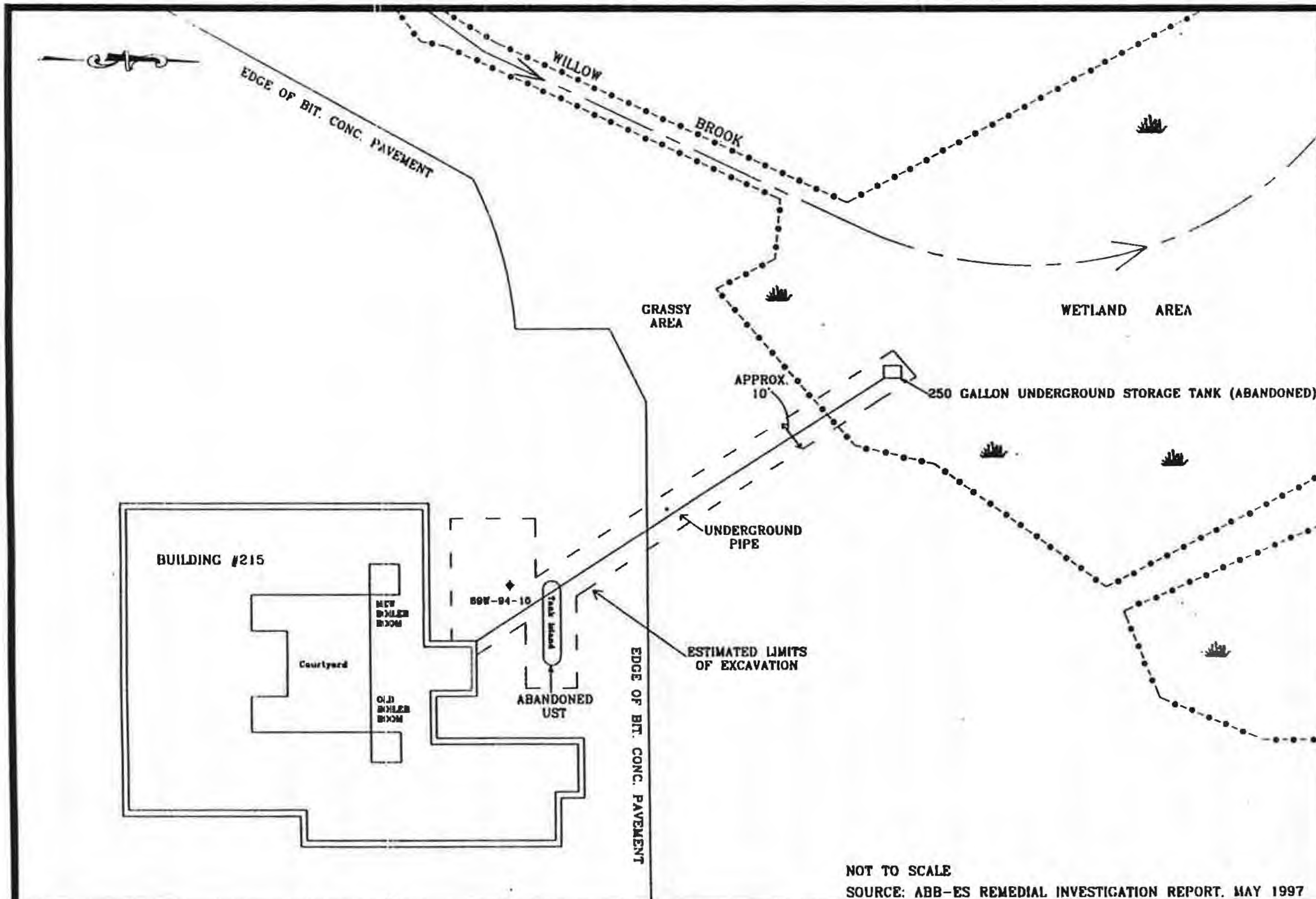
Prior to the initiation of field activities, an Action Memorandum was prepared by WESTON® in accordance with 40 CFR Section 300.415 of the National Contingency Plan. This Action Memorandum was reviewed and approved by the Massachusetts Department of Environmental Protection (MADEP) and the United States Environmental Protection Agency (USEPA) during December 1997.

A Site Specific Health and Safety Plan (SSHASP) was prepared during December 1997 to establish standard safety and health procedures for WESTON® and subcontractor personnel in the performance of their work at this site. The SSHASP was reviewed and approved by WESTON®'s Certified Industrial Hygienist and Project Manager. All project activities at AOC 69W were governed by this SSHASP.

3.2 SITE PREPARATION AND MOBILIZATION

Prior to initiation of excavation activities, WESTON® contacted DIG-SAFE and the Devens Commerce Center during November 1997 and provided them with information about the location and depth of excavation at AOC 69W so that the local utilities could identify and mark any buried utilities in the vicinity of the site. No buried utilities were identified in the vicinity of the excavation areas at AOC 69W. WESTON® also informed the Devens Fire Department of the scope and schedule of field activities at AOC 69W and obtained a UST removal and disposal permit from the Devens Fire Chief's office.

Site mobilization activities were conducted beginning December 17, 1997. Site safety equipment such as first aid equipment, fire extinguishers, personal protective equipment (PPE), air monitoring instruments (Organic Vapor Monitor), and other supplies were procured. Site control measures such as high-visibility orange fencing, warning signs and barricades were setup around the site perimeter to prevent unauthorized access and to prevent untrained personnel from entering the work zones. The estimated boundaries of the excavation were marked out on the ground as shown in Figure 3-1 to assist in determining the sequence of excavation activities. Approximately 200 linear



ESTIMATED LIMITS OF EXCAVATION

AREA OF CONTAMINATION 69W
ELEMENTARY SCHOOL
DEVENS, MASSACHUSETTS

FIGURE 3-1

WESTON

feet of silt fence was established around the concrete vault excavation area in order to prevent erosion and possible migration of silt and contaminants to Willow Brook during a rain or snow event. Hay bales were positioned around the concrete vault excavation area to prevent erosion. Minimal clearing of vegetation was needed in order to provide access for the excavator to the concrete vault area. A CAT 330 excavator and a CASE 580 backhoe were mobilized to perform the UST removal and excavation activities.

A temporary contaminated soil staging area was prepared by laying down two layers of 8-mil polyethylene sheeting on the paved area behind the Elementary School building. This staging area was bermed with hay bales and the polyethylene sheeting was extended over the berms to prevent migration of contamination away from the temporary staging area. Several polyethylene tarps were procured to cover the contaminated soil stockpile at the end of each day or during a rain or snow event, to prevent the contaminated soil stockpile from becoming water-logged. The staging area was expanded each time additional volume of contaminated soil was generated.

3.3 CONTAMINATED SOIL EXCAVATION AND STAGING

3.3.1 Underground Concrete Vault Excavation

The underground concrete vault excavation was commenced on December 18, 1997. The underground concrete vault was located in the field based on identifying landmarks at the location as indicated in the RI Report for AOC 69W (ABB-ES, 1997). Crushed stone was found in the overburden of the concrete vault. Initially, a 10 ft. x 10 ft. area of the overburden was excavated at this location to a depth of 1 ft., and the crushed stone and soil were staged on polyethylene sheets. This overburden soil showed some evidence of staining and petroleum odor.

The top of the underground concrete vault was located approximately 1.5 ft bgs. The vault was circular in cross-section with a diameter of approximately 5 ft. and a height of 5 ft. The bottom of the vault was approximately 6-7 ft bgs. The vault appeared to have had a circular reinforced concrete lid with a port hole that was broken into several pieces. The inside of the vault was filled with stone and soil and showed small amounts of petroleum contamination in the top layers and heavy petroleum contamination in the soil and stone in the bottom 1-2 ft. of the vault. The contaminated soil and broken sections of the concrete vault were set aside for staging as contaminated soil. The water table was at a depth of 4 ft. bgs. The soils surrounding the concrete vault were sandy gravel to an approximate depth of 5 ft. bgs and sandy and silty at depths below 5 ft. bgs.

Excavation continued below the water table to a depth of 7 ft. bgs. The soils in the northern and western sidewalls of the excavation towards Willow Brook showed some evidence of contamination and staining at depths of 4 -7 ft. bgs. The eastern sidewall of the excavation did not indicate any visual staining or contamination based on field screening. The southern sidewall showed some evidence of contamination in the vicinity of the underground pipe connection to the concrete vault. Excavation was continued in the north and west sidewalls for an additional 3-4 ft. until field screens indicated that all soils showing contamination above 1,000 ppm. TPH were removed. A transite pipe (6" in diameter) was found on the north sidewall at a depth of 1.5 -2 ft. bgs. and ran towards Willow Brook, on the west side of monitoring well ZWM-95-15. This pipe was approximately 15 ft. long and ended about 5 ft. away from Willow Brook. The last section of underground piping draining into the concrete vault was a 6" dia. transite pipe. A tee-section of the transite pipe (also 6" dia.) was excavated in the overburden soil and appeared to have been tied into the port hole on the concrete lid of the vault, to enable the underground pipe to drain into the vault.

At the conclusion of the excavation of the sidewalls and the floor, there was a slight oily sheen on the groundwater at the concrete vault, which was absorbed by sorbent pads. No more oily sheen was observed on the groundwater in this area after the underground pipe and associated contaminated soils upstream of the concrete vault were excavated.

Confirmatory soil samples were collected from the sidewalls as a composite of grab samples at depths ranging from 3-7 ft. bgs. in each sidewall, and one sample was collected from the floor of the concrete vault excavation. Confirmatory soil sampling is discussed in subsection 3.7 of this report.

3.3.2 Underground Pipe and Trench Excavation

The underground pipe leading from the UST area in the parking lot of the Elementary School was first traced back from the concrete vault towards the School building, by digging several test pits along the length of the pipe in the grassy area north of the paved parking lot of the Elementary School.

The pipe sections were excavated proceeding in an upstream direction from the concrete vault towards the Elementary School building. Initially, the overburden soils were removed and staged on polyethylene sheeting adjacent to the trench excavation. A trench was then excavated to extend 4 ft. on either side of the centerline of the pipe, and to a depth of 1 ft. below the bottom of the pipe. The pipe surface was exposed as much as possible to examine the nature of the pipe joins, pipe contents and evidence of leakage and soil contamination around the joins.

The last section of the pipe immediately upstream of the concrete vault was made of transite and had a diameter of 6". The depth of the pipe was 1.5 - 2 ft. bgs. All pipe sections upstream of this section were made of clay, with each section approximately 4 ft. in length. Spigot ends of each section were inserted into the bell flanges of adjacent sections, and no grouting or sealing of the joins was evident. In the portion of the underground pipeline buried in the grassy area, a few of the pipe joins showed evidence of leakage, and significant but localized petroleum contamination was found in the soils adjacent to and below the pipe joins, with the contamination extending to approximately 1-2 ft. below the water table. The underground pipe was approximately 5 ft. bgs. at the edge of the paved parking lot. There was approximately 1" of brown to orange -colored silty material inside the pipe that appeared to have some "weathered petroleum" odor to it. The underground pipe sections were crushed during their excavation and were placed along with the contaminated soils for future disposal.

The trench excavation was widened and deepened depending upon the presence and level of petroleum contamination in the soil. Excavation was continued until all soils showing petroleum contamination above 1,000 ppm via the Non-Dispersive Infrared Spectrometer (NDIR) field screening samples were removed from the pipe trench excavations. The trench excavation was initially halted at the edge of the paved parking lot to facilitate movement of equipment over the parking lot during the UST and contaminated soil removal in the paved parking lot of the Elementary School. Final excavation boundaries are shown in Figure 3-2.

3.3.3 UST Removal and Disposal

The 10,000 gallon UST located in the parking lot north of the Elementary School contained oily water. WESTON® hired General Chemical Corporation (GCC), Framingham, MA as a subcontractor to pump out the contents and clean the UST. GCC performed these activities on

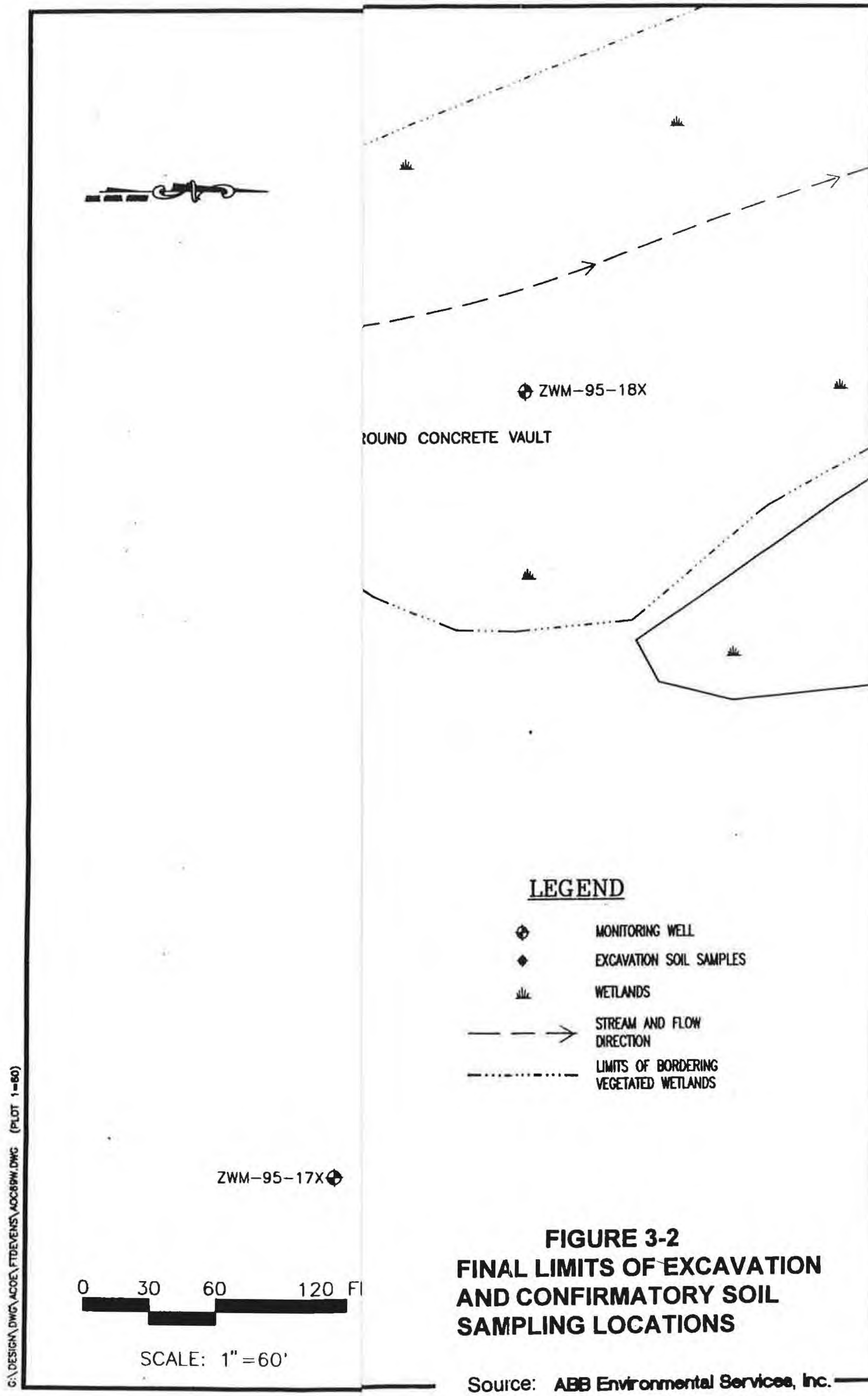


FIGURE 3-2
FINAL LIMITS OF EXCAVATION AND CONFIRMATORY SOIL SAMPLING LOCATIONS

Source: ABB Environmental Services, Inc.

December 12, 1997. Approximately 660 gallons of oily water and tank bottoms were pumped into a vacuum truck. Confined space entry was performed and the inside walls of the tank were cleaned manually. One drum of personal protective equipment (PPE) and sorbent pads was generated from the UST cleaning activities. The tank contents, the PPE and sorbent pads were disposed of at GCC's Framingham, MA disposal facility. Appendix D contains a copy of the Hazardous Waste Manifest used for the transport and disposal of these wastes.

The UST removal activities were begun on January 5, 1998. The manway and associated concrete block, curbing around the tank island and the vent pipe were first removed. Approximately 6-8 " of asphalt paving was then removed from the overburden above the UST. Approximately 60 cubic yards of asphalt from the UST area was transported offsite and disposed of at P.J. Keating Co., Lunenburg, MA for asphalt recycling. There was no evidence of petroleum contamination in the soils underneath the asphalt pavement except a small pocket of petroleum contamination in the soils around the fill pipe, which was staged separately.

The UST did not show any evidence of leaks or deterioration in the walls. The top of the UST was approximately 2 feet below ground surface and the bottom of the UST was at a depth of approximately 9 feet below ground surface (bgs). The depth to groundwater during the UST removal was approximately 8 ft. bgs. Two brass pipes (feed and return lines) and a single brass pipe enclosing a plastic tube for the petrometer gauge were also removed. No product was found in these pipes. These pipes were removed all the way to the edge of the excavation adjacent to the loading dock of the Elementary School and the remaining sections of the pipes were crimped. No product was emanating from the remaining sections of the pipes.

The UST was inspected by Deputy Fire Chief Rick Hewitt on January 5, 1998 and certified as fit for transportation and disposal at an approved tank disposal yard. The UST and appurtenances were transported to James G. Grant, Co., in Readville, MA. for disposal (see Appendix D for a copy of the tank permit and UST disposal certificate).

The UST had been strapped to a concrete pad below. The concrete pad had an average thickness of 14" and the top surface of the pad was about 1 ft. below the water table. The pad was approximately 15 ft. wide and 20 ft. long and was heavily reinforced. WESTON® mobilized a CAT 330 excavator with a hoe ram (hammer) attachment and crushed the concrete pad in place to smaller pieces so that the pad could be excavated. The smaller chunks of the concrete pad were excavated and placed on a polyethylene sheet. These chunks did not show any evidence of staining from fuel oil and appeared free from contamination. The chunks have been transported to the Central Soil Storage Facility at Devens, MA. for future disposal.

3.3.4 UST Area Excavation

The UST excavation showed no evidence of petroleum contamination in the overburden soils at depths from 0-4 ft. bgs. over and around the UST. Soils at these depth were sandy, with no evidence of staining or petroleum odor. No headspace readings were registered on samples collected from these overburden soils, thereby indicating the absence of petroleum contamination at these depths. The east sidewall of the UST excavation showed some pockets of contamination at depths of 7-9 ft. bgs. which were removed. Excavation was advanced an additional 3-4 ft. into the east sidewall to a depth of 10 ft. bgs (2 ft. below the water table) until NDIR field screens indicated that soils on this sidewall showed petroleum contamination well below 1,000 ppm. The north , west and south sidewalls showed pockets of soil with dark staining at a depth of 7-10 ft. bgs (from approximately 1 ft. above the water table to 2 ft. below the water table). Field screens of soils from this layer showed TPH concentrations exceeding 5000 ppm. Existing monitoring well 69W-94-11 was removed during the excavation since the soil contamination extended beyond the location of the monitoring well.

Subsequent to the excavation of the concrete pad underneath the UST, additional soil was removed from the floor of the excavation at this location, to a depth of 10-11 ft. bgs. Soils at 11 ft. bgs at this location were silty and did not exhibit any petroleum staining or odor. After field screening indicated that these soils did not show TPH concentration greater than 1,000 ppm, confirmatory soil samples were collected from the floor of the excavation in the UST area and sent to the offsite laboratory for analysis by MADEP Extractable and Volatile Petroleum Hydrocarbons (EPH & VPH). Additionally, a sample was taken from the east sidewall of the UST excavation from a depth of 7-10 ft. bgs for offsite confirmatory analysis.

In addition to the return and feed lines leading to the Elementary School building from the UST, two other brass pipes were found at a depth of 7' ft. bgs. in the excavation on the south side of the UST excavation. These appeared to head in a direction towards the underground concrete trench, but were found to terminate in the soil on the west side of the UST location. There was no free product in either of the two pipes, and these pipes were staged for future disposal.

3.3.5 Hot Spot Excavation

Based on the RI data for AOC 69W (ABB-ES, 1997) subsurface soil contamination was present in a hot-spot around the location of monitoring well 69W-94-10 as shown in Figure 3-2 (ABB-ES, 1997). Subsequent to the UST removal, excavation was to continue to remove contaminated subsurface soil in both the UST excavation (if present) and in the hot-spot area. The quantity of contaminated soil estimated to be excavated during the removal action at this site was 1,200 cubic yards. Figure 3-1 shows the boundaries of the excavation estimated prior to the commencement of excavation activities. However, the actual areal extent of petroleum contamination in the subsurface soil was significantly larger than expected and a total of approximately 3,500 cubic yards of petroleum-contaminated soil were removed. Figure 3-2 shows the final limits of excavation at AOC 69W. The excavation activities are described in detail below.

The UST excavation was extended in a southerly direction towards the Elementary School building and in a westerly direction towards the underground pipe trench due to the presence of heavy staining and strong petroleum odor in the soils immediately above and below the water table. The excavation was also extended in a northerly direction to remove soils with TPH contamination above 1,000 ppm as indicated by NDIR field screening.

Prior to the removal of contaminated subsurface soils, the asphalt paving was removed to the estimated boundaries of excavation in the hot-spot area. The paved parking lot had been sloped away from the Elementary School building to drain stormwater runoff away from the Elementary School building. This slope accounted for a difference in elevation of over 1 ft. between the edges of the parking lot at the School building and the edge of the grassy area.

The southern boundary of the excavation was set to be parallel to the disabled access ramp of the Elementary School building and extending from the loading dock on the southeast corner of the excavation to the end of the disabled access ramp on the southwest corner of the Elementary School building. This boundary was set approximately 8 ft. away from the disabled access ramp in order to prevent any damage to the structural stability of either the disabled access ramp or the Elementary

School building itself. Existing groundwater monitoring well 69W-94-10 was removed during the excavation of the hot-spot since it was in the middle of the excavation area. The sidewalls of the excavation were benched at a depth of 5 ft. bgs to create a 4 ft. wide bench around the entire boundary of the excavation, to prevent cave-ins and to reduce the overburden pressure on the sidewalls.

Excavated overburden soils were field screened at a frequency of one sample per 15-20 cubic yards. Overburden soils in the hot-spot area did not show any evidence of contamination through staining or petroleum odor or headspace readings above 10 ppm, down to a depth of 4 ft. bgs. Overburden soils at these depths were generally sandy gravel in nature. Soils in the southeast corner of the excavation near the loading dock were sandy and appeared different from the rest of the soils in the excavation, indicating that they were backfilled separately from the rest of the area.

During the excavation of the hot-spot area, the underground pipe trench was advanced from the edge of the paved area towards the Elementary School building. The underground pipeline changed direction in the paved area, and headed due south towards the north side entrance door of the Elementary School as shown in Figure 3-3. The underground pipe continues in a southerly direction underneath the Elementary School. The pipe sections were solid and did not show any breaks or perforations. There was no evidence of any collection system or crushed stone in place along the underground pipeline. The pipe sections did not contain any free product and were crushed and staged with the contaminated soils.

Soils were generally contaminated in the hot spot area from a depth of 5-6 ft. bgs to a depth of 10-11 ft. bgs. Soils at these depths showing heavy staining or a strong odor from petroleum contamination were excavated and staged in the contaminated soil stockpile. Soils excavated from these depths were field screened using a combination of headspace and the NDIR screening if the contamination was not obvious due to odor or staining.

Excavation of the floor of the hot spot area was continued to a depth of 2-3 ft. below the water table. Since the soils excavated from below the water table were saturated with water, they were staged within the excavation by preparing a bench on the sidewall of the excavation and placing the wet soils so that they could be drained before being transported to the contaminated soil staging area. At a depth of approx. 11 ft. bgs (2-3 ft. below the water table), soils were silty and did not show heavy staining or a strong petroleum odor indicating that they were not significantly contaminated. This was indicated by field screens on samples collected from the floor of the excavation. Excavation was stopped at this depth since the excavator could not reach any deeper without being introduced into the excavation which would have caused unsafe conditions for the equipment and the operator.

The hot-spot area excavation showed significant contamination on the south sidewall adjacent to the Elementary School, with NDIR field screen results showing TPH concentrations in excess of 5,000 ppm. However, excavation could not be advanced any further in this direction due to the proximity of the Elementary School building, and the potential danger to the structural stability of the building. The contamination on the south sidewall of the hot-spot excavation appears to be concentrated at a depth of 7-11 ft. bgs. with the heaviest contamination at a depth of 8-11 ft. bgs.

Excavation was extended to the west side of the excavation beyond the underground pipe trench until soils showed a TPH concentration of less than 1,000 ppm on the NDIR. Confirmatory composite soil samples were then collected along the west sidewall of the excavation from a depth of 5-8 ft. bgs (one ft. above to 2 ft. below the water table) for offsite EPH and VPH analyses. After the initial round of sampling, one sidewall sample 69W-HS-WSW-2 showed an exceedance of the MCP S1/GW1 standard for the c9-c18 Aliphatics at 2200 ppm, and for the c11-c22 Aromatics at 520 ppm. Additional soil was excavated on this sidewall and a confirmatory soil sample was collected and analyzed. Analytical results for this sample indicated that the petroleum concentration in soils at this location were below the MCP S1/GW1 standards for EPH and VPH.

Excavation on the east side was not advanced beyond the location of the loading dock of the Elementary School since the sidewalls did not show presence of petroleum contamination greater than 1,000 ppm on the NDIR field screens above or below the water table.

Excavation was advanced on the north side to remove petroleum contamination visible on the sidewalls near the water table. This excavation advanced approximately 50 ft. northward of existing monitoring wells 69W-94-12 and 69W-94-13 as shown in Figure 3-4. Monitoring wells 69W-94-12 and 69W-94-13 were undisturbed during the excavation.

During excavation activities, contaminated soils were transported and staged in the temporary staging area constructed behind the Elementary School building. Clean overburden soils were staged behind the school, away from the contaminated soil stockpiles to prevent cross-contamination.

At the conclusion of excavation activities, the contaminated soil was transported to the Central Soil Storage Facility (Bldg. 202 area) at Devens, MA and staged in a stockpile area called Stockpile D. This area was lined with a 20-mil smooth High-Density Polyethylene (HDPE) liner. Stockpile D has a drainage system to drain moisture generated by the thawing of the contaminated soil from AOC 69W. The stockpile has sand berms and will be covered with a 10-mil textured HDPE cover material that has been factory-seamed.

During excavation activities, an oily sheen developed on the groundwater due to contact with contaminated soil. Sorbent pads and booms were used to absorb the oily sheen. At the conclusion of excavation activities, approximately 1900 gallons of oily water were pumped out from the surface of the standing groundwater in the excavation, by Cyn Environmental Services, Inc. and disposed of at their disposal facility in Stoughton, MA (see Appendix D for a copy of the hazardous waste manifest for disposal of this waste). Sorbent pads and booms were placed at the upstream and downstream ends of the underground pipe trench and downstream of the concrete vault excavation to prevent any oily sheen from the hot spot excavation from migrating towards Willow Brook. Silt fences and haybales were also set up downstream of the concrete vault excavation to prevent silt and sediment from washing into Willow Brook during winter storm events.

3.3.6 Underground Pipe Investigation

At the conclusion of excavation activities in late February 1998, the section of the underground pipe remaining under the Elementary School building was approximately 6 inches above the water table (approximately 8 ft. bgs). The pipe was not discharging any water or visible product at this time. WESTON® conducted several investigations to determine the length and direction of the pipe underneath the building. Initially, a smoke test was conducted during which a smoke generator was used to introduce smoke at the free end of the pipe, which was then sealed tight to prevent backflow of the smoke out of the pipe. WESTON® requested the presence of the Devens Fire Department in the event the smoke entered the building and set off the smoke alarms. Several firemen and

WESTON® personnel checked all the rooms of the building, all floor drains and vents for evidence of smoke. No evidence was found of the smoke emanating into the building from the pipe.

Further investigation involved introducing soapy water and foam into the floor drains and sumps of the boiler rooms to determine if they were tied in to the underground pipe. This water did not discharge out of the pipe. Concurrently, a review was made of the as-built drawings of the Elementary School building on file with the Devens Commerce Center and these drawings did not show the presence of the underground pipe.

Next, a video inspection system was used to investigate the pipe. The pipe was submerged under the high water table during this test. The sediment in the pipe caused the water to become turbid when the video camera unit was introduced into the pipe. Since the video camera could not see the upstream stretches of the pipe due to turbidity and due to the presence of debris inside the pipe which could have damaged the video camera, this test was abandoned.

As a final investigative measure, the Devens Commerce Center's utility contractor conducted a high pressure wash test to remove any debris and to investigate the upstream end of the pipe. The pressure washer is self-propelled and has a pressure of 2,000 psi at the nozzle. The nozzle propelled itself for a distance of approximately 180 feet and stopped abruptly, indicating that the pipe may not have an outlet at the upstream end. All floor drains and boiler room sumps were investigated for any evidence of water from the pressure washer and they did not show any such evidence.

After discussions between CENAE and Regulatory personnel, it was determined that the underground pipe should be grouted for its entire explored length of approximately 180 ft. with concrete before completing the backfilling operations at the site. The pipe was filled with approximately 5 CY of tremie concrete using a concrete pump on April 30, 1998.

3.4 FIELD SCREENING AND CONFIRMATORY SAMPLING

During the soil excavation, field screening was conducted using a Non-Dispersive Infrared Spectrometer (NDIR). Field screening samples were collected at a frequency of one sample for every 15-20 cubic yards of excavated material. The excavated soil was staged in stockpiles of 15-20 cubic yards and samples were collected from the stockpile to determine TPH levels. A field screening goal of 1,000 ppm had been established in the Action Memorandum to segregate excavated soils. Stockpiles with soils that showed a TPH concentration of greater than 1,000 ppm on the NDIR were deemed contaminated and staged in the temporary contaminated soil staging area. Table 3-1 presents the results of the field screening analyses.

At the conclusion of excavation in each area, confirmatory soil samples were collected for MADEP EPH/VPH analyses at an offsite laboratory. Along the sidewalls, a confirmatory soil sample was collected from each segment of approximately 50 linear ft. of each sidewall of the excavation. Each confirmatory soil sample was prepared by collecting several grab samples within that segment of the sidewall at even distances (approx. 10-15 ft. apart) and compositing the grab samples for EPH analysis. A grab sample from a middle location was utilized for VPH analysis. Samples were also collected from the excavation floor below the water table by utilizing the excavator, since sampling personnel could not enter the water-logged excavation due to safety reasons. Several grab samples were collected to represent each section of the floor of the excavation and composited for EPH analysis. One of the grab samples was set aside for VPH analysis. Figure 3-3 shows the locations and sample IDs for confirmatory soil sampling locations at AOC 69W. Table 3-2 presents a summary of the analytical results from confirmatory soil sampling at AOC 69W. Appendix A contains analytical results reports for confirmatory soil sampling.

3.5 WASTE CHARACTERIZATION SAMPLING

The Action Memorandum for AOC 69W called for waste characterization sampling of the contaminated excavated soil at a frequency of one sample per 100 cubic yards of contaminated excavated soil. Accordingly, thirty five (35) waste characterization soil samples were collected at a frequency of one sample for every 100 cubic yards of excavated contaminated soil. These soils were sent to Katahdin Analytical Services, Inc. in Westbrook, ME to be analyzed for Volatile Organic Compounds (VOCs) by EPA Method 8260, Semivolatile Organic Compounds (SVOCs) by EPA Method 8270, RCRA Characteristics by EPA Methods 1110/7.3.3.2/7.3.4.2/1010, Total PCBs by EPA Method 8081, Total Petroleum Hydrocarbons by EPA Method 8015, RCRA Metals by EPA Method 6010. These are parameters required to be analyzed in order to meet criteria for reuse as landfill cover at a Massachusetts landfill. Analytical results show that the soils excavated from AOC 69W meet the criteria for reuse as landfill cover at a Massachusetts landfill. Appendix B contains copies of analytical results reports from waste characterization sampling.

3.6 BACKFILLING OPERATIONS

Backfilling operations were begun in March 1998. Prior to the backfilling operations, a sample of the backfill material was sent to an offsite laboratory to be analyzed for VOCs, SVOCs, PCBs, Total RCRA Metals and TPH. The concentrations in the sample of the parameters analyzed were below MCP S1/GW1 standards. Initially, the concrete vault excavation and the underground pipe trench upstream of the concrete vault were backfilled with imported gravel. A CAT D4 LGP dozer and a 7 ton vibratory roller were used to compact the backfill. The material was placed in lifts of 12" thickness and several passes were made with the roller.

The remaining excavation was backfilled to an elevation of about 6 inches higher than the existing water table elevation (3 ft. bgs during March 1998). The backfill material was compacted initially by making several passes with the dozer. The vibratory roller was not used at this time due to the proximity of the water table to the ground surface. At the time of preparation of this report, the backfill material is being allowed to settle, before compaction and additional backfilling activities are commenced.

Adequate compaction will be performed using a vibratory roller, and field compaction tests will be performed to achieve necessary soil compaction results. Appendix C contains copies of analytical results reports from backfill material verification sampling.

3.7 SITE RESTORATION

Site restoration activities include regrading all areas impacted by excavation activities, loaming and seeding the impacted unpaved areas and re-paving the parking lot area with asphalt These activities will be conducted after backfilling operations are completed. These activities are scheduled to be completed during the month of June 1998.

AREA OF CONTAMINATION (AOC) 69W
DEVENS ELEMENTARY SCHOOL
NDIR Field Screening Results

LEGEND *CSP=CLEAN STOCKPILE* *HS = HOT SPOT* *PL=PLUME* *PLT=PLUME TOE* *TP=TEST PIT*	*UP = UNDERGROUND PIPE* *UST-OB= UST OVERBURDEN* *UST = UNDERGROUND STORAGE TANK* *V= UNDERGROUND CONCRETE VAULT*	
Sample Id	**Sample Location**	**TPH Concentration**
69W-PLT-FL-6	Northern plume-east sidewall	766
69W-PLT-NSW	Northern plume-east sidewall	29
69W-PLT-WSW	Northern plume-east sidewall	63
69W-PLWSW-1	Northern plume-east sidewall	12
69W-PLWSW-2	Northern plume-east sidewall	18
69W-UP-1ESW	Underground pipe trench -grid1	3260
69W-UP-1WSW	Underground pipe trench -grid1	3112
69W-UP-2ESW	Underground pipe trench -grid2	>5000
69W-UP-2WSW	Underground pipe trench -grid2	>5000
69W-UP-3ESW	Underground pipe trench -grid3	5372
69W-UP-3WSW	Underground pipe trench -grid3	358
69W-UP-4ESW	Underground pipe trench -grid4	4556
69W-UP-4WSW	Underground pipe trench -grid4	444
69W-UP-G1-ESW	Underground pipe trench -grid1	1417
69W-UP-G1-FL	Underground pipe trench -grid1	2021
69W-UP-G1-WSW	Underground pipe trench -grid1	922
69W-UP-G1-WSW-1	Underground pipe trench -grid1	385
69W-UP-G1-WSW-2	Underground pipe trench -grid1	30
69W-UP-G1-WSW-3	Underground pipe trench -grid1	694
69W-UP-G1-WSW-4	Underground pipe trench -grid1	1664
69W-UP-G1-WSW-5	Underground pipe trench -grid1	996
69W-UP-G2-ESW	Underground pipe trench -grid2	367
69W-UP-G2-FL-02	Underground pipe trench -grid2	82
69W-UP-G2-WSW	Underground pipe trench -grid2	63
69W-UP-G3-ESW	Underground pipe trench -grid3	2419
69W-UP-G3-WSW	Underground pipe trench -grid3	514
69W-UP-OB-1	Underground pipe overburden	48
69W-UP-OB-2	Underground pipe overburden	238
69W-UP-OB-3	Underground pipe overburden	56
69W-UP-OB-4	Underground pipe overburden	68
69W-UST-ESW	UST excavation-east sidewall	19
69W-UST-FL	UST excavation-floor	66
69W-UST-OB-1	UST Excavation-overburden	316
69W-UST-OB-2	UST Excavation-overburden	230
69W-UST-OB-3	UST Excavation-overburden	265
69W-UST-OB-4	UST Excavation-overburden	265
69W-UST-OB-5	UST Excavation-overburden	275
69W-V-ESW-01	Underground concrete vault	1060
69W-V-FL-01	Underground concrete vault	1286
69W-V-NSW-01	Underground concrete vault	145
69W-V-WSW-01	Underground concrete vault	395

AREA OF CONTAMINATION (AOC) 69W
DEVENS ELEMENTARY SCHOOL
NDIR Field Screening Results

LEGEND		
CSP=CLEAN STOCKPILE	*UP = UNDERGROUND PIPE*	
HS = HOT SPOT	*UST-OB= UST OVERBURDEN*	
PL=PLUME	*UST = UNDERGROUND STORAGE TANK*	
PLT=PLUME TOE	*V= UNDERGROUND CONCRETE VAULT*	
TP=TEST PIT		
Sample Id	**Sample Location**	**TPH Concentration**
69W-HS-OB-24	Hotspot-overburden	86
69W-HS-OB-25	Hotspot-overburden	26
69W-HSP-1	Hotspot pipe area	3592
69W-HSP-2-2NSW	Hotspot pipe area	98
69W-HSP-2-FL	Hotspot pipe area	5492
69W-HSSEFL-1	Hotspot Southeast Floor	54
69W-HS-SS-1-PIPE	Hotspot pipe area	383
69W-HS-SS-2	Hotspot South Floor	5208
69W-NSW-TP-3	Excav. north sidewall testpit	
69W-NSW-TP1	Excav. north sidewall testpit	>5000
69W-NSW-TP2	Excav. north sidewall testpit	>5000
69W-PL-ESW-1	Northern plume-east sidewall	211
69W-PL-ESW-10	Northern plume-east sidewall	32
69W-PL-ESW-11	Northern plume-east sidewall	234
69W-PL-ESW-12	Northern plume-east sidewall	35
69W-PL-ESW-13	Northern plume-east sidewall	76
69W-PL-ESW-14	Northern plume-east sidewall	52
69W-PL-ESW-15	Northern plume-east sidewall	5508
69W-PL-ESW-15D	Northern plume-east sidewall	5030
69W-PL-ESW-16	Northern plume-east sidewall	504
69W-PL-ESW-17	Northern plume-east sidewall	33
69W-PL-ESW-18	Northern plume-east sidewall	52
69W-PL-ESW-19	Northern plume-east sidewall	38
69W-PL-ESW-2	Northern plume-east sidewall	310
69W-PL-ESW-20	Northern plume-east sidewall	55
69W-PL-ESW-21	Northern plume-east sidewall	216
69W-PL-ESW-21D	Northern plume-east sidewall	114
69W-PL-ESW-3	Northern plume-east sidewall	246
69W-PL-ESW-4	Northern plume-east sidewall	2668
69W-PL-ESW-5	Northern plume-east sidewall	440
69W-PL-ESW-6	Northern plume-east sidewall	3372
69W-PL-ESW-7	Northern plume-east sidewall	994
69W-PL-ESW-8	Northern plume-east sidewall	121
69W-PL-ESW-9	Northern plume-east sidewall	51
69W-PL-FL-2	Northern plume-floor	516
69W-PL-FL-3	Northern plume-floor	>5000
69W-PL-FL-4	Northern plume-floor	1802
69W-PL-FL-5	Northern plume-floor	62
69W-PL-NSW-15-2	Northern plume-east sidewall	3752
69W-PL-NSW-15-3	Northern plume-east sidewall	1242
69W-PLESW-M	Northern plume-east sidewall	276
69W-PLFL-1	Northern plume-floor	66
69W-PLT-ESW	Northern plume-east sidewall	320

AREA OF CONTAMINATION (AOC) 69W
DEVENS ELEMENTARY SCHOOL
NDIR Field Screening Results

LEGEND *CSP=CLEAN STOCKPILE* *HS = HOT SPOT* *PL=PLUME* *PLT=PLUME TOE* *TP=TEST PIT*	*UP = UNDERGROUND PIPE* *UST-OB= UST OVERBURDEN* *UST = UNDERGROUND STORAGE TANK* *V= UNDERGROUND CONCRETE VAULT*	
Sample Id	**Sample Location**	**TPH Concentration**
69W-CSP-1	Overburden from vault excav.	220
69W-CSP-2	Overburden from vault excav.	75
69W-CSP-3	Overburden from vault excav.	178
69W-CSP-4	Overburden from vault excav.	32
69W-CSP-5	Overburden from vault excav.	47
69W-CSP-6	Overburden from vault excav.	33
69W-CSP-7	Overburden from vault excav.	78
69W-CSP-8	Overburden from vault excav.	57
69W-CSP-9	Overburden from vault excav.	466
69W-V-OB-1	Overburden from vault excav.	43
69W-HS-ESW	Hotspot -east sidewall	77
69W-HS-FL-1	Hotspot - floor	4244
69W-HS-FL-2	Hotspot - floor	4014
69W-HS-FL-N	Hotspot - floor	23
69W-HS-TP	Hotspot - floor test pit	>5000
69W-HS-OB-10	Hotspot-overburden	44
69W-HS-OB-11	Hotspot-overburden	30
69W-HS-OB-12	Hotspot-overburden	23
69W-HS-OB-13	Hotspot-overburden	1156
69W-HS-OB-14	Hotspot-overburden	2644
69W-HS-OB-15	Hotspot-overburden	5528
69W-HS-OB-16	Hotspot-overburden	5748
69W-HS-OB-17	Hotspot-overburden	31
69W-HS-OB-18	Hotspot-overburden	>5000
69W-HS-OB-19	Hotspot-overburden	117
69W-HS-OB-20	Hotspot-overburden	33
69W-HS-OB-21	Hotspot-overburden	70
69W-HS-OB-22	Hotspot-overburden	352
69W-HS-OB-23	Hotspot-overburden	57
69W-HS-OB-7	Hotspot-overburden	37
69W-HS-OB-8	Hotspot-overburden	62
69W-HS-OB-9	Hotspot-overburden	390
69W-HS-SSW-1	Hotspot south sidewall	>5000
69W-HS-SSW-2	Hotspot south sidewall	>5000
69W-HS-WSSW	Hotspot west/south sidewall	77
69W-HS-WTP	Hotspot westside testpit	4994
69W-HSOB-1	Hotspot-overburden	27
69W-HS-OB-2	Hotspot-overburden	42
69W-HS-OB-3	Hotspot-overburden	1019
69W-HS-OB-4	Hotspot-overburden	236
69W-HS-OB-5	Hotspot-overburden	76
69W-HS-OB-6	Hotspot-overburden	39
69W-HS-FL-PL	Hotspot-floor	>5000

AOC 69W- SUMMARY OF CONFIRMATION SAMPLE RESULTS

	MCP S1/GW1	69W-HS-SSW1	69W-HS-SSW-2	69W-HS-OB-15	69W-HS-WSW	69W-HS-FL-2	69W-HS-FL-1
Lab Batch Number		**WO-0098**	**WO-0098**	**WO-0075**	**WO-0106**	**WO-0098**	**WO-0098**
Sample Depth in feet (bgs)	**Standards**	**7-10**	**7-10**	**6**	**7-10**	**11**	**11**
EPH PARAMETERS							
Aliphatics/Aromatics							
C9-C18 Aliphatics	**1000**	**3600**	**5400**	**1800**	480 J	**10000**	560
C19-C36 Aliphatics	**2500**	360	**670**	310	91 J	**1200**	67
C11-C22 Aromatics	**200**	**1100**	**1200**	**700**	44	**2300**	110
Targeted PAH's Analytes							
2-Methylnaphthalene	**4**	1J	**22 J**	**12 J**	<0.56	**25J**	**2.5**
Acenaphthene	**20**	<0.068	7.4	0.32	<0.56	16	1.4
Acenaphthylene	**100**	<0.068	<0.064	<.07	<0.56	<0.076	<0.61
Anthracene	**1000**	<0.068	0.37 J	0.24	<0.56	2.2 J	<0.61
Benzo (a) anthracene	**0.7**	<0.068	0.099	<0.07	<0.56	0.096	<0.61
Benzo (b) fluoranthene	**0.7**	<0.068	0.064	<0.07	<0.56	<0.076	<0.61
Benzo (k) fluoranthene	**7**	<0.068	<0.064	<0.07	<0.56	<0.076	<0.61
Benzo (a) pyrene	**0.7**	<0.068	<0.064	<0.07	<0.56	<0.076	<0.61
Benzo (g,h.i) perylene	**1000**	<0.068	<0.064	<0.07	<0.56	<0.076	<0.61
Chrysene	**7**	J0.039	0.076	<0.07	<0.56	0.089	<0.61
Dibenz (a,h) anthracene	**0.7**	<0.068	<0.064	<0.07	<0.56	<0.076	<0.61
Fluoranthene	**1000**	0.24	.38J	0.13	<0.56	1.8 J	<0.61
Fluorene	**400**	.56 J	.76J	.68J	<0.56	8.3J	2.8
Indeno (1,2,3-cd) pyrene	**0.7**	<0.068	<0.064	<0.07	<0.56	<0.076	<0.61
J	**4**	.99 J	5.7 J	1.6J	<0.56	**7.1J**	<0.61
Phenanthrene	**700**	5.2 J	6.3J	3.8J	<0.56	29J	1
Pyrene	**700**	0.44 J	5.4J	0.18	<0.56	.5 J	<0.61
VPH PARAMETERS							
Aliphatics/Aromatics							
C5-C8 Aliphatics	**100**	<96	<120	<9.8	<11	**<110**	<13
C-9-C12 Aliphatics	**1000**	770	670	21	14	**1300**	140
C9-C10 Aromatics	**100**	**650**	**560**	20	15	**960**	**100**
Targeted VPH Analytes							
Benzene	**10**	<12	<14	<1.2	<1.3	<13	<1.6
Ethylbenzene	**80**	<12	<14	<1.2	<1.3	<13	<1.6
m,p-Xylenes	**500**	<48	<58	<4.9	<5.4	<54	<6.4
Methyl-tert-butylether	**0.3**	<36	<43	<3.6	<4.0	<40	<4.8
Naphthalene	**4**	<24	<29	2.6	<2.7	<27	<3.2
o-Xylene	**500**	<24	<29	<2.5	<2.7	<27	<3.2
Toluene	**90**	<36	<43	<3.6	<4.0	<40	<4.8

All data is given in parts per million.

AOC 69W- SUMMARY OF CONFIRMATION SAMPLE RESULTS

	MCP S1/GW1	69W-HS-SE-FL	69W-HS-ESW-1	69W-HS-WSW-1	69W-UST-ESW	69W-UST-FL-1	69W-HS-FL-3
Lab Batch Number		WO-0075	WO-0098	WO-0239	WO-0075	WO-0098	WO-0239
Sample Depth in feet (bgs)	**Standards**	**11**	**7-10**	**7-10**	**7-10**	**12-13**	**7-10**
EPH PARAMETERS							
Aliphatics/Aromatics							
C9-C18 Aliphatics	**1000**	13 U	<3.4	69	11 U	97	36
C19-C36 Aliphatics	**2500**	10 U	<4.6	25	8.3 U	23 U	15 U
C11-C22 Aromatics	**200**	<11	<9.7	26	12 U	48	24
Targeted PAH's Analytes							
2-Methylnaphthalene	**4**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
Acenaphthene	**20**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
Acenaphthylene	**100**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
Anthracene	**1000**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
Benzo (a) anthracene	**0.7**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
Benzo (b) fluoranthene	**0.7**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
Benzo (k) fluoranthene	**7**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
Benzo (a) pyrene	**0.7**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
Benzo (g,h.i) perylene	**1000**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
Chrysene	**7**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
Dibenz (a,h) anthracene	**0.7**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
Fluoranthene	**1000**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
Fluorene	**400**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
Indeno (1,2,3-cd) pyrene	**0.7**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
J	**4**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
Phenanthrene	**700**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
Pyrene	**700**	<0.63	<0.57	<0.58	<0.62	<0.60	<0.60
VPH PARAMETERS							
Aliphatics/Aromatics							
C5-C8 Aliphatics	**100**	<10	<12	<14	<10	<10	<13
C-9-C12 Aliphatics	**1000**	<2.7	5.5	<3.5	<2.6	26	5.8 U
C9-C10 Aromatics	**100**	<5.3	<6.1	<6.9	<5.3	31	<6.5
Targeted VPH Analytes							
Benzene	**10**	<1.3	<1.5	<1.7	<1.	<1.2	<1.6
Ethylbenzene	**80**	<1.3	<1.5	<1.7	<1.3	<1.2	<1.6
m,p-Xylenes	**500**	<5.3	<6.1	<6.9	<5.3	<5.1	<6.5
Methyl-tert-butylether	**0.3**	<4.0	<4.5	<5.1	<3.9	<3.8	<4.8
Naphthalene	**4**	<2.7	<3.1	<3.5	<2.6	<2.6	<3.2
o-Xylene	**500**	<2.7	<3.1	<3.5	<2.6	<2.6	<3.2
Toluene	**90**	<4.0	<4.5	<5.1	<3.9	<3.8	<4.8
All data is given in parts per million.							

AOC 69W- SUMMARY OF CONFIRMATION SAMPLE RESULTS

	MCP S1/GW1	69W-HS-WSW-2	69W-PL-FL-5	69W-HS-FL-4	69W-PL-ESW-1	69W-HS-WSW-3	69W-PL-NSW-2
Lab Batch Number		WO-0239	WO-0239	WO-0239	WO-0239	WO-0239	WO-0239
Sample Depth in feet (bgs)	**Standards**	6-9	7-10	5-8	5-8	5-8	3-6
EPH PARAMETERS							
Aliphatics/Aromatics							
C9-C18 Aliphatics	**1000**	**2200**	310	16	120	860	3.3
C19-C36 Aliphatics	**2500**	290	56	17 U	44	130	8.1 U
C11-C22 Aromatics	**200**	**520**	80	14	20	**220**	9
Targeted PAH's Analytes							
2-Methylnaphthalene	**4**	**14**	<0.58	<0.61	<0.58	<0.55	<0.53
Acenaphthene	**20**	3.3	<0.58	<0.61	<0.58	0.83	<0.53
Acenaphthylene	**100**	<2.1	<0.58	<0.61	<0.58	<0.55	<0.53
Anthracene	**1000**	<2.1	<0.58	<0.61	<0.58	<0.55	<0.53
Benzo (a) anthracene	**0.7**	**<2.1**	<0.58	<0.61	<0.58	<0.55	<0.53
Benzo (b) fluoranthene	**0.7**	**<2.1**	<0.58	<0.61	<0.58	<0.55	<0.53
Benzo (k) fluoranthene	**7**	<2.1	<0.58	<0.61	<0.58	<0.55	<0.53
Benzo (a) pyrene	**0.7**	**<2.1**	<0.58	<0.61	<0.58	<0.55	<0.53
Benzo (g,h.i) perylene	**1000**	<2.1	<0.58	<0.61	<0.58	<0.55	<0.53
Chrysene	**7**	<2.1	<0.58	<0.61	<0.58	<0.55	<0.53
Dibenz (a,h) anthracene	**0.7**	**<2.1**	<0.58	<0.61	<0.58	<0.55	<0.53
Fluoranthene	**1000**	<2.1	<0.58	<0.61	<0.58	<0.55	<0.53
Fluorene	**400**	6.8	<0.58	<0.61	<0.58	2.1	<0.53
Indeno (1,2,3-cd) pyrene	**0.7**	**<2.1**	<0.58	<0.61	<0.58	<0.55	<0.53
J	**4**	2.4	<0.58	<0.61	<0.58	<0.55	<0.53
Phenanthrene	**700**	4.1	<0.58	<0.61	<0.58	1.5	<0.53
Pyrene	**700**	<2.1	<0.58	<0.61	<0.58	<0.55	<0.53
VPH PARAMETERS							
Aliphatics/Aromatics							
C5-C8 Aliphatics	**100**	<46	<13	<13	<14	<12	<12
C-9-C12 Aliphatics	**1000**	200	130	3.8 U	<3.6	150	<2.9
C9-C10 Aromatics	**100**	**290**	62	<6.5	<7.3	.100	<5.8
Targeted VPH Analytes							
Benzene	**10**	<5.6	<1.5	<1.6	<1.7	<1.4	<1.4
Ethylbenzene	**80**	<5.6	<1.5	<1.6	<1.7	<1.4	<1.4
m,p-Xylenes	**500**	<23	<6.4	<6.5	<7.3	<6.0	<5.8
Methyl-tert-butylether	**0.3**	<17	<4.7	<4.8	<5.4	<4.4	<4.3
Naphthalene	**4**	**<12**	<3.2	<3.3	<3.6	<3.0	<2.9
o-Xylene	**500**	<12	<3.2	<3.3	<3.6	<3.0	<2.9
Toluene	**90**	<17	<4.7	<4.8	<5.4	<4.4	<4.3
All data is given in parts per million.							

AOC 69W- SUMMARY OF CONFIRMATION SAMPLE RESULTS

	MCP S1/GW1	69W-HS-NSW-1	69W-UP-G3-WSW	69W-UP-G3-FL	69W-UP-G3-ESW	69W-UP-G2-WSW
Lab Batch Number		WO-0239	WO-0106	WO-0106	WO-0106	WO-0106
Sample Depth in feet (bgs)	**Standards**	3-6	4-5	5	4-5	4-5
EPH PARAMETERS						
Aliphatics/Aromatics						
C9-C18 Aliphatics	**1000**	410	13 U	10 U	<3.8	43 U
C19-C36 Aliphatics	**2500**	68	11 U	19 U	5.4 U	28 U
C11-C22 Aromatics	**200**	120	10 U	27 U	<11	17 U
Targeted PAH's Analytes						
2-Methylnaphthalene	**4**	1.9	<0.55	<0.58	<0.64	<0.52
Acenaphthene	**20**	0.79	<0.55	<0.58	<0.64	<0.52
Acenaphthylene	**100**	<0.61	<0.55	<0.58	<0.64	<0.52
Anthracene	**1000**	<0.61	<0.55	<0.58	<0.64	<0.52
Benzo (a) anthracene	**0.7**	<0.61	<0.55	<0.58	<0.64	<0.52
Benzo (b) fluoranthene	**0.7**	<0.61	<0.55	<0.58	<0.64	<0.52
Benzo (k) fluoranthene	**7**	<0.61	<0.55	<0.58	<0.64	<0.52
Benzo (a) pyrene	**0.7**	<0.61	<0.55	<0.58	<0.64	<0.52
Benzo (g,h.i) perylene	**1000**	<0.61	<0.55	<0.58	<0.64	<0.52
Chrysene	**7**	<0.61	<0.55	<0.58	<0.64	<0.52
Dibenz (a,h) anthracene	**0.7**	<0.61	<0.55	<0.58	<0.64	<0.52
Fluoranthene	**1000**	<0.61	<0.55	<0.58	<0.64	<0.52
Fluorene	**400**	1.4	<0.55	<0.58	<0.64	<0.52
Indeno (1,2,3-cd) pyrene	**0.7**	<0.61	<0.55	<0.58	<0.64	<0.52
J	**4**	<0.61	<0.55	<0.58	<0.64	<0.52
Phenanthrene	**700**	0.98	<0.55	<0.58	<0.64	<0.52
Pyrene	**700**	<0.61	<0.55	<0.58	<0.64	<0.52
VPH PARAMETERS						
Aliphatics/Aromatics						
C5-C8 Aliphatics	**100**	<13	<9.2	<9.8	<11	<9
C-9-C12 Aliphatics	**1000**	7.4 U	<2.3	<2.5	<2.7	<2.3
C9-C10 Aromatics	**100**	<6.6	<4.7	<5.0	<5.4	<4.5
Targeted VPH Analytes						
Benzene	**10**	<1.6	<1.1	<1.2	<1.3	<1.1
Ethylbenzene	**80**	<1.6	<1.1	<1.2	<1.3	<1.1
m,p-Xylenes	**500**	<6.6	<4.7	<5.0	<5.4	<4.5
Methyl-tert-butylether	**0.3**	<4.9	<3.5	<3.7	<4.0	<3.4
Naphthalene	**4**	<3.3	<2.3	<2.5	<2.7	<2.3
o-Xylene	**500**	<3.3	<2.3	<2.5	<2.7	<2.3
Toluene	**90**	<4.9	<3.5	<3.7	<4.0	<3.4

All data is given in parts per million.

AOC 69W- SUMMARY OF CONFIRMATION SAMPLE RESULTS

	MCP S1/GW1	69W-UP-G2-WSW-DUP	69W-UP-G2-FL-2	69W-UP-G2-ESW	69W-UP-G1-WSW-2	69W-UP-G1-FL
Lab Batch Number		**WO-0106**	**WO-0267**	**WO-0106**	**WO-0267**	**WO-0106**
Sample Depth in feet (bgs)	**Standards**	**4-5**	**5**	**4-5**	**3-4**	**4**
EPH PARAMETERS						
Aliphatics/Aromatics						
C9-C18 Aliphatics	**1000**	210 J	4.3	3.4 U	720	14 U
C19-C36 Aliphatics	**2500**	80 J	6.1	<4.2	350	10 U
C11-C22 Aromatics	**200**	28 J	<10	<8.9	39	12 U
Targeted PAH's Analytes						
2-Methylnaphthalene	**4**	<0.54	<0.59	<0.52	<0.54	<0.59
Acenaphthene	**20**	<0.54	<0.59	<0.52	<0.54	<0.59
Acenaphthylene	**100**	<0.54	<0.59	<0.52	<0.54	<0.59
Anthracene	**1000**	<0.54	<0.59	<0.52	<0.54	<0.59
Benzo (a) anthracene	**0.7**	<0.54	<0.59	<0.52	<0.54	<0.59
Benzo (b) fluoranthene	**0.7**	<0.54	<0.59	<0.52	<0.54	<0.59
Benzo (k) fluoranthene	**7**	<0.54	<0.59	<0.52	<0.54	<0.59
Benzo (a) pyrene	**0.7**	<0.54	<0.59	<0.52	<0.54	<0.59
Benzo (g,h.i) perylene	**1000**	<0.54	<0.59	<0.52	<0.54	<0.59
Chrysene	**7**	<0.54	<0.59	<0.52	<0.54	<0.59
Dibenz (a,h) anthracene	**0.7**	<0.54	<0.59	<0.52	<0.54	<0.59
Fluoranthene	**1000**	<0.54	<0.59	<0.52	<0.54	<0.59
Fluorene	**400**	<0.54	<0.59	<0.52	<0.54	<0.59
Indeno (1,2,3-cd) pyrene	**0.7**	<0.54	<0.59	<0.52	<0.54	<0.59
J	**4**	<0.54	<0.59	<0.52	<0.54	<0.59
Phenanthrene	**700**	<0.54	<0.59	<0.52	<0.54	<0.59
Pyrene	**700**	<0.54	<0.59	<0.52	<0.54	<0.59
VPH PARAMETERS						
Aliphatics/Aromatics						
C5-C8 Aliphatics	**100**	<9.8	<13	<8.9	<12	<12
C-9-C12 Aliphatics	**1000**	<2.5	<3.2	<2.2	<3	43
C9-C10 Aromatics	**100**	<4.9	<6.5	<4.5	<6	24
Targeted VPH Analytes						
Benzene	**10**	<1.2	<1.6	<1.1	<1.4	<1.5
Ethylbenzene	**80**	<1.2	<1.6	<1.1	<1.4	<1.5
m,p-Xylenes	**500**	<4.9	<6.5	<4.5	<6.0	<6.2
Methyl-tert-butylether	**0.3**	<3.7	<4.8	<3.3	<4.4	<4.6
Naphthalene	**4**	<2.5	<3.2	<2.2	<3.0	<3.1
o-Xylene	**500**	<2.5	<3.2	<2.2	<3.0	<3.1
Toluene	**90**	<3.7	<4.8	<3.3	<4.4	<4.6

All data is given in parts per million.

AOC 69W- SUMMARY OF CONFIRMATION SAMPLE RESULTS

	MCP S1/GW1	69W-UP-G1-ESW	69W-V-WSW-1	69W-V-FL-1	69W-V-ESW-1	69W-V-NSW-1	69W-PL-FL-6
Lab Batch Number		WO-0106	WO-0267	WO-0267	WO-0267	WO-0267	WO-0451
Sample Depth in feet (bgs)	Standards	4-6	5-7	7	6-8	6-8	7
EPH PARAMETERS							
Aliphatics/Aromatics							
C9-C18 Aliphatics	1000	120 J	**1200**	600	**1700**	74	310*
C19-C36 Aliphatics	2500	68 J	380	130	480	120	36*
C11-C22 Aromatics	200	28	82	77	180	22	120*
Targeted PAH's Analytes							
2-Methylnaphthalene	4	<0.54	<0.70	<0.59	<0.60	<0.58	1.2
Acenaphthene	20	<0.54	<0.70	<0.59	<0.60	<0.58	0.92
Acenaphthylene	100	<0.54	<0.70	<0.59	<0.60	<0.58	<0.61
Anthracene	1000	<0.54	<0.70	<0.59	<0.60	<0.58	<0.61
Benzo (a) anthracene	0.7	<0.54	<0.70	<0.59	<0.60	<0.58	<0.61
Benzo (b) fluoranthene	0.7	<0.54	<0.70	<0.59	<0.60	<0.58	<0.61
Benzo (k) fluoranthene	7	<0.54	<0.70	<0.59	<0.60	<0.58	<0.61
Benzo (a) pyrene	0.7	<0.54	<0.70	<0.59	<0.60	<0.58	<0.61
Benzo (g,h.i) perylene	1000	<0.54	<0.70	<0.59	<0.60	<0.58	<0.61
Chrysene	7	<0.54	<0.70	<0.59	<0.60	<0.58	<0.61
Dibenz (a,h) anthracene	0.7	<0.54	<0.70	<0.59	<0.60	<0.58	<0.61
Fluoranthene	1000	<0.54	<0.70	<0.59	<0.60	<0.58	<0.61
Fluorene	400	<0.54	<0.70	<0.59	<0.60	<0.58	1.4
Indeno (1,2,3-cd) pyrene	0.7	<0.54	<0.70	<0.59	<0.60	<0.58	<0.61
J	4	<0.54	<0.70	<0.59	<0.60	<0.58	<0.61
Phenanthrene	700	<0.54	<0.70	<0.59	<0.60	<0.58	<0.61
Pyrene	700	<0.54	<0.70	<0.59	<0.60	<0.58	<0.61
VPH PARAMETERS							
Aliphatics/Aromatics							
C5-C8 Aliphatics	100	<11	<16	<13	<15	<13	<13
C-9-C12 Aliphatics	1000	<2.9	<4	43	36	<3.2	52
C9-C10 Aromatics	100	<5.8	<8.1	37	35	<6.5	33
Targeted VPH Analytes							
Benzene	10	<1.4	<2.0	<1.6	<1.8	<1.6	<1.6
Ethylbenzene	80	<1.4	<2.0	<1.6	<1.8	<1.6	<1.6
m,p-Xylenes	500	<5.8	<8.1	<6.5	<7.4	<6.5	<6.5
Methyl-tert-butylether	0.3	<4.3	<6.0	<4.8	<5.5	<4.8	<4.8
Naphthalene	4	<2.9	<4.0	<3.2	<3.7	<3.2	<3.2
o-Xylene	500	<2.9	<4.0	<3.2	<3.7	<3.2	<3.2
Toluene	90	<4.3	<6.0	<4.8	<5.5	<4.8	<4.8

All data is given in parts per million.

AOC 69W- SUMMARY OF CONFIRMATION SAMPLE RESULTS

	MCP S1/GW1	69W-PL-FL-7	69W-PL-ESW-2
Lab Batch Number		**WO-0451**	**WO-0451**
Sample Depth in feet (bgs)	**Standards**	**6**	**4-6**
EPH PARAMETERS			
Aliphatics/Aromatics			
C9-C18 Aliphatics	**1000**	370*	5.6*
C19-C36 Aliphatics	**2500**	110*	7.9*
C11-C22 Aromatics	**200**	23*	<11
Targeted PAH's Analytes			
2-Methylnaphthalene	**4**	<0.61	<0.65
Acenaphthene	**20**	<0.61	<0.65
Acenaphthylene	**100**	<0.61	<0.65
Anthracene	**1000**	<0.61	<0.65
Benzo (a) anthracene	**0.7**	<0.61	<0.65
Benzo (b) fluoranthene	**0.7**	<0.61	<0.65
Benzo (k) fluoranthene	**7**	<0.61	<0.65
Benzo (a) pyrene	**0.7**	<0.61	<0.65
Benzo (g,h.i) perylene	**1000**	<0.61	<0.65
Chrysene	**7**	<0.61	<0.65
Dibenz (a,h) anthracene	**0.7**	<0.61	<0.65
Fluoranthene	**1000**	<0.61	<0.65
Fluorene	**400**	<0.61	<0.65
Indeno (1,2,3-cd) pyrene	**0.7**	<0.61	<0.65
J	**4**	<0.61	<0.65
Phenanthrene	**700**	<0.61	<0.65
Pyrene	**700**	<0.61	<0.65
VPH PARAMETERS			
Aliphatics/Aromatics			
C5-C8 Aliphatics	**100**	<13	<14
C-9-C12 Aliphatics	**1000**	<3.2	<3.5
C9-C10 Aromatics	**100**	<6.5	<7.0
Targeted VPH Analytes			
Benzene	**10**	<1.6	<1.7
Ethylbenzene	**80**	<1.6	<1.7
m,p-Xylenes	**500**	<6.5	<7.0
Methyl-tert-butylether	**0.3**	<4.8	<5.2
Naphthalene	**4**	<3.2	<3.5
o-Xylene	**500**	<3.2	<3.5
Toluene	**90**	<4.8	<5.2
All data is given in parts per million.			

HUMAN HEALTH RISK ASSESSMENT

O-1 VAPOR MIGRATION PATHWAY ANALYSIS

O-2 CALCULATIONS

O-3 HHRA SHORT TOXICITY PROFILES

VAPOR MIGRATION PATHWAY ANALYSIS

Vapor Migration Pathway Analysis

This Appendix presents an evaluation of the subsurface soil and groundwater to indoor air vapor migration exposure pathway. This evaluation has been performed to determine whether fuel oil-related constituents that may be in soil and groundwater beneath the Former Elementary School at AOC 69W have migrated, or have the potential to migrate, to the air inside the school building. Fuel oil-related constituents that may have a potentially complete migration pathway are then evaluated in the human health risk assessment (Section 9.1).

The migration pathway evaluation was performed using the analytical data collected in support of the RI at AOC 69W, and the indoor air quality sampling, as presented in this report. The methods and results of these activities are discussed below.

I. Conceptual Model and Rationale

Migration of compounds from soil and groundwater can occur if the compounds volatilize from soil or groundwater and accumulate in soil gas. Soil gas can migrate through the soil and accumulate beneath a building floor slab, where it can subsequently move through cracks in the floor slab or between the floor slab and the walls, to air inside the building. Once inside the building, the soil gas can dilute into indoor air, where people occupying the building may breathe it. Soil gas can theoretically achieve equilibrium with building air. However, this is not likely to happen because air inside the building is always being exchanged with air outside the building, either through leaks in the building walls, windows, and roof, or far more significantly through the operation of building ventilation systems which are required for all publicly occupied buildings. A vapor migration pathway is potentially complete when a constituent has been detected in a source (i.e., presence in soil or groundwater), a transport mechanism (i.e., volatilization and transport in soil gas), and a receiving medium (e.g., air inside the building).

At AOC 69W, fuel oil was released from USTs and leaking pipes to the shallow subsurface soil in the early 1970's. A portion of the area of fuel oil contaminated soil and groundwater appears to be located beneath the northwestern and north central portions of the building, including portions of the cafeteria/kitchen area, library, and a classroom located between these two areas (Figure 1). The area of contamination in the vicinity of the northwestern area of the building appears to extend from outside the building to the new boiler room (represented by boring location ZWM-96-19X), and the edge of the courtyard (represented by boring location ZWM-96-21X) (Figure 1). The area of contamination in the vicinity of the central area of the building appears to extend from outside the building to a point between the old boiler room (represented by boring location ZWM-96-20X); no fuel-related constituents were detected soil boring samples or groundwater samples collected in the old boiler room (Figure 1).

A crawl space is located beneath the cafeteria/kitchen area. The crawl space is approximately 4 feet high, has a dirt floor, and is not mechanically vented. The library, as well as the rest of the building, are constructed on a cement floor slab. Because the crawl space has a dirt floor, overlies a potential area of subsurface soil and groundwater contamination, and has a very low air exchange rate, it is more likely that vapors originating from subsurface fuel oil contamination would be present in this area than any other area inside the building.

Air Sampling To ensure that possibly complete vapor migration pathways could be identified, air sampling devices were placed in the areas of the school that were most likely to have indoor air that could be effected by subsurface conditions. The air sampling performed at the former elementary school building is described in detail in Appendix M. In summary, the areas sampled included all rooms located over the areas of possible soil and groundwater contamination (library, classroom between library and cafeteria, cafeteria/kitchen, the crawl space beneath the cafeteria, and the crawl space beneath the kitchen) (Figure 2). A sample was also collected in the northeastern classroom nearest the area of soil and groundwater contamination (there is no contamination beneath the building in this area) (Figures 1 and 2). Finally, a sample was collected from the headspace of the monitoring well located in the new boiler room, and the classroom located adjacent to the new boiler room (Figure 2). Because the soil samples collected 9 ft bgs and deeper (which are at the water table) from the boring installed in the new boiler room contained fuel oil-related constituents, it follows that those constituents would likely be detected in the head space of this boring (now a monitoring well screened across the water table) if the vapor migration pathway was complete in this area of the building. Several air samples were also collected as background samples from areas upwind and downwind of the building. In addition, one sample was collected from a classroom on the southwest side of the building to represent indoor background conditions (sample ZWA-97-07X; Figure 2).

Air samples were analyzed for target volatile organic hydrocarbons that could be associated with fuel oil, as described in the Air Sampling Workplan (ABB-ES, 1997). In preparation for air sampling, all containers, materials, and substances in the school that potentially contained any of the target analytes were removed from the school building. The building was then aired out by leaving building windows open for a period of three days prior to sampling. The windows were closed, the doors to the boiler room were closed and sealed with duct tape (the boiler room being a possible source of target compound vapors), and air sampling devices were placed in the target rooms.

II. Migration Pathway Evaluation Methods

The vapor migration pathway evaluation was performed by comparing indoor air quality data collected at each location (i.e., room) with soil and groundwater data collected from locations as near as possible to the air sample locations. The presence and concentrations of constituents in these media were evaluated together to establish whether a migration pathway could be complete. Published and site-specific background air data were also evaluated to help determine the likelihood of a complete migration pathway; however, these data were not used to demonstrate that potentially complete migration pathways were not complete (i.e., not used to "screen-out" migration pathways). There are four areas included in this evaluation, each representing a portion of the building where air samples were collected: 1) Cafeteria area; 2) New boiler room area; 3) Northeast classroom; and 4) Library area.

Because EPH and VPH analytical methods had not yet been developed for air, it was necessary to analyze a range of target VOC compounds each representing specific petroleum hydrocarbon chain length fractions (constituents classified as petroleum hydrocarbons may be aliphatic or aromatic compounds, and may have carbon chain lengths ranging from 5 to greater than 36). The various target compounds analyzed in air samples can then be compared to measurements of extractable petroleum hydrocarbon (EPH) and volatile petroleum hydrocarbon (VPH) carbon chain length fractions in soil and groundwater to draw inferences regarding vapor migration. The target petroleum hydrocarbon constituents, and the carbon chain length fractions which they represent, are summarized below:

Target compound in air samples	Representative carbon chain length fraction
1,2,4-trimethylbenzene	C9-C10 aromatic VPH
1,3,5-trimethylbenzene	C9-C10 aromatic VPH
2-methylheptane	C5-C8 aliphatic VPH
3-methylheptane	C5-C8 aliphatic VPH
octane	C5-C8 aliphatic VPH
nonane	C9-C12 aliphatic VPH
decane	C9-C18 aliphatic EPH
dodecane	C19-C36 aliphatic EPH

No target compounds for the C11-C22 aromatic EPH fractions were analyzed because hydrocarbons in this fraction (representing most PAH compounds) are not readily volatile and are not anticipated to be associated with Number 2 fuel oil related releases.

All air sample results were submitted for data validation. The data quality report for the air sample data is provided in Appendix M. In summary, one sample (the duplicate of ZWA-97-03X) was rejected because the sampling canister failed. All detected and non-detected sample results were qualified as estimated, and were assigned "J" or "UJ" qualifiers, respectively.

III. Migration Pathway Evaluation Results

Cafeteria Area Three air samples were collected from the cafeteria area: two from the crawl space beneath the kitchen and cafeteria, and one from the cafeteria room (Figure 2). Soil samples in the vicinity of the cafeteria area were collected from two Terraprobe locations on the north side of the building (ZWR-95-26X and ZWR-33X), and soil samples were collected from the boring in the old boiler room (ZWM-96-20X) (Figure 1). Groundwater samples in the vicinity of the cafeteria area were collected from a monitoring well located on the north side of the building (ZWM-95-16X) and from the boring in the old boiler room (ZWM-96-20X) (Figure 1).

TPH, reported as screening-level TPH data for total, gasoline-range organics, and diesel range organics, were detected in the two Terraprobe locations. Xylene was also detected at a low concentration in one of the Terraprobe locations (ZWR-95-26X). C9-C10 aromatic VPH was detected at a low concentration (7 ug/L) in groundwater at ZWM-96-16X, but no fuel-related constituents were detected in groundwater or soil beneath the old boiler room (Table 1).

Ethylbenzene, octane, toluene, xylene, and acetone were detected in at least one of the air samples collected from the crawl space beneath the cafeteria (Table 1). As indicated in Table 1, three of these constituents (ethylbenzene, toluene, and acetone) were not detected in the soil and groundwater, indicating that a vapor migration pathway is not complete for ethylbenzene, toluene, and acetone. Only octane and xylene were detected in soil in the vicinity of the cafeteria (octane may be a constituent of TPH). However, neither of these constituents was detected in the air sample collected from cafeteria room, indicating that they did not migrate from the crawl space to the overlying room at detectable concentrations. Since the air in the cafeteria room, as opposed to the air in the cafeteria crawl space, is the medium that occupants of the school would potentially be exposed to, a complete migration pathway does not exist. Since the crawl space, with its dirt floor potentially overlying fuel-related soil contamination and its very low air exchange rate, likely represents best-case conditions for detecting vapor migration, it is unlikely that xylene and octane would migrate to air in the overhead cafeteria at any measurable concentration in the future.

New Boiler Room Area Two air samples were collected from the new boiler room area: one from the head space of the well in the new boiler room, and one in the classroom adjacent to the south side of the boiler room (Figure 2). Soil samples in the vicinity of the new boiler room area were collected from soil borings in the new boiler room (ZWM-96-19X), and the courtyard (ZWM-96-21X) (Figure 1). Groundwater samples were also collected at these boring locations (now monitoring wells) (Figure 1).

All EPH and VPH fractions evaluated in this analysis were detected in the new boiler room soil sample collected at 9 ft bgs (ZWM-96-19X). C9-C10 aromatic VPH, and C9-C12 aliphatic VPH were detected in the groundwater from that location. No fuel-related constituents were detected in groundwater or soil collected from the location in the courtyard (Table 2).

Toluene, ethylbenzene, xylene, and acetone were detected in the air sample collected in the classroom next to the new boiler room (Table 2). Of these, only acetone was detected in the well head space sample. The presence of acetone in air samples is likely to be due to laboratory introduced contamination, as acetone is not a component of fuel oil. Toluene, ethylbenzene, and xylene were not detected in the soil and groundwater in the vicinity of these rooms. This indicates that there are no complete vapor migration pathways from soil or groundwater to the air in the classroom south of the new boiler room.

The presence of ethylbenzene, toluene, and xylenes in the sample collected from the classroom is likely due to ambient conditions in the building. These chemicals are contained in vinyl floor coverings, paint, adhesives, caulking, and carpeting; some of these products were identified in the building. In addition, ethylbenzene and xylene were detected at concentrations below published indoor air background concentrations (Table 5), and the total concentration of toluene, xylene, and ethylbenzene in the classroom air sample (91 ug/m^3) is within the range of total aromatic hydrocarbons (18 to 130 ug/m^3) reported in older offices and schools (USEPA, 1991). Finally, exposures to air in the new boiler room would occur only to facility workers (e.g., janitors) for short periods of time. Fuel oil spills and combustion associated with the operation of the boiler would likely contribute far higher concentrations to the new boiler room air than would migration fuel-related compounds from soil to indoor air.

Northeast Classroom A single air sample (ZWA-97-03X) was collected from the northeast classroom (Figure 2). No soil contamination was identified in the vicinity of the northeastern portion of the building during the RI. However, there is a possibility that groundwater beneath this area contains fuel-related constituents (as indicated by the data presented in Table 3). Therefore, only groundwater data were evaluated with air data in this analysis. Groundwater samples in the vicinity of the northeast classroom area were collected from a monitoring well located on the west side of the building (ZWM-95-16X) and from the boring in the old boiler room (ZWM-96-20X) (Figure 1).

C9-C10 aromatic VPH was detected at a low concentration (7 ug/L) in groundwater at ZWM-96-16X, but no fuel-related constituents were detected in groundwater or soil beneath the old boiler room (Table 3). Several target compounds were detected in air, including methylheptane, ethylbenzene, octane, toluene, and xylene (Table 3). However, none of these analytes were detected in groundwater beneath the classroom area, indicating that the presence of these compounds in air is not related to subsurface conditions beneath the classroom; vapor migration pathways are not complete.

The presence of the aliphatic and aromatic hydrocarbons identified in the sample collected from the classroom is likely due to ambient conditions in the building. These chemicals are contained in vinyl floor coverings, paint, adhesives, caulking, and carpeting; paints were stored in the old boiler room located near this classroom.

Library Area Two air samples were collected from the library area: one from the library (ZWA-97-10X), and one from the classroom east of the library (ZWA-97-01X; south of the new boiler room and west of the kitchen) (Figure 2). In addition, data for the air sample collected from the crawl space beneath the kitchen was included in this analysis because the classroom is located next to the kitchen and has an access door to the crawl space beneath the kitchen. Soil samples in the vicinity of the library area were collected from two Terraprobe locations on the north side of the building (ZWR-95-28X, and ZWR-95-30X), and the soil boring in the new boiler room (ZWM-96-19X) (Figure 1). Groundwater samples in the vicinity of the library area were collected from a monitoring well on the north side of the building (69W-94-10), and the new boiler room (ZWM-96-19X) (Figure 1).

TPH in soil, reported as screening-level TPH data for total, gasoline-range organics, or diesel range organics, were detected in the two Terraprobe locations. Xylene, ethylbenzene and toluene were also detected in the Terraprobe samples. All EPH and VPH fractions evaluated in this analysis were detected in the new boiler room soil sample collected at 9 ft bgs (ZWM-96-19X).

C9-C10 aromatic VPH and C9-C12 aliphatic VPH were detected in the groundwater from that location. All EPH and VPH fractions except C19-C36 aliphatic EPH, in addition to ethylbenzene, were detected in the groundwater sample collected from 69W-94-10 (Table 4).

2-Methylheptane, ethylbenzene, toluene, xylene, and acetone were detected in air samples collected from the library and/or the classroom (Table 4). Of these, ethylbenzene, toluene, xylene, and acetone were detected in the air sample collected from the crawl space beneath the kitchen. Ethylbenzene, toluene, and xylene were also detected in soil collected from the vicinity of the library area. The presence of acetone is likely to be due to laboratory introduced contamination, as acetone is not a component of fuel oil. Therefore, because ethylbenzene, toluene, and xylene are present in potential source area media, the crawl space, and the indoor air in the vicinity of the source area, it appears that the migration pathways for these constituents may be potentially complete. In addition, 2-methylheptane may be related to the presence of gasoline-range TPH detected in the Terraprobe samples collected on the north side of the library area (Table 4). Therefore, this constituent is considered to have a potentially complete migration pathway as well.

Toluene was detected in indoor air at concentrations approximately one order of magnitude higher than xylene and ethylbenzene, yet it was detected in only one soil sample (ZWR-95-30X), and at a concentration (0.026 mg/kg) up to two orders of magnitude lower than the xylene and ethylbenzene soil concentrations (Table 4). Since xylene, ethylbenzene, and toluene have similar vapor pressures (ranging from 0.0066 Torr for toluene to 0.0084 Torr for ethylbenzene), and similar soil/water partition coefficients (ranging from 14 for toluene to 40 for xylene), it would be expected that these three constituents would be detected in indoor air at concentrations that parallel their soil concentrations. However, as shown below, whereas the ratios of xylene to ethylbenzene in air are similar to their ratios in soil, the ratios of toluene to ethylbenzene and xylene in air are orders of magnitude higher than the ratios of these substances in soil. This indicates that it is highly unlikely that the presence of toluene in air is due to its presence in soil in the vicinity of these rooms.

Comparison	Air Ratio (a)	Soil Ratio (b)
Toluene : ethylbenzene	37	0.03
Toluene : xylene	8.9	0.007
Xylene : ethylbenzene	4.7	4.4

(a) based on comparison of average air concentrations in samples collected in classroom (ZWA-97-01X) and library (ZWA-97-10X)
(b) based on comparison of average soil concentrations in samples ZWM-96-19X (9 ft bgs), ZWR-95-30X, and ZWR-95-28X.

When evaluating potentially complete migration pathways, it is important to observe that ethylbenzene and xylene are components of carpet, paint, and adhesives, and can be emitted as those materials age and degrade (USEPA, 1991). The library is carpeted, and paints and adhesives were identified in the building. More importantly, a partially-filled five-gallon bucket of fuel oil below a leaking fuel line was also identified in the new boiler room, which is located across the hallway from the library/classroom area. This fuel oil could serve as a source of vapors to indoor air.

In addition, ethylbenzene and xylene were both detected in the library air sample at concentrations below the lowest published background concentrations (Table 5). Ethylbenzene and xylene concentrations in the adjacent classroom air sample and crawl space air sample were detected at concentrations below the 90th percentile indoor air concentrations, and the site-specific indoor background concentrations (Table 5). Moreover, the ratio of xylene to ethylbenzene concentrations in published and site-specific background concentrations are consistently between 2.5 and 3.5 (Table 5), and the ratio of ethylbenzene to xylene concentrations in the library, classroom, and crawl space samples are between 2.8 and 3.8 (Table 4). Finally, the concentrations of ethylbenzene, xylene, and 2-methylheptane in the classroom were higher than the concentrations in the crawl space (2-methylheptane was not detected in the crawl space sample; Table 4). If the presence of constituents in indoor air is due to migration from soil gas, to crawl space air, to air in the rooms above the crawl space, it is extremely unlikely that constituent concentrations would be higher in the overlying rooms than in the crawl space.

Together, this evidence strongly suggests that the presence of ethylbenzene, xylenes, and 2-methylheptane in air samples collected from the library and classroom is an artifact of ambient background conditions that are consistent with buildings similar to the Former Elementary School. Nevertheless, because these compounds were detected in the environmental media required for a complete migration pathway (i.e., soil or groundwater, crawl space air, and indoor air), the possibility of a complete vapor migration pathway for 2-methylheptane, ethylbenzene, and xylene cannot be ruled out. No other constituents in indoor air samples collected from the building can reasonably be attributed to the presence of subsurface fuel-oil related contamination at AOC 69W.

IV. Conclusions

The following conclusions can be drawn from this analysis:

1. Volatile organic hydrocarbon compounds that could be associated with fuel oil were detected in air samples collected throughout the Former Elementary School, including background locations in and outside of the building.
2. With the possible exception of the northwestern portion of the building, there is no evidence to suggest that constituents detected in indoor air are associated with the possible presence of fuel oil-contaminated soil and/or groundwater beneath the building. In general, indoor air sample concentrations are within the ranges of aliphatic and aromatic hydrocarbon background concentrations published in the literature. This information, combined with the presence of several possible sources of these compounds inside the building, suggest that

detections in indoor air samples are merely representative of the ambient conditions in public buildings such as the Former Elementary School.

3. The presence of ethylbenzene, xylene, and 2-methylheptane in air samples collected from the library and adjacent classroom is likely related to sources within the building (e.g., carpeting, paint, adhesives, and fuel oil leaks in the new boiler room), as detected concentrations are consistent with the ranges of typical background concentrations. However, because these constituents were detected in indoor air, crawl space air, and subsurface soil or groundwater beneath the that portion of the building, the possible presence of a complete migration pathway could not be ruled out.

References

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TABLE .
AOC 69W - DEVENS ELEMENTARY SCHOOL
INDOOR AIR QUALITY - MIGRATION PATHWAY EVALUATION
DEVENS, MASSACHUSETTS

CAFETERIA AREA

	Air Samples (ug/m3)			Soil Samples (mg/kg)				Groundwater Samples (ug/L)			
Site ID: / Canister: / Location: / COMPOUND	ZWA-97-02X A209 Kitchen/ Cafeteria	ZWA-97-05X 70 Crawl space under cafeteria	ZWA-97-06X B237 Crawl space under kitchen	ZWM-96-20X 2 ft bgs Old boiler room	ZWM-96-20X 4 ft bgs Old boiler room	ZWR-95-26X [a] 7 ft bgs Outside, N of area	ZWR-95-33X [a] 7 ft bgs Outside, N of area	ZWM-95-16X Outside, N of area	ZWM-96-20X Old boiler room	Pathway Potentially Complete?	Reason
1,2,4 Trimethylbenzene (C9-C10 ar; VPH)	< 4.4	< 4.4	< 4.4	< 0.25	< 0.25	45 [b]	160 [d]	7	< 5	NO	ND Air
1,3,5 Trimethylbenzene (C9-C10 ar; VPH)	< 4.4	< 4.4	< 4.4	< 0.25	< 0.25	45 [b]	160 [d]	7	< 5	NO	ND Air
2-Methylheptane (C5-C8 al; VPH)	< 4.4	< 4.4	< 4.4	< 0.13	< 0.13	45 [b]	160 [d]	< 2.5	< 2.5	NO	ND Air
3-Methylheptane (C5-C8 al; VPH)	< 4.4	< 4.4	< 4.4	< 0.13	< 0.13	45 [b]	160 [d]	< 2.5	< 2.5	NO	ND Air
Decane (C9-C18 al; EPH)	< 4.4	< 4.4	< 4.4	< 1.5	< 1.7	0.71 [c]	160 [d]	< 25	< 25	NO	ND Air
Dodecane (C19-C36 al; EPH)	< 22	< 22	< 22	< 0.15	< 0.17	0.71 [c]	160 [d]	< 2.5	< 2.5	NO	ND Air
Ethylbenzene	470	< 4.4	5.2	< 0.05	< 0.05	ND	ND	< 5	< 5	NO	ND S/G
Methyl tert-butyl Ether	< 4.4	< 4.4	< 4.4	< 0.25	< 0.25	ND	ND	< 25	< 25	NO	ND Air
Nonane (C9-C12 al; VPH)	< 4.4	< 4.4	< 4.4	< 0.013	< 0.013	45 [b]	160 [d]	< 0.25	< 0.25	NO	ND Air
Octane (C5-C8 al; VPH)	< 4.4	< 4.4	5.5	< 0.13	< 0.13	45 [b]	160 [d]	< 2.5	< 2.5	NO	ND Air [1]
Toluene	72 B	13 B	150 B	< 0.05	< 0.05	ND	ND	< 5	< 5	NO	ND S/G
Xylene	< 8.8	< 8.8	18.3 BJ	< 0.05	< 0.05	0.0023	ND	< 5	< 5	NO	ND Air [1]
Acetone	200 B	38 B	81 B	ND	ND	ND	ND	ND	ND	NO	LAB
Tetrachloroethylene	< 4.4	< 4.4	< 4.4	ND	ND	ND	ND	ND	ND	NO	ND Air

Notes

All air sample results reported as "<" are qualified "UJ"; all other results are qualified "J"

[a] Field Screening Results

[b] Reported as 45 mg/kg gasoline-range organics

[c] Reported as 0.71 mg/kg diesel-range organics

[d] Field screening results reported 160 mg/kg by TPH-IR

Shade = concentration above background; comparison is presented in Table 5.

ND = Not detected

NA = Not analyzed

ND Air = Not detected in air; therefore, no complete migration pathway because VOC is not migrating to air within the building

ND S/G = Not detected in soil and groundwater; therefore, presence of VOC in air within building is not attributable to soil and groundwater beneath building

LAB = Presence due to laboratory contamination

[1] VOC was detected in one portion of crawl space, but not in air in room above crawl space; therefore, migration pathway to exposure point (cafeteria) is not complete

TABLE 2
AOC 69W - DEVENS ELEMENTARY SCHOOL
INDOOR AIR QUALITY - MIGRATION PATHWAY EVALUATION
DEVENS, MASSACHUSETTS

NEW BOILER ROOM AREA

	Air Samples (ug/m3)		Soil Samples (mg/kg)				Groundwater Samples (ug/L)			
Site ID:	ZWA-97-08X	ZWA-97-09X	ZWM-96-19X	ZWM-96-19X	ZWM-96-21X	ZWM-96-21X	ZWM-96-19X	ZWM-96-21X	Pathway	Reason
Canister:	A211	92	5 feet bgs	9 feet bgs	4 feet bgs	8 feet bgs	New		Potentially	
Location:	Classr'm S of new boiler room	Boiler room well head sample	Boiler room	Boiler room	Courtyard	Courtyard	Boiler room	Courtyard	Complete?	
COMPOUND										
1,2,4 Trimethylbenzene (C9-C10 ar; VPH)	< 4.4	< 22	< 0.25	3.5	< 0.25	< 0.25	45	< 5	NO	ND Air
1,3,5 Trimethylbenzene (C9-C10 ar; VPH)	< 4.4	< 22	< 0.25	3.5	< 0.25	< 0.25	15	< 5	NO	ND Air
2-Methylheptane (C5-C8 al; VPH)	< 4.4	< NA	< 0.13	0.27	< 0.13	< 0.13	< 2.5	< 2.5	NO	ND Air
3-Methylheptane (C5-C8 al; VPH)	< 4.4	< NA	< 0.13	0.27	< 0.13	< 0.13	< 2.5	< 2.5	NO	ND Air
Decane (C9-C18 al; EPH)	< 4.4	< NA	< 1.5	560	< 1.7	< 1.6	< 25	< 25	NO	ND Air
Dodecane (C19-C36 al; EPH)	< 22	< NA	< 0.15	110	< 0.17	< 0.16	< 2.5	< 2.5	NO	ND Air
Ethylbenzene	4.3 J	< 22	< 0.05	< 0.05	< 0.05	< 0.05	< 5	< 5	NO	ND Air
Methyl tert-butyl Ether	< 4.4	< NA	< 0.25	< 0.25	< 0.25	< 0.25	< 25	< 25	NO	ND Air
Nonane (C9-C12 al; VPH)	< 4.4	< NA	< 0.013	8.3	< 0.013	< 0.013	31	< 25	NO	ND Air
Octane (C5-C8 al; VPH)	< 4.4	< NA	< 0.13	0.27	< 0.13	< 0.13	< 2.5	< 2.5	NO	ND Air
Toluene	70 B	< 22	< 0.05	< 0.05	< 0.05	< 0.05	< 5	< 5	NO	ND Air [1]
Xylene	17.1 J	< 44	< 0.05	< 0.05	< 0.05	< 0.05	< 5	< 5	NO	ND S/G [1]
Acetone	54 B	210 B	ND	ND	ND	ND	ND	ND	NO	LAB
Tetrachloroethylene	< 4.4	360	ND	ND	ND	ND	ND	ND	NO	ND Air

Notes:

All air sample results reported as "<" are qualified "UJ"; all other results are qualified "J"

Shade = concentration above background; comparison is presented in Table 5.

ND = Not detected

NA = Not analyzed

ND Air = Not detected in air; therefore, no complete migration pathway because VOC is not migrating to air within the building

ND S/G = Not detected in soil and groundwater; therefore, presence of VOC in air within building is not attributable to soil and groundwater beneath building

LAB = Presence due to laboratory contamination

[1] VOC was not detected in boiler room well-head sample, indicating that migration pathway to exposure point (indoor air) is not complete

TABLE 3
AOC 69W - DEVENS ELEMENTARY SCHOOL
INDOOR AIR QUALITY - MIGRATION PATHWAY EVALUATION
DEVENS, MASSACHUSETTS

NORTHEAST CLASSROOM

	Air Samples (ug/m3)		Groundwater Samples (ug/L)					
Site ID:		ZWA-97-03X		ZWM-95-16X		ZWM-96-20X	Pathway Potentially Complete?	Reason
Canister:		A210						
Location:		1st Classr'm NE Wing		Outside, NW of classroom		Old Boiler Room		
COMPOUND								
1,2,4 Trimethylbenzene (C9-C10 ar; VPH)	<	4.4		7	<	5	NO	ND Air
1,3,5 Trimethylbenzene (C9-C10 ar; VPH)	<	4.4		7	<	5	NO	ND Air
2-Methylheptane (C5-C8 al; VPH)		19	<	2.5	<	2.5	NO	ND S/G
3-Methylheptane (C5-C8 al; VPH)		8.7	<	2.5	<	2.5	NO	ND S/G
Decane (C9-C18 al; EPH)	<	4.4	<	25	<	25	NO	ND Air
Dodecane (C19-C36 al; EPH)	<	22	<	2.5	<	2.5	NO	ND Air
Ethylbenzene		27	<	5	<	5	NO	ND S/G
Methyl tert-butly Ether	<	4.4	<	25	<	25	NO	ND Air
Nonane (C9-C12 al; VPH)		7.2	<	0.25	<	0.25	NO	ND S/G
Octane (C5-C8 al; VPH)		21	<	2.5	<	2.5	NO	ND S/G
Toluene		1000 B	<	5	<	5	NO	ND S/G
Xylene		92 B	<	5	<	5	NO	ND S/G
Acetone		82 B		ND		ND	NO	LAB
Tetrachloroethylene	<	4.4		ND		ND	NO	ND Air

Notes:
All air sample results reported as "<" are qualified "UJ"; all other results are qualified "J"
Shade = concentration above background; comparison is presented in Table 5.
ND = Not detected
NA = Not analyzed
ND Air = Not detected in air; therefore, no complete migration pathway because VOC is not migrating to air within the building
ND S/G = Not detected in soil and groundwater; therefore, presence of VOC in air within building is not attributable to soil and groundwater beneath the building.
LAB = Presence due to laboratory contamination

TABLE 4
AOC 69W - DEVENS ELEMENTARY SCHOOL
INDOOR AIR QUALITY - MIGRATION PATHWAY ANALYSIS
DEVENS, MASSACHUSETTS

LIBRARY AREA

	Air Samples (ug/m3)			Soil Samples (mg/kg)				Groundwater Samples (ug/L)			
Site ID:	ZWA-97-10X	ZWA-97-01X	ZWA-97-06X	ZWM-96-19X	ZWM-96-19X	ZWR-95-30X [a]	ZWR-95-28X [a]	ZWM-96-19X	69W-94-10	Pathway	Reason
Canister:	62	A230	B237	5 feet bgs	9 feet bgs	6 feet bgs	10 feet bgs			Potentially	
Location:	Library	Classroom N of new boiler room	Crawl space under kitchen	Boiler room	Boiler room	Outside, N of classrooms	Outside, N of classrooms	New boiler room	Outside, N of classrooms	Complete?	
COMPOUND											
1,2,4 Trimethylbenzene (C9-C10 ar; VPH)	< 4.4	< 4.4	< 4.4	< 0.25	3.5	540 [c]	3500 [e]	45	790	NO	ND Air
1,3,5 Trimethylbenzene (C9-C10 ar; VPH)	< 4.4	< 4.4	< 4.4	< 0.25	3.5	540 [c]	3500 [e]	45	790	NO	ND Air
2-Methylheptane (C5-C8 al; VPH)	5.2	8	< 4.4	< 0.13	0.27	540 [c]	3500 [e]	< 2.5	17	**YES**	[1]
3-Methylheptane (C5-C8 al; VPH)	< 4.4	< 4.4	< 4.4	< 0.13	0.27	540 [c]	3500 [e]	< 2.5	17	NO	ND Air
Decane (C9-C18 al; EPH)	< 4.4	< 4.4	< 4.4	< 1.5	560	3.4 [b]	540 [c]	< 25	590	NO	ND Air
Dodecane (C19-C36 al; EPH)	< 22	< 22	< 22	< 0.15	110	3.4 [b]	540 [c]	< 2.5	< 2.5	NO	ND Air
Ethylbenzene	2.8 J	7.9	5.2	< 0.05	< 0.05	0.26	2.2	< 5	35	**YES**	[2]
Methyl tert-butly Ether	< 4.4	< 4.4	< 4.4	< 0.25	< 0.25	ND	ND	< 25	< 25	NO	ND Air
Nonane (C9-C12 al; VPH)	< 4.4	< 4.4	< 4.4	< 0.013	8.3	540 [c]	3500 [e]	31	550	NO	ND Air
Octane (C5-C8 al; VPH)	< 4.4	< 4.4	5.5	< 0.13	0.27	540 [c]	3500 [e]	< 2.5	17	NO	ND Air
Toluene	82 B	260 B	150 B	< 0.05	< 0.05	0.026	ND	< 5	< 5	**YES**	[1]
Xylene	8	30.4 B	18.3 BJ	< 0.05	< 0.05	6.5	4.4	< 5	< 5	**YES**	[2]
Acetone	52 B	470 B	81 B	ND	ND	ND	ND	ND	ND	NO	LAB
Tetrachloroethylene	< 4.4	< 4.4	< 4.4	ND	ND	ND	ND	ND	ND	NO	ND Air

Notes:

All air sample results reported as "<" are qualified "UJ"; all other results are qualified "J"

Shade = concentration above background; comparison presented in Table 5.

[a] Field screening data

[b] Reported as 3.4 mg/kg diesel-range TPH

[c] Reported as 540 mg/kg gasoline-range TPH

[d] Not reported

[e] Reported as 3500 mg/kg gasoline-range TPH

ND = Not detected

NA = Not analyzed

ND Air = Not detected in air; therefore, no complete migration pathway because VOC is not migrating to air within the building

ND S/G = Not detected in soil and groundwater; therefore, presence of VOC in air within building is not attributable to soil and groundwater beneath building

LAB = Presence due to laboratory contamination

[1] Detected in soil and/or groundwater, and in air at concentration above background; therefore, migration pathway potentially complete

[2] Detected in soil and/or groundwater, but in air at concentration below background; therefore, cause of presence in air is inconclusive

ABLE 5

AOC 69W - DEVENS ELEMENTARY SCHOOL

INDOOR AIR QUALITY SAMPLE COMPARISON TO BACKGROUND CONDITIONS

DEVENS, MASSACHUSETTS

	Potential Exposure Points					Published Background Conditions				Site-Specific Background Conditions			
Site ID:	ZWA-97-02X	ZWA-97-01X	ZWA-97-08X	ZWA-97-03X	ZWA-97-10X	Indoor Upper Quartile (a)	Indoor 50th percentile (b)	Indoor 90th percentile (b)	Indoor Non-residential buildings (c) (range of means)	ZWA-97-07X	ZWA-97-11X	ZWA-97-12X	ZWA-97-13X
Canister:	A209	A230	A211	A210	62					B246	A207	A221	B233
Location:	Kitchen/ Cafeteria	Classroom N of new boiler room	Classr'm S of new boiler room	1st Classr'm NE Wing	Library					SW classr'm (indoor backgrnd)	Front parking lot downwind (bkgrnd)	Near wells upwind (bkgrnd)	Playground upwind (backgrnd)
COMPOUND													
1,2,4 Trimethylbenzene	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	4.02	5	20	NA	< 4.4	< 4.4	< 4.4	< 4.4
1,3,5 Trimethylbenzene	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	5.5	2	5	NA	< 4.4	< 4.4	< 4.4	< 4.4
2-Methylheptane	< 4.4	8	< 4.4	19	5.2	NA	NA	NA	NA	7.2	< 4.4	< 4.4	< 4.4
3-Methylheptane	< 4.4	< 4.4	< 4.4	8.7	< 4.4	NA	NA	NA	NA	8.9	< 4.4	< 4.4	< 4.4
Decane	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	4.14	10	50	NA	< 4.4	< 4.4	< 4.4	< 4.4
Dodecane	< 22	< 22	< 22	< 22	< 22	NA	5	10	NA	< 22	< 22	< 22	< 22
Ethylbenzene	470	7.9	4.3 J	27	2.8 J	9.79	10	20	1.16 - 17.2	9.9	3.2 J	< 4.4	< 4.4
Methyl tert-butyl Ether	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	NA	NA	NA	NA	< 4.4	< 4.4	< 4.4	< 4.4
Nonane	< 4.4	< 4.4	< 4.4	7.2	< 4.4	6.4	5	20	NA	5	< 4.4	< 4.4	< 4.4
Octane	< 4.4	< 4.4	< 4.4	21	< 4.4	4.37	5	10	NA	9.1	< 4.4	< 4.4	< 4.4
Toluene	72 B	360 B	70 B	1000 B	82 B	29.16	65	150	7.84 - 98.7	36 B	63 B	38 B	19 B
Xylene	< 8.8	30.4 B	17.1 J	92 B	8	NA	25	50	3.66 - 16.8	34.8 B	8.2 B	< 8.8	< 8.8
Acetone	200 B	470 B	54 B	82 B	52 B	27.4	NA	NA	11.1 - 62.7	30 B	440 B	27 B	31 B
Tetrachloroethylene	< 4.4	< 4.4	< 4.4	< 4.4	< 4.4	NA	5	20	NA	< 4.4	< 4.4	< 4.4	< 4.4

Notes: < = Less than certified reporting limits; qualified as "UJ"

B - Analyte found in blank;

NA - Not available

All results not assigned a "<" ("UJ") qualifier are "J" qualified

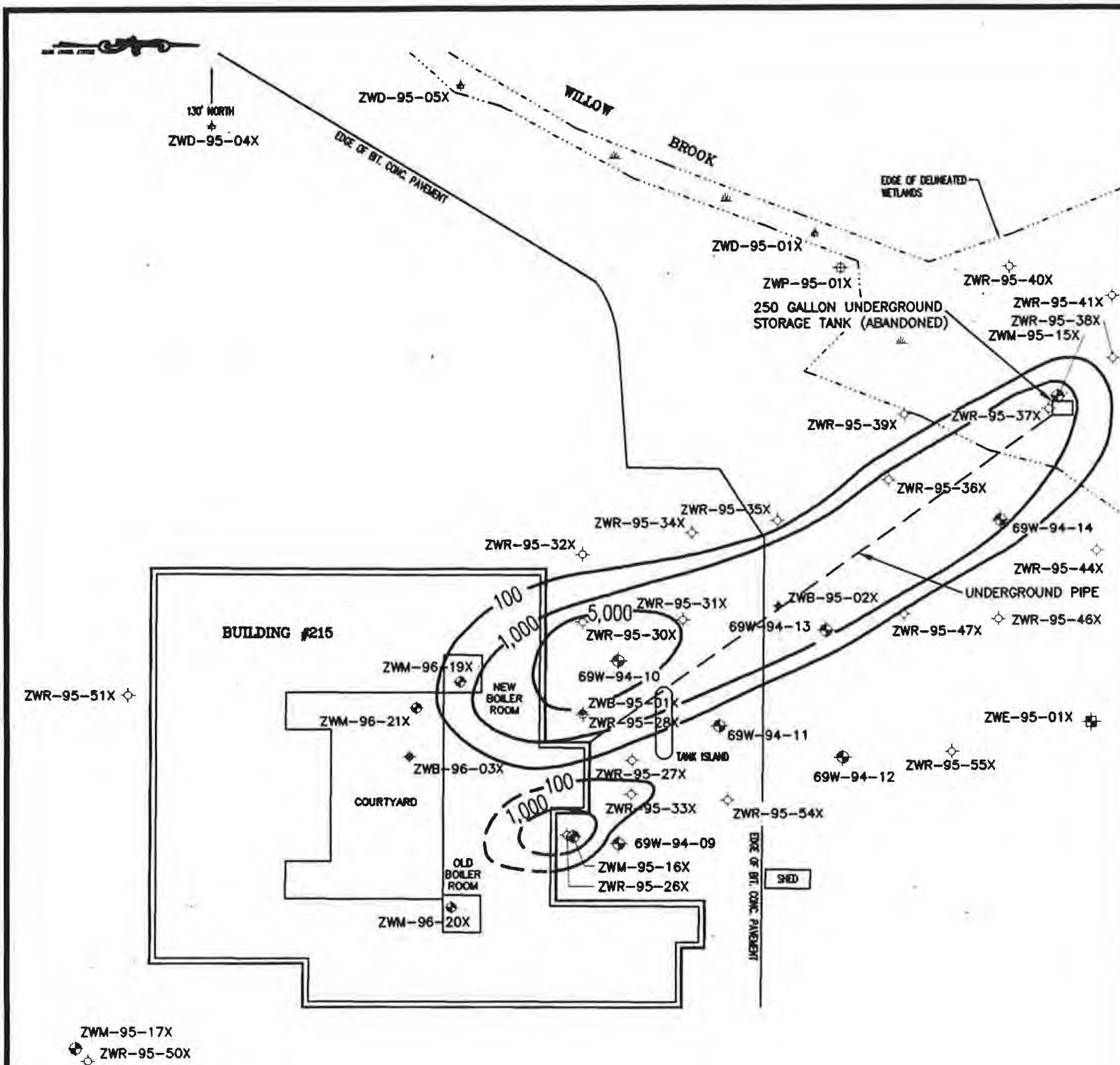
All concentrations in ug/m3

Shading indicates concentration greater than the lowest published upper quartile, 50 percentile, or 90 percentile background concentration or, if published values are unavailable, the lowest site-specific background concentration.

[a] Upper quartile concentrations from the EPA National Ambient Compounds VOC Data Base (Shah and Singh, 1988)

[b] From data base of measurements recorded in 1170 homes (Stolwijk, 1990).

[c] Measurements recorded in three non-residential buildings (USEPA, 1991).



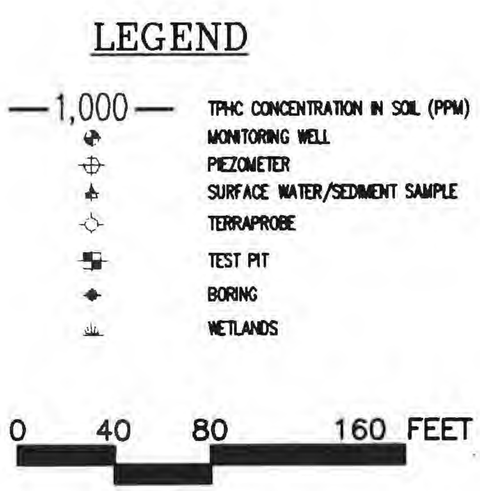
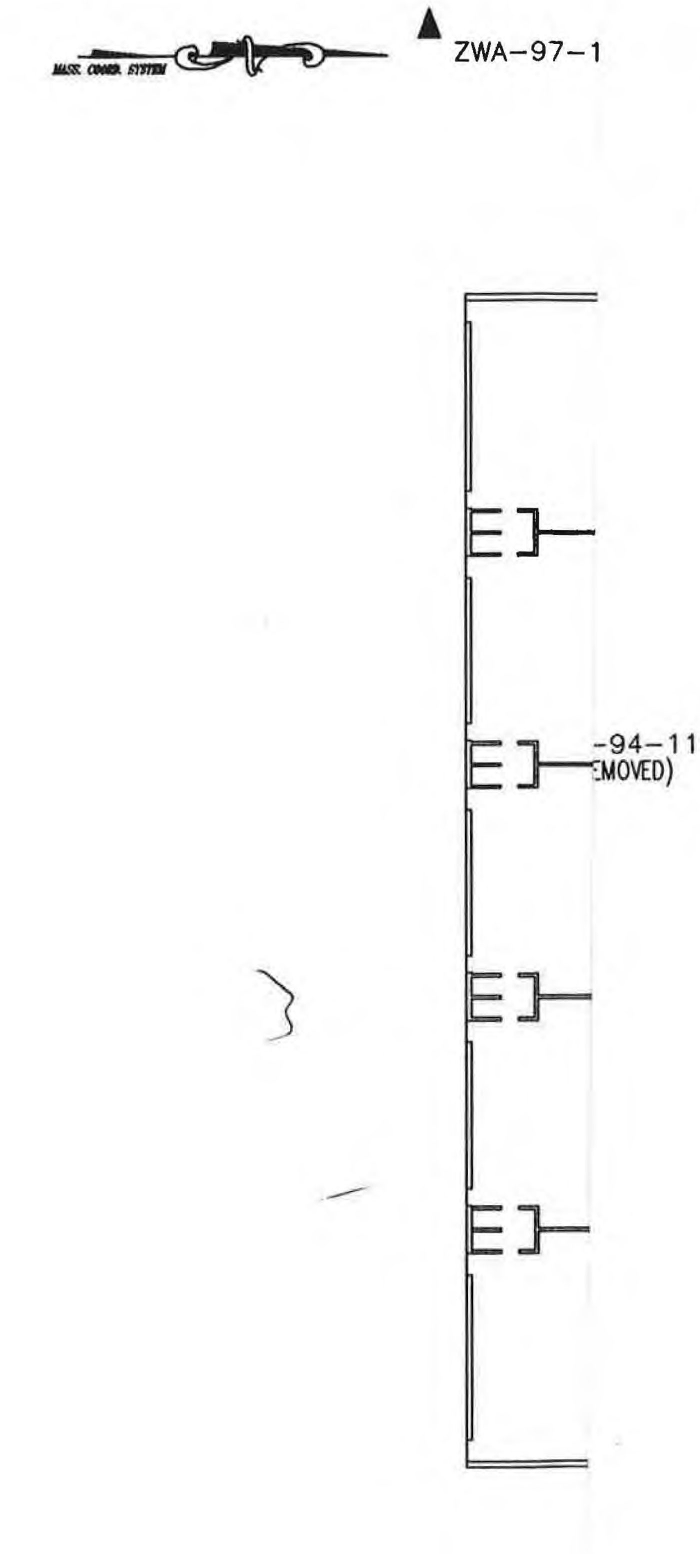


FIGURE O-1
TPHC CONCENTRATIONS IN SUBSURFACE SOILS (4-10' BGS)
FIELD ANALYTICAL RESULTS
AOC 69W
REMEDIAL INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

3144 03 J144F042.DWG 8/20/98



LEGEND

- EXISTING MONITORING WELL LOCATION
- EXISTING BORING LOCATION
- AIR SAMPLING LOCATION (1997)
- (REMOVED) REMOVED DURING 1997-1998 SOIL REMOVAL ACTION

0 200 400 800 FEET

SCALE: 1"=400'

FIGURE O-2
AIR SAMPLING LOCATIONS
AOC 69W
REMEDIAL INVESTIGATION REPORT
DEVENS, MA

Harding Lawson Associates

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CALCULATIONS

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - RME SCENARIO
CURRENT AND FUTURE SITE MAINTENANCE WORKER MOWING IN GRASSY AREA
AOC 69 W
FORT DEVENS
TABLE 1

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	$[OHM]_{soil}$	chemical specific	chemical-specific	
INGESTION RATE	IR	100	mg-soil/day	USEPA, 1994
ADHERENCE FACTOR	AF	0.51	mg-soil/cm²-skin	MADEP, 1995
AVERAGE SURFACE AREA (1)	SA	5,200	cm²/day	calculated per MADEP, 1995
RELATIVE ABSORPTION FACTOR-ORAL	RAF-O	chemical specific	unitless	MADEP, 1994, 1995
RELATIVE ABSORPTION FACTOR -DERM	RAF-D	chemical specific	unitless	MADEP, 1994, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	70	kg	USEPA, 1989
EXPOSURE PERIOD	EP	25	years	USEPA, 1991
EXPOSURE FREQUENCY (2)	EF	64	events/year	Assumption
EXPOSURE DURATION (2)	ED	1	day/event	Assumption
AVERAGING PERIOD				
CANCER	AP	70	years	USEPA, 1989
NONCANCER	AP	25	years	USEPA, 1991

(1) 50th percentile of surface areas for males: head, hands, arms.

MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
MADEP, 1995. Guidance for Disposal Site Risk Characterization. Interim Final Policy WSC/ORS-95-141. July 1995.
USEPA, 1989. Exposure Factors Handbook EPA/600/8-89/043. May 1989.
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors." OSWER Directive 9285.6-03.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{[OHM]soil \times IR \times RAF\text{-}O \times CF \times EF \times ED \times EP}{BW \times AP \times 365\ days/yr}$$

$$\text{INTAKE-DERMAL} = \frac{[OHM]soil \times SA \times AF \times RAF\text{-}D \times EF \times ED \times EP \times CF}{BW \times AP \times 365\ days/yr}$$

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - RME SCENARIO
CURRENT AND FUTURE SITE MAINTENANCE WORKER MOWING IN GRASSY AREA
AOC 69 W
FORT DEVENS
TABLE 1

CARCINOGENIC EFFECTS

	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	18	1	1.6E-06	0.03	1.3E-06	1.5E+00	2.4E-06	1.9E-06	4.3E-06
Beryllium	0.85	1	7.6E-08	0.03	6.0E-08	4.3E+00	3.3E-07	2.6E-07	5.9E-07
						1			
						1			
SUMMARY CANCER RISK							3E-06	2E-06	5E-06

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Arsenic	18	1	4.5E-06	0.03	3.6E-06	3.0E-04	1.5E-02	1.2E-02	2.7E-02
Beryllium	0.85	1	2.1E-07	0.03	1.7E-07	2.0E-03	1.1E-04	8.5E-05	1.9E-04
Iron	10300	1	2.6E-03	0.03	2.1E-03	3.0E-01	8.6E-03	6.8E-03	1.5E-02
Manganese	240	1	6.0E-05	0.14	2.2E-04	4.7E-02	1.3E-03	4.7E-03	6.0E-03
Total Petroleum Hydrocarbons	936	1	2.3E-04	0.2	1.2E-03	3.0E-02	7.8E-03	4.1E-02	4.9E-02
SUMMARY HAZARD INDEX							3E-02	7E-02	1E-01

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - CENTRAL TENDENCY
CURRENT AND FUTURE SITE MAINTENANCE WORKER MOWING IN GRASSY AREA
AOC 69 W
FORT DEVENS
TABLE 2

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	$[OHM]_{soil}$	chemical specific	chemical-specific	
INGESTION RATE	IR	50	mg-soil/day	USEPA, 1994
ADHERENCE FACTOR	AF	0.51	mg-soil/cm²-skin	MADEP, 1995
AVERAGE SURFACE AREA (1)	SA	5,200	cm²/day	calculated per MADEP, 1995
RELATIVE ABSORPTION FACTOR-ORAL	RAF-O	chemical specific	unitless	MADEP, 1994, 1995
RELATIVE ABSORPTION FACTOR -DERM	RAF-D	chemical specific	unitless	MADEP, 1994, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT	BW	70	kg	USEPA, 1989
EXPOSURE PERIOD	EP	9	years	USEPA, 1994
EXPOSURE FREQUENCY (2)	EF	64	events/year	Assumption
EXPOSURE DURATION (2)	ED	1	day/event	Assumption
AVERAGING PERIOD				
CANCER	AP	70	years	MADEP, 1995
NONCANCER	AP	9	years	USEPA, 1991

(1) 50th percentile of surface areas for males: head, hands, arms.

MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
MADEP, 1995. Guidance for Disposal Site Risk Characterization. Interim Final Policy WSC/ORS-95-141. July 1995.
USEPA, 1989. Exposure Factors Handbook EPA/600/8-89/043. May 1989.
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors." OSWER Directive 9285.6-03.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{[OHM]soil \times IR \times RAF\text{-}O \times CF \times EF \times ED \times EP}{BW \times AP \times 365\ days/yr}$$

$$\text{INTAKE-DERMAL} = \frac{[OHM]soil \times SA \times AF \times RAF\text{-}D \times EF \times ED \times EP \times CF}{BW \times AP \times 365\ days/yr}$$

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - CENTRAL TENDENCY
CURRENT AND FUTURE SITE MAINTENANCE WORKER MOWING IN GRASSY AREA
AOC 69 W
FORT DEVENS
TABLE 2

CARCINOGENIC EFFECTS

	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	18	1	2.9E-07	0.03	4.6E-07	1.5E+00	4.3E-07	6.9E-07	1.1E-06
Beryllium	0.85	1	1.4E-08	0.03	2.2E-08	4.3E+00	5.9E-08	9.4E-08	1.5E-07
						1			
						1			
SUMMARY CANCER RISK							5E-07	8E-07	1E-06

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Arsenic	18	1	2.3E-06	0.03	3.6E-06	0.0003	7.5E-03	1.2E-02	1.9E-02
Beryllium	0.85	1	1.1E-07	0.03	1.7E-07	0.002	5.3E-05	8.5E-05	1.4E-04
Iron	10300	1	1.3E-03	0.03	2.1E-03	0.3	4.3E-03	6.8E-03	1.1E-02
Manganese	240	1	3.0E-05	0.14	2.2E-04	0.047	6.4E-04	4.7E-03	5.4E-03
Total Petroleum Hydrocarbons	936	1	1.2E-04	0.2	1.2E-03	0.03	3.9E-03	4.1E-02	4.5E-02
SUMMARY HAZARD INDEX							2E-02	7E-02	8E-02

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

INHALATION EXPOSURE TO PARTICULATES AND VOLATILES FROM SURFACE SOIL – RME SCENARIO
CURRENT AND FUTURE SITE MAINTENANCE WORKER MOWING IN GRASSY AREA
AOC 69W
FORT DEVENS, MA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS
CONCENTRATION SOIL	CS	Maximum	mg/kg
CONCENTRATION AIR PARTICULATES	CAp	Calculated	mg/m³
CONCENTRATION AIR VOLATILES	CAv	Calculated	mg/m³
VOLATILIZATION FACTOR	VF	Calculated	m³/kg
PARTICULATE EMISSIONS FACTOR	PEF	1.32E+09	m³/kg
INHALATION RATE	IhR	2.5	m³/hour
BODY WEIGHT	BW	70	kg
EXPOSURE TIME	ET	8	hours/day
EXPOSURE FREQUENCY	EF	64	days/year
EXPOSURE DURATION	ED	25	years
AVERAGING TIME			
CANCER	AT	70	years
NONCANCER	AT	25	years

Note:
For noncarcinogenic effects: AT = EF/365 days per year
ND – Value not determined

EQUATIONS

CANCER RISK = INTAKE (mg/kg–day) x CANCER SLOPE FACTOR $(mg/kg-day)^{-1}$

$$\text{INTAKE} = \frac{(CAp + CAv) \times IhR \times ET \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

HAZARD QUOTIENT = AVERAGE DAILY CONCENTRATION (mg/m^3) / REFERENCE CONCENTRATION (mg/m^3)

$$\text{AVERAGE DAILY CONCENTRATION} = \frac{(CAp + CAv) \times EF \times ED}{AT \times 365 \text{ days/yr}}$$

AIR CONCENTRATION PARTICULATES = CS x 1/PEF

AIR CONCENTRATION VOLATILES = CS x 1/VF (VF is not calculated because no volatiles are selected as CPCs).

CARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m³/kg)	CAv (mg/m³)	CAp (mg/m³)		INTAKE (mg/kg–day)	INHALATION CANCER SLOPE FACTOR $(mg/kg-day)^{-1}$	CANCER RISK	PERCENT TOTAL RISK
Arsenic	18	NA	NA	1.36E–08		2.4E–10	1.5E+01	3.7E–09	97.42%
Beryllium	0.85	NA	NA	6.44E–10		1.2E–11	8.4E+00	9.7E–11	2.58%
NA = Not applicable							SUMMARY CANCER RISK	4E–09	

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m³/kg)	CAv (mg/m³)	CAp (mg/m³)		AVERAGE DAILY CONCENTRATION (mg/m^3)	INHALATION REFERENCE CONCENTRATION (mg/m^3)	HAZARD QUOTIENT	PERCENT TOTAL RISK
Arsenic	18	NA	NA	1.36E–08		2.4E–09	ND		
Beryllium	0.85	NA	NA	6.44E–10		1.1E–10	2.0E–05	5.6E–06	0.87%
Iron	10300	NA	NA	7.80E–06		1.4E–06	ND		
Manganese	240	NA	NA	1.82E–07		3.2E–08	5.0E–05	6.4E–04	98.80%
Total Petroleum Hydrocarbons	936	NA	NA	7.09E–07		1.2E–07	6.0E–02	2.1E–06	0.32%
NA = Not applicable						SUMMARY HAZARD INDEX		0.0006	

TA

INHALATION EXPOSURE TO PARTICULATES AND VOLATILES FROM SURFACE SOIL – CENTRAL TENDENCY
CURRENT AND FUTURE SITE MAINTENANCE WORKER MOWING IN GRASSY AREA
AOC 69W
FORT DEVENS, MA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS
CONCENTRATION SOIL	CS	Maximum	mg/kg
CONCENTRATION AIR PARTICULATES	CAp	Calculated	mg/m³
CONCENTRATION AIR VOLATILES	CAv	Calculated	mg/m³
VOLATILIZATION FACTOR	VF	Calculated	m³/kg
PARTICULATE EMISSIONS FACTOR	PEF	1.32E+09	m³/kg
INHALATION RATE	IhR	2.5	m³/hour
BODY WEIGHT	BW	70	kg
EXPOSURE TIME	ET	8	hours/day
EXPOSURE FREQUENCY	EF	64	days/year
EXPOSURE DURATION	ED	9	years
AVERAGING TIME			
CANCER	AT	70	years
NONCANCER	AT	9	years

Note:
For noncarcinogenic effects: AT = EF/365 days per year
ND – Value not determined

EQUATIONS

CANCER RISK = INTAKE (mg/kg–day) x CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$

$$\text{INTAKE} = \frac{(CAp + CAv) \times IhR \times ET \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

HAZARD QUOTIENT = AVERAGE DAILY CONCENTRATION (mg/m^3) / REFERENCE CONCENTRATION (mg/m^3)

$$\text{AVERAGE DAILY CONCENTRATION} = \frac{(CAp + CAv) \times EF \times ED}{AT \times 365 \text{ days/yr}}$$

AIR CONCENTRATION PARTICULATES = CS x 1/PEF

AIR CONCENTRATION VOLATILES = CS x 1/VF (VF is not calculated because no volatiles are selected as CPCs).

CARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m³/kg)	CAv (mg/m³)	CAp (mg/m³)		INTAKE (mg/kg–day)	INHALATION CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$	CANCER RISK	PERCENT TOTAL RISK
Arsenic	18	NA	NA	1.36E–08		8.8E–11	1.5E+01	1.3E–09	97.42%
Beryllium	0.85	NA	NA	6.44E–10		4.1E–12	8.4E+00	3.5E–11	2.58%
NA = Not applicable							SUMMARY CANCER RISK	1E–09	

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m³/kg)	CAv (mg/m³)	CAp (mg/m³)		AVERAGE DAILY CONCENTRATION (mg/m³)	INHALATION REFERENCE CONCENTRATION (mg/m³)	HAZARD QUOTIENT	PERCENT TOTAL RISK
Arsenic	18	NA	NA	1.36E–08		2.4E–09	ND		
Beryllium	0.85	NA	NA	6.44E–10		1.1E–10	2.0E–05	5.6E–06	0.87%
Iron	10300	NA	NA	7.80E–06		1.4E–06	ND		
Manganese	240	NA	NA	1.82E–07		3.2E–08	5.0E–05	6.4E–04	98.80%
Total Petroleum Hydrocarbons	936	NA	NA	7.09E–07		1.2E–07	6.0E–02	2.1E–06	0.32%
NA = Not applicable					SUMMARY HAZARD INDEX			0.0006	

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - RME SCENARIO
CURRENT AND FUTURE CHILD TRESPASSER (6-18 years) PLAYING IN GRASSY AREA
AOC 69W
FORT DEVENS, MA
TABLE 5

18-Aug-98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	MAXIMUM	chemical-specific	
INGESTION RATE	IR	100	mg-soil/day	USEPA, 1994
ADHERENCE FACTOR	AF	0.51	mg-soil/cm²-skin	MADEP, 1995
AVERAGE SURFACE AREA (1)	SA	5,053	cm²/day	calculated per MADEP, 1995
RELATIVE ABSORPTION FACTOR-ORAL	RAF-O	chemical specific	unitless	MADEP, 1994, 1995
RELATIVE ABSORPTION FACTOR -DERM	RAF-D	chemical specific	unitless	MADEP, 1994, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT (2)	BW	45	kg	calculated per MADEP, 1995
EXPOSURE PERIOD	EP	13	years	Assumption
EXPOSURE FREQUENCY (3)	EF	96	events/year	Assumption
EXPOSURE DURATION	ED	1	day/event	Assumption
AVERAGING PERIOD				
CANCER	AP	70	years	USEPA, 1989
NONCANCER	AP	13	years	Assumption

(1) 50th percentile of surface areas for males: head, hands, forearms, lower legs, feet.
(2) 50th percentile of body weights for males.

MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
MADEP, 1995. Guidance for Disposal Site Risk Characterization. Interim Final Policy WSC/ORS-95-141. July 1995.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{[\text{OHM}]\text{soil} \times \text{IR} \times \text{RAF-O} \times \text{CF} \times \text{EF} \times \text{ED} \times \text{EP}}{\text{BW} \times \text{AP} \times 365 \text{ days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{[\text{OHM}]\text{soil} \times \text{SA} \times \text{AF} \times \text{RAF-D} \times \text{EF} \times \text{ED} \times \text{EP} \times \text{CF}}{\text{BW} \times \text{AP} \times 365 \text{ days/yr}}$$

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - RME SCENARIO
CURRENT AND FUTURE CHILD TRESPASSER (6-18 years) PLAYING IN GRASSY AREA
AOC 69W
FORT DEVENS, MA
TABLE 5

18-Aug-98

CARCINOGENIC EFFECTS

	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	18	1.00	2.0E-06	0.03	1.5E-06	1.5E+00	2.9E-06	2.3E-06	5.2E-06
Beryllium	0.85	1.00	9.2E-08	0.03	7.1E-08	4.3E+00	4.0E-07	3.1E-07	7.0E-07
					SUMMARY CANCER RISK		3E-06	3E-06	6E-06

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Arsenic	18	1.00	1.1E-05	0.03	8.1E-06	3.0E-04	3.5E-02	2.7E-02	6.2E-02
Beryllium	0.85	1.00	5.0E-07	0.03	3.8E-07	2.0E-03	2.5E-04	1.9E-04	4.4E-04
Iron	10300	1.00	6.0E-03	0.03	4.7E-03	3.0E-01	2.0E-02	1.6E-02	3.6E-02
Manganese	240	1.00	1.4E-04	0.14	5.2E-04	4.7E-02	3.0E-03	1.1E-02	1.4E-02
Total Petroleum Hydrocarbons	936	1	5.5E-04	0.2	2.8E-03	3.0E-02	1.8E-02	9.4E-02	1.1E-01
					SUMMARY HAZARD INDEX		8E-02	1E-01	2E-01

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - CENTRAL TENDENCY
CURRENT AND FUTURE CHILD TRESPASSER (6-18 years) PLAYING IN GRASSY AREA
AOC 69W
FORT DEVENS, MA
TABLE 6

18-Aug-98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	MAXIMUM	chemical-specific	
INGESTION RATE	IR	50	mg-soil/day	USEPA, 1994
ADHERENCE FACTOR	AF	0.51	mg-soil/cm²-skin	MADEP, 1995
AVERAGE SURFACE AREA (1)	SA	5,053	cm²/day	calculated per MADEP, 1995
RELATIVE ABSORPTION FACTOR-ORAL	RAF-O	chemical specific	unitless	MADEP, 1994, 1995
RELATIVE ABSORPTION FACTOR -DERM	RAF-D	chemical specific	unitless	MADEP, 1994, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT (2)	BW	45	kg	calculated per MADEP, 1995
EXPOSURE PERIOD	EP	9	years	Assumption
EXPOSURE FREQUENCY (3)	EF	96	events/year	Assumption
EXPOSURE DURATION	ED	1	day/event	Assumption
AVERAGING PERIOD				
CANCER	AP	70	years	USEPA, 1989
NONCANCER	AP	9	years	Assumption

(1) 50th percentile of surface areas for males: head, hands, forearms, lower legs, feet
(2) 50th percentile of body weights for males.

MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
MADEP, 1995. Guidance for Disposal Site Risk Characterization. Interim Final Policy WSC/ORS-95-141. July 1995.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{\text{[OHM]soil x IR x RAF-O x CF x EF x ED x EP}}{\text{BW x AP x 365 days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{\text{[OHM]soil x SA x AF x RAF-D x EF x ED x EP x CF}}{\text{BW x AP x 365 days/yr}}$$

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - CENTRAL TENDENCY
CURRENT AND FUTURE CHILD TRESPASSER (6-18 years) PLAYING IN GRASSY AREA
AOC 69W
FORT DEVENS, MA
TABLE 6

18-Aug-98

CARCINOGENIC EFFECTS

	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	18	1.00	6.8E-07	0.03	1.0E-06	1.5E+00	1.0E-06	1.6E-06	2.6E-06
Beryllium	0.85	1.00	3.2E-08	0.03	4.9E-08	4.3E+00	1.4E-07	2.1E-07	3.5E-07
						SUMMARY CANCER RISK	1E-06	2E-06	3E-06

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Arsenic	18	1.00	5.3E-06	0.03	8.1E-06	3.0E-04	1.8E-02	2.7E-02	4.5E-02
Beryllium	0.85	1.00	2.5E-07	0.03	3.8E-07	2.0E-03	1.2E-04	1.9E-04	3.2E-04
Iron	10300	1.00	3.0E-03	0.03	4.7E-03	3.0E-01	1.0E-02	1.6E-02	2.6E-02
Manganese	240	1.00	7.0E-05	0.14	5.2E-04	4.7E-02	1.5E-03	1.1E-02	1.2E-02
Total Petroleum Hydrocarbons	936	1	2.7E-04	0.2	2.8E-03	3.0E-02	9.1E-03	9.4E-02	1.0E-01
						SUMMARY HAZARD INDEX	4E-02	1E-01	2E-01

TAE
INHALATION EXPOSURE TO PARTICULATES FROM SURFACE SOIL - RME SCENARIO
CURRENT AND FUTURE CHILD TRESPASSER (6-18 years)
AOC 69W
FORT DEVENS, MA

69WUCIM	19-Aug-98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS
CONCENTRATION SOIL	CS	Maximum	mg/kg
CONCENTRATION AIR PARTICULATES	CAp	Calculated	mg/m³
CONCENTRATION AIR VOLATILES	CAv	NA	mg/m³
VOLATILIZATION FACTOR	VF	see table	m³/kg
PARTICULATE EMISSIONS FACTOR	PEF	1.32E+09	m³/kg
INHALATION RATE	IhR	2.3	m³/hour
BODY WEIGHT	BW	70	kg
EXPOSURE TIME	ET	8	hours/day
EXPOSURE FREQUENCY	EF	64	days/year
EXPOSURE DURATION	ED	25	years
AVERAGING TIME			
CANCER	AT	70	years
NONCANCER	AT	25.00	years

Note:
For noncarcinogenic effects: AT = EF/365 days per year — NA - Not applicable
TPHC - Total Petroleum Hydrocarbons — ND - Value not determined

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR $(mg/kg-day)^{-1}$

$$\text{INTAKE} = \frac{(CAp + CAv) \times IhR \times ET \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

HAZARD QUOTIENT = AVERAGE DAILY CONCENTRATION (mg/m^3) / REFERENCE CONCENTRATION (mg/m^3)

$$\text{AVERAGE DAILY CONCENTRATION} = \frac{(CAp + CAv) \times EF \times ED}{AT \times 365 \text{ days/yr}}$$

AIR CONCENTRATION PARTICULATES = CS x 1/PEF

AIR CONCENTRATION VOLATILES = CS x 1/VF

CARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m³/kg)	CAv (mg/m³)	CAp (mg/m³)		INTAKE (mg/kg-day)	INHALATION CANCER SLOPE FACTOR $(mg/kg-day)^{-1}$	CANCER RISK	PERCENT TOTAL RISK
Surface Soil									
Arsenic	18	NA	NA	1.36E-08		2.2E-10	1.5E+01	3.4E-09	97.42%
Beryllium	0.85	NA	NA	6.44E-10		1.1E-11	8.4E+00	8.9E-11	2.58%
NA = Not applicable							SUMMARY CANCER RISK	3E-09	

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m³/kg)	CAv (mg/m³)	CAp (mg/m³)		AVERAGE DAILY CONCENTRATION (mg/m³)	INHALATION REFERENCE CONCENTRATION (mg/m³)	HAZARD QUOTIENT	PERCENT TOTAL RISK
Surface Soil									
Arsenic	18	NA	NA	1.36E-08		2.4E-09	ND		
Beryllium	0.85	NA	NA	6.44E-10		1.1E-10	2.0E-05	5.6E-06	0.85%
Iron	10700	NA	NA	8.11E-06		1.4E-06	ND		
Manganese	249	NA	NA	1.89E-07		3.3E-08	5.0E-05	6.6E-04	99.15%
TPHC	936	NA	NA	7.09E-07		1.2E-07	6.0E-02	2.1E-06	0.31%
NA = Not applicable						SUMMARY HAZARD INDEX		6.7E-04	

TAB.
INHALATION EXPOSURE TO PARTICULATES FROM SURFACE SOIL – CENTRAL TENDENCY
CURRENT AND FUTURE CHILD TRESPASSER (6–18 years)
AOC 69W
FORT DEVENS, MA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS
CONCENTRATION SOIL	CS	Maximum	mg/kg
CONCENTRATION AIR PARTICULATES	CAp	Calculated	mg/m^3
CONCENTRATION AIR VOLATILES	CAv	NA	mg/m^3
VOLATILIZATION FACTOR	VF	see table	m^3/kg
PARTICULATE EMISSIONS FACTOR	PEF	1.32E+09	m^3/kg
INHALATION RATE	IhR	2	m^3/hour
BODY WEIGHT	BW	70	kg
EXPOSURE TIME	ET	8	hours/day
EXPOSURE FREQUENCY	EF	64	days/year
EXPOSURE DURATION	ED	9	years
AVERAGING TIME			
CANCER	AT	70	years
NONCANCER	AT	9.00	years

Note:
For noncarcinogenic effects: AT = EF/365 days per year
NA – Not applicable
TPHC – Total Petroleum Hydrocarbons
ND – Value not determined

EQUATIONS

CANCER RISK = INTAKE (mg/kg–day) x CANCER SLOPE FACTOR $(mg/kg-day)^{-1}$

$$\text{INTAKE} = \frac{(CAp + CAv) \times IhR \times ET \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

HAZARD QUOTIENT = AVERAGE DAILY CONCENTRATION (mg/m^3) / REFERENCE CONCENTRATION (mg/m^3)

$$\text{AVERAGE DAILY CONCENTRATION} = \frac{(CAp + CAv) \times EF \times ED}{AT \times 365 \text{ days/yr}}$$

AIR CONCENTRATION PARTICULATES = CS x 1/PEF

AIR CONCENTRATION VOLATILES = CS x 1/VF

CARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m^3/kg)	CAv (mg/m^3)	CAp (mg/m^3)		INTAKE (mg/kg–day)	INHALATION CANCER SLOPE FACTOR $(mg/kg-day)^{-1}$	CANCER RISK	PERCENT TOTAL RISK
Surface Soil									
Arsenic	18	NA	NA	1.36E–08		7.0E–11	1.5E+01	1.1E–09	97.42%
Beryllium	0.85	NA	NA	6.44E–10		3.3E–12	8.4E+00	2.8E–11	2.58%
NA = Not applicable							SUMMARY CANCER RISK	1E–09	

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m^3/kg)	CAv (mg/m^3)	CAp (mg/m^3)		AVERAGE DAILY CONCENTRATION (mg/m^3)	INHALATION REFERENCE CONCENTRATION (mg/m^3)	HAZARD QUOTIENT	PERCENT TOTAL RISK
Surface Soil									
Arsenic	18	NA	NA	1.36E–08		2.4E–09	ND		
Beryllium	0.85	NA	NA	6.44E–10		1.1E–10	2.0E–05	5.6E–06	0.85%
Iron	10700	NA	NA	8.11E–06		1.4E–06	ND		
Manganese	249	NA	NA	1.89E–07		3.3E–08	5.0E–05	6.6E–04	99.15%
TPHC	936	NA	NA	7.09E–07		1.2E–07	6.0E–02	2.1E–06	0.31%
NA = Not applicable						SUMMARY HAZARD INDEX		6.7E–04	

TRSDIDED
EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SEDIMENT - RME SCENARIO
CURRENT AND FUTURE CHILD TRESPASSER (6-18 years) WADING IN WETLAND AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA
8

18-Aug-98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SEDIMENT	$[OHM]_{sediment}$	chemical specific	chemical-specific	
INGESTION RATE	IR	100	mg-sediment/day	USEPA, 1994
ADHERENCE FACTOR	AF	0.51	mg-sediment/cm²-skin	MADEP, 1995
AVERAGE SURFACE AREA (1)	SA	5,053	cm²/day	calculated per MADEP, 1995
RELATIVE ABSORPTION FACTOR-ORAL	RAF-O	chemical specific	unitless	MADEP, 1994, 1995
RELATIVE ABSORPTION FACTOR -DERM	RAF-D	chemical specific	unitless	MADEP, 1994, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT (2)	BW	45	kg	calculated per MADEP, 1995
EXPOSURE PERIOD	EP	13	years	Assumption
EXPOSURE FREQUENCY (3)	EF	24	events/year	Assumption
EXPOSURE DURATION	ED	1	day/event	Assumption
AVERAGING PERIOD				
CANCER	AP	70	years	USEPA, 1989
NONCANCER	AP	13	years	Assumption

(1) 50th percentile of surface areas for males aged 6 through 18 years: head, hands, forearms, lower legs, feet.
(2) 50th percentile of body weights for males aged 6 through 18 years.

MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
MADEP, 1995. Guidance for Disposal Site Risk Characterization. Interim Final Policy WSC/ORS-95-141. July 1995.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{[OHM]sediment \times IR \times RAF\text{-}O \times CF \times EF \times ED \times EP}{BW \times AP \times 365\ days/yr}$$

$$\text{INTAKE-DERMAL} = \frac{[OHM]sediment \times SA \times AF \times RAF\text{-}D \times EF \times ED \times EP \times CF}{BW \times AP \times 365\ days/yr}$$

TRSDIDED
EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SEDIMENT - RME SCENARIO
CURRENT AND FUTURE CHILD TRESPASSER (6-18 years) WADING IN WETLAND AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA
8

19-Aug-98

CARCINOGENIC EFFECTS

COMPOUND	SEDIMENT CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	14	1.00	3.8E-07	0.03	2.9E-07	1.5E+00	5.7E-07	4.4E-07	1.0E-06
					SUMMARY CANCER RISK		6E-07	4E-07	1E-06

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

NONCARCINOGENIC EFFECTS (CONTINUED)

COMPOUND	SEDIMENT CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Arsenic	14	1.00	2.0E-06	0.03	1.6E-06	3.0E-04	6.8E-03	5.3E-03	1.2E-02
Iron	10900	1.00	1.6E-03	0.03	1.2E-03	3.0E-01	5.3E-03	4.1E-03	9.4E-03
Manganese	186	1.00	2.7E-05	0.14	1.0E-04	4.7E-02	5.8E-04	2.1E-03	2.7E-03
Total Petroleum Hydrocarbons	290	1.00	4.2E-05	0.20	2.2E-04	3.0E-02	1.4E-03	7.3E-03	8.7E-03
					SUMMARY HAZARD INDEX		3E-02	4E-02	7E-02

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

TRSDIDED
EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SEDIMENT - CENTRAL TENDENCY
CURRENT AND FUTURE CHILD TRESPASSER (6-18 years) WADING IN WETLAND AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA
9

18-Aug-98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SEDIMENT	$[OHM]_{sediment}$	chemical specific	chemical-specific	
INGESTION RATE	IR	50	mg-sediment/day	USEPA, 1994
ADHERENCE FACTOR	AF	0.51	mg-sediment/cm²-skin	MADEP, 1995
AVERAGE SURFACE AREA (1)	SA	5,053	cm²/day	calculated per MADEP, 1995
RELATIVE ABSORPTION FACTOR-ORAL	RAF-O	chemical specific	unitless	MADEP, 1994, 1995
RELATIVE ABSORPTION FACTOR -DERM	RAF-D	chemical specific	unitless	MADEP, 1994, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT (2)	BW	45	kg	calculated per MADEP, 1995
EXPOSURE PERIOD	EP	9	years	Assumption
EXPOSURE FREQUENCY	EF	24	events/year	Assumption
EXPOSURE DURATION	ED	1	day/event	Assumption
AVERAGING PERIOD				
CANCER	AP	70	years	USEPA, 1989
NONCANCER	AP	9	years	Assumption

(1) 50th percentile of surface areas for males aged 6 through 18 years: head, hands, forearms, lower legs, feet.
(2) 50th percentile of body weights for males aged 6 through 18 years.

MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
MADEP, 1995. Guidance for Disposal Site Risk Characterization. Interim Final Policy WSC/ORS-95-141. July 1995.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{[OHM]sediment \times IR \times RAF\text{-}O \times CF \times EF \times ED \times EP}{BW \times AP \times 365\ days/yr}$$

$$\text{INTAKE-DERMAL} = \frac{[OHM]sediment \times SA \times AF \times RAF\text{-}D \times EF \times ED \times EP \times CF}{BW \times AP \times 365\ days/yr}$$

TRSDIDED
EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SEDIMENT - CENTRAL TENDENCY
CURRENT AND FUTURE CHILD TRESPASSER (6-18 years) WADING IN WETLAND AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA
9

18-Aug-98

CARCINOGENIC EFFECTS

COMPOUND	SEDIMENT CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	14	1.00	1.3E-07	0.03	2.0E-07	1.5E+00	2.0E-07	3.1E-07	5.0E-07
SUMMARY CANCER RISK							2E-07	3E-07	5E-07

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

NONCARCINOGENIC EFFECTS (CONTINUED)

COMPOUND	SEDIMENT CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Arsenic	14	1.00	1.0E-06	0.03	1.6E-06	3.0E-04	3.4E-03	5.3E-03	8.7E-03
Iron	10900	1.00	8.0E-04	0.03	1.2E-03	3.0E-01	2.7E-03	4.1E-03	6.8E-03
Manganese	186	1.00	1.4E-05	0.14	1.0E-04	4.7E-02	2.9E-04	2.1E-03	2.4E-03
Total Petroleum Hydrocarbons	290	1.00	2.1E-05	0.20	2.2E-04	3.0E-02	7.1E-04	7.3E-03	8.0E-03
SUMMARY HAZARD INDEX							1E-02	4E-02	6E-02

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

TABLE 10

INCIDENTAL INGESTION OF AND DERMAL CONTACT WITH GROUNDWATER DISCHARGING TO SURFACE WATER - RME SCENARIO
CURRENT AND FUTURE TRESPASSER CHILD TRESPASSER (6-16 Years) WADING IN THE WETLANDS AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA
EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS
CONCENTRATION WATER	CW	Maximum	mg/liter
INGESTION RATE	IR	0.05	liters/hour
SURFACE AREA EXPOSED	SA	5,053	cm^2/day
CONVERSION FACTOR	CF	0.001	liter/cm□u3□
BODY WEIGHT	BW	45	kg
EXPOSURE TIME	ET	2.6	hours/day
EXPOSURE FREQUENCY	EF	24	days/year
EXPOSURE DURATION	ED	13	years
AVERAGING TIME			
CANCER	AT	70	years
NONCANCER	AT	13	years
PERMEABILITY COEFFICIENT	Kpevent	Chemical-specific	cm/day

Notes:
For noncarcinogenic effects: AT = ED
ND - Value not determined
TPHC - Total Petroleum Hydrocarbons

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)□u-1□

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

INTAKE = (INTAKE-INGESTION) + (INTAKE-DERMAL)

INTAKE-INGESTION = CW x IR x ET x EF x ED / BW x AT x 365 days/yr

INTAKE-DERMAL = CW x K□lpevent□ x SA x CF x EF x ED / BW x AT x 365 days/yr

TABLE 10

INCIDENTAL INGESTION OF AND DERMAL CONTACT WITH GROUNDWATER DISCHARGING TO SURFACE WATER - RME SCENARIO
CURRENT AND FUTURE TRESPASSER CHILD TRESPASSER (6-16 Years) WADING IN THE WETLANDS AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA
CARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATIO (mg/L)	INTAKE INGESTION (mg/kg-day)	ERMEABILIT COEFFICIENT (cm/day)	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR ORAL (mg/kg-day)-1	DERMAL (mg/kg-day)-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK	PERCENT TOTAL RISK
Bis(2-ethylhexyl)phthalate	0.05	1.8E-06	6.7E-01	4.6E-05	1.4E-02	1.4E-02	2.5E-08	6.4E-07	6.7E-07	21.97%
Arsenic	0.04	1.4E-06	2.6E-03	1.4E-07	1.5E+00	1.5E+00	2.1E-06	2.1E-07	2.3E-06	76.67%
Chloroform	0.00034	1.2E-08	4.6E-01	2.1E-07	6.0E-03	6.0E-03	7.2E-11	1.3E-09	1.4E-09	0.04%
Trichloroethylene	0.0033	1.2E-07	8.6E-01	3.9E-06	1.0E-02	1.0E-02	1.2E-09	3.9E-08	4.0E-08	1.32%
					SUMMARY CANCER RISK		2E-06	9E-07	3E-06	

NONCARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATIO (mg/L)	INTAKE INGESTION (mg/kg-day)	ERMEABILIT COEFFICIENT (cm/day)	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE ORAL (mg/kg-day)	DERMAL (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT	PERCENT TOTAL RISK
2-Methylnaphthalene	0.06	1.1E-05	7.7E-01	3.4E-04	4.0E-02	4.0E-02	2.85E-04	8.53E-03	8.8E-03	4.38%
Bis(2-ethylhexyl)phthalate	0.05	9.5E-06	6.7E-01	2.5E-04	2.0E-02	2.0E-02	4.75E-04	1.24E-02	1.3E-02	6.39%
Naphthalene	0.021	4.0E-06	2.8E-01	4.3E-05	4.0E-02	4.0E-02	9.97E-05	1.09E-03	1.2E-03	0.59%
Phenanthrene	0.015	2.8E-06	1.1E+00	1.2E-04	4.0E-02	4.0E-02	7.12E-05	3.05E-03	3.1E-03	1.55%
Aluminum	0.2	3.8E-05	2.6E-03	3.8E-06	1.0E+00	2.0E-01	3.80E-05	1.92E-05	5.7E-05	0.03%
Arsenic	0.04	7.6E-06	2.6E-03	7.7E-07	3.0E-04	2.9E-04	2.53E-02	2.65E-03	2.8E-02	13.92%
Iron	5.2	9.9E-04	2.6E-03	1.0E-04	3.0E-01	6.0E-03	3.29E-03	1.66E-02	2.0E-02	9.92%
Manganese	0.66	1.3E-04	2.6E-03	1.3E-05	2.4E-02	9.6E-04	5.22E-03	1.32E-02	1.8E-02	9.17%
Chloroform	0.00034	6.5E-08	4.6E-01	1.2E-06	1.0E-02	1.0E-02	6.46E-06	1.15E-04	1.2E-04	0.06%
Trichloroethylene	0.0005	9.5E-08	8.6E-01	3.2E-06	6.0E-03	6.0E-03	1.58E-05	5.29E-04	5.4E-04	0.27%
EPH										
C9-C18 Aliphatics	0.15	2.8E-05	2.9E+00	3.2E-03	6.0E-01	3.0E-01	4.75E-05	1.07E-02	1.1E-02	5.35%
C10-C22 Aromatics	0.053	1.0E-05	2.9E+00	1.1E-03	3.0E-02	2.7E-02	3.36E-04	4.20E-02	4.2E-02	21.08%
VPH										
C5-C8 Aliphatics	0.02	3.8E-06	8.1E-01	1.2E-04	6.0E-02	4.8E-02	6.33E-05	2.49E-03	2.6E-03	1.27%
C9-C12 Aliphatics	0.061	1.2E-05	2.9E+00	1.3E-03	6.0E-01	4.8E-01	1.93E-05	2.72E-03	2.7E-03	1.36%
C9-C10 Aromatics	0.062	1.2E-05	2.9E+00	1.3E-03	3.0E-02	2.7E-02	3.93E-04	4.92E-02	5.0E-02	24.66%
					SUMMARY HAZARD INDEX		0.04	0.17	0.20	

TABLE 11

INCIDENTAL INGESTION OF AND DERMAL CONTACT WITH GROUNDWATER DISCHARGING TO SURFACE WATER - CENTRAL TENDENCY
CURRENT AND FUTURE TRESPASSER CHILD TRESPASSER (6-16 Years) WADING IN THE WETLANDS AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS
CONCENTRATION WATER	CW	Average	mg/liter
INGESTION RATE	IR	0.025	liters/hour
SURFACE AREA EXPOSED	SA	5,053	cm^2/day
CONVERSION FACTOR	CF	0.001	liter/cm□u3□
BODY WEIGHT	BW	45	kg
EXPOSURE TIME	ET	2.6	hours/day
EXPOSURE FREQUENCY	EF	24	days/year
EXPOSURE DURATION	ED	9	years
AVERAGING TIME			
CANCER	AT	70	years
NONCANCER	AT	9	years
PERMEABILITY COEFFICIENT	Kpevent	Chemical-specific	cm/day

Notes:
For noncarcinogenic effects: AT = ED
ND - Value not determined
TPHC - Total Petroleum Hydrocarbons

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)□u-1□

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

INTAKE = (INTAKE-INGESTION) + (INTAKE-DERMAL)

$$\text{INTAKE-INGESTION} = \frac{CW \times IR \times ET \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{CW \times K\square lpevent\square \times SA \times CF \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

TABLE 11

INCIDENTAL INGESTION OF AND DERMAL CONTACT WITH GROUNDWATER DISCHARGING TO SURFACE WATER - CENTRAL TENDENCY
CURRENT AND FUTURE TRESPASSER CHILD TRESPASSER (6-16 Years) WADING IN THE WETLANDS AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA
CARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATIO (mg/L)	INTAKE INGESTION (mg/kg-day)	ERMEABILIT COEFFICIENT (cm/day)	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR ORAL (mg/kg-day)□u-1□	DERMAL (mg/kg-day)□u-1□	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK	PERCENT TOTAL RISK
Bis(2-ethylhexyl)phthalate	0.05	6.1E-07	6.7E-01	3.2E-05	1.4E-02	1.4E-02	8.5E-09	4.5E-07	4.5E-07	33.88%
Arsenic	0.04	4.9E-07	2.6E-03	9.9E-08	1.5E+00	1.5E+00	7.3E-07	1.5E-07	8.8E-07	65.75%
Chloroform	0.0003	3.7E-09	4.6E-01	1.3E-07	6.0E-03	6.0E-03	2.2E-11	7.8E-10	8.1E-10	0.06%
Trichloroethylene	0.0005	6.1E-09	8.6E-01	4.1E-07	1.0E-02	1.0E-02	6.1E-11	4.1E-09	4.1E-09	0.31%
					SUMMARY CANCER RISK		7E-07	6E-07	1E-06	

NONCARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATIO (mg/L)	INTAKE INGESTION (mg/kg-day)	ERMEABILIT COEFFICIENT (cm/day)	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE ORAL (mg/kg-day)	DERMAL (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT	PERCENT TOTAL RISK
2-Methylnaphthalene	0.06	5.7E-06	7.7E-01	3.4E-04	4.0E-02	4.0E-02	1.42E-04	8.53E-03	8.7E-03	4.45%
Bis(2-ethylhexyl)phthalate	0.05	4.7E-06	6.7E-01	2.5E-04	2.0E-02	2.0E-02	2.37E-04	1.24E-02	1.3E-02	6.47%
Naphthalene	0.02	1.9E-06	2.8E-01	4.1E-05	4.0E-02	4.0E-02	4.75E-05	1.03E-03	1.1E-03	0.55%
Phenanthrene	0.015	1.4E-06	1.1E+00	1.2E-04	4.0E-02	4.0E-02	3.56E-05	3.05E-03	3.1E-03	1.58%
Aluminum	0.2	1.9E-05	2.6E-03	3.8E-06	1.0E+00	2.0E-01	1.90E-05	1.92E-05	3.8E-05	0.02%
Arsenic	0.04	3.8E-06	2.6E-03	7.7E-07	3.0E-04	2.9E-04	1.27E-02	2.65E-03	1.5E-02	7.85%
Iron	5.2	4.9E-04	2.6E-03	1.0E-04	3.0E-01	6.0E-03	1.65E-03	1.66E-02	1.8E-02	9.38%
Manganese	0.66	6.3E-05	2.6E-03	1.3E-05	2.4E-02	9.6E-04	2.61E-03	1.32E-02	1.6E-02	8.11%
Chloroform	0.0003	2.8E-08	4.6E-01	1.0E-06	1.0E-02	1.0E-02	2.85E-06	1.02E-04	1.0E-04	0.05%
Trichloroethylene	0.0005	4.7E-08	8.6E-01	3.2E-06	6.0E-03	6.0E-03	7.91E-06	5.29E-04	5.4E-04	0.28%
EPH										
C9-C18 Aliphatics	0.15	1.4E-05	2.9E+00	3.2E-03	6.0E-01	3.0E-01	2.37E-05	1.07E-02	1.1E-02	5.50%
C10-C22 Aromatics	0.05	4.7E-06	2.9E+00	1.1E-03	3.0E-02	2.7E-02	1.58E-04	3.97E-02	4.0E-02	20.42%
VPH										
C5-C8 Aliphatics	0.02	1.9E-06	8.1E-01	1.2E-04	6.0E-02	4.8E-02	3.17E-05	2.49E-03	2.5E-03	1.29%
C9-C12 Aliphatics	0.06	5.7E-06	2.9E+00	1.3E-03	6.0E-01	4.8E-01	9.50E-06	2.68E-03	2.7E-03	1.38%
C9-C10 Aromatics	0.08	7.6E-06	2.9E+00	1.7E-03	3.0E-02	2.7E-02	2.53E-04	6.34E-02	6.4E-02	32.67%
					SUMMARY HAZARD INDEX		0.02	0.2	0.2	

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - RME SCENARIO
FUTURE PUPIL (6-18 years) PLAYING IN GRASSY AREA
AOC 69W
FORT DEVENS, MA
TABLE 12

18-Aug-98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	MAXIMUM	chemical-specific	
INGESTION RATE	IR	100	mg-soil/day	USEPA, 1994
ADHERENCE FACTOR	AF	0.51	mg-soil/cm²-skin	MADEP, 1995
AVERAGE SURFACE AREA (1)	SA	5,053	cm²/day	calculated per MADEP, 1995
RELATIVE ABSORPTION FACTOR-ORAL	RAF-O	chemical specific	unitless	MADEP, 1994, 1995
RELATIVE ABSORPTION FACTOR -DERM	RAF-D	chemical specific	unitless	MADEP, 1994, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT (2)	BW	45	kg	calculated per MADEP, 1995
EXPOSURE PERIOD	EP	13	years	Assumption
EXPOSURE FREQUENCY	EF	140	events/year	Assumption
EXPOSURE DURATION	ED	1	day/event	Assumption
AVERAGING PERIOD				
CANCER	AP	70	years	USEPA, 1989
NONCANCER	AP	13	years	Assumption

(1) 50th percentile of surface areas for males: head, hands, forearms, lower legs, feet
(2) 50th percentile of body weights for males.

MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
MADEP, 1995. Guidance for Disposal Site Risk Characterization. Interim Final Policy WSC/ORS-95-141. July 1995.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

INTAKE-INGESTION = $\dfrac{\text{[OHM]soil x IR x RAF-O x CF x EF x ED x EP}}{\text{BW x AP x 365 days/yr}}$

INTAKE-DERMAL = $\dfrac{\text{[OHM]soil x SA x AF x RAF-D x EF x ED x EP x CF}}{\text{BW x AP x 365 days/yr}}$

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - RME SCENARIO
FUTURE PUPIL (6-18 years) PLAYING IN GRASSY AREA
AOC 69W
FORT DEVENS, MA
TABLE 12

18-Aug-98

CARCINOGENIC EFFECTS

	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	18	1.00	2.8E-06	0.03	2.2E-06	1.5E+00	4.3E-06	3.3E-06	7.6E-06
Beryllium	0.85	1.00	1.3E-07	0.03	1.0E-07	4.3E+00	5.8E-07	4.5E-07	1.0E-06
						SUMMARY CANCER RISK	5E-06	4E-06	9E-06

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Arsenic	18	1.00	1.5E-05	0.03	1.2E-05	3.0E-04	5.1E-02	4.0E-02	9.1E-02
Beryllium	0.85	1.00	7.2E-07	0.03	5.6E-07	2.0E-03	3.6E-04	2.8E-04	6.4E-04
Iron	10300	1.00	8.8E-03	0.03	6.8E-03	3.0E-01	2.9E-02	2.3E-02	5.2E-02
Manganese	240	1.00	2.0E-04	0.14	7.5E-04	4.7E-02	4.4E-03	1.6E-02	2.0E-02
Total Petroleum Hydrocarbons	936	1	8.0E-04	0.2	4.1E-03	3.0E-02	2.7E-02	1.4E-01	1.6E-01
						SUMMARY HAZARD INDEX	1E-01	2E-01	3E-01

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - CENTRAL TENDENCY
FUTURE PUPIL (6-18 years) PLAYING IN GRASSY AREA
AOC 69W
FORT DEVENS, MA
TABLE 13

19-Aug-98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	MAXIMUM	chemical-specific	
INGESTION RATE	IR	50	mg-soil/day	USEPA, 1994
ADHERENCE FACTOR	AF	0.51	mg-soil/cm²-skin	MADEP, 1995
AVERAGE SURFACE AREA (1)	SA	5,053	cm²/day	calculated per MADEP, 1995
RELATIVE ABSORPTION FACTOR-ORAL	RAF-O	chemical specific	unitless	MADEP, 1994, 1995
RELATIVE ABSORPTION FACTOR -DERM	RAF-D	chemical specific	unitless	MADEP, 1994, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT (2)	BW	45	kg	calculated per MADEP, 1995
EXPOSURE PERIOD	EP	9	years	Assumption
EXPOSURE FREQUENCY	EF	140	events/year	Assumption
EXPOSURE DURATION	ED	1	day/event	Assumption
AVERAGING PERIOD				
CANCER	AP	70	years	USEPA, 1989
NONCANCER	AP	9	years	Assumption

(1) 50th percentile of surface areas for males: head, hands, forearms, lower legs, feet.
(2) 50th percentile of body weights for males.

MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
MADEP, 1995. Guidance for Disposal Site Risk Characterization. Interim Final Policy WSC/ORS-95-141. July 1995.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{[\text{OHM}]_{\text{soil}} \times \text{IR} \times \text{RAF-O} \times \text{CF} \times \text{EF} \times \text{ED} \times \text{EP}}{\text{BW} \times \text{AP} \times 365\ \text{days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{[\text{OHM}]_{\text{soil}} \times \text{SA} \times \text{AF} \times \text{RAF-D} \times \text{EF} \times \text{ED} \times \text{EP} \times \text{CF}}{\text{BW} \times \text{AP} \times 365\ \text{days/yr}}$$

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - CENTRAL TENDENCY
FUTURE PUPIL (6-18 years) PLAYING IN GRASSY AREA
AOC 69W
FORT DEVENS, MA
TABLE 13

18-Aug-98

CARCINOGENIC EFFECTS

	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	18	1.00	9.9E-07	0.03	1.5E-06	1.5E+00	1.5E-06	2.3E-06	3.8E-06
Beryllium	0.85	1.00	4.7E-08	0.03	7.2E-08	4.3E+00	2.0E-07	3.1E-07	5.1E-07
						SUMMARY CANCER RISK	2E-06	3E-06	4E-06

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Arsenic	18	1.00	7.7E-06	0.03	1.2E-05	3.0E-04	2.6E-02	4.0E-02	6.5E-02
Beryllium	0.85	1.00	3.6E-07	0.03	5.6E-07	2.0E-03	1.8E-04	2.8E-04	4.6E-04
Iron	10300	1.00	4.4E-03	0.03	6.8E-03	3.0E-01	1.5E-02	2.3E-02	3.7E-02
Manganese	240	1.00	1.0E-04	0.14	7.5E-04	4.7E-02	2.2E-03	1.6E-02	1.8E-02
Total Petroleum Hydrocarbons	936	1	4.0E-04	0.2	4.1E-03	3.0E-02	1.3E-02	1.4E-01	1.5E-01
						SUMMARY HAZARD INDEX	6E-02	2E-01	3E-01

TA.
INHALATION EXPOSURE TO PARTICULATES FROM SURFACE SOIL - RME SCENARIO
FUTURE PUPIL
AOC 69W
FORT DEVENS, MA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS
CONCENTRATION SOIL	CS	Maximum	mg/kg
CONCENTRATION AIR PARTICULATES	CAp	Calculated	mg/m³
CONCENTRATION AIR VOLATILES	CAv	NA	mg/m³
VOLATILIZATION FACTOR	VF	see table	m³/kg
PARTICULATE EMISSIONS FACTOR	PEF	1.32E+09	m³/kg
INHALATION RATE	IhR	2.3	m³/hour
BODY WEIGHT	BW	45	kg
EXPOSURE TIME	ET	8	hours/day
EXPOSURE FREQUENCY	EF	140	days/year
EXPOSURE DURATION	ED	13	years
AVERAGING TIME			
CANCER	AT	70	years
NONCANCER	AT	13.00	years

Note:
For noncarcinogenic effects: AT = EF/365 days per year — NA - Not applicable
TPHC - Total Petroleum Hydrocarbons — ND - Value not determined

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR $(mg/kg-day)^{-1}$

$$\text{INTAKE} = \frac{(CAp + CAv) \times IhR \times ET \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

HAZARD QUOTIENT = AVERAGE DAILY CONCENTRATION (mg/m^3) / REFERENCE CONCENTRATION (mg/m^3)

$$\text{AVERAGE DAILY CONCENTRATION} = \frac{(CAp + CAv) \times EF \times ED}{AT \times 365\ days/yr}$$

AIR CONCENTRATION PARTICULATES = CS x 1/PEF

AIR CONCENTRATION VOLATILES = CS x 1/VF

CARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m³/kg)	CAv (mg/m³)	CAp (mg/m³)		INTAKE (mg/kg-day)	INHALATION CANCER SLOPE FACTOR (mg/kg-day)⁻¹	CANCER RISK	PERCENT TOTAL RISK
Surface Soil									
Arsenic	18	NA	NA	1.36E-08		4.0E-10	1.5E+01	6.0E-09	97.42%
Beryllium	0.85	NA	NA	6.44E-10		1.9E-11	8.4E+00	1.6E-10	2.58%
NA = Not applicable							SUMMARY CANCER RISK	6E-09	

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m³/kg)	CAv (mg/m³)	CAp (mg/m³)		AVERAGE DAILY CONCENTRATION (mg/m³)	INHALATION REFERENCE CONCENTRATION (mg/m³)	HAZARD QUOTIENT	PERCENT TOTAL RISK
Surface Soil									
Arsenic	18	NA	NA	1.36E-08		5.2E-09	ND		
Beryllium	0.85	NA	NA	6.44E-10		2.5E-10	2.0E-05	1.2E-05	0.85%
Iron	10700	NA	NA	8.11E-06		3.1E-06	ND		
Manganese	249	NA	NA	1.89E-07		7.2E-08	5.0E-05	1.4E-03	99.15%
TPHC	936	NA	NA	7.09E-07		2.7E-07	6.0E-02	4.5E-06	0.31%
NA = Not applicable						SUMMARY HAZARD INDEX		1.5E-03	

TA:
INHALATION EXPOSURE TO PARTICULATES FROM SURFACE SOIL – CENTRAL TENDENCY
FUTURE PUPIL
AOC 69W
FORT DEVENS, MA

69WUCIM	18-Aug-98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS
CONCENTRATION SOIL	CS	Maximum	mg/kg
CONCENTRATION AIR PARTICULATES	CAp	Calculated	mg/m^3
CONCENTRATION AIR VOLATILES	CAv	NA	mg/m^3
VOLATILIZATION FACTOR	VF	see table	m^3/kg
PARTICULATE EMISSIONS FACTOR	PEF	1.32E+09	m^3/kg
INHALATION RATE	IhR	2	m^3/hour
BODY WEIGHT	BW	45	kg
EXPOSURE TIME	ET	8	hours/day
EXPOSURE FREQUENCY	EF	140	days/year
EXPOSURE DURATION	ED	9	years
AVERAGING TIME			
CANCER	AT	70	years
NONCANCER	AT	9.00	years

Note:
For noncarcinogenic effects: AT = EF/365 days per year
NA – Not applicable
TPHC – Total Petroleum Hydrocarbons
ND – Value not determined

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR $(mg/kg-day)^{-1}$

INTAKE = $\frac{(CAp + CAv) \times IhR \times ET \times EF \times ED}{BW \times AT \times 365\ days/yr}$

HAZARD QUOTIENT = AVERAGE DAILY CONCENTRATION (mg/m^3) / REFERENCE CONCENTRATION (mg/m^3)

AVERAGE DAILY CONCENTRATION = $\frac{(CAp + CAv) \times EF \times ED}{AT \times 365\ days/yr}$

AIR CONCENTRATION PARTICULATES = CS x 1/PEF

AIR CONCENTRATION VOLATILES = CS x 1/VF

CARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m^3/kg)	CAv (mg/m^3)	CAp (mg/m^3)		INTAKE (mg/kg-day)	INHALATION CANCER SLOPE FACTOR $(mg/kg-day)^{-1}$	CANCER RISK	PERCENT TOTAL RISK
Surface Soil									
Arsenic	18	NA	NA	1.36E-08		2.4E-10	1.5E+01	3.6E-09	97.42%
Beryllium	0.85	NA	NA	6.44E-10		1.1E-11	8.4E+00	9.5E-11	2.58%
NA = Not applicable							SUMMARY CANCER RISK	4E-09	

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m^3/kg)	CAv (mg/m^3)	CAp (mg/m^3)		AVERAGE DAILY CONCENTRATION (mg/m^3)	INHALATION REFERENCE CONCENTRATION (mg/m^3)	HAZARD QUOTIENT	PERCENT TOTAL RISK
Surface Soil									
Arsenic	18	NA	NA	1.36E-08		5.2E-09	ND		
Beryllium	0.85	NA	NA	6.44E-10		2.5E-10	2.0E-05	1.2E-05	0.85%
Iron	10700	NA	NA	8.11E-06		3.1E-06	ND		
Manganese	249	NA	NA	1.89E-07		7.2E-08	5.0E-05	1.4E-03	99.15%
TPHC	936	NA	NA	7.09E-07		2.7E-07	6.0E-02	4.5E-06	0.31%
NA = Not applicable						SUMMARY HAZARD INDEX		1.5E-03	

TRSDIDED
EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SEDIMENT - RME SCENARIO
FUTURE PUPIL (6-18 years) WADING IN WETLAND AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA
16

18-Aug-98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SEDIMENT	$[OHM]_{sediment}$	chemical specific	chemical-specific	
INGESTION RATE	IR	100	mg-sediment/day	USEPA, 1994
ADHERENCE FACTOR	AF	0.51	mg-sediment/cm²-skin	MADEP, 1995
AVERAGE SURFACE AREA (1)	SA	5,053	cm²/day	calculated per MADEP, 1995
RELATIVE ABSORPTION FACTOR-ORAL	RAF-O	chemical specific	unitless	MADEP, 1994, 1995
RELATIVE ABSORPTION FACTOR -DERM	RAF-D	chemical specific	unitless	MADEP, 1994, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT (2)	BW	45	kg	calculated per MADEP, 1995
EXPOSURE PERIOD	EP	13	years	Assumption
EXPOSURE FREQUENCY (3)	EF	24	events/year	Assumption
EXPOSURE DURATION	ED	1	day/event	Assumption
AVERAGING PERIOD				
CANCER	AP	70	years	USEPA, 1989
NONCANCER	AP	13	years	Assumption

(1) 50th percentile of surface areas for males aged 6 through 18 years: head, hands, forearms, lower legs, feet.
(2) 50th percentile of body weights for males aged 6 through 18 years.
(3) 2 events per month, June through August.
MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
MADEP, 1995. Guidance for Disposal Site Risk Characterization. Interim Final Policy WSC/ORS-95-141. July 1995.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{[OHM]sediment \times IR \times RAF\text{-}O \times CF \times EF \times ED \times EP}{BW \times AP \times 365\ days/yr}$$

$$\text{INTAKE-DERMAL} = \frac{[OHM]sediment \times SA \times AF \times RAF\text{-}D \times EF \times ED \times EP \times CF}{BW \times AP \times 365\ days/yr}$$

TRSDIDED
EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SEDIMENT - RME SCENARIO
FUTURE PUPIL (6-18 years) WADING IN WETLAND AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA
16

18-Aug-98

CARCINOGENIC EFFECTS

COMPOUND	SEDIMENT CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	14	1.00	3.8E-07	0.03	2.9E-07	1.5E+00	5.7E-07	4.4E-07	1.0E-06
SUMMARY CANCER RISK							6E-07	4E-07	1E-06

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

NONCARCINOGENIC EFFECTS (CONTINUED)

COMPOUND	SEDIMENT CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Arsenic	14	1.00	2.0E-06	0.03	1.6E-06	3.0E-04	6.8E-03	5.3E-03	1.2E-02
Iron	10900	1.00	1.6E-03	0.03	1.2E-03	3.0E-01	5.3E-03	4.1E-03	9.4E-03
Manganese	186	1.00	2.7E-05	0.14	1.0E-04	4.7E-02	5.8E-04	2.1E-03	2.7E-03
Total Petroleum Hydrocarbons	290	1.00	4.2E-05	0.20	2.2E-04	3.0E-02	1.4E-03	7.3E-03	8.7E-03
SUMMARY HAZARD INDEX							3E-02	4E-02	7E-02

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

TRSDIDED
EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SEDIMENT - CENTRAL TENDENCY
FUTURE PUPIL (6-18 years) WADING IN WETLAND AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA
17

18-Aug-98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SEDIMENT	$[OHM]_{sediment}$	chemical specific	chemical-specific	
INGESTION RATE	IR	50	mg-sediment/day	USEPA, 1994
ADHERENCE FACTOR	AF	0.51	mg-sediment/cm²-skin	MADEP, 1995
AVERAGE SURFACE AREA (1)	SA	5,053	cm²/day	calculated per MADEP, 1995
RELATIVE ABSORPTION FACTOR-ORAL	RAF-O	chemical specific	unitless	MADEP, 1994, 1995
RELATIVE ABSORPTION FACTOR -DERM	RAF-D	chemical specific	unitless	MADEP, 1994, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT (2)	BW	45	kg	calculated per MADEP, 1995
EXPOSURE PERIOD	EP	9	years	Assumption
EXPOSURE FREQUENCY	EF	24	events/year	Assumption
EXPOSURE DURATION	ED	1	day/event	Assumption .
AVERAGING PERIOD				
CANCER	AP	70	years	USEPA, 1989
NONCANCER	AP	9	years	Assumption

(1) 50th percentile of surface areas for males aged 6 through 18 years: head, hands, forearms, lower legs, feet.
(2) 50th percentile of body weights for males aged 6 through 18 years.

MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
MADEP, 1995. Guidance for Disposal Site Risk Characterization. Interim Final Policy WSC/ORS-95-141. July 1995.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{[OHM]sediment \times IR \times RAF\text{-}O \times CF \times EF \times ED \times EP}{BW \times AP \times 365\ days/yr}$$

$$\text{INTAKE-DERMAL} = \frac{[OHM]sediment \times SA \times AF \times RAF\text{-}D \times EF \times ED \times EP \times CF}{BW \times AP \times 365\ days/yr}$$

TRSDIDED
EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SEDIMENT - CENTRAL TENDENCY
FUTURE PUPIL (6-18 years) WADING IN WETLAND AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA
17

18-Aug-98

CARCINOGENIC EFFECTS

COMPOUND	SEDIMENT CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	14	1.00	1.3E-07	0.03	2.0E-07	1.5E+00	2.0E-07	3.1E-07	5.0E-07
					SUMMARY CANCER RISK		2E-07	3E-07	5E-07

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

NONCARCINOGENIC EFFECTS (CONTINUED)

COMPOUND	SEDIMENT CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Arsenic	14	1.00	1.0E-06	0.03	1.6E-06	3.0E-04	3.4E-03	5.3E-03	8.7E-03
Iron	10900	1.00	8.0E-04	0.03	1.2E-03	3.0E-01	2.7E-03	4.1E-03	6.8E-03
Manganese	186	1.00	1.4E-05	0.14	1.0E-04	4.7E-02	2.9E-04	2.1E-03	2.4E-03
Total Petroleum Hydrocarbons	290	1.00	2.1E-05	0.20	2.2E-04	3.0E-02	7.1E-04	7.3E-03	8.0E-03
				SUMMARY HAZARD INDEX			1E-02	4E-02	6E-02

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

TABLE 18

INCIDENTAL INGESTION OF AND DERMAL CONTACT WITH GROUNDWATER DISCHARGING TO SURFACE WATER - RME SCENARIO
FUTURE PUPIL (6-18 Years) WADING IN THE WETLANDS AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS
CONCENTRATION WATER	CW	average	mg/liter
INGESTION RATE	IR	0.05	liters/hour
SURFACE AREA EXPOSED	SA	5,053	cm^2/day
CONVERSION FACTOR	CF	0.001	liter/cm^3
BODY WEIGHT	BW	45	kg
EXPOSURE TIME	ET	2.6	hours/day
EXPOSURE FREQUENCY	EF	24	days/year
EXPOSURE DURATION	ED	13	years
AVERAGING TIME			
CANCER	AT	70	years
NONCANCER	AT	13	years
PERMEABILITY COEFFICIENT	Kpevent	Chemical-specific	cm/day

Notes:
For noncarcinogenic effects: AT = ED
ND - Value not determined
TPHC - Total Petroleum Hydrocarbons

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

INTAKE = (INTAKE-INGESTION) + (INTAKE-DERMAL)

$$\text{INTAKE-INGESTION} = \frac{CW \times IR \times ET \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{CW \times K_{pevent} \times SA \times CF \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

TABLE 18

INCIDENTAL INGESTION OF AND DERMAL CONTACT WITH GROUNDWATER DISCHARGING TO SURFACE WATER - RME SCENARIO
FUTURE PUPIL (6-18 Years) WADING IN THE WETLANDS AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA
CARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATIO (mg/L)	INTAKE INGESTION (mg/kg-day)	ERMEABILIT COEFFICIENT (cm/day)	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR ORAL (mg/kg-day)-1	DERMAL (mg/kg-day)-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK	PERCENT TOTAL RISK
Bis(2-ethylhexyl)phthalate	0.05	1.8E-06	6.7E-01	4.6E-05	1.4E-02	1.4E-02	2.5E-08	6.4E-07	6.7E-07	21.97%
Arsenic	0.04	1.4E-06	2.6E-03	1.4E-07	1.5E+00	1.5E+00	2.1E-06	2.1E-07	2.3E-06	76.67%
Chloroform	0.00034	1.2E-08	4.6E-01	2.1E-07	6.0E-03	6.0E-03	7.2E-11	1.3E-09	1.4E-09	0.04%
Trichloroethylene	0.0033	1.2E-07	8.6E-01	3.9E-06	1.0E-02	1.0E-02	1.2E-09	3.9E-08	4.0E-08	1.32%
					SUMMARY CANCER RISK		2E-06	9E-07	3E-06	

NONCARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATIO (mg/L)	INTAKE INGESTION (mg/kg-day)	ERMEABILIT COEFFICIENT (cm/day)	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE ORAL (mg/kg-day)	DERMAL (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT	PERCENT TOTAL RISK
2-Methylnaphthalene	0.06	1.1E-05	7.7E-01	3.4E-04	4.0E-02	4.0E-02	2.85E-04	8.53E-03	8.8E-03	4.38%
Bis(2-ethylhexyl)phthalate	0.05	9.5E-06	6.7E-01	2.5E-04	2.0E-02	2.0E-02	4.75E-04	1.24E-02	1.3E-02	6.39%
Naphthalene	0.021	4.0E-06	2.8E-01	4.3E-05	4.0E-02	4.0E-02	9.97E-05	1.09E-03	1.2E-03	0.59%
Phenanthrene	0.015	2.8E-06	1.1E+00	1.2E-04	4.0E-02	4.0E-02	7.12E-05	3.05E-03	3.1E-03	1.55%
Aluminum	0.2	3.8E-05	2.6E-03	3.8E-06	1.0E+00	2.0E-01	3.80E-05	1.92E-05	5.7E-05	0.03%
Arsenic	0.04	7.6E-06	2.6E-03	7.7E-07	3.0E-04	2.9E-04	2.53E-02	2.65E-03	2.8E-02	13.92%
Iron	5.2	9.9E-04	2.6E-03	1.0E-04	3.0E-01	6.0E-03	3.29E-03	1.66E-02	2.0E-02	9.92%
Manganese	0.66	1.3E-04	2.6E-03	1.3E-05	2.4E-02	9.6E-04	5.22E-03	1.32E-02	1.8E-02	9.17%
Chloroform	0.00034	6.5E-08	4.6E-01	1.2E-06	1.0E-02	1.0E-02	6.46E-06	1.15E-04	1.2E-04	0.06%
Trichloroethylene	0.0005	9.5E-08	8.5E-01	3.1E-06	6.0E-03	6.0E-03	1.58E-05	5.23E-04	5.4E-04	0.27%
EPH										
C9-C18 Aliphatics	0.15	2.8E-05	2.9E+00	3.2E-03	6.0E-01	3.0E-01	4.75E-05	1.07E-02	1.1E-02	5.35%
C10-C22 Aromatics	0.053	1.0E-05	2.9E+00	1.1E-03	3.0E-02	2.7E-02	3.36E-04	4.20E-02	4.2E-02	21.08%
VPH										
C5-C8 Aliphatics	0.02	3.8E-06	8.1E-01	1.2E-04	6.0E-02	4.8E-02	6.33E-05	2.49E-03	2.6E-03	1.27%
C9-C12 Aliphatics	0.061	1.2E-05	2.9E+00	1.3E-03	6.0E-01	4.8E-01	1.93E-05	2.72E-03	2.7E-03	1.36%
C9-C10 Aromatics	0.062	1.2E-05	2.9E+00	1.3E-03	3.0E-02	2.7E-02	3.93E-04	4.92E-02	5.0E-02	24.66%
					SUMMARY HAZARD INDEX		0.04	0.17	0.20	

TABLE 19

INCIDENTAL INGESTION OF AND DERMAL CONTACT WITH GROUNDWATER DISCHARGING TO SURFACE WATER - CENTRAL TENDENCY
FUTURE PUPIL (6-18 Years) WADING IN THE WETLANDS AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS
CONCENTRATION WATER	CW	Maximum	mg/liter
INGESTION RATE	IR	0.025	liters/hour
SURFACE AREA EXPOSED	SA	5,053	cm^2/day
CONVERSION FACTOR	CF	0.001	liter/cm□u3□
BODY WEIGHT	BW	45	kg
EXPOSURE TIME	ET	2.6	hours/day
EXPOSURE FREQUENCY	EF	24	days/year
EXPOSURE DURATION	ED	9	years
AVERAGING TIME			
CANCER	AT	70	years
NONCANCER	AT	9	years
PERMEABILITY COEFFICIENT	Kpevent	Chemical-specific	cm/day

Notes:
For noncarcinogenic effects: AT = ED
ND - Value not determined
TPHC - Total Petroleum Hydrocarbons

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)□u-1□

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

INTAKE = (INTAKE-INGESTION) + (INTAKE-DERMAL)

$$\text{INTAKE-INGESTION} = \frac{CW \times IR \times ET \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{CW \times K\square\text{lpevent}\square \times SA \times CF \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

TABLE 19

INCIDENTAL INGESTION OF AND DERMAL CONTACT WITH GROUNDWATER DISCHARGING TO SURFACE WATER - CENTRAL TENDENCY
FUTURE PUPIL (6-18 Years) WADING IN THE WETLANDS AREA DURING SPRING SEASON
AOC 69W
FORT DEVENS, MA
CARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATIO (mg/L)	INTAKE INGESTION (mg/kg-day)	ERMEABILIT COEFFICIENT (cm/day)	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR ORAL (mg/kg-day)-1	DERMAL (mg/kg-day)-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK	PERCENT TOTAL RISK
Bis(2-ethylhexyl)phthalate	0.05	6.1E-07	6.7E-01	3.2E-05	1.4E-02	1.4E-02	8.5E-09	4.5E-07	4.5E-07	33.88%
Arsenic	0.04	4.9E-07	2.6E-03	9.9E-08	1.5E+00	1.5E+00	7.3E-07	1.5E-07	8.8E-07	65.75%
Chloroform	0.0003	3.7E-09	4.6E-01	1.3E-07	6.0E-03	6.0E-03	2.2E-11	7.9E-10	8.1E-10	0.06%
Trichloroethylene	0.0005	6.1E-09	8.6E-01	4.1E-07	1.0E-02	1.0E-02	6.1E-11	4.1E-09	4.1E-09	0.31%
					SUMMARY CANCER RISK		7E-07	6E-07	1E-06	

NONCARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATIO (mg/L)	INTAKE INGESTION (mg/kg-day)	ERMEABILIT COEFFICIENT (cm/day)	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE ORAL (mg/kg-day)	DERMAL (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT	PERCENT TOTAL RISK
2-Methylnaphthalene	0.06	5.7E-06	7.7E-01	3.4E-04	4.0E-02	4.0E-02	1.42E-04	8.53E-03	8.7E-03	4.45%
Bis(2-ethylhexyl)phthalate	0.05	4.7E-06	6.7E-01	2.5E-04	2.0E-02	2.0E-02	2.37E-04	1.24E-02	1.3E-02	6.47%
Naphthalene	0.02	1.9E-06	2.8E-01	4.1E-05	4.0E-02	4.0E-02	4.75E-05	1.03E-03	1.1E-03	0.55%
Phenanthrene	0.015	1.4E-06	1.1E+00	1.2E-04	4.0E-02	4.0E-02	3.56E-05	3.05E-03	3.1E-03	1.58%
Aluminum	0.2	1.9E-05	2.6E-03	3.8E-06	1.0E+00	2.0E-01	1.90E-05	1.92E-05	3.8E-05	0.02%
Arsenic	0.04	3.8E-06	2.6E-03	7.7E-07	3.0E-04	2.9E-04	1.27E-02	2.65E-03	1.5E-02	7.85%
Iron	5.2	4.9E-04	2.6E-03	1.0E-04	3.0E-01	6.0E-03	1.65E-03	1.66E-02	1.8E-02	9.38%
Manganese	0.66	6.3E-05	2.6E-03	1.3E-05	2.4E-02	9.6E-04	2.61E-03	1.32E-02	1.6E-02	8.11%
Chloroform	0.0003	2.8E-08	4.6E-01	1.0E-06	1.0E-02	1.0E-02	2.85E-06	1.02E-04	1.0E-04	0.05%
Trichloroethylene	0.0005	4.7E-08	8.6E-01	3.2E-06	6.0E-03	6.0E-03	7.91E-06	5.29E-04	5.4E-04	0.28%
EPH										
C9-C18 Aliphatics	0.15	1.4E-05	2.9E+00	3.2E-03	6.0E-01	3.0E-01	2.37E-05	1.07E-02	1.1E-02	5.50%
C10-C22 Aromatics	0.05	4.7E-06	2.9E+00	1.1E-03	3.0E-02	2.7E-02	1.58E-04	3.97E-02	4.0E-02	20.42%
VPH										
C5-C8 Aliphatics	0.02	1.9E-06	8.1E-01	1.2E-04	6.0E-02	4.8E-02	3.17E-05	2.49E-03	2.5E-03	1.29%
C9-C12 Aliphatics	0.06	5.7E-06	2.9E+00	1.3E-03	6.0E-01	4.8E-01	9.50E-06	2.68E-03	2.7E-03	1.38%
C9-C10 Aromatics	0.08	7.6E-06	2.9E+00	1.7E-03	3.0E-02	2.7E-02	2.53E-04	6.34E-02	6.4E-02	32.67%
					SUMMARY HAZARD INDEX		0.02	0.2	0.2	

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - RME SCENARIO
FUTURE UTILITY/CONSTRUCTION WORKER
AOC 69W
FORT DEVENS, MA
TABLE 20

18-Aug-98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	MAXIMUM	chemical-specific	
INGESTION RATE	IR	480	mg-soil/day	USEPA,1998
ADHERENCE FACTOR	AF	0.51	mg-soil/cm²-skin	MADEP, 1995
AVERAGE SURFACE AREA (1)	SA	5,200	cm²/day	calculated per MADEP, 1995
RELATIVE ABSORPTION FACTOR-ORAL	RAF-O	chemical specific	unitless	MADEP, 1994, 1995
RELATIVE ABSORPTION FACTOR -DERM	RAF-D	chemical specific	unitless	MADEP, 1994, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT (2)	BW	70	kg	calculated per MADEP, 1995
EXPOSURE PERIOD	EP	0.35	years	Assumption
EXPOSURE FREQUENCY	EF	90	events/year	Assumption
EXPOSURE DURATION	ED	1	day/event	Assumption
AVERAGING PERIOD				
CANCER	AP	70	years	USEPA, 1989
NONCANCER	AP	0.35	years	Assumption

(1) 50th percentile of surface areas for males: head, hands.
(2) 50th percentile of body weights for males.

MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
MADEP, 1995. Guidance for Disposal Site Risk Characterization. Interim Final Policy WSC/ORS-95-141. July 1995.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{[\text{OHM}]\text{soil} \times \text{IR} \times \text{RAF-O} \times \text{CF} \times \text{EF} \times \text{ED} \times \text{EP}}{\text{BW} \times \text{AP} \times 365 \text{ days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{[\text{OHM}]\text{soil} \times \text{SA} \times \text{AF} \times \text{RAF-D} \times \text{EF} \times \text{ED} \times \text{EP} \times \text{CF}}{\text{BW} \times \text{AP} \times 365 \text{ days/yr}}$$

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - RME SCENARIO
FUTURE UTILITY/CONSTRUCTION WORKER
AOC 69W
FORT DEVENS, MA
TABLE 20

19-Aug-98

CARCINOGENIC EFFECTS

	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	18	1.00	1.5E-07	0.03	2.5E-08	1.5E+00	2.3E-07	3.8E-08	2.7E-07
Beryllium	0.85	1.00	7.2E-09	0.03	1.2E-09	4.3E+00	3.1E-08	5.1E-09	3.6E-08
					SUMMARY CANCER RISK		3E-07	4E-08	3E-07

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Arsenic	18	1.00	3.0E-05	0.03	5.0E-06	3.0E-04	1.0E-01	1.7E-02	1.2E-01
Beryllium	0.85	1.00	1.4E-06	0.03	2.4E-07	2.0E-03	7.2E-04	1.2E-04	8.4E-04
Iron	10300	1.00	1.7E-02	0.03	2.9E-03	3.0E-01	5.8E-02	9.6E-03	6.8E-02
Manganese	240	1.00	4.1E-04	0.14	3.2E-04	4.7E-02	8.6E-03	6.8E-03	1.5E-02
Total Petroleum Hydrocarbons	936	1	1.6E-03	0.2	1.7E-03	3.0E-01	5.3E-03	5.8E-03	1.1E-02
					SUMMARY HAZARD INDEX		2E-01	4E-02	2E-01

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - CENTRAL TENDENCY
FUTURE UTILITY/CONSTRUCTION WORKER
AOC 69W
FORT DEVENS, MA
TABLE 21

19-Aug-98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	MAXIMUM	chemical-specific	
INGESTION RATE	IR	200	mg-soil/day	Assumption
ADHERENCE FACTOR	AF	0.51	mg-soil/cm²-skin	MADEP, 1995
AVERAGE SURFACE AREA (1)	SA	5,200	cm²/day	calculated per MADEP, 1995
RELATIVE ABSORPTION FACTOR-ORAL	RAF-O	chemical specific	unitless	MADEP, 1994, 1995
RELATIVE ABSORPTION FACTOR -DERM	RAF-D	chemical specific	unitless	MADEP, 1994, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT (2)	BW	70	kg	calculated per MADEP, 1995
EXPOSURE PERIOD	EP	0.35	years	Assumption
EXPOSURE FREQUENCY	EF	90	events/year	Assumption
EXPOSURE DURATION	ED	1	day/event	Assumption
AVERAGING PERIOD				
CANCER	AP	70	years	USEPA, 1989
NONCANCER	AP	0.35	years	Assumption

(1) 50th percentile of surface areas for males: head, hands, forearms, lower legs.
(2) 50th percentile of body weights for males.

MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
MADEP, 1995. Guidance for Disposal Site Risk Characterization. Interim Final Policy WSC/ORS-95-141. July 1995.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{[\text{OHM}]\text{soil} \times \text{IR} \times \text{RAF-O} \times \text{CF} \times \text{EF} \times \text{ED} \times \text{EP}}{\text{BW} \times \text{AP} \times 365 \text{ days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{[\text{OHM}]\text{soil} \times \text{SA} \times \text{AF} \times \text{RAF-D} \times \text{EF} \times \text{ED} \times \text{EP} \times \text{CF}}{\text{BW} \times \text{AP} \times 365 \text{ days/yr}}$$

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SURFACE SOIL - CENTRAL TENDENCY
FUTURE UTILITY/CONSTRUCTION WORKER
AOC 69W
FORT DEVENS, MA
TABLE 21

19-Aug-98

CARCINOGENIC EFFECTS

	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	18	1.00	6.3E-08	0.03	2.5E-08	1.5E+00	9.5E-08	3.8E-08	1.3E-07
Beryllium	0.85	1.00	3.0E-09	0.03	1.2E-09	4.3E+00	1.3E-08	5.1E-09	1.8E-08
SUMMARY CANCER RISK							1E-07	4E-08	2E-07

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Arsenic	18	1.00	1.3E-05	0.03	5.0E-06	3.0E-04	4.2E-02	1.7E-02	5.9E-02
Beryllium	0.85	1.00	6.0E-07	0.03	2.4E-07	2.0E-03	3.0E-04	1.2E-04	4.2E-04
Iron	10300	1.00	7.3E-03	0.03	2.9E-03	3.0E-01	2.4E-02	9.6E-03	3.4E-02
Manganese	240	1.00	1.7E-04	0.14	3.2E-04	4.7E-02	3.6E-03	6.8E-03	1.0E-02
Total Petroleum Hydrocarbons	936	1	6.6E-04	0.2	1.7E-03	3.0E-01	2.2E-03	5.8E-03	8.0E-03
SUMMARY HAZARD INDEX							7E-02	4E-02	1E-01

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SUBSURFACE SOIL - RME SCENARIO
FUTURE UTILITY/CONSTRUCTION WORKER
AOC 69W
FORT DEVENS, MA
TABLE 22

18-Aug-98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	MAXIMUM	chemical-specific	
INGESTION RATE	IR	480	mg-soil/day	USEPA,1994
ADHERENCE FACTOR	AF	0.51	mg-soil/cm²-skin	MADEP, 1995
AVERAGE SURFACE AREA (1)	SA	5,200	cm²/day	calculated per MADEP, 1995
RELATIVE ABSORPTION FACTOR-ORAL	RAF-O	chemical specific	unitless	MADEP, 1994, 1995
RELATIVE ABSORPTION FACTOR -DERM	RAF-D	chemical specific	unitless	MADEP, 1994, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT (2)	BW	70	kg	calculated per MADEP, 1995
EXPOSURE PERIOD	EP	0.35	years	Assumption
EXPOSURE FREQUENCY	EF	90	events/year	Assumption
EXPOSURE DURATION	ED	1	day/event	Assumption
AVERAGING PERIOD				
CANCER	AP	70	years	USEPA, 1989
NONCANCER	AP	0.35	years	Assumption

(1) 50th percentile of surface areas for males: head, hands

(2) 50th percentile of body weights for males

MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.

MADEP, 1995. Guidance for Disposal Site Risk Characterization. Interim Final Policy WSC/ORS-95-141. July 1995.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{\text{[OHM]soil x IR x RAF-O x CF x EF x ED x EP}}{\text{BW x AP x 365 days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{\text{[OHM]soil x SA x AF x RAF-D x EF x ED x EP x CF}}{\text{BW x AP x 365 days/yr}}$$

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SUBSURFACE SOIL - RME SCENARIO
FUTURE UTILITY/CONSTRUCTION WORKER
AOC 69W
FORT DEVENS, MA
TABLE 22

19-Aug-98

CARCINOGENIC EFFECTS

	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	7.3	1.00	6.2E-08	0.03	1.0E-08	1.5E+00	9.3E-08	1.5E-08	1.1E-07
					SUMMARY CANCER RISK		9E-08	2E-08	1E-07

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Arsenic	7.3	1.00	1.2E-05	0.03	2.0E-06	3.0E-04	4.1E-02	6.8E-03	4.8E-02
Iron	5900	1.00	1.0E-02	0.03	1.7E-03	3.0E-01	3.3E-02	5.5E-03	3.9E-02
Total Petroleum Hydrocarbons	900	1.00	1.5E-03	0.2	1.7E-03	3.0E-01	5.1E-03	5.6E-03	1.1E-02
C11-C22 aliphatics	260	1.00	4.4E-04	0.2	4.9E-04	3.0E-01	1.5E-03	1.6E-03	3.1E-03
C19- C36 aliphatics	670	1.00	1.1E-03	0.2	1.3E-03	6.0E+00	1.9E-04	2.1E-04	4.0E-04
C9- C18 aliphatics	5400	1.00	9.1E-03	0.2	1.0E-02	6.0E-01	1.5E-02	1.7E-02	3.2E-02
C9-C12 aliphatics	770	1.00	1.3E-03	0.2	1.4E-03	6.0E-01	2.2E-03	2.4E-03	4.6E-03
C9-C10 aromatics	119	1.00	2.0E-04	0.2	2.2E-04	3.0E-01	6.7E-04	7.4E-04	1.4E-03
					SUMMARY HAZARD INDEX		1E-01	4E-02	1E-01

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SUBSURFACE SOIL - CENTRAL TENDENCY
FUTURE UTILITY/CONSTRUCTION WORKER
AOC 69W
FORT DEVENS, MA
TABLE 23

18-Aug-98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	MAXIMUM	chemical-specific	
INGESTION RATE	IR	200	mg-soil/day	Assumption
ADHERENCE FACTOR	AF	0.51	mg-soil/cm²-skin	MADEP, 1995
AVERAGE SURFACE AREA (1)	SA	5,200	cm²/day	calculated per MADEP, 1995
RELATIVE ABSORPTION FACTOR-ORAL	RAF-O	chemical specific	unitless	MADEP, 1994, 1995
RELATIVE ABSORPTION FACTOR -DERM	RAF-D	chemical specific	unitless	MADEP, 1994, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	
BODY WEIGHT (2)	BW	70	kg	calculated per MADEP, 1995
EXPOSURE PERIOD	EP	0.35	years	Assumption
EXPOSURE FREQUENCY	EF	90	events/year	Assumption
EXPOSURE DURATION	ED	1	day/event	Assumption
AVERAGING PERIOD				
CANCER	AP	70	years	USEPA, 1989
NONCANCER	AP	0.35	years	Assumption

(1) 50th percentile of surface areas for males: head, hands.
(2) 50th percentile of body weights for males.

MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
MADEP, 1995. Guidance for Disposal Site Risk Characterization. Interim Final Policy WSC/ORS-95-141. July 1995.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)^-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

INTAKE-INGESTION = $\dfrac{\text{[OHM]soil x IR x RAF-O x CF x EF x ED x EP}}{\text{BW x AP x 365 days/yr}}$

INTAKE-DERMAL = $\dfrac{\text{[OHM]soil x SA x AF x RAF-D x EF x ED x EP x CF}}{\text{BW x AP x 365 days/yr}}$

EXPOSURE TO DIRECT CONTACT AND INCIDENTAL INGESTION OF SUBSURFACE SOIL - CENTRAL TENDENCY
FUTURE UTILITY/CONSTRUCTION WORKER
AOC 69W
FORT DEVENS, MA
TABLE 23

19-Aug-98

CARCINOGENIC EFFECTS

	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION	CANCER RISK DERMAL	TOTAL CANCER RISK
Arsenic	7.3	1.00	2.6E-08	0.03	1.0E-08	1.5E+00	3.9E-08	1.5E-08	5.4E-08
					SUMMARY CANCER RISK		4E-08	2E-08	5E-08

[1] MADEP, 1994. Background Documentation for the Development of MCP Numerical Standards. April 1994.
ND = no data available

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	INGESTION RAF [1]	INTAKE INGESTION (mg/kg-day)	DERMAL RAF [1]	INTAKE DERMAL (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
Arsenic	7.3	1.00	5.1E-06	0.03	2.0E-06	3.0E-04	1.7E-02	6.8E-03	2.4E-02
Iron	5900	1.00	4.2E-03	0.03	1.7E-03	3.0E-01	1.4E-02	5.5E-03	1.9E-02
Total Petroleum Hydrocarbons	900	1.00	6.3E-04	0.2	1.7E-03	3.0E-01	2.1E-03	5.6E-03	7.7E-03
C11-C22 aliphatics	260	1.00	1.8E-04	0.2	4.9E-04	3.0E-01	6.1E-04	1.6E-03	2.2E-03
C19- C36 aliphatics	670	1.00	4.7E-04	0.2	1.3E-03	6.0E+00	7.9E-05	2.1E-04	2.9E-04
C9- C18 aliphatics	5400	1.00	3.8E-03	0.2	1.0E-02	6.0E-01	6.3E-03	1.7E-02	2.3E-02
C9-C12 aliphatics	770	1.00	5.4E-04	0.2	1.4E-03	6.0E-01	9.0E-04	2.4E-03	3.3E-03
C9-C10 aromatics	119	1.00	8.4E-05	0.2	2.2E-04	3.0E-01	2.8E-04	7.4E-04	1.0E-03
					SUMMARY HAZARD INDEX		4E-02	4E-02	8E-02

TAL

INHALATION EXPOSURE TO PARTICULATES FROM SURFACE SOIL AND SUBSURFACE SOIL (0-10 feet bgs) - RME SCENARIO

FUTURE UTILITY/CONSTRUCTION WORKER

AOC 69W

FORT DEVENS, MA

69WUCIM	19-Aug-98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS
CONCENTRATION SOIL	CS	Maximum	mg/kg
CONCENTRATION AIR PARTICULATES	CAp	Calculated	mg/m³
CONCENTRATION AIR VOLATILES	CAv	NA	mg/m³
VOLATILIZATION FACTOR	VF	see table	m³/kg
PARTICULATE EMISSIONS FACTOR	PEF	1.32E+09	m³/kg
INHALATION RATE	IhR	4.8	m³/hour
BODY WEIGHT	BW	70	kg
EXPOSURE TIME	ET	8	hours/day
EXPOSURE FREQUENCY	EF	90	days/year
EXPOSURE DURATION	ED	0.35	years
AVERAGING TIME			
CANCER	AT	70	years
NONCANCER	AT	0.35	years

Note:

For noncarcinogenic effects: AT = EF/365 days per year

NA - Not applicable

TPHC - Total Petroleum Hydrocarbons

ND - Value not determined

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR $(mg/kg-day)^{-1}$

$$\text{INTAKE} = \frac{(CAp + CAv) \times IhR \times ET \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

HAZARD QUOTIENT = AVERAGE DAILY CONCENTRATION (mg/m^3) / REFERENCE CONCENTRATION (mg/m^3)

$$\text{AVERAGE DAILY CONCENTRATION} = \frac{(CAp + CAv) \times EF \times ED}{AT \times 365 \text{ days/yr}}$$

AIR CONCENTRATION PARTICULATES = CS x 1/PEF

AIR CONCENTRATION VOLATILES = CS x 1/VF

CARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m³/kg)	CAv (mg/m³)	CAp (mg/m³)	INTAKE (mg/kg-day)	INHALATION CANCER SLOPE FACTOR $(mg/kg-day)^{-1}$	CANCER RISK	PERCENT TOTAL RISK
Surface Soil								
Arsenic	18	NA	NA	1.36E-08	9.2E-12	1.5E+01	1.4E-10	69.83%
Beryllium	0.85	NA	NA	6.44E-10	4.4E-13	8.4E+00	3.7E-12	1.85%
						Subtotal	**1.4E-10**	
Subsurface Soil								
Arsenic	7.3	NA	NA	5.53E-09	3.7E-12	1.5E+01	5.6E-11	28.32%
						Subtotal	**5.6E-11**	
NA = Not applicable						**SUMMARY CANCER RISK**	**2E-10**	

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m³/kg)	CAv (mg/m³)	CAp (mg/m³)	AVERAGE DAILY CONCENTRATION (mg/m³)	INHALATION REFERENCE CONCENTRATION (mg/m³)	HAZARD QUOTIENT	PERCENT TOTAL RISK
Surface Soil								
Arsenic	18	NA	NA	1.36E-08	3.4E-09	ND		
Beryllium	0.85	NA	NA	6.44E-10	1.6E-10	2.0E-05	7.9E-06	0.00%
Iron	10700	NA	NA	8.11E-06	2.0E-06	ND		
Manganese	249	NA	NA	1.89E-07	4.7E-08	5.0E-05	9.3E-04	0.12%
TPHC	936	NA	NA	7.09E-07	1.7E-07	6.0E-02	2.9E-06	0.00%
						Subtotal	**9.4E-04**	0.12%
Subsurface Soil								
Arsenic	7.3	NA	NA	5.53E-09	1.4E-09	ND		
Iron	5900	NA	NA	4.47E-06	1.1E-06	ND		
TPHC	900	NA	NA	6.82E-07	1.7E-07	6.0E-02	2.8E-06	0.00%
C11-C22 aromatics	260	10066	2.58E-02	1.97E-07	6.4E-08	7.1E-02	9.0E-02	11.80%
C19-C36 aliphatics	670	NA	NA	5.08E-07	1.3E-07	ND		
C9-C18 aliphatics	5400	2267	2.38E+00	4.09E-06	5.9E-01	2.0E+00	2.9E-01	38.62%
C9-C12 aliphatics	770	1103	6.98E-01	5.83E-07	1.7E-01	2.0E+00	8.6E-02	11.32%
C9-C10 aromatics	119	1686	7.06E-02	9.02E-08	1.7E-02	6.0E-02	2.9E-01	38.14%
						Subtotal	**7.6E-01**	99.88%
NA = Not applicable						**SUMMARY HAZARD INDEX**	**7.6E-01**	

TA.

INHALATION EXPOSURE TO PARTICULATES FROM SURFACE SOIL AND SUBSURFACE SOIL (0–10 feet bgs) – CENTRAL TENDENCY
FUTURE UTILITY/CONSTRUCTION WORKER
AOC 69W
FORT DEVENS, MA

69WUCIA	19–Aug–98

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS
CONCENTRATION SOIL	CS	Maximum	mg/kg
CONCENTRATION AIR PARTICULATES	CAp	Calculated	mg/m³
CONCENTRATION AIR VOLATILES	CAv	NA	mg/m³
VOLATILIZATION FACTOR	VF	NA	m³/kg
PARTICULATE EMISSIONS FACTOR	PEF	1.32E+09	m³/kg
INHALATION RATE	IhR	1.5	m³/hour
BODY WEIGHT	BW	70	kg
EXPOSURE TIME	ET	8	hours/day
EXPOSURE FREQUENCY	EF	90	days/year
EXPOSURE DURATION	ED	0.35	years
AVERAGING TIME			
CANCER	AT	70	years
NONCANCER	AT	0.35	years

Note:
For noncarcinogenic effects: AT = EF/365 days per year
TPHC – Total Petroleum Hydrocarbons   ND – Value not determined

EQUATIONS

CANCER RISK = INTAKE (mg/kg–day) x CANCER SLOPE FACTOR (mg/kg–day)$^{-1}$

$$\text{INTAKE} = \frac{(CAp + CAv) \times IhR \times ET \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

HAZARD QUOTIENT = AVERAGE DAILY CONCENTRATION (mg/m³) / REFERENCE CONCENTRATION (mg/m³)

$$\text{AVERAGE DAILY CONCENTRATION} = \frac{(CAp + CAv) \times EF \times ED}{AT \times 365 \text{ days/yr}}$$

AIR CONCENTRATION PARTICULATES = CS x 1/PEF

AIR CONCENTRATION VOLATILES = CS x 1/VF (VF is not calculated because no volatiles are selected as CPCs)

CARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m³/kg)	CAv (mg/m³)	CAp (mg/m³)	INTAKE (mg/kg–day)	INHALATION CANCER SLOPE FACTOR (mg/kg–day)$^{-1}$	CANCER RISK	PERCENT TOTAL RISK
Surface Soil								
Arsenic	18	NA	NA	1.36E–08	2.9E–12	1.5E+01	4.3E–11	69.83%
Beryllium	0.85	NA	NA	6.44E–10	1.4E–13	8.4E+00	1.1E–12	1.85%
						Subtotal	**4.4E–11**	
Outside Building Subsurface Soil								
Arsenic	7.3	NA	NA	5.53E–09	1.2E–12	1.5E+01	1.8E–11	28.32%
						Subtotal	**1.8E–11**	
NA = Not applicable						**SUMMARY CANCER RISK**	6E–11	

NONCARCINOGENIC EFFECTS

COMPOUND	SOIL CONCENTRATION (mg/kg)	VF (m³/kg)	CAv (mg/m³)	CAp (mg/m³)	AVERAGE DAILY CONCENTRATION (mg/m³)	INHALATION REFERENCE CONCENTRATION (mg/m³)	HAZARD QUOTIENT	PERCENT TOTAL RISK
Surface Soil								
Arsenic	18	NA	NA	1.36E–08	3.4E–09	ND		
Beryllium	0.85	NA	NA	6.44E–10	1.6E–10	2.0E–05	7.9E–06	0.00%
Iron	10700	NA	NA	8.11E–06	2.0E–06	ND		
Manganese	249	NA	NA	1.89E–07	4.7E–08	5.0E–05	9.3E–04	0.12%
TPHC	940	NA	NA	7.12E–07	1.8E–07	6.0E–02	2.9E–06	0.00%
						Subtotal	0.0009	0.12%
Outside Building Subsurface Soil								
Arsenic	7.3	NA	NA	5.53E–09	1.4E–09	ND		
Iron	5900	NA	NA	4.47E–06	1.1E–06	ND		
TPHC	900	NA	NA	6.82E–07	1.7E–07	6.0E–02	2.8E–06	0.00%
C11–C22 aliphatics	260	10066	2.58E–02	1.97E–07	6.4E–08	7.1E–02	9.0E–02	
C19–C36 aliphatics	670	NA	NA	5.08E–07	1.3E–07	ND		
C9–C18 aliphatics	5400	2267	2.38E+00	4.09E–06	5.9E–01	2.0E+00	2.9E–01	
C9–C12 aliphatics	770	1103	6.98E–01	5.83E–07	1.7E–01	2.0E+00	8.6E–02	
C9–C10 aromatics	119	1686	7.06E–02	9.02E–08	1.7E–02	6.0E–02	2.9E–01	
						Subtotal	0.8	99.88%
NA = Not applicable					**SUMMARY HAZARD INDEX**		0.8	

TABLE 26
CALCULATION OF THE VOLATILIZATION FACTOR - REVISED MODEL

EQUATIONS:

$$VF\ (m^3/kg) = Q/C \times (3.14 \times D_A \times T)^{1/2} \times 10^{-4}(m^2/cm^2) / (2 \times \rho_b \times D_A)$$

where

$$DA = [(\theta_a^{10/3} D_i H' + \theta_w^{10/3} D_w)/n^2] / \rho_b K_d + \theta_w + \theta_a H'$$

PARAMETER/DEFINITION	UNITS	DEFAULT
VF / volatilization factor	m^3/kg	Calculated
D_A / apparent diffusivity	cm^2/s	Calculated
Q/C / inverse of the mean concentration at the center of a 0.5-acre-square source	g/m^2-s per kg/m^3	74.23 (Portland, ME)
T / exposure interval	s	1.7E+07
ρ_b / dry soil bulk density	g/cm^3	1.5
θ_a / air-filled soil porosity	L_{air}/L_{soil}	n - θ_w
n / total soil porosity	L_{pore}/L_{soil}	1 - (ρ_b/ρ_s)
θ_w / water-filled soil porosity	L_{water}/L_{soil}	0.15
ρ_s / soil particle density	g/cm^3	2.65
D_i / diffusivity in air	cm^2/s	chemical-specific
H' / Henry's Law constant	dimensionless	chemical-specific
D_w / diffusivity in water	cm^2/s	chemical-specific
K_d / soil-water partition coefficient (K_{oc} x f_{oc}) organics	cm^3/g	chemical-specific
K_{oc} / soil organic carbon partition coefficient	cm^3/g	chemical-specific
f_{oc} / fraction organic carbon in soil	g/g	0.006

Source: USEPA, 1996. Soil Screening Guidance: User's Guide. Office of Solid Waste and Emergency Response, EPA/540/R-96/018, April.

TABLE 26, continued
CALCULATION OF THE VOLATILIZATION FACTOR

CHEMICAL	D_i (cm^2/s)	H'	D_w (cm^2/s)	K_d (cm^3/g)	K_{oc} (cm^3/g)	D_A (cm^2/s)	VF (m^3/kg)
C11-C22 Aromatics	0.06	0.03	9.00E-06	30	5000	3.19E-06	**10066**
C9-C18 Aliphatics	0.07	69.0000	9.00E-06	4080	680000	6.29E-05	**2267**
C9-C12 Aliphatics	0.07	65.00000	9.00E-06	900	150000	2.66E-04	**1103**
C9-C10 Aromatics	0.07	0.33	9.00E-06	10.67	1778	0.00011364	**1686**

Di, H', and Koc values from "Characterizing risks posed by petroleum contaminated sites: Implementatin of the MADEP VP/EPH approach" 1997.

Dw is a conservative estimate

TABLE 27

INGESTION OF GROUNDWATER AS DRINKING WATER (UNFILTERED SAMPLES) - RME SCENARIO
ADULT RESIDENT
AOC 69W
FORT DEVENS, MA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION WATER	CW	chemical-specific	ug/liter	
INGESTION RATE	IR	2	liters/day	USEPA, 1994
BODY WEIGHT	BW	70	kg	USEPA, 1994
CONVERSION FACTOR	CF	0.001	mg/ug	
EXPOSURE FREQUENCY	EF	350	days/year	USEPA, 1994
EXPOSURE DURATION	ED	30	years	USEPA, 1994
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1994
NONCANCER	AT	30	years	USEPA, 1994

USEPA, 1994. EPA Region I Risk Updates; Number 2 "Interim Standard Default Exposure Parameters"

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE} = \frac{\text{CW x IR x EF x ED x CF}}{\text{BW x AT x 365 days/year}}$$

Note: For noncarcinogenic effects, AT = ED.

TABLE 27

INGESTION OF GROUNDWATER AS DRINKING WATER (UNFILTERED SAMPLES) - RME SCENARIO
ADULT RESIDENT
AOC 69W
FORT DEVENS, MA

CARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION
Bis(2-ethylhexyl)phthalate	500	UG/LITER	5.9E-03	1.4E-02	8.2E-05
Arsenic	190	UG/LITER	2.2E-03	1.5E+00	3.3E-03
Chloroform	0.55	UG/LITER	6.5E-06	6.0E-03	3.9E-08
Trichloroethylene	3.3	UG/LITER	3.9E-05	1.0E-02	3.9E-07
			TOTAL CANCER RISK		3E-03

NONCARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION
2-Methylnaphthalene	600	UG/LITER	1.6E-02	4.0E-02	4.1E-01
Bis(2-ethylhexyl)phthalate	500	UG/LITER	1.4E-02	2.0E-02	6.8E-01
Naphthalene	200	UG/LITER	5.5E-03	4.0E-02	1.4E-01
Aluminum	450	UG/LITER	1.2E-02	1.0E+00	1.2E-02
Arsenic	190	UG/LITER	5.2E-03	3.0E-04	1.7E+01
Iron	26000	UG/LITER	7.1E-01	3.0E-01	2.4E+00
Manganese	2700	UG/LITER	7.4E-02	2.4E-02	3.1E+00
Chloroform	0.55	UG/LITER	1.5E-05	1.0E-02	1.5E-03
Trichloroethylene	3.3	UG/LITER	9.0E-05	6.0E-03	1.5E-02
EPH					
C9-C18 Aliphatics	600	UG/LITER	1.6E-02	6.0E-01	2.7E-02
C10-C22 Aromatics	300	UG/LITER	8.2E-03	3.0E-02	2.7E-01
VPH					
C5-C8 Aliphatics	47	UG/LITER	1.3E-03	6.0E-02	2.1E-02
C9-C12 Aliphatics	300	UG/LITER	8.2E-03	6.0E-01	1.4E-02
C9-C10 Aromatics	610	UG/LITER	1.7E-02	3.0E-02	5.6E-01
			TOTAL HAZARD INDEX		25

ND = no data available.

TABLE 28

INGESTION OF GROUNDWATER AS DRINKING WATER (UNFILTERED SAMPLES)- RME SCENARIO
CHILD RESIDENT
AOC 69W
FORT DEVENS, MA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION WATER	CW	chemical-specific	ug/liter	
INGESTION RATE	IR	1	liters/day	USEPA, 1995
BODY WEIGHT	BW	15	kg	USEPA, 1991
CONVERSION FACTOR	CF	0.001	mg/ug	
EXPOSURE FREQUENCY	EF	350	days/year	USEPA, 1995
EXPOSURE DURATION	ED	6	years	USEPA, 1995
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	6	years	USEPA, 1991

USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance:
"Standard Default Exposure Factors"; OSWER Directive 9285.6-03.
USEPA, 1995. Region IV Supplemental Gudance to RAGS, Bulletin No. 3, November.

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE} = \frac{\text{CW x IR x EF x ED x CF}}{\text{BW x AT x 365 days/year}}$$

Note: For noncarcinogenic effects, AT = ED.

TABLE 28

INGESTION OF GROUNDWATER AS DRINKING WATER (UNFILTERED SAMPLES)- RME SCENARIO
CHILD RESIDENT
AOC 69W
FORT DEVENS, MA

CARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION
Bis(2-ethylhexyl)phthalate	500	UG/LITER	2.7E-03	1.4E-02	3.8E-05
Arsenic	190	UG/LITER	1.0E-03	1.5E-00	1.6E-03
Chloroform	0.55	UG/LITER	3.0E-06	6.0E-03	1.8E-08
Trichloroethylene	3.3	UG/LITER	1.8E-05	1.0E-02	1.8E-07
			TOTAL CANCER RISK		2E-03

NONCARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION
2-Methylnaphthalene	600	UG/LITER	3.8E-02	4.0E-02	9.6E-01
Bis(2-ethylhexyl)phthalate	500	UG/LITER	3.2E-02	2.0E-02	1.6E+00
Naphthalene	200	UG/LITER	1.3E-02	4.0E-02	3.2E-01
Aluminum	450	UG/LITER	2.9E-02	1.0E-00	2.9E-02
Arsenic	190	UG/LITER	1.2E-02	3.0E-04	4.0E+01
Iron	26000	UG/LITER	1.7E-00	3.0E-01	5.5E+00
Manganese	2700	UG/LITER	1.7E-01	2.4E-02	7.2E+00
Chloroform	0.55	UG/LITER	3.5E-05	1.0E-02	3.5E-03
Trichloroethylene	3.3	UG/LITER	2.1E-04	6.0E-03	3.5E-02
EPH					
C9-C18 Aliphatics	600	UG/LITER	3.8E-02	6.0E-01	6.4E-02
C10-C22 Aromatics	300	UG/LITER	1.9E-02	3.0E-02	6.4E-01
VPH					
C5-C8 Aliphatics	47	UG/LITER	3.0E-03	6.0E-02	5.0E-02
C9-C12 Aliphatics	300	UG/LITER	1.9E-02	6.0E-01	3.2E-02
C9-C10 Aromatics	610	UG/LITER	3.9E-02	3.0E-02	1.3E+00
			TOTAL HAZARD INDEX		57

TABLE 29

INGESTION OF GROUNDWATER AS DRINKING WATER (UNFILTERED SAMPLES) - CENTRAL TENDENCY
ADULT RESIDENT
AOC 69W
FORT DEVENS, MA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION WATER	CW	chemical-specific	ug/liter	
INGESTION RATE	IR	1.4	liters/day	USEPA, 1994
BODY WEIGHT	BW	70	kg	USEPA, 1994
CONVERSION FACTOR	CF	0.001	mg/ug	
EXPOSURE FREQUENCY	EF	350	days/year	USEPA, 1994
EXPOSURE DURATION	ED	9	years	USEPA, 1994
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1994
NONCANCER	AT	9	years	USEPA, 1994

USEPA, 1994. EPA Region I Risk Updates; Number 2 "Interim Standard Default Exposure Parameters"

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE} = \frac{CW \times IR \times EF \times ED \times CF}{BW \times AT \times 365 \text{ days/year}}$$

Note: For noncarcinogenic effects, AT = ED.

TABLE 29

INGESTION OF GROUNDWATER AS DRINKING WATER (UNFILTERED SAMPLES) - CENTRAL TENDENCY
ADULT RESIDENT
AOC 69W
FORT DEVENS, MA

CARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION
Bis(2-ethylhexyl)phthalate	50	UG/LITER	1.2E-04	1.4E-02	1.7E-06
Arsenic	40	UG/LITER	9.9E-05	1.5E+00	1.5E-04
Chloroform	0.3	UG/LITER	7.4E-07	6.0E-03	4.4E-09
Trichloroethylene	0.5	UG/LITER	1.2E-06	1.0E-02	1.2E-08
TOTAL CANCER RISK					1E-04

NONCARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION
2-Methylnaphthalene	60	UG/LITER	1.2E-03	4.0E-02	2.9E-02
Bis(2-ethylhexyl)phthalate	50	UG/LITER	9.6E-04	2.0E-02	4.8E-02
Naphthalene	20	UG/LITER	3.8E-04	4.0E-02	9.6E-03
Aluminum	200	UG/LITER	3.8E-03	1.0E+00	3.8E-03
Arsenic	40	UG/LITER	7.7E-04	3.0E-04	2.6E+00
Iron	5200	UG/LITER	1.0E-01	3.0E-01	3.3E-01
Manganese	660	UG/LITER	1.3E-02	2.4E-02	5.3E-01
Chloroform	0.3	UG/LITER	5.8E-06	1.0E-02	5.8E-04
Trichloroethylene	0.5	UG/LITER	9.6E-06	6.0E-03	1.6E-03
EPH					
C9-C18 Aliphatics	150	UG/LITER	2.9E-03	6.0E-01	4.8E-03
C10-C22 Aromatics	50	UG/LITER	9.6E-04	3.0E-02	3.2E-02
VPH					
C5-C8 Aliphatics	20	UG/LITER	3.8E-04	6.0E-02	6.4E-03
C9-C12 Aliphatics	60	UG/LITER	1.2E-03	6.0E-01	1.9E-03
C9-C10 Aromatics	80	UG/LITER	1.5E-03	3.0E-02	5.1E-02
TOTAL HAZARD INDEX					4

ND = no data available.

TABLE 30

INGESTION OF GROUNDWATER AS DRINKING WATER (UNFILTERED SAMPLES) CENTRAL TENDENCY
CHILD RESIDENT
AOC 69W
FORT DEVENS, MA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION WATER	CW	chemical-specific	ug/liter	
INGESTION RATE	IR	0.7	liters/day	USEPA, 1995
BODY WEIGHT	BW	15	kg	USEPA, 1991
CONVERSION FACTOR	CF	0.001	mg/ug	
EXPOSURE FREQUENCY	EF	350	days/year	USEPA, 1995
EXPOSURE DURATION	ED	2	years	USEPA, 1995
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	2	years	USEPA, 1991

USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance:
"Standard Default Exposure Factors"; OSWER Directive 9285.6-03.
USEPA, 1995. Region IV Supplemental Gudance to RAGS, Bulletin No. 3, November.

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

INTAKE = $\dfrac{CW \times IR \times EF \times ED \times CF}{BW \times AT \times 365 \text{ days/year}}$

Note: For noncarcinogenic effects, AT = ED.

TABLE 30

INGESTION OF GROUNDWATER AS DRINKING WATER (UNFILTERED SAMPLES) CENTRAL TENDENCY
CHILD RESIDENT
AOC 69W
FORT DEVENS, MA

CARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	CANCER SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK INGESTION
Bis(2-ethylhexyl)phthalate	50	UG/LITER	6.4E-05	1.4E-02	8.9E-07
Arsenic	40	UG/LITER	5.1E-05	1.5E+00	7.7E-05
Chloroform	0.3	UG/LITER	3.8E-07	6.0E-03	2.3E-09
Trichloroethylene	0.5	UG/LITER	6.4E-07	1.0E-02	6.4E-09
			TOTAL CANCER RISK		8E-05

NONCARCINOGENIC EFFECTS

COMPOUND	WATER CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	REFERENCE DOSE (mg/kg-day)	HAZARD QUOTIENT INGESTION
2-Methylnaphthalene	60	UG/LITER	2.7E-03	4.0E-02	6.7E-02
Bis(2-ethylhexyl)phthalate	50	UG/LITER	2.2E-03	2.0E-02	1.1E-01
Naphthalene	20	UG/LITER	8.9E-04	4.0E-02	2.2E-02
Aluminum	200	UG/LITER	8.9E-03	1.0E+00	8.9E-03
Arsenic	40	UG/LITER	1.8E-03	3.0E-04	6.0E+00
Iron	5200	UG/LITER	2.3E-01	3.0E-01	7.8E-01
Manganese	660	UG/LITER	3.0E-02	2.4E-02	1.2E+00
Chloroform	0.3	UG/LITER	1.3E-05	1.0E-02	1.3E-03
Trichloroethylene	0.5	UG/LITER	2.2E-05	6.0E-03	3.7E-03
EPH					
C9-C18 Aliphatics	150	UG/LITER	6.7E-03	6.0E-01	1.1E-02
C10-C22 Aromatics	50	UG/LITER	2.2E-03	3.0E-02	7.5E-02
VPH					
C5-C8 Aliphatics	20	UG/LITER	8.9E-04	6.0E-02	1.5E-02
C9-C12 Aliphatics	60	UG/LITER	2.7E-03	6.0E-01	4.5E-03
C9-C10 Aromatics	80	UG/LITER	3.6E-03	3.0E-02	1.2E-01
			TOTAL HAZARD INDEX		8

TABLE 31

INHALATION EXPOSURE TO VOCs IN INDOOR AIR - RME SCENARIO
FUTURE PUPIL
AOC 69W
FORT DEVENS, MA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION AIR	CA	chemical-	ug/m^3	Modeled
CONVERSION FACTOR 1	CF_1	24	hours/day	
EXPOSURE TIME	ET	6	hours/day	USEPA, 1989
EXPOSURE FREQUENCY	EF	180	days/year	USEPA, 1991
EXPOSURE DURATION	ED	13	years	USEPA, 1991
CONVERSION FACTOR 2	CF_2	365	days/year	
AVERAGING TIME CANCER	AT	70	years	USEPA, 1989
AVERAGING TIME NONCANCER	AT	13	years	USEPA, 1989

USEPA, 1989. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, (Part A)
EPA/540/1-89/002; December 1989.
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Assumptions".

EQUATIONS

CANCER RISK = AVG. CONC. (ug/m^3) * CANCER UNIT RISK $(ug/m^3)^{-1}$

HAZARD QUOTIENT = AVG.CONC.(ug/m^3)/REF. CONC. (ug/m^3)

$$\text{AVG. CONC.} = \frac{CA_{air} * EF * ET * ED}{AT * CF1 * CF2}$$

TABLE 31

INHALATION EXPOSURE TO VOCs IN INDOOR AIR - RME SCENARIO
FUTURE PUPIL
AOC 69W
FORT DEVENS, MA

CARCINOGENIC EFFECTS

COMPOUND	VOLATILE OR NON-VOLATILE? V/NV	INDOOR AIR CONCENTRATION (ug/m^3)	AVERAGE AIR CONCENTRATION LIFETIME (ug/m^3)	INHALATION CANCER UNIT RISK (ug/m^3)$^{-1}$	CANCER RISK
No carcinogenic CPCs					
				SUMMARY CANCER RISK	0E+00

NA = not applicable. This analyte is not volatile and has therefore not been evaluated via this volatilization model.

NONCARCINOGENIC EFFECTS

COMPOUND	VOLATILE OR NON-VOLATILE? V/NV	INDOOR AIR CONCENTRATION (ug/m^3)	AVERAGE AIR CONCENTRATION FOR TIME PERIOD (ug/m^3)	CHRONIC INHALATION RfC [1] (ug/m^3)	HAZARD QUOTIENT
Ethylbenzene	V	4.7E+02	5.8E+01	1.0E+03	5.8E-02
Octane	V	2.1E+01	2.6E+00	2.0E+02	1.3E-02
Toluene	V	1.0E+03	1.2E+02	4.0E+02	3.1E-01
Acetone	V	4.7E+02	5.8E+01	ND	NA
			0.0E+00	ND	
				SUMMARY HAZARD INDEX	0.4

[1] RfC is the Reference Concentration published by USEPA.
ND = no data available.
NA = not applicable. The analyte is not volatile and has therefore not been evaluated via this volatilization model.

TABLE 32

INHALATION EXPOSURE TO VOCs IN INDOOR AIR - CENTRAL TENDENCY
FUTURE PUPIL
AOC 69W
FORT DEVENS, MA

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION AIR	CA	chemical-	ug/m^3	Modeled
CONVERSION FACTOR 1	CF_1	24	hours/day	
EXPOSURE TIME	ET	6	hours/day	USEPA, 1989
EXPOSURE FREQUENCY	EF	180	days/year	USEPA, 1991
EXPOSURE DURATION	ED	9	years	USEPA, 1991
CONVERSION FACTOR 2	CF_2	365	days/year	
AVERAGING TIME CANCER	AT	70	years	USEPA, 1989
AVERAGING TIME NONCANCER	AT	9	years	USEPA, 1989

USEPA, 1989. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, (Part A) EPA/540/1-89/002; December 1989.

USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Assumptions".

EQUATIONS

CANCER RISK = AVG. CONC. (ug/m^3) * CANCER UNIT RISK $(ug/m^3)^{-1}$

HAZARD QUOTIENT = AVG.CONC.(ug/m^3)/REF. CONC. (ug/m^3)

$$\text{AVG. CONC.} = \frac{CA_{air} * EF * ET * ED}{AT * CF1 * CF2}$$

TABLE 32

INHALATION EXPOSURE TO VOCs IN INDOOR AIR - CENTRAL TENDENCY
FUTURE PUPIL
AOC 69W
FORT DEVENS, MA

CARCINOGENIC EFFECTS

COMPOUND	VOLATILE OR NON-VOLATILE? V/NV	INDOOR AIR CONCENTRATION (ug/m^3)	AVERAGE AIR CONCENTRATION LIFETIME (ug/m^3)	INHALATION CANCER UNIT RISK (ug/m^3)$^{-1}$	CANCER RISK
No carcinogenic CPCs					
			SUMMARY CANCER RISK		0E+00

NA = not applicable. This analyte is not volatile and has therefore not been evaluated via this volatilization model.

TABLE 32

INHALATION EXPOSURE TO VOCs IN INDOOR AIR - CENTRAL TENDENCY
FUTURE PUPIL
AOC 69W
FORT DEVENS, MA

NONCARCINOGENIC EFFECTS

COMPOUND	VOLATILE OR NON-VOLATILE? V/NV	INDOOR AIR CONCENTRATION (ug/m^3)	AVERAGE AIR CONCENTRATION FOR TIME PERIOD (ug/m^3)	CHRONIC INHALATION RfC [1] (ug/m^3)	HAZARD QUOTIENT
			0.0E+00		
Ethylbenzene	V	4.7E+02	5.8E+01	1.0E+03	5.8E-02
Octane	V	2.1E+01	2.6E+00	2.0E+02	1.3E-02
Toluene	V	1.0E+03	1.2E+02	4.0E+02	3.1E-01
Acetone	V	4.7E+02	5.8E+01	ND	
			0.0E+00	ND	
				SUMMARY HAZARD INDEX	0.38

[1] RfC is the Reference Concentration published by USEPA.
ND = no data available.
NA = not applicable. The analyte is not volatile and has therefore not been evaluated via this volatilization model.

HHRA SHORT TOXICITY PROFILES

HUMAN HEALTH RISK ASSESSMENT SHORT TOXICITY PROFILES

Aluminum. Aluminum occurs naturally in the soil and makes up approximately 8 percent of the earths crust. Higher soil concentrations are associated with industries which burn coal and aluminum mining and smelting. Human exposures to aluminum may occur through ingestion of foods grown in soil that contains aluminum and use of antacids, antiperspirants, and other drug store items. Aluminum in antiperspirants can cause skin rashes in some people. Factory workers who inhale large amounts of aluminum dust may develop lung problems. Aluminum has caused lower birth weights in some animals. Studies have shown that aluminum accumulates in the brains of people with Alzheimer's disease. However, any causal link between aluminum exposure and this disease is yet to be demonstrated. Both human epidemiological studies and animal experiments strongly suggests that aluminum is not a carcinogen.

References:

Agency for Toxic Substances and Disease Registry (ATSDR), 1989. "Toxicological Profile for Aluminum"; Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, October 1989.

Arsenic. Arsenic has been used in pesticide formulations and has industrial uses in tanneries, as well as the glass and wine making industries. Toxicity depends on its chemical form. Arsenic is an irritant of the skin, mucous membranes, and gastrointestinal tract. Symptoms of acute toxicity include vomiting, diarrhea, convulsions, and a severe drop in blood pressure. Subchronic effects include hyperpigmentation, sensory-motor polyneuropathy, persistent headache, and lethargy. Chronic oral exposure has caused skin lesions, peripheral vascular disease, and peripheral neuropathy. The USEPA has classified arsenic in Group A, human carcinogen, based on increased incidence of lung cancer in occupational studies.

References:

Agency for Toxic Substances and Disease Registry (ATSDR), 1992. "Toxicological Profile for Arsenic"; Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, February 1992.

Beryllium. Beryllium is a trace element that is obtained by extraction from mineral ores. Most beryllium is contributed to the environment by the burning of fossil fuels which contain beryllium ore. Beryllium is generally incorporated into alloy metals that are used in jet engine parts and electrical components. Pure beryllium metal is used in parts for aircraft brakes, nuclear weapons, nuclear reactors, and precision instruments.

Available data on beryllium suggest that it is most toxic to the lung. Acute inhalation exposures to high concentrations of beryllium in the air can cause chemical pneumonitis, the symptoms of which include cough, shortness of breath, and fatigue. These symptoms can persist and even worsen after exposure to beryllium has been discontinued. Chronic inhalation exposures to low concentrations of beryllium can produce chronic beryllium disease, which results in inhibited breathing efficiency. Inhalation of beryllium has been shown to produce lung cancer in animals, and an increased incidence of lung cancer has been demonstrated in workers who are exposed to beryllium in the air. Therefore beryllium has been classified by the USEPA as a B2, probable human carcinogen.

References:

Agency for Toxic Substances and Disease Registry (ATSDR), 1991. "Toxicological Profile for Beryllium"; Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, February 1991.

Bis(2-ethylhexyl)phthalate (DEHP). DEHP is used industrially as a plasticizer for resins and is found in many plastic materials as it makes them more flexible. It is also used in manufacturing organic pump fluids in electrical capacitors. Acute exposure to DEHP has produced eye and mucous membrane irritation, nausea, and diarrhea. Chronic exposure of laboratory animals to DEHP indicate that the target organs are the liver, causing morphological and biochemical changes, as well as the testes, producing damage to the seminiferous tubules. DEHP has produced developmental and reproductive effects in laboratory animals including spina bifida and reduced fertility. DEHP has been shown to cause a dose-related increase in liver tumors in mice and rats. Thus, the USEPA has designated DEHP as a B2, probable human carcinogen.

References:

ATSDR, 1991. Toxicological Profile for Di(2-ethylhexyl)phthalate. Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, October, 1991.

Chloroform. Originally used as a general anesthetic, chloroform is used now in the production of air conditioning coolant, as a solvent, and in the manufacture of pesticides and dyes. It can also be found in dry cleaning agents, plastics, and floor polishes, and as a by product of drinking water purification. Acute exposure to chloroform via inhalation produced dizziness and gastrointestinal upset. Dermal contact with chloroform produces burns. It is a CNS depressant and chronic exposure has been shown to cause liver and kidney toxicity as well as cardiac arrhythmias. Several studies indicate that chloroform is carcinogenic via the oral route causing liver carcinoma in mice and kidney tumors. The USEPA has designated chloroform as a B2 carcinogen, a probable human carcinogen.

References:

Amdur, Mary O., John Doull, Curtis D. Klaassen, 1991. Toxicology: The Basic Science of Poisons, 4th edition; Pergamon Press, Inc. New York.

Integrated Risk Information System (IRIS), 1993. United States Environmental Protection Agency.

Iron. Iron is a metal which is required for a variety of physiological functions such as heme biosynthesis, oxidative phosphorylation and mixed-function oxidase-mediated metabolic reactions. Only divalent forms of iron are absorbed. As absorption occurs, divalent iron is biochemically converted to trivalent iron, the biologically active form. Under normal conditions, absorbed dietary iron is complexed to hemoglobin and transported to the liver for storage until needed for physiological reactions. The balance of iron is regulated only by the amount of dietary intake and the degree of intestinal absorption. Intestinal absorption tends to be low (2 - 15%) except during periods of increased iron need when absorption efficiency increases dramatically.

Acute iron toxicity has been well characterized following the accidental ingestion of iron-containing preparations by children. Shortly after ingestion, the corrosive effects of iron cause vomiting and diarrhea, often bloody. Later signs include shock, metabolic acidosis, seizures, liver and/or kidney failure, coma, and death. Chronic iron overload manifests as disturbances in liver function, diabetes mellitus, and endocrine and cardiovascular effects. Inhalation of iron containing dust or fumes in occupational settings may result in deposition of iron particles in the lungs leading to interstitial fibrosis. Autopsies of hematite miners noted an increase in lung cancer. However, the etiology of the lung cancer may be related to factors other than iron exposure such as cigarette, silica or PAH exposures.

References:

Aisen, P., Cohen, G. and Kang, J.O., 1990. Iron Toxicosis. Int. Rev. Exp. Pathol. 31:1-46.

Goyer, R.A., 1991. Toxic Effects of Metals. In: Casarett and Doull's Toxicology: The Basic Science of Poisons, 3rd edition. Eds. C.D. Klaassen, M.O. Amdur and J. Doull. Macmillan Publishing Co. N.Y.

Manganese. Manganese is a naturally occurring substance found in many types of rock. It does not generally occur in the environment as the pure metal, rather, it is found combined with other chemicals such as sulfur, oxygen, and chlorine. Manganese is mixed with iron to make various types of steel. Manganese is a component of some ceramics, pesticides, fertilizers, and in nutritional supplements. In small doses manganese is beneficial to human health. Manganese miners and steel workers exposed to elevated concentrations of manganese have evidenced mental and emotional disturbances, and slow and clumsy body movements. Target organs of manganese are the lung and CNS. When inhaled, manganese dust can also cause lung irritation. EPA has classified manganese as a Class D, not classifiable as to human carcinogenicity.

References:

Agency for Toxic Substances and Disease Registry (ATSDR), 1991. "Toxicological Profile for Manganese"; Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, February 1991.

2-Methylnaphthalene. 2-Methylnaphthalene is a member of the polycyclic aromatic hydrocarbons (PAH) class of organic compounds, and is used in the synthesis of chemicals such as insecticides. Toxicological data on 2-methylnaphthalene is extremely limited. However, based on its structural similarity to naphthalene, it is likely to be metabolized through a similar process, and therefore is expected to exert effects similar to those induced by naphthalene. Humans can absorb naphthalene via the inhalation, oral, and dermal routes. Evidence from human and animal studies suggests that naphthalene is metabolized by the P450 mixed function oxidase system to form metabolites that exert toxic effects. The primary target organ for naphthalene metabolites in humans is the red blood cell. Various types and severities of anemias resulting from erythrocyte hemolysis have been documented in humans and animals exposed to naphthalene. Some evidence also suggests that naphthalene metabolites can induce cataracts in humans and animals. No studies were located investigating genotoxicity or cancer in humans.

References:
ATSDR, 1989. Toxicological Profile for Naphthalene and 2-Methylnaphthalene. Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, October, 1989.

Naphthalene. Naphthalene is a member of the polycyclic aromatic hydrocarbons (PAH) class of compounds which contain two or more aromatic rings. PAHs are ubiquitous in nature and are also manmade. Naphthalene occurs naturally in coal tar, crude oil, and is formed from incomplete combustion of organic material. It is also product of pyrolysis in tobacco smoke. Naphthalene is used for the production of phthalic anhydride, which is used for the production of plasticizers. Naphthalene is also used in moth balls, for the production of the insecticide carbaryl, and in numerous resins, dyes, pharmaceuticals, and other organic materials.

Naphthalene is absorbed through the inhalation, oral, and dermal routes, and appears to be more toxic to humans than laboratory animals. The principal toxic effect of naphthalene in humans and animals is hemolysis of red blood cells, which can lead to anemia, decreased oxygen carrying capacity, and jaundice. Humans pre-disposed to anemia, such as those with G6DP enzyme deficiency, may be particularly sensitive to naphthalene toxicity. Exposure to naphthalene has also been correlated with increased risk of cataract formation. Animal studies were negative for naphthalene reproductive toxicity. Although no human epidemiological data are available for assessing naphthalene carcinogenicity, animal data investigating naphthalene toxicity are equivocal. The USEPA has placed naphthalene in weight-of-evidence Group D, not classifiable as to human carcinogenicity.

References:
Agency for Toxic Substances and Disease Registry (ATSDR), 1990. "Toxicological Profile for Naphthalene"; Agency for Toxic Substances and Disease Registry, U.S. Public Health Service. October, 1990.

Phenanthrene. Phenanthrene is a member of the polycyclic aromatic hydrocarbons (PAH) class of compounds which contain two or more aromatic rings. PAHs are ubiquitous in nature and are also man made. Phenanthrene occurs naturally in coal tar, crude oil, and is formed from incomplete combustion of organic material.

Phenanthrene has been shown to be a skin photosensitizer in humans. Intraperitoneally injection in rats produced liver effects. Although limited evidence exists that phenanthrene is a mutagen, the majority of tests have proved negative. Equivocal evidence exists for cancer after dermal application of phenanthrene in rats. Ingestion of 200 mg of phenanthrene produced no tumors in rats after two months.

References:

MADEP, 1992. "Risk Assessment Shortform Residential Exposure Scenario, Version 1.6"; Policy #WSC/ORS-142-92; Office of Research and Standards and the Bureau of Waste Site Cleanup, Boston, MA; September 1992.

Pyrene. Pyrene is a member of the polycyclic aromatic hydrocarbon (PAH) class of compounds which contain two or more aromatic rings. They are ubiquitous in nature and are also man-made. Pyrene occurs naturally in coal tar, crude oil, and is formed from incomplete combustion of organic material. Pyrene is reported to be a skin irritant to humans. Rats administered pyrene exhibited blood chemistry changes, as well as liver and kidney damage. Pyrene was shown to be inactive as an initiating agent and thus has been classified by the USEPA as a D carcinogen.

References:

ATSDR, 1989. Toxicological Profile for Polycyclic Aromatic Hydrocarbons. Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, October, 1989.

Trichloroethene. Trichloroethene is a man-made chlorinated solvent that is used extensively in industry as a metal decreasing agent. Trichloroethene is also used in dry cleaning and as a solvent in paints and adhesives.

Several human deaths and acute neurotoxic effects have been attributed to oral and inhalation exposure to trichloroethene. In animals, oral and inhalation exposure to trichloroethene have produce neurotoxic effects, including behavioral changes, and renal toxicity. Additionally, inhalation and oral exposures to trichloroethene in animals have produced lung, liver, and testicular cancers. Epidemiological data in humans is insufficient to conclude whether trichloroethene is a human carcinogen. However, studies on trichloroethene metabolism suggest that it is metabolized similarly
in humans and laboratory animals. Therefore, the USEPA has place trichloroethene in weight-of-evidence group B2, probable human carcinogen.

References:

MADEP, 1992. "Risk Assessment Shortform Residential Exposure Scenario, Version 1.6"; Policy #WSC/ORS-142-92; Office of Research and Standards and the Bureau of Waste Site Cleanup, Boston, MA; September 1992.

Xylenes. Xylene is a volatile organic compound that is generally composed of a mixture of the meta, ortho, and para isomers. Xylenes are used as solvents, in paints, thinners, cleaners, degreasers, and as a component in gasoline.

Xylenes are absorbed by oral, inhalation, and dermal exposures, and distribute to all tissues, particularly those with high fat contents. All three isomers produce similar effects, although the potency with which various effects are produced may vary from effect to effect with each isomer. In both humans and animals, xylene exposure has been associated with central nervous system depression, impaired learning and memory, and tremors. In humans, inhalation of xylene may produce prolonged respiratory tract inflammation and edema. In laboratory animals, exposures to xylenes have produced adverse reproductive effects, including increased fetal death rate and retarded development. There is no evidence of carcinogenicity in humans or animals.

References:

MADEP, 1992. "Risk Assessment Shortform Residential Exposure Scenario, Version 1.6"; Policy #WSC/ORS-142-92; Office of Research and Standards and the Bureau of Waste Site Cleanup, Boston, MA; September 1992.

VPH/EPH FRACTIONS

Chemical surrogates were chosen to represent the different aliphatic and aromatic fractions of TPH. Appropriate surrogates are referenced below for each fraction.

C5-C8 Aliphatics. n-Hexane is the reference compound for the TPH fraction containing C5-C8 alkanes/cycloalkanes. Through epidemiological studies on n-hexane-exposed workers, sensorimotor polyneuropathy has been observed as the main toxic effect of long-term exposure. Other noted effects include cranial neuropathy, blurred vision, and abnormal color vision. The onset of symptoms may be delayed for several months to a year after exposure. Affected individuals may recover completely, but some may retain sensorimotor deficits. A number of animal studies have been conducted that document n-hexane's neuropathic effects.

Reference:

MADEP, 1994. Interim Final Petroleum Report: Development of Health-Based Alternative to the Total Petroleum Hydrocarbon (TPH) Parameter. August.

C9-C12 Aliphatics. See profile for n-Hexane provided for C5-C8 Aliphatics above.

C9-C18 Aliphatics. See profile for n-Hexane provided for C5-C8 Aliphatics above.

C19-C36 Aliphatics. See profile for n-Hexane provided for C5-C8 Aliphatics above.

C9-C10 Aromatics. See profiles for xylene and pyrene.

C10-C22 Aromatics. See profiles for naphthalene and pyrene.

ECOLOGICAL RISK ASSESSMENT

P-1 EXPOSURE AND EFFECTS ASSUMPTIONS

P-2 ECOLOGICAL RISK CALCULATIONS

P-3 STATISTICAL ANALYSIS OF TOXICITY TESTING (MIDGE GROWTH)

EXPOSURE AND EFFECTS ASSUMPTIONS

STUDY AREA 69W
ECOLOGICAL SURVEY

Baseline Ecological Risk Assessment
Fort Devens, Massachusetts

INTRODUCTION:

The following is a summary of the ecological survey of the terrestrial and wetland habitats associated with the area of concern (AOC) 69W, which took place on October 13, 1995 (Figure 5-3). A site walk over was conducted to evaluate the type and extent of ecologically significant habitats within AOC 69W. This was accomplished by walking the length of both sides of the drainage ditch and transects through the wetland, and general observations of the terrestrial habitats. For the purpose of this evaluation the upper and lower portions of the ditch were characterized separately. The terrestrial and wetland habitats along the ditch and Willow Brook were characterized into major habitat types through the qualitative analysis of plant species, microtopography, and hydrology. Individual site descriptions and plant species lists are provided below.

UPPER PORTION 69W: DEGRADED DITCH

The upper portion begins at the outfall of the drainage ditch that goes under Antietam Road. The ditch is unlined; the bottom consists of unconsolidated, poorly-sorted, well-graded, gravel- to cobble-sized material, including some remnants of asphalt underlain by a coarse to medium sand. The ditch is approximately three feet wide and five feet deep, and the slope of the ditch was estimated at 3 to 5 percent. Decomposing organic matter is nearly absent from the bottom of the ditch which suggests that a non-depositional environment exists. The ditch receives runoff during rain events and snow-melt from areas above Antietam Road, and does not typically contain standing water. Any runoff that does not immediately flow out of the ditch probably infiltrates the ground. The area immediately adjacent to the upper portion of the drainage ditch consists of mowed grass. Trees present along the upper west side of the drainage ditch include Norway spruce (*Picea abies*). On the lower west side the dominant tree is the red maple (*Acer rubrum*). Both species appear to be planted. A list of additional tree, shrub, and herbaceous vegetation found in the upper portion of AOC 69W is presented below.

Tree and shrub species:
slippery elm (*Ulmus rubra*)
pin oak (*Quercus palustris*)
swamp white oak (*Quercus bicolor*)
shagbark hickory (*Carya ovata*)

Herbaceous species:
sedges (*Cyperus sp.*)
rice-cutgrass (*Leersia oryzoides*)
nightshade (*Solanum dulcamara*)
boneset (*Eupatorium perfoliatum*)

American chestnut (*Castanea dentata*)
white mulberry (*Morus alba*)
red-osier dogwood (*Cornus stolonifera*)
arrow-wood (*Viburnum recognitum*)
swamp azalea (*Rhododendron viscosum*)
cow vetch (*Vicia cracca*)
Jewel weed (*Impatiens capensis*)
common dodder (*Cuscuta gronovii*)
butter cup (*Ranunculus sp.*)
cocklebur (*Xanthium strumarium*)

LOWER PORTION 69W: WETLAND COMPLEX

Approximately 300 to 350 yards downgradient of the culvert at Antietam Road, the drainage ditch turns slightly to the northwest. At this point, the area immediately adjacent to the northeast side of the drainage ditch transitions into a small triangular-shaped persistent emergent wetland approximately 0.25 acres in size. The area extending west from the drainage ditch to MacArthur Boulevard is clearly well maintained (mowed). The wetland area has an open canopy, with very well developed mound and pool microtopography. At the time of the visit, surface water was not present; however, this area is probably temporarily flooded or intermittently flooded during and immediately following rain events, and in the spring and fall. A list of tree, shrub, and herbaceous vegetation found in the lower portion of AOC 69W is presented below.

Tree and shrub species:
red maple (*Acer rubrum*)
white pine (*Pinus strobus*)
gray birch (*Betula populifolia*)
arrow-wood (*Viburnum recognitum*)
highbush blueberry (*Vaccinium corymbosum*)
buckthorn (*Rhamnus frangula*)

***Herbaceous species*:**
tussock sedge (*Carex stricta*)
woolly sedge (*Scirpus cyperinus*)
blue-joint (*Calamagrostis canadensis*)
broad-leaved cattail (*Typha latifolia*)
Joe pye-weed (*Eupatorium dubium*)
boneset (*Eupatorium perfoliatum*)
arrow-leaved tearthumb (*Polygonum sagittatum*)
hardhack (*Spirea tomentosa*)

ECOLOGICAL RISK CALCULATIONS

Table P-1
Exposure Parameters for Representative Wildlife Species
AOC 69W

Remedial Investigation Report
Devens, Massachusetts

Representative Wildlife Species	Body Weight (kg)	Reported Diet	Assumed Diet for Exposure Assessment (% of diet)	Food Ingestion Rate (kg/day)	Water Intake Rate (l/day)	Exposure Duration [a]	Home Range (acres)
Short-tailed shrew (*Blarina brevicauda*)	0.017 [b]	Earthworms, slugs, snails, fungi, insects, and vegetation [c]	78% Invertebrates 12% Plants 10% Soil [d]	0.0024 [e]	0.0025 [f]	1	0.96 ± 0.09 [c]
White-footed mouse (*Peromyscus leucopus*)	0.040 [c]	Seeds and some insects [c]	88% Plants 10% Invertebrates 2% Soil [c]	0.0049 [e]	0.0055 [f]	1	0.147 [g]
American robin (*Turdus migratorius*)	0.077 [h]	Fruits and invertebrates [c].	57% Plants 33% Invertebrates 10% Soil [i]	0.011 [j]	0.011 [k]	0.75	0.48 [l]
Red-winged blackbird (*Agelaius phoeniceus*)	0.054 [m]	Weed seeds and grain; insects, caterpillars, grubs, grasshoppers, spiders, and snails; also some berries [m].	73% Vegetable matter 24% Insects/invertebrates [m] 3% Soil [d]	0.0087 [j]	0.0083 [k]	0.75	0.54 [n]
Raccoon (*Procyon lotor*)	3.99 [o]	Mostly fleshy fruits, nuts acorns, corn; also frogs, crayfish, and insects [c]	Sediment Exposures: 91% Aquatic organisms 9% Sediment [i] Surface Soil Exposures: 56% Plants 14% Invertebrates 19% Mammals 2% Birds 9% Soil [i]	0.214 [e]	0.344 [f]	1	385 [p]

References:

[a] Proportion of the year that the receptor is estimated to actively forage at the site.
[b] Mean of means reported for male and female shrews in summer and fall (USEPA, 1993a).
[c] Wildlife Exposure Factors Handbook (USEPA, 1993a). Values for the cotton mouse and deer mouse are used for the white-footed mouse when not available.
[d] Estimated soil ingestion.
[e] Calculated using the mammal equation based on body weight (Wt.) in kg. Food ingestion (kg/day) = $0.0687 \times Wt^{0.822}$ (kg) (USEPA, 1993a).
[f] Calculated using the mammal equation based on body weight (Wt.) in kg. Water ingestion (l/day) = $0.099 \times Wt^{0.90}$ (kg) (USEPA, 1993a).
[g] Average of male and female deer mice in Virginia mixed deciduous forests (USEPA, 1993a).

Table P-1
Exposure Parameters for Representative Wildlife Species
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Representative Wildlife Species	Body Weight (kg)	Reported Diet	Assumed Diet for Exposure Assessment (% of diet)	Food Ingestion Rate (kg/day)	Water Intake Rate (l/day)	Exposure Duration [a]	Home Range (acres)

[h] Mean year-round value for male and female robins in Pennsylvania (USEPA, 1993a).
[i] The sediment ingestion for raccoons was estimated to be the same as their estimated soil ingestion. The soil ingestion rate for the robin was assumed to be the same as for American woodcocks, which ingest higher percentages of soil because of their relatively high dietary composition of earthworms (USEPA 1993a).
[j] Calculated using the bird equation based on body weight (Wt.) in kg. Food ingestion (kg/day) = $0.0582 \times Wt^{0.651}$ (kg) (USEPA, 1993a).
[k] Calculated using the bird equation based on body weight (Wt.) in kg. Water ingestion (l/day) = $0.059 \times Wt^{0.67}$ (kg) (USEPA, 1993a).
[l] Average of mean home range values provided for robins feeding nestlings and fledglings (USEPA, 1993a).
[m] Estimated from Terres (1980).
[n] DeGraaf & Rudis (1986).
[o] Median of mean weights for male and female raccoons in Alabama (USEPA, 1993a).
[p] Average of adult male and female raccoons from May to December (USEPA, 1993a).

Notes:
AOC = Area of contamination
kg = kilograms
kg/day = kilograms per day
l/day = liters per day
% = percent

Table P-2
Summary of Bioaccumulation Data
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Analyte	log K_{ow}	[b]	Bioaccumulation Factor [a]: Terrestrial Invertebrate [c]	Terrestrial Plant [d]	Mammal [e]	Bird [f]	Aquatic [g] Invertebrate	Aquatic Plant
INORGANICS								
Beryllium	NA		NA	2.0E-03 [h]	5.0E-02 [i]	5.0E-02 [i]	NA	NA
Cobalt	NA		1.0E+00 [j]	4.0E-03 [h]	1.0E+00 [k]	1.0E+00	1.0E+00	9.3E-03 [l]
Copper	NA		1.6E-01 [m]	7.8E-01 [n]	6.0E-01 [o]	6.0E-01	1.6E-01	6.0E-02 [l]
Lead	NA		7.8E-02 [p]	0.0E+00 [o]	1.5E-02 [k]	1.5E-02	NA	NA
Mercury	NA		6.8E-02 [q]	1.8E-01 [h]	1.0E-02 [r]	2.3E+00	NA	NA
Nickel	NA		2.3E-01 [s]	1.2E-02 [h]	3.0E-01 [k]	3.0E-01	2.3E-01	1.2E-02 [t]
Selenium	NA		7.6E-01 [u]	9.0E-03 [v]	7.5E-01 [k]	5.1E-01 [w]	NA	NA
Zinc	NA		1.8E+00 [m]	6.1E-01 [n]	2.1E+00 [k]	2.1E+00	NA	NA
PESTICIDES/PCBs								
4,4'-DDD	6		3.3E+00 [x]	1.0E-02 [y]	1.2E+00 [z]	2.9E+00 [aa]	2.1E+01 [ab]	1.0E-02 [y]
4,4'-DDE	5.7		1.7E+00 [x]	1.0E-02 [y]	1.2E+00 [z]	2.9E+00 [aa]	2.1E+00 [ab]	1.0E-02 [y]
4,4'-DDT	6.4		5.7E-01 [x]	1.0E-02 [y]	1.2E+00 [z]	2.9E+00 [aa]	2.1E+00 [ab]	1.0E-02 [y]
SEMIVOLATILES								
Acenaphthylene	4.1	4.9	5.0E-02	1.1E-02	1.5E-01	1.5E-01	NA	NA
Anthracene	4.5	4.9	5.0E-02	1.1E-02	1.5E-01	1.5E-01	NA	NA
Benzo(k)fluoranthene	6.1	4.9	5.0E-02	1.1E-02	1.5E-01	1.5E-01	5.0E-02	1.1E-02
Chrysene	5.7	4.9	5.0E-02	1.1E-02	1.5E-01	1.5E-01	NA	NA
Fluoranthene	4.95 [ac]	4.9	5.0E-02	1.1E-02	1.5E-01	1.5E-01	5.0E-02	1.1E-02
Flourene	4.2	4.9	5.0E-02	1.1E-02	1.5E-01	1.5E-01	NA	NA
Phenanthrene	4.5	4.9	5.0E-02	1.1E-02	1.5E-01	1.5E-01	5.0E-02	1.1E-02
Pyrene	5.3	4.9	5.0E-02	1.1E-02	1.5E-01	1.5E-01	5.0E-02	1.1E-02
VOLATILES								
Acetone	-0.24		NA	NA	NA	NA	NA	NA
Toluene	2.79		NA	NA	NA	NA	NA	NA
Trichlorofluoromethane	2.5		NA	NA	NA	NA	NA	NA
Xylenes	3.2		NA	NA	NA	NA	NA	NA

NOTES:

[a] Units for bioaccumulation factors (BAFs) are mg/kg fresh wt tissue over mg/kg dry wt soil for terrestrial invertebrates and plants, mg/kg fresh wt. tissue over mg/kg fresh wt. food for small mammals and small birds, and mg/kg fresh wt. tissue over mg/kg fresh wt. sediment for aquatic plants and organisms. No BAFs were calculated for VOAs since available evidence suggests that these analytes do not bioaccumulate.

[b] From Superfund Chemical Data Matrix (USEPA, 1993b) unless otherwise noted. Log K_{ow}s for classes of semivolatile compounds were averaged to provide an average BAF value. The average calculated for PAHs was 4.9.

[c] Average of earthworm BAFs for SVOCs (Beyer, 1990) converted from dry weight to wet weight assuming earthworm is 80% water, unless otherwise noted. When no earthworm data were available, the BAF for small mammals was used as a surrogate.

[d] Plant BAF calclulated using the following equation presented by Travis and Arms (1988) unless otherwise noted:
log (Plant Uptake Factor) = 1.588-0.578 (log K_{ow}). Converted from dry weight to wet weight plant concentration assuming 80% water content.

[e] Calculated using the following equation in Travis and Arms (1988) for semivolatile organic analytes with log K_{ow}s > 5:
log BTF (biotransfer factor) = log K_{ow} - 7.6; result multiplied by average ingestion rates for non-lactating and lactating test animals to convert from BTFs to BAFs, and divided by a factor of 0.2 to convert from dry feed to fresh feed. There is an uncertainty involved in using this equation for PAHs because this study did not use any PAHs in the regression analysis. BAFs for analytes with log K_{ow}s < 5 are assumed to be 0.15 because they are unlikely to bioaccumulate in animal tissue (Maughan, 1993).

[f] Bioaccumulation data are generally lacking for avians. When no bird data were available, the BAF for small mammals was used as a surrogate.

[g] Used to represent bioaccumulation from sediment to aquatic invertebrates. Sediment BAFs are presented for only those analytes that were selected as sediment CPCs. When no aquatic BAF data were available, the BAF for terrestrial inverebrates was used as a surrogate.

[h] Value from Baes et al. (1984) for leafy portions of plants multiplied by 0.2 to represent 80% water composition of plants.

[i] Mean of value reported for *Sorex arcineus* in MacFadyen (1980).

[j] Prey-specific value not available; value shown is small mammal BAF for this chemical.

[k] Value derived from biotransfer factors (BTFs), presented in Baes et al. (1984) for uptake into cattle. BTF converted to BAF by multiplying by food ingestion rate of 50 kg/day wet weight.

[l] Aquatic plant BAFs derived from an uptake study (Cherry & Guthrie, 1979) with two sedge species, *Andropogon virginicus* and *Cyperus retrofractus*, that were exposed to contaminated sediment. Values were converted from dry weight plant tissue to wet weight by applying a factor of 0.2 (assuming plants are 80% water).

[m] BCF for earthworms from Diercxsens et al. (1985).

[n] Median of values reported from Levine et al. (1989).

[o] Mammal value for copper from Levine et al., 1989. Lead does not accumulate in plant tissue, therefore, a BAF of zero was assigned.

[p] Geometric mean of BAF values (fresh wt./dry wts) for worms and woodlice (USEPA, 1985a). Fresh weight tissue concentrations calculated

Table P-2
Summary of Bioaccumulation Data
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Analyte	log K_{ow} [b]	Bioaccumulation Factor [a]					
		Terrestrial Invertebrate [c]	Terrestrial Plant [d]	Mammal [e]	Bird [f]	Aquatic [g] Invertebrate	Aquatic Plant

assuming 80% body water content.

[q] Uptake value (fresh wt./dry wt.) for earthworms from USEPA (1985b) sludge document. Fresh weight tissue concentrations calculated assuming 80% body water content.

[r] USEPA, 1985b.

[s] Value from nickel sludge document (USEPA, 1985c) multiplied by 0.2 to represent 80% water composition of earthworms.

[t] BAF for the terrestrial plant was used as a surrogate.

[u] Average of values for industrial soils from Beyer and Cromatie (1987) multiplied by 0.2 to represent 80% water composition in earthworms.

[v] Based on reported ratio of selenium in plant tissue and iron fly ash amended soil (Stoewsand et. al., 1978).

[w] Based on average of reported ratio of selenium in diet to liver, kidney, and breast tissue of chickens (Eisler, 1985).

[x] Geometric means of 4,4'-DDT [Davis (1968), Davis & Harrison (1966), Wheatley & Hardman (1968), Bailey et al. (1970), Cramp & Olney (1967), and Beyer & Gish (1980)], 4,4'-DDE [Davis (1968), Davis & Harrison (1966), Cramp & Olney (1967), Collett & Harrison (1968), Hunt & Sacho (1969), and Gish (1970)], and 4,4-DDD [Barker (1958), Davis (1968), Davis & Harrison (1966), Cramp & Olney (1967), Collett & Harrison (1968), Wheatley & Hardman (1968), Hunt & Sacho (1969), Bailey et al. (1970), Dimond et al. (1970), Gish (1970), and Beyer & Gish (1980)] reported for earthworms. Dry soil concentrations calculated assuming 10% moisture content in sandy-loam soils (Donahue et al., 1977).

[y] Geometric mean of 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE BAFs (fresh wt/dry wt) reported for roots (carrot, potato, sugar beet), grains (corn, oats), and legumes (alfalfa) derived from USEPA (1985d) converted from dry weight to wet-weight per values provided by Suter (1993).

[z] BAF for shrews and voles calculated using measured concentrations of DDT_R in stomach content and in whole body (Forsyth & Petrle, 1984).

[aa] Whole-body pheasant BAF for 4,4'-DDT presented in USEPA (1985d); derived from Kenaga (1973).

[ab] Amphipod to sediment mean biomagnification factor for total DDT in Lake Michigan and Lake Ontario (Evans iet al. , 1991).

[ac] USEPA (1992), Dermal Exposure Guidance.

NA = Not available

Table P-3
Ingestion Toxicity Information for Wildlife
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Remedial Investigation Report
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Chemical	Test Species	Test Type	Duration	Effect	Lethal RTV mg/kgBW-day Oral LD_{50}	Lethal RTV mg/kgBW-day LOAEL	Sublethal RTV mg/kgBW-day LOAEL	Sublethal RTV mg/kgBW-day NOAEL	Reference
INORGANIC ANALYTES									
Beryllium	Rat	Oral LD_{50}	NR	Mortality	10				USEPA, 1985
	Rat	Oral (chronic)	NR	Increase in lung sarcomas			0.22		USEPA, 1985
	Rat	Oral (chronic)	3.2 years	Respiratory, cardiopulmonary, hematological, and hepatic effects			0.85		ATSDR, 1991a
Cobalt	Rat	Oral LD_{50}		Mortality	91				ATSDR, 1991b
	Rat	Single oral dose		Hepatic/renal hyperemia					ATSDR, 1991b
	Rat	Oral (subchronic)	8 weeks	Decreased body weight gain			4.2		ATSDR, 1991b
	Rat	Oral (chronic)	98 days	Testicular degeneration			13		ATSDR, 1991b
	Rat	Oral (chronic)	69 days	Testicular atrophy			20		ATSDR, 1991b
	Dog	Oral (subchronic)	4 weeks	Increased red blood cell count			5		ATSDR, 1991b
Copper	Rat	Single oral dose		Reproductive effects			152		NIOSH, 1985 and RTECS, 1993
	Rat	Oral LD_{50}	NR	Mortality	940				Sax, 1984
	Mouse	Oral (chronic)	30 days	Decreased litter sizes with teratogenic effects			100		Lecyk, 1980
Lead	Rat	Oral	NR	Reproductive effects			790		RTECS, 1993
	Rat	Oral	NR	Reproductive effects			1,140		RTECS, 1993
	Rat	Oral	NR	Reproductive effects			520		RTECS, 1993
	Rat	Oral	NR	Reproductive effects			1,100		RTECS, 1993
	Calf	Oral LD_{50}	NR	Mortality	220				Eisler, 1988
	Rat	Oral (subchronic)	12-14 days	Decreased fetal body weight			2.5		McClain and Becker, 1972
	Mouse	Oral	NR	Reproductive effects			1,120		RTECS, 1993
	Mouse	Oral	NR	Reproductive effects			6,300		RTECS, 1993
	Mouse	Oral	NR	Reproductive effects			300		RTECS, 1993
	Mouse	Oral	NR	Reproductive effects			4,800		RTECS, 1993
	Domestic animal	Oral	NR	Reproductive effects			662		RTECS, 1993
	Mammal	Oral	NR	Reproductive effects			2,118		RTECS, 1993
	Kestrel	Diet	NR	Decreased egg laying fertility; decreased egg shell				4.61 [a]	Eisler, 1988
	Kestrel nestlings	Oral	10 days	Reduced growth and brain weight; abnormal devel			125		Eisler, 1988
	Japanese quail	Oral LD_{50}	5 days	Mortality	24,752				Hill and Camardese, 1986
	Rat	Oral (chronic)	2 generation	Developmental effects				7	Kimmel et al., 1980 and Grant et al., 1980
	Guinea pig	Oral LD_{50}		Mortality	300				Sax, 1984
	Rock dove	Oral (chronic)	NS	Kidney pathology; learning deficiences			6.25		Anders et al., 1982 and Dietz et al., 1979
	Rock dove	Oral LD_{50}		Mortality	375				Kendall and Scanlon, 1985
Mercury	Mouse	Oral LD_{50}		Mortality	22				NIOSH, 1985
	Mouse	Oral (subchronic)	Day 6-17 (g	Stillbirths and neonatal death			4		Suzuki, 1979
	Rat	Oral (subchronic)	Day 6-14 (g	Retarded fetus growth			4		Suzuki, 1979
organomercury	Rat	Oral (chronic)	NR	Reduced fertility			0.5		Eisler, 1987a
	Rat	Oral LD_{50}		Mortality	18				NIOSH, 1985
organomercury	Pig	Oral (subchronic)	Pregnancy	High incidence of stillbirths			0.5		Eisler, 1987a

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Chemical	Test Species	Test Type	Duration	Effect	Lethal RTV mg/kgBW-day Oral LD_{50}	Lethal RTV mg/kgBW-day LOAEL	Sublethal RTV mg/kgBW-day LOAEL	Sublethal RTV mg/kgBW-day NOAEL	Reference
organomercury	Mule deer	Oral LD_{50}		Mortality	17.9				Eisler, 1987a
organomercury	River otter	Oral LD_{50}		Mortality	2				Eisler, 1987a
organomercury	Mink	Oral LD_{50}		Mortality	1				Eisler, 1987a
organomercury	Dog	Oral (subchronic)	Pregnancy	High incidence of stillbirths			0.1		Eisler, 1987a
methylmercury	House sparrow	Oral LD_{50}		Mortality	12.6				Eisler, 1987a
ethylmercury	Rock dove	Oral LD_{50}		Mortality	22.8				Eisler, 1987a
	Chicken	Oral LD_{50}		Mortality	20				Fimreite, 1979
	Bantam chicken	Oral LD_{50}		Mortality	190				Fimreite, 1979
ethylmercury	Prairie chicken	Oral LD_{50}		Mortality	11.5				Eisler, 1987a
ethylmercury	Chukar	Oral LD_{50}		Mortality	26.9				Eisler, 1987a
methylmercury	Corturnix	Oral LD_{50}		Mortality	11				Eisler, 1987a
	Mallard	Oral	NR	Reproduction, behavior			0.064		USEPA, 1993a
methylmercury	Black duck	Oral (subchronic)	28 weeks	Reproduction inhibited			0.22 [a]		Eisler, 1987a
methylmercury	Fulvous whistling	Oral LD_{50}		Mortality	37.8				Eisler, 1987a
methylmercury	Northern bobwhit	Oral LD_{50}		Mortality	23.8				Eisler, 1987a
methylmercury	Bobwhite quail	Oral LD_{50}	5 days	Mortality	523				Hill et al., 1975
	Japanese quail	Oral LD_{50}		Mortality	14.4				Eisler, 1987a
ethylmercury	Gray partridge	Oral LD_{50}		Mortality	17.6				Eisler, 1987a
organomercury	Gray pheasant	Oral (subchronic)	30 days	Reduced reproductive ability			0.64		Eisler, 1987a
methylmercury	Ring-necked phea	Oral LD_{50}		Mortality	11.5				Eisler, 1987a
	Mouse	Oral (subchronic)	50 days	Embryotoxicity and teratogenicity			0.9		Suzuki, 1979
Nickel	Rat	Oral	NR	Reproductive effects			158		RTECS, 1994
	Rat	Oral LD_{50}	NR	Mortality	67				USEPA, 1985c
	Rat	Oral (chronic)	2 years	Decreased body weight gain			50		USEPA, 1985c
	Rat	Oral LD_{50}	NR	Mortality	350				Sax, 1984
	Japanese quail	Oral (acute)	5 days	Mortality	504				Hill and Camardese, 1986
	Dog	Oral (chronic)	2 years	Histological lesions in bone marrow			62.5		USEPA, 1987
Selenium	Rat	Oral LD_{50}	NR	Mortality	6,700				RTECS, 1993
	Rat	Oral LD_{50}	NR	Mortality	138				Sax, 1984
	Mouse	Oral	NR	Reproductive effects			134		RTECS, 1993
	Mallard	Oral (subchronic)	3 months	Reduced hatchability			1.75		Eisler, 1985
	Rat	Oral (chronic)	2 years	Decrease in breeding			0.2		ATSDR, 1988
	Rat	Oral (chronic)	NS	Histological changes in heart and kidney			0.045		Eisler, 1985
	Japanese quail	Oral (chronic)	NS	Reduced egg hatching			0.6		Eisler, 1985
	Mallard	Oral (subchronic)	3 months	NOAEL for tratogenic effects			0.72	0.36	Eisler, 1985
	Horse	Oral LD_{50}		MLD	3.3				Eisler, 1985
	Mallard	Oral	6 weeks	Increased mort[illegible]		2.7 [a]			Heinz et al., 1988
	Black-crowned ni	Oral	NR	NOAEL for e[illegible] ability				0.61 [a]	Smith et al., 1988
Zinc	Rat	Oral LD_{50}		Mortality	2,510				RTECS, 1993

Table P-3
Ingestion Toxicity Information for Wildlife
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Chemical	Test Species	Test Type	Duration	Effect	Lethal RTV mg/kgBW-day		Sublethal RTV mg/kgBW-day		Reference
					Oral LD_{50}	LOAEL	LOAEL	NOAEL	
	Rat	Oral	Gestation	Fetal resorptions in 4 to 20% of population			200		Shlicker and Cox, 1968
	Ferret	Oral	3-13 days	Mortality and gastrointestinal effects		390			Straube et al., 1980
	Rat	Oral (subchronic)	NR	Kidney toxicity			160		Llobet, et al., 1988
PESTICIDES/PCBs									
4,4'-DDE	Rat	Oral LD_{50}	NR	Mortality	800				RTECS, 1993
	Mouse	Oral LD_{50}	NR	Mortality	700				RTECS, 1993
	Hamster	Oral LD_{50}	NR	Mortality	>5,000				RTECS, 1993
	Mallard	Oral	NR	Eggshell thinning			2.91		USEPA, 1993c
	Mallard	Oral	2 years	Reproductive: embryo mortality, cracked eggs			0.58		USEPA, 1993c
	Kestrel	Oral	NR	Eggshell thinning			0.39		USEPA, 1993c
4,4'-DDT (surrogate for 4,4'-DDD	Rat	Oral LD_{50}	NR	Mortality	87				RTECS, 1993
and 4,4'-DDE)	Rat	Oral LD_{50}		Mortality	100				USEPA, 1985d
	Rat	Oral	NR	Reproductive			112		RTECS, 1993
	Rat	Oral	NR	Reproductive			100		RTECS, 1993
	Rat	Oral	NR	Reproductive			430		RTECS, 1993
	Rat	Oral	NR	Reproductive			1,890		RTECS, 1993
	Rat	Oral	NR	Reproductive			250		RTECS, 1993
	Rat	Oral	NR	Reproductive			50		RTECS, 1993
	Rat	Oral (chronic)	3 generation	Reproductive			0.2		IRIS, 1991
	Rat	Oral	2 years	Reproductive			2.5		USEPA, 1993c
	Mouse	Oral LD_{50}	NR	Mortality	135				RTECS, 1993
	Mouse	Oral LD_{50}		Mortality	200				USEPA, 1985d
	Mouse	Oral	NR	Reproductive			504		RTECS, 1993
	Mouse	Oral	NR	Reproductive			81		RTECS, 1993
	Mouse	Oral	NR	Reproductive			124		RTECS, 1993
	Mouse	Oral	NR	Reproductive			148		RTECS, 1993
	Rabbit	Oral LD_{50}	NR	Mortality	250				RTECS, 1993
	Rabbit	Oral	NR	Reproductive			150		RTECS, 1993
	Guinea pig	Oral LD_{50}	NR	Mortality	150				RTECS, 1993
	Hamster	Oral LD_{50}	NR	Mortality	>5,000				RTECS, 1993
	Dog	Oral LD_{50}	NR	Mortality	150				RTECS, 1993
	Dog	Oral LD_{50}		Mortality	60				USEPA, 1985d
	Dog	Oral	NR	Reproductive			3,540		RTECS, 1993
	Dog	Oral (chronic)	14 months	Stillbirths, delayed estrus, reduced libido, lack of mammary gland develop			12		ATSDR, 1992a
	Monkey	Oral LD_{50}	NR	Mortality	200				RTECS, 1993
	Chicken	Oral (subchronic)	10 weeks	Decreased reproductive success; toxic symptoms			91.4 [a]		USEPA, 1985d
	Rock dove	Oral LD_{50}		Mortality	4,000				USFWS, 1984
	Black duck	Oral (chronic)	2 years	Reduced eggshell thickness			0.14 [a]		Longcore and Stendell, 1977
	Mallard	Oral LD_{50}		Mortality	2,240				USFWS, 1984

Table P-3
Ingestion Toxicity Information for Wildlife
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Chemical	Test Species	Test Type	Duration	Effect	Lethal RTV mg/kgBW-day Oral LD_{50}	Lethal RTV mg/kgBW-day LOAEL	Sublethal RTV mg/kgBW-day LOAEL	Sublethal RTV mg/kgBW-day NOAEL	Reference
	Mallard	Oral (subchronic)	96 days	Reduced eggshell thickness			2.8		Longcore and Stendell, 1977
	Mallard	Oral	NR	Eggshell thinning			1.16		USEPA, 1993c
	Mallard	Oral	NR	Eggshell thinning			2.91		USEPA, 1993c
	Mallard	Oral	2 years	Reproductive			1.45		USEPA, 1993c
	California quail	Oral LD_{50}		Mortality	595				USFWS, 1984
	Japanese quail	Oral LD_{50}		Mortality	841				USFWS, 1984
	Pheasant	Oral LD_{50}		Mortality	1,334				USFWS, 1984
	Sandhill crane	Oral LD_{50}		Mortality	1,200				USFWS, 1984
	Kestrel	Oral (chronic)	7 wk - 1 yr	Reduced eggshell thickness			0.56a		USEPA, 1985d
	Kestrel	Oral (chronic)	1 year	Reduced eggshell thickness			0.16a		Wiemeyer, et al., 1986
	Barn owl	Oral (chronic)	2 years	Reduced eggshell thickness			0.14 [a]		Longcore and Stendell, 1977
SEMIVOLATILE ORGANIC COMPOUNDS									
Acenaphthylene	Rat	Oral (chronic)	40 days	Physiological changes			600		USEPA, 1984
Anthracene	Mouse	Oral LD_{50}	NR	Mortality	17,000				RTECS, 1993
	Rodents	Oral (chronic)	NS	Carcinogenicity			3,300		Eisler, 1987b
	Mouse	Oral (chronic)	90 days	Clinical and pathological effects				1,000	IRIS, 1990
Benzo(k)fluoranthene	Rodents	Oral (chronic)	NS	Carcinogenicity			40		Eisler, 1987b
Chrysene	Rodents	Oral (chronic)	NS	Carcinogenicity			99		Eisler, 1987b
Fluoranthene	Rat	Oral LD_{50}	NR	Mortality	2,000				RTECS, 1994
	Mouse	Oral (subchronic)	90 days	Nephropathy; clinical and pathological effects			250	125	IRIS, 1990
Fluorene	Mouse	Oral (chronic)	13 weeks	Hematological changes			250	125	IRIS, 1990
Phenanthrene	Mouse	Oral LD_{50}	NR	Mortality	700				RTECS, 1994
	Mouse	Oral (subchronic)	6 months	Increased liver weight			120		USEPA, 1989
Pyrene	Rat	Oral LD_{50}	NR	Mortality	2,700				RTECS, 1993 and NIOSH, 1985
	Mouse	Oral LD_{50}	NR	Mortality	800				RTECS, 1993 and NIOSH, 1985
VOLATILE ORGANIC COMPOUNDS									
Acetone	Rat	Oral	NR	Reproductive effects			273,000		RTECS, 1993
	Rat	Oral LD_{50}	NR	Mortality	5,800				RTECS, 1993
	Rat	Oral LD_{50}		Mortality	9,750				Sax, 1984
	Mouse	Oral LD_{50}	NR	Mortality	3,000				RTECS, 1993
	Rabbit	Oral LD_{50}	NR	Mortality	5,340				RTECS, 1993

Table P-3
Ingestion Toxicity Information for Wildlife
AOC 69W

Remedial Investigation Report
Devens, Massachusetts

Chemical	Test Species	Test Type	Duration	Effect	Lethal RTV mg/kgBW-day		Sublethal RTV mg/kgBW-day		Reference
					Oral LD_{50}	LOAEL	LOAEL	NOAEL	
Toluene	Rat	Oral (subchronic)	13 weeks	Increased liver and kidney weight			446		IRIS, 1991
	Rat	Oral LD_{50}		Mortality	$\boxed{5,000}$				NIOSH, 1985
	Mouse	Oral (subchronic)	76 days	Decreased open field activity			$\boxed{76}$		ATSDR, 1992b
Trichlorofluoromethane	Mouse	LD_{50} (inter-peritoneal injection)		Mortality	$\boxed{1,743}$				Sax, 1984
Xylenes (total)	Rat	Oral LD_{50}		Mortality	$\boxed{4,300}$				NIOSH, 1985
	Rat	Oral (chronic)	103 weeks	Hyperactivity, decreased BW, mortality			$\boxed{500}$	250	IRIS, 1991
	Japanese quail	Oral (acute)	5 days	Mortality	20,000	$\boxed{2,014}$			Hill and Camardese, 1986

NOTES:
AOC = Area of contamination
LD_{50} = Dose resulting in 50% mortality in test population
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
BW = Body weight
NR = Not reported
[a] Converted to dose per kilogram body weight by multiplying by ingestion and dividing by body weight. Body weights for birds obtained from Dunning, 1984.
Ingestion rates were calculated using the following regression equation (for all birds) from USEPA, 1993a: Food Ingestion (kg/day) = 0.00582 * Body Weight $^{0.651}$ (kg).
Ingestion rates for the chicken from NRC, 1984 (pg. 13).

Table P-4
RTVs Selected for Ecological Risk Assessment (mg/kgBW/day) [a]
AOC 69W

Remedial Investigation Report
Devens, Massachusetts

Compound	Small Mammal [b]			Small Bird [c]			Predatory Mammal [d]		
	Lethal	Sublethal	Selected RTV	Lethal	Sublethal	Selected RTV	Lethal	Sublethal	Selected RTV
Inorganic Analytes									
Beryllium	2	0.85	0.85	2	0.85	0.85	2	0.85	0.85
Cobalt	18.2	4.2	4.2	18.2	4.2	4.2	18.2	4.2	4.2
Copper	188	100	100	188	100	100	188	100	100
Lead	60	2.5	2.5	75	125	75	60	2.5	2.5
Mercury	3.6	0.9	0.9	2.9	0.064	0.064	0.2	0.1	0.1
Nickel	13	50	13	100	50	50	13	50	13
Selenium	28	0.2	0.2	2.7	0.6	0.6	28	0.2	0.2
Zinc	390	200	200	390	200	200	390	200	200
Pesticides/PCBs									
4,4'-DDD	17.4	0.2	0.2	119	0.14	0.14	12	12	12
4,4'-DDE	140	0.2	0.2	119	0.39	0.39	140	12	12
4,4'-DDT	17.4	0.2	0.2	119	0.14	0.14	12	12	12
Semivolatile Organic Compounds									
Acenaphthylene	120 [e]	10 [e]	10	120 [e]	10 [e]	10	120 [e]	10 [e]	10
Anthracene	3,400	10 [e]	10	3,400	10 [e]	10	3,400	10 [e]	10
Benzo(k)fluoranthene	120 [e]	10 [e]	10	120 [e]	10 [e]	10	120 [e]	10 [e]	10
Chrysene	120 [e]	10 [e]	10	120 [e]	10 [e]	10	120 [e]	10 [e]	10
Fluoranthene	400	10 [e]	10	400	10 [e]	10	400	10 [e]	10
Flourene	120 [e]	10 [e]	10	120 [e]	10 [e]	10	120 [e]	10 [e]	10
Phenanthrene	140	10 [e]	10	140	10 [e]	10	140	10 [e]	10
Pyrene	160	10 [e]	10	160	10 [e]	10	160	10 [e]	10
Volatile Organic Compounds									
Acetone	600	273,000	600	600	273,000	600	600	273,000	600
Toluene	1,000	76	76	1,000	76	76	1,000	76	76
Trichlorofluoromethane	350	35 [f]	35	350	35 [f]	35	350	35 [f]	35
Xylenes	860	500	500	2,014	500	500	860	500	500

Notes:

[a] Lethal RTVs correspond to the boxed lethal RTV (one-fifth of the oral LD_{50} or the LOAEL) presented in Table P-3. When available, oral LD_{50} data were preferentially chosen. Sublethal RTVs correspond to the boxed sublethal RTV (LOAEL or NOAEL) presented in Table P-3. When available, sublethal LOAEL data were preferentially chosen.

[b] These RTVs represent chemical concentrations that are not anticipated to result in adverse effects for the short-tailed shrew and white-footed mouse.

[c] These RTVs represent chemical concentrations that are not anticipated to result in adverse effects for the American robin or red-winged blackbird. When no data were available, the small mammal value was used as a surrogate.

[d] These RTVs represent chemical concentrations that are not anticipated to result in adverse effects for the raccoon. When no data were available, the small mammal value was used as a surrogate.

[e] The value for benzo(a)pyrene was used as a surrogate.

[f] A sublethal RTV was derived by applying a factor of 0.1 to the lethal RTV, which is expected to be protective of 99% of the population (USEPA, 1986).

AOC = Area of contamination

LD_{50} = Median lethal dose.

LOAEL = Lowest Observed Adverse Effect Level

NOAEL = No Observed Adverse Effect Level.

RTV = Reference toxicity value.

NA = Not available.

TABLE P-5

SUMMARY OF TOXICITY DATA FOR PLANT RECEPTORS

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Devens, Massachusetts

Chemical	Reference	RTV in soil [a] (µg/g)
INORGANICS		
Beryllium	Will and Suter, 1994	10
Cobalt	Will and Suter, 1994	20
Copper	Will and Suter, 1994	100
Lead	Will and Suter, 1994	50
Mercury	Will and Suter, 1994	0.3
Nickel	Will and Suter, 1994	30
Selenium	Will and Suter, 1994	1
Zinc	Will and Suter, 1994	50
SEMI-VOLATILE ORGANICS		
Acenaphthylene		25 [b]
Anthracene		25 [b]
Benzo(k)flouranthene		25 [b]
Chrysene		25 [b]
Fluoranthene		25 [b]
Fluorene		25 [b]
Phenanthrene		25 [b]
Pyrene		25 [b]
VOLATILE ORGANICS		
Acetone	NA	NA
Toluene	Will and Suter, 1994	200
Trichlorofluoromethane	NA	NA
Xylene (total)	Hulzebos et al., 1993 [c]	>1,000

Notes:

[a] RTVs in soil are equal to chemical concentrations in soil that are not expected to result in adverse effects to plants.

[b] Value for acenaphthene used as a surrogate (Hulzebos et al., 1993).

[c] Value represents 14-day growth EC_{50}s for *Lactuca sativa* in soil.

NA = Not available

TABLE P-6

SUMMARY OF TOXICITY DATA FOR TERRESTRIAL INVERTEBRATE RECEPTORS

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Remedial Investigation Report

Devens, Massachusetts

Chemical	Test Type	Test Duration	Test Species	Chemical Concentration (µg/g)	Effect	RTV (µg/g)	Reference
INORGANICS							
Beryllium	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA	NA
Copper	Soil Test	14 day	*E. foetida*	10	0 % mortality		Bouche et al., 1987
Copper	Soil Test	14 day	*E. foetida*	30	20 % mortality	30	Bouche et al., 1987
Copper	Soil Test	20 week	*E. foetida*	2,000 [a]	Decrease in cocoon production		Malecki et al., 1982
Copper	Soil Test	2 week	*E. foetida*	643	LC_{50}		Neuhauser et al., 1985
Lead	Soil Test	20 week	*E. foetida*	5,000 [a]	Decrease in cocoon production		Malecki et al., 1982
Lead	Soil Test	2 week	*E. foetida*	5,941	LC_{50}	1,190 [b]	Neuhauser et al., 1985
Mercury	Soil Test	14 day	*E. foetida*	36	0 % mortality	36	Bouche et al., 1987
Mercury	Soil Test	14 day	*E. foetida*	216	60 % mortality		Bouche et al., 1987
Nickel	Soil Test	20 week	*E. foetida*	400 [a]	Decrease in cocoon production	400	Malecki et al., 1982
Nickel	Soil Test	2 week	*E. foetida*	757	LC_{50}		Neuhauser et al., 1985
Selenium	NA	NA	NA	NA	NA	NA	NA
Zinc	Soil Test	20 week	*E. foetida*	5,000 [a]	Decrease in cocoon production		Malecki et al., 1982
Zinc	Soil Test	2 week	*E. foetida*	662	LC_{50}	130 [b]	Neuhauser et al., 1985
SEMI-VOLATILE ORGANIC COMPOUNDS							
Acenaphthylene	Soil Test	14 day	*E. foetida*	173	LC_{50}	34 [c]	Neuhauser et al., 1985.
Anthracene	Soil Test	14 day	*E. foetida*	173	LC_{50}	34 [c]	Neuhauser et al., 1985.
Benzo(k)flouranthene	Soil Test	14 day	*E. foetida*	173	LC_{50}	34 [c]	Neuhauser et al., 1985.
Chrysene	Soil Test	14 day	*E. foetida*	173	LC_{50}	34 [c]	Neuhauser et al., 1985.
Fluoranthene	Soil Test	14 day	*E. foetida*	173	LC_{50}	34 [c]	Neuhauser et al., 1985
Fluorene	Soil Test	14 day	*E. foetida*	173	LC_{50}	34 [c]	Neuhauser et al., 1985.
Fluorene	Soil Test	14 day	4 test species	187	LC_{50}		Neuhauser et al., 1986.
Phenanthrene	Soil Test	14 day	*E. foetida*	173	LC_{50}	34 [c]	Neuhauser et al., 1985
Pyrene	Soil Test	14 day	*E. foetida*	173	LC_{50}	34 [c]	Neuhauser et al., 1985
VOLATILE ORGANIC COMPOUNDS							
Acetone	NA	NA	NA	NA	NA	NA	NA
Toluene	Soil Test	14 day	*E. foetida*	106	LC_{50}	21 [c]	Neuhauser et al., 1985
Trichlorofluoromethane	NA	NA	NA	NA	NA	NA	NA
Xylene (total)	Soil Test	14 day	*E. foetida*	106	LC_{50}	21 [c]	Neuhauser et al., 1985

NOTES:

[a] Acetate salt

[b] Conservative factor of 0.2 applied to endpoint; resultant value should be protective of 99.9% of the exposued population from acute effects (USEPA, 1986).

[c] Equal to the lowest LC_{50} in each chemical class, multiplied by a safety factor of 0.2, as described in text. Value for carbaryl used for aromatic hydrocarbons. Value for fluorene used for polycyclic aromatic hydrocarbons.

AOC = Area of contamination

NA = Not available

Table P-7
AQUIRE Toxicity Information[1]
(in ug/l)
AOC 69W

Remedial Investigation Report
Devens, Massachusetts

Chemical Name	Species	Age	Exposure	Effect	Effect Concentration		AQUIRE Reference Number	Year of Publication
					Lethal	Sublethal		
Inorganic Compounds								
Arsenic	Ceriodaphnia reticulata; Water flea;	< 4 H	48 H	LC$_{50}$	1,800		311181	84
	Daphnia magna; Water flea;	< 24 H	48 H	LC$_{50}$	3,800		311181	84
	Daphnia pulex; Water flea;	< 24 H	48 H	LC$_{50}$	1,900		311181	84
	Ictalurus punctatus; Channel catfish;	400 G	0.1 to 7 WK	RSD		1,910 to 2,500	315333	77
	Lepomis cyanellus; Green sunfish;	<4 YR, 5.5-90.7 G	4 MO	HIS		1,000 to 20,000	311560	85
	Lepomis macrochirus; Bluegill;	NR	6 MO	MOR *	5,000		212143	73
	Myriophyllum spicatum; Water-milfoil;	4 CM APEX	32 D	EC$_{50}$BM *		2,600	212262	74
	Myriophyllum spicatum; Water-milfoil;	4 CM APEX	32 D	EC$_{50}$BM *		2,900	212262	74
	Myriophyllum spicatum; Water-milfoil;	4 CM APEX	32 D	EC$_{50}$GR *		3,600	212262	74
	Myriophyllum spicatum; Water-milfoil;	4 CM APEX	32 D	EC$_{50}$GR *		4,100	212262	74
	Simocephalus vetulus; Water flea;	< 24 H	48 H	LC$_{50}$	$\boxed{1,700}$		311181	84
Iron	Dugesia dorotocephala; Turbellarian, flatworm;	18-20 MM	1 H	BEH *		1,000 to 50,000	310581	91
	Lemna minor; Duckweed;	20 COLONIES OR 40 FRONDS	4 D	EC$_{50}$GR *		$\boxed{3,700}$	311789	86
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EGGS AND LARVA	NR	DVP *		5,700	315523	82
	Salmo trutta; Brown trout;	ALEVIN	NR	MOR *	5,170		311637	83
	Salmo trutta; Brown trout;	EGG	NR	HAT *		460	311637	83
	Salmo trutta; Brown trout;	EYED EGGS	NR	MOR *	5,170		311637	83
	Salmo trutta; Brown trout;	NEWLY HAT ALEVIN	NR	MOR *	3,020		311637	83
	Tilapia sparrmanii; Banded bream;	10.24-99.43 G	2 to 72 H	OC *		88,000	213066	89
Manganese	Algae; Algae, phytoplankton, algal mat;	NATURAL COLONY	38 D	POP *		$\boxed{280}$	212862	69
	Anabolia nervosa; Quiver fly;	LARVAE	7 D	LET	2,000,000		210725	57
	Chironomus thummi; Midge;	LARVAE	7 D	LET	1,000,000		210725	57
	Cyprinidae; Minnow, carp family;	1 SUMMER	2.25 H	LET *	1,000,000		210725	57
	Cyprinidae; Minnow, carp family;	1 SUMMER	24 H	LET *	2,000,000		210725	57
	Cyprinidae; Minnow, carp family;	1 SUMMER	25 H	LET *	1,800,000		210725	57
	Cyprinidae; Minnow, carp family;	1 SUMMER	4.17 D	LET *	800,000		210725	57
	Cyprinidae; Minnow, carp family;	1 SUMMER	5.13 D	LET *	700,000		210725	57
	Cyprinidae; Minnow, carp family;	1 SUMMER	6.63 D	LET *	650,000		210725	57
	Cyprinidae; Minnow, carp family;	1 SUMMER	7 D	MOR *	600,000		210725	57
	Cyprinidae; Minnow, carp family;	1 SUMMER	78 H	LET *	900,000		210725	57
	Cyprinidae; Minnow, carp family;	2 SUMMERS	48 H	LET *	2,000,000		210725	57
	Gammarus roeseli; Scud;	NR	7 D	LET	70,000		210725	57
	Lemna minor; Duckweed;	20 COLONIES OR 40 FRONDS	4 D	EC$_{50}$GR *		31,000	311789	86
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	1 SUMMER	10 H	LET *	700,000		210725	57
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	1 SUMMER	13 H	LET *	600,000		210725	57
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	1 SUMMER	34 H	LET *	300,000		210725	57
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	1 SUMMER	5 D	LET *	100,000		210725	57
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	1 SUMMER	7 D	MOR *	75,000		210725	57
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	1 SUMMER	77 H	LET *	150,000		210725	57

Table P-7
AQUIRE Toxicity Information[1]
(in ug/l)
AOC 69W

Remedial Investigation Report
Devens, Massachusetts

Chemical Name	Species	Age	Exposure	Effect	Effect Concentration		AQUIRE Reference Number	Year of Publication
					Lethal	Sublethal		
Manganese (cont.)	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	2 SUMMERS	34 H	LET *	600,000		210725	57
	Salvelinus fontinalis; Brook trout;	1 SUMMER	15 H	LET *	700,000		210725	57
	Salvelinus fontinalis; Brook trout;	1 SUMMER	23 H	LET *	600,000		210725	57
	Salvelinus fontinalis; Brook trout;	1 SUMMER	4.79 D	LET *	150,000		210725	57
	Salvelinus fontinalis; Brook trout;	1 SUMMER	66 H	LET *	300,000		210725	57
	Salvelinus fontinalis; Brook trout;	1 SUMMER	7 D	MOR *	100,000		210725	57
	Salvelinus fontinalis; Brook trout;	2 SUMMERS	41 H	LET *	600,000		210725	57
	Tinca tinca; Tench;	1 SUMMER	48 H	LET *	2,000,000		210725	57
	Tinca tinca; Tench;	1 SUMMER	6.75 D	LET *	1,500,000		210725	57
	Tinca tinca; Tench;	1 SUMMER	7 D	MOR *	1,200,000		210725	57
	Tinca tinca; Tench;	1 SUMMER	7 D	MOR *	1,300,000		210725	57
	Tinca tinca; Tench;	1 SUMMER	96 H	LET *	1,800,000		210725	57
	Tinca tinca; Tench;	2 SUMMERS	7 D	LET *	2,000,000		210725	57
	Tubifex tubifex; Tubificid worm;	NR	7 D	LET	700,000		210725	57
Pesticides/PCBs								
gamma-Chlordane (alpha-Chlorane used as a surrogate)	Lepomis macrochirus; Bluegill;	NR	96 H	LC50	7.1		210666	80
Semivolatile Organic Compounds								
2-Methylnaphthalene	Cyprinus carpio; Common, mirror carp	125-550 G	72 H	RSD		5	225915	80
	Scenedesmus subspicatus; Green algae;	NR	10 D	GRO *		2,000,000	215189	80
	Scenedesmus subspicatus; Green algae;	NR	10 D	PGR		2,000,000	207839	80
bis(2-Ethylhexyl)phthalate	Anacystis aeruginosa; Blue-green algae;	LOG-PHASE 500000 CELLS/ML	96 H	EC_{50}GR		> =320	215336	81
	Anacystis aeruginosa; Blue-green algae;	LOG-PHASE 500000 CELLS/ML	96 H	PGR *		> =320	215336	81
	Brachydanio rerio; Zebra danio, zebrafish;	4-5 WK	96 H	LC_{50}	>320		215390	84
	Brachydanio rerio; Zebra danio, zebrafish;	4-5 WK	96 H	MOR *	> =320		215390	84
	Brachydanio rerio; Zebra danio, zebrafish;	<4 H, EGGS	5 WK	DVP *		> =1000	215390	84
	Brachydanio rerio; Zebra danio, zebrafish;	1-2 D	96 H	MOR *	> =320		215390	84
	Brachydanio rerio; Zebra danio, zebrafish;	<4 H, EGGS	5 WK	GRO *		> =1000	215390	84
	Brachydanio rerio; Zebra danio, zebrafish;	1-2 D	96 H	BEH *		> =320	215390	84
	Brachydanio rerio; Zebra danio, zebrafish;	4-5 WK	96 H	BEH *		> =320	215390	84
	Brachydanio rerio; Zebra danio, zebrafish;	1-2 D	96 H	LC_{50}	>320		215390	84
	Brachydanio rerio; Zebra danio, zebrafish;	<4 H, EGGS	5 WK	MOR *	> =1000		215390	84
	Bufo woodhousei fowleri; Fowler's toad;	EMBRYO TO LARVA	to 8 D *	LC_{50}	3,880		216772	78
	Bufo woodhousei fowleri; Fowler's toad;	LARVA	96 H *	LC_{50}	3,880		216772	78
	Carassius auratus; Goldfish;	EMBRYO TO LARVA	96 H *	LC_{50}	6,180		216772	78
	Carassius auratus; Goldfish;	EGGS, 4 D POSTHATCH	96 H	LC_{50}	> 191000		210563	79
	Carassius auratus; Goldfish;	EGGS, 4 D POSTH[illegible]H	96 H	LC_{50}	> 186000		210563	79
	Carassius auratus; Goldfish;	EGGS, 4 D POST[illegible]	8 D	LC_{50}	> 191000		210563	79

Table P-7
AQUIRE Toxicity Information[1]
(in ug/l)
AOC 69W

Remedial Investigation Report
Devens, Massachusetts

Chemical Name	Species	Age	Exposure	Effect	Effect Concentration		AQUIRE Reference Number	Year of Publication
					Lethal	Sublethal		
bis(2-Ethylhexyl)phthalate (cont.)	Carassius auratus; Goldfish;	EGGS, 4 D POSTHATCH	8 D	LC_{50}	> 186000		210563	79
	Chironomus plumosus; Midge;	EGG	30 D	HAT *		560	217688	77
	Chironomus plumosus; Midge;	LARVAE	30 D	DVP *		560	217688	77
	Chlorella pyrenoidosa; Green algae;	LOG-PHASE 10000 CELLS/ML	96 H	EC_{50}GR		>320	215336	81
	Chlorella pyrenoidosa; Green algae;	LOG-PHASE 10000 CELLS/ML	96 H	PGR *		> =320	215336	81
	Daphnia magna; Water flea;	<24 H	24 H	LC_{50}	>68000		215184	80
	Daphnia magna; Water flea;	NR	21 D	REP *		10	210736	73
	Daphnia magna; Water flea;	< 24 H	21 D	MOR *	10		311061	82
	Daphnia magna; Water flea;	NR	21 D	REP *		2.5	210736	73
	Daphnia magna; Water flea;	< 24 H	21 D	MOR *	3.2		311061	82
	Daphnia magna; Water flea;	NR	21 D	REP *		3	210736	73
	Daphnia magna; Water flea;	< 24 H	48 H	LOC *		47	311061	82
	Daphnia magna; Water flea;	NR	21 D	REP *		30	210736	73
	Daphnia magna; Water flea;	<1 D	2 WK	MOR *	32		215336	81
	Daphnia magna; Water flea;	FIRST INSTAR, < 24 H	7 D	BIO *		811	312340	87
	Daphnia magna; Water flea;	FIRST INSTAR, < 24 H	7 D	MOR *	158		312340	87
	Daphnia magna; Water flea;	<1 D	3 WK	LC_{50}	>320		215336	81
	Daphnia magna; Water flea;	FIRST INSTAR, < 24 H	7 D	MOR *	811		312340	87
	Daphnia magna; Water flea;	<24 H	2 WK	REP *		320	215336	81
	Daphnia magna; Water flea;	NR	14 D	REP *		10	210736	73
	Daphnia magna; Water flea;	<24 H	48 H	LC_{50}	11,000		215184	80
	Daphnia magna; Water flea;	NR	14 D	REP *		3	210736	73
	Daphnia magna; Water flea;	FIRST INSTAR, < 24 H	21 D	MOR *	158		312340	87
	Daphnia magna; Water flea;	NR	14 D	REP *		30	210736	73
	Daphnia magna; Water flea;	FIRST INSTAR, < 24 H	7 D	BIO *		158	312340	87
	Daphnia magna; Water flea;	< 24 H	21 D	MOR *	100		311061	82
	Daphnia magna; Water flea;	<1 D	3 WK	MOR *	> =320		215336	81
	Daphnia magna; Water flea;	< 24 H	21 D	MOR *	32		311061	82
	Daphnia magna; Water flea;	<24 H	48 H	MOR *	1,100		215184	80
	Daphnia magna; Water flea;	<1 D	2 WK	LC_{50}	>320		215336	81
	Daphnia magna; Water flea;	<1 D	24 H	EC_{50}IM		>320	215336	81
	Daphnia magna; Water flea;	FIRST INSTAR, < 24 H	21 D	MOR *	811		312340	87
	Daphnia magna; Water flea;	1ST INSTAR, 24 H	21 D	REP		3	210732	73
	Daphnia magna; Water flea;	<1 D	2 WK	MOR *	> =320		215336	81
	Daphnia pulex; Water flea;	NEONATE, < 24 H	48 H	EC_{50}IM		133	312730	87
	Euglena gracilis; Flagellate euglenoid;	LOG-PHASE 10000 CELLS/ML	96 H	EC_{50}GR		>320	215336	81
	Euglena gracilis; Flagellate euglenoid;	LOG-PHASE 10000 CELLS/ML	96 H	PGR *		> =320	215336	81
	Gammarus pseudolimnaeus; Scud;	NR	96 H	LC_{50}	>32000		210732	73
	Gammarus pseudolimnaeus; Scud;	JUVENILE	96 H	LC_{50}	> 32000		210666	80
	Gammarus pulex; Scud;	>12 MM	10 D	LOC *		100	210079	91

Table P-7
AQUIRE Toxicity Information[1]
(in ug/l)
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Chemical Name	Species	Age	Exposure	Effect	Effect Concentration Lethal	Effect Concentration Sublethal	AQUIRE Reference Number	Year of Publication
bis(2-Ethylhexyl)phthalate (cont.)	Gammarus pulex; Scud;	>12 MM	10 D	LOC *		500	210079	91
	Gasterosteus aculeatus; Three spine stickleback;	4-5 WK	48 H	LC_{50}	> 300		210823	89
	Gasterosteus aculeatus; Three spine stickleback;	4-5 WK	96 H	LC_{50}	> 300		210823	89
	Gasterosteus aculeatus; Three spine stickleback;	4-5 WK	24 H	LC_{50}	> 300		210823	89
	Gasterosteus aculeatus; Three spine stickleback;	EGGS, < 6 H	35 D	EC_{50} *		> 320	210823	89
	Gasterosteus aculeatus; Three spine stickleback;	4-5 WK	24 H	EC_{50} *		> 300	210823	89
	Gasterosteus aculeatus; Three spine stickleback;	EGGS, < 6 H	35 D	LC_{50}	> 320		210823	89
	Gasterosteus aculeatus; Three spine stickleback;	4-5 WK	72 H	LC_{50}	> 300		210823	89
	Gasterosteus aculeatus; Three spine stickleback;	4-5 WK	48 H	EC_{50} *		> 300	210823	89
	Gasterosteus aculeatus; Three spine stickleback;	4-5 WK	72 H	EC_{50} *		> 300	210823	89
	Gasterosteus aculeatus; Three spine stickleback;	4-5 WK	96 H	EC_{50} *		> 300	210823	89
	Ictalurus punctatus; Channel catfish;	1.5 G	96 H	LC_{50}	> 100000		210666	80
	Ictalurus punctatus; Channel catfish;	EMBRYO TO LARVA	96 H *	LC_{50}	690		216772	78
	Jordanella floridae; Flagfish;	28-35 D	3 WK	MOR *	>=320		215336	81
	Jordanella floridae; Flagfish;	<36 H	4 WK	MOR *	>=320		215336	81
	Jordanella floridae; Flagfish;	<36 H	7 D	LC_{50}	>320		215336	81
	Jordanella floridae; Flagfish;	1-2 D	96 H	LC_{50}	>320		215336	81
	Jordanella floridae; Flagfish;	4-5 WK	96 H	BEH *		>=320	215336	81
	Jordanella floridae; Flagfish;	4-5 WK	96 H	LC_{50}	>320		215336	81
	Jordanella floridae; Flagfish;	1-2 D	48 H	LC_{50}	>320		215336	81
	Jordanella floridae; Flagfish;	<36 H	4 WK	GRO *		>=320	215336	81
	Jordanella floridae; Flagfish;	28-35 D	4 WK	MOR *	>=320		215336	81
	Jordanella floridae; Flagfish;	<36 H	4 WK	LC_{50}	>320		215336	81
	Jordanella floridae; Flagfish;	4-5 WK	48 H	LC_{50}	>320		215336	81
	Jordanella floridae; Flagfish;	1-2 D	96 H	BEH *		>=320	215336	81
	Jordanella floridae; Flagfish;	28-35 D	4 WK	GRO *		>=320	215336	81
	Jordanella floridae; Flagfish;	28-35 D	2 WK	MOR *	>=320		215336	81
	Jordanella floridae; Flagfish;	28-35 D	4 WK	REP *		>=320	215336	81
	Jordanella floridae; Flagfish;	28-35 D	1 WK	MOR *	>=320		215336	81
	Lepomis macrochirus; Bluegill;	0.32-1.2 G, JUVENILE	24 H	LC_{50}	>770000		215590	81
	Lepomis macrochirus; Bluegill;	0.32-1.2 G, JUVENILE	96 H	LC_{50}	>770000		215590	81
	Lepomis macrochirus; Bluegill;	0.6 G	96 H	LC_{50}	> 100000		210666	80
	Lepomis macrochirus; Bluegill;	JUVENILE, 35 - 60 MM	0.7 H	AVO *		112,400	215272	80
	Micropterus salmoides; Largemouth bass;	EGGS, 4 D POSTHATCH	84 H	LC_{50}	32,100		210563	79
	Micropterus salmoides; Largemouth bass;	EMBRYO TO LAR[illegible]	96 H *	LC_{50}	32,900		216772	78
	Micropterus salmoides; Largemouth bass;	EMBRYO TO LA[illegible]	96 H *	LC_{50}	42,100		216772	78

Table P-7
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Chemical Name	Species	Age	Exposure	Effect	Effect Concentration		AQUIRE Reference Number	Year of Publication
					Lethal	Sublethal		
bis(2-Ethylhexyl)phthalate (cont.)	Micropterus salmoides; Largemouth bass;	EGGS, 4 D POSTHATCH	7.5 D	LC$_{50}$	45,500		210563	79
	Micropterus salmoides; Largemouth bass;	EGGS, 4 D POSTHATCH	7.5 D	LC$_{50}$	55,700		210563	79
	Micropterus salmoides; Largemouth bass;	EGGS, 4 D POSTHATCH	84 H	LC$_{50}$	65,500		210563	79
	Oncorhynchus kisutch; Coho salmon, silver salmon;	1.5 G	96 H	LC$_{50}$	> 100000		210666	80
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EYED EGGS	12 D *	MOR *	54		217859	76
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EYED EGGS	100 D	HAT *		54	217859	76
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EYED EGGS	12 D *	MOR *	14		217859	76
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EGGS, 4 D POSTHATCH	23 D	LC$_{50}$	154,000		210563	79
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EYED EGGS	12 D *	MOR *	5		217859	76
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EGGS, 4 D POSTHATCH	27 D	LC$_{50}$	149,200		210563	79
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	1.5 G	96 H	LC$_{50}$	> 100000		210666	80
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EMBRYO TO LARVA	96 H *	LC$_{50}$	149,200		216772	78
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EYED EGGS	24 D *	MOR *	14		217859	76
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EYED EGG	90 D	VTE *		14	215109	77
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EYED EGGS	24 D *	MOR *	5		217859	76
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EYED EGGS	100 D	GRO *		62	217859	76
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EYED EGGS	24 D *	MOR *	54		217859	76
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EGGS, 4 D POSTHATCH	27 D	LC$_{50}$	139,500		210563	79
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EYED EGGS	5 D *	MOR *	14		217859	76
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EYED EGG	90 D	GRO *		54	215109	77
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EYED EGGS	5 D *	MOR *	5		217859	76
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EGGS, 4 D POSTHATCH	23 D	LC$_{50}$	139,100		210563	79
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EYED EGG	90 D	VTE *		5	215109	77
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EMBRYO TO LARVA	96 H *	LC$_{50}$	139,500		216772	78
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	EYED EGGS	5 D *	MOR *	54		217859	76
	Oryzias latipes; Medaka, high-eyes;	28-35 D	4 WK	GRO *		> =320	215336	81
	Oryzias latipes; Medaka, high-eyes;	28-35 D	4 WK	REP *		> =320	215336	81
	Oryzias latipes; Medaka, high-eyes;	1-2 D	96 H	BEH *		> =320	215336	81
	Oryzias latipes; Medaka, high-eyes;	4-5 WK	48 H	LC$_{50}$	>320		215336	81
	Oryzias latipes; Medaka, high-eyes;	28-35 D	1 WK	MOR *	> =320		215336	81
	Oryzias latipes; Medaka, high-eyes;	4-5 WK	96 H	BEH *		> =320	215336	81
	Oryzias latipes; Medaka, high-eyes;	28-35 D	3 WK	MOR *	> =320		215336	81
	Oryzias latipes; Medaka, high-eyes;	4-5 WK	96 H	LC$_{50}$	>320		215336	81
	Oryzias latipes; Medaka, high-eyes;	28-35 D	4 WK	LC$_{50}$	>320		215336	81
	Oryzias latipes; Medaka, high-eyes;	<36 H	4 WK	LC$_{50}$	>320		215336	81
	Oryzias latipes; Medaka, high-eyes;	1-2 D	96 H	LC$_{50}$	>320		215336	81
	Oryzias latipes; Medaka, high-eyes;	<36 H	4 WK	MOR *	> =320		215336	81
	Oryzias latipes; Medaka, high-eyes;	1-2 D	48 H	LC$_{50}$	>320		215336	81

Table P-7
AQUIRE Toxicity Information[1]
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Chemical Name	Species	Age	Exposure	Effect	Effect Concentration: Lethal	Effect Concentration: Sublethal	AQUIRE Reference Number	Year of Publication
bis(2-Ethylhexyl)phthalate (cont.)	Oryzias latipes; Medaka, high-eyes;	28-35 D	2 WK	MOR *	>=320		215336	81
	Oryzias latipes; Medaka, high-eyes;	28-35 D	4 WK	MOR *	>=320		215336	81
	Oryzias latipes; Medaka, high-eyes;	<36 H	7 D	LC_{50}	>320		215336	81
	Pimephales promelas; Fathead minnow;	7.5 MO, 1.24 G	56 D	MOR *	62		217859	76
	Pimephales promelas; Fathead minnow;	7.5 MO, 1.24 G	56 D	GRO *		62	217859	76
	Pimephales promelas; Fathead minnow;	FRY, 10 D	127 D	GRO *		100	215109	77
	Pimephales promelas; Fathead minnow;	FRY, 10 D	127 D	VTE *		11	215109	77
	Poecilia reticulata; Guppy;	21-28 D	2 WK	LC_{50}	>320		215336	81
	Poecilia reticulata; Guppy;	21-28 D	48 H	LC_{50}	>320		215336	81
	Poecilia reticulata; Guppy;	21-28 D	4 WK	LC_{50}	>320		215336	81
	Poecilia reticulata; Guppy;	21-28 D	1 WK	LC_{50}	>320		215336	81
	Rana arvalis; Moorfrog;	EGGS	3 WK	HAT		0.89 to 187.40	215904	87
	Rana pipiens; Leopard frog;	EMBRYO TO LARVA	to 8 D *	LC_{50}	4,440		216772	78
	Rana pipiens; Leopard frog;	LARVA	96 H *	LC_{50}	4,440		216772	78
	Salvelinus fontinalis; Brook trout;	ADULT, 1.5 YR	150 D	GRO *		52	215109	77
	Salvelinus fontinalis; Brook trout;	ADULT, 1.5 YR	150 D	VTE *		3.7	215109	77
	Selenastrum capricornutum; Green algae;	LOG-PHASE 50000 CELLS/ML	96 H	EC_{50}GR		>320	215336	81
	Selenastrum capricornutum; Green algae;	LOG-PHASE 50000 CELLS/ML	96 H	PGR *		>=320	215336	81
	Stephanodiscus hantzschii; Diatom;	LOG-PHASE 10000 CELLS/ML	96 H	EC_{50}GR		>320	215336	81
	Stephanodiscus hantzschii; Diatom;	LOG-PHASE 10000 CELLS/ML	96 H	PGR *		>=320	215336	81
Dibenzofuran	Daphnia magna; Water flea	<24 H	24 H	LC_{50}	7500		5184	80
	Daphnia magna; Water flea	<24 H	48 H	LC_{50}	1700		5184	80
	Daphnia magna; Water flea	<24 H	48 H	MOR	280		5184	80
	Daphnia magna; Water flea	<24 H	48 H	LC_{50}	1340		5374	90
	Poecilia reticulata; Guppy	3-4 W	96 H	LC_{50}	1800		5374	90
	Daphnia magna; Water flea	<24 H	48 H	LC_{50}	12000		5374	90
	Poecilia reticulata; Guppy	3-4 W	96 H	LC_{50}	18000		5374	90
	Pimephales promelas; Fathead minnow	32 D, 21.7 MM, 0.134 G	96 H	LC_{50}	1780		12859	88
	Pimephales promelas; Fathead minnow	29 D, 22.8 MM, 0.165 G	96 H	LC_{50}	1850		12859	88
Volatile Organic Compounds								
1,1,1-Trichloroethane	Daphnia magna; Water flea	<24 H	48 H	MOR	530000		203607	80
	Daphnia magna; Water flea	< 24 H	17D	LC_{50}	5400		309801	89
	Daphnia magna; Water flea	<24 H	17D	REP		2400	309800	89
	Daphnia magna; Water flea	<24 H	17D	REP		1300	309799	89
	Lepomis macrochirus; Bluegill	JUVENILE, 0.32-1.2 G	96H	LC_{50}	40000		208969	81
1,1,1-Tric iane (cont.)	Lepomis macrochirus; Bluegill	JUVENILE, 0.32-	24H	LC_{50}	40000		208968	81

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Chemical Name	Species	Age	Exposure	Effect	Effect Concentration		AQUIRE Reference Number	Year of Publication
					Lethal	Sublethal		
	Pimephales promelas; Fathead minnow	1.04 G, 49.0 MM	96H	LC_{50}	52800		213685	78
	Pimephales promelas; Fathead minnow	31 D, 15.6 MM, 0.060 G	96H	LC_{50}	42300		302682	86
	Pimephales promelas; Fathead minnow	1.04 G, 49.0 MM	24 H	EC_{50}IM		12100	213688	78
	Pimephales promelas; Fathead minnow	1.04 G, 49.0 MM	96H	EC_{50}IM		11100	213691	78
	Pimephales promelas; Fathead minnow	1.04 G, 49.0 MM	96H	LC_{50}	105000		213687	78
	Pimephales promelas; Fathead minnow	1.04 G, 49.0 MM	72H	LC_{50}	55400		213686	78
	Pimephales promelas; Fathead minnow	31 D, 21.3 MM, 0139 G	96H	LC_{50}	52900		302675	86
	Pimephales promelas; Fathead minnow	1.04 G, 49.0 MMZ	72H	EC_{50}IM		11100	213690	78
	Pimephales promelas; Fathead minnow	1.04 G, 49.0 MM	48 H	EC_{50}IM		11500	213689	78
Acetone	Aedes aegypti;Mosquito	3rd INST-AR	48 H	LC_{50}	15,000,000		310574	83
	Ambystoma mexicanum;Salamander	3-4 WK	48 H	LC_{50}	20,000,000		219740	80
	Asellus aquaticus;Aquatic sowbug	NR	48 H	LC_{50}	7,550,000		315788	83
	Chironomus thummi;Midge	NR	48 H	LC_{50}	13,000,000		315788	83
	Chlorella pyrenoidosa;Green algae	LOG PHASE	48 H	GRO		3,400,000	310574	83
	Cipangopaludina malleata;Mud snail	NR	48 H	LC_{50}	48,000,000		219158	72
	Cloeon dipterum;Mayfly	NR	48 H	LC_{50}	7,600,000		315788	83
	Corixa punctata;Water boatman	NR	48 H	LC_{50}	5,000,000		315788	83
	Culex pipiens;Mosquito	3rd INST-AR	48 H	LC_{50}	17,000,000		310574	83
	Culex restuans;White dotted mosquito	3rd INST-AR	18 H	LC_{50}	6,190,000		212192	81
	Daphnia magna;Water flea	< =24 H	28 D	MOR	1,100,000		310694	83
	Daphnia magna;Water flea	< =24 H	28 D	MOR	4,300,000		310694	83
	Daphnia magna;Water flea	< =24 H	7 D	MOR	2,200,000		310694	83
	Daphnia magna;Water flea	< =24 H	14 D	MOR	4,300,000		310694	83
	Daphnia magna;Water flea	< =24 H	28 D	MOR	550,000		310694	83
	Daphnia magna;Water flea	< =24 H	7 D	MOR	550,000		310694	83
	Daphnia magna;Water flea	< =24 H	14 D	MOR	550,000		310694	83
	Daphnia magna;Water flea	< =24 H	21 D	MOR	550,000		310694	83
	Daphnia magna;Water flea	8 H	0.25 H	LOC		9,280,000	212171	44
	Daphnia magna;Water flea	< =24 H	7 D	LET	8,700,000		310694	83
	Daphnia magna;Water flea	< =24 H	21 D	MOR	1,100,000		310694	83
	Daphnia magna;Water flea	< =24 H	14 D	MOR	1,100,000		310694	83
	Daphnia magna;Water flea	< =24 H	28 D	MOR	2,200,000		310694	83
	Daphnia magna;Water flea	< =24 H	7 D	MOR	1,100,000		310694	83
	Daphnia magna;Water flea	< =24 H	14 D	MOR	2,200,000		310694	83
	Daphnia magna;Water flea	< =24 H	28 D	REP		4,300,000	310694	83
Acetone (cont.)	Daphnia magna;Water flea	< =24 H	21 D	MOR	4,300,000		310694	83
	Daphnia magna;Water flea	< =24 H	48 H	LC_{50}	31000000		310694	83

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Chemical Name	Species	Age	Exposure	Effect	Effect Concentration Lethal	Effect Concentration Sublethal	AQUIRE Reference Number	Year of Publication
	Daphnia magna;Water flea	< =24 H	24 H	LC_{50}	35,000,000		310694	83
	Daphnia magna;Water flea	< =24 H	21 D	MOR	2,200,000		310694	83
	Daphnia magna;Water flea	<24 H	48 H	EC_{50}IM		13,500,000	212193	80
	Daphnia magna;Water flea	< =24 H	28 D	REP		1,100,000	310694	83
	Daphnia magna;Water flea	< =24 H	7 D	MOR	4,300,000		310694	83
	Daphnia pulex;Water flea	<24 H	18 H	LC_{50}	1,220,000		212192	81
	Dugesia lugubris;Turbellarian	NR	48 H	LC_{50}	7,500,000		315788	83
	Erpobdella octoculata;Leech	NR	48 H	LC_{50}	7,000,000		315788	83
	Gambusia affinis;Mosquitofish	ADULT FEMALE	96 H	LC_{50}	13,000,000		210508	57
	Gambusia affinis;Mosquitofish	ADULT FEMALE	24 H	LC_{50}	13,500,000		210508	57
	Gambusia affinis;Mosquitofish	ADULT FEMALE	48 H	LC_{50}	13,000,000		210508	57
	Gammarus pulex;Scud	NR	48 H	LC_{50}	6,000,000		315788	83
	Hydra oligactis;Hydra	NR	48 H	LC_{50}	13,500,000		315788	83
	Hydra oligactis;Hydra	BUD-LESS	48 H	LC_{50}	13,500,000		310574	83
	Indoplanorbis exustus;Snail	NR	48 H	LC_{50}	35,000,000		219158	72
	Ischnura elegans;Dragonfly	NR	48 H	LC_{50}	6,400,000		315788	83
	Lepomis macrochirus;Bluegill	5.3-7.2cm 3.5-3.9 g	96 H	LC_{50}	8,300,000		212406	68
	Lepomis macrochirus;Bluegill	NR	96 H	LC_{50}	8,300,000		210949	68
	Lymnaea stagnalis;Great pond snail	3-4 WK	48 H	LC_{50}	7,000,000		310574	83
	Lymnaea stagnalis;Great pond snail	NR	48 H	LC_{50}	7,000,000		315788	83
	Nemoura cinerea;Stonefly	NR	48 H	LC_{50}	10,300,000		315788	83
	Oncorhynchus mykiss;Rainbow trout	5-8 WK	48 H	LC_{50}	7,400,000		310574	83
	Oncorhynchus mykiss;Rainbow trout	10.0cm 10.2 g	6 H	LET	12,500,000		210991	78
	Oncorhynchus mykiss;Rainbow trout	1.0 g	96 H	LC_{50}	5,540,000		210666	80
	Oncorhynchus mykiss;Rainbow trout	9.4 cm 10.8 g	24 H	LC_{50}	6,100,000		210991	78
	Oryzias latipes;Medaka, high-eyes	4-5 WK	48 H	LC_{50}	14,300,000		310574	83
	Palaemonetes kadiakensis;Grass shrimp, freshwater prawn	JUVENILE	18 H	LC_{50}	2,610,000		212192	81
	Physa acuta;Bladder snail	NR	48 H	LC_{50}	35,000,000		219158	72
	Pimephales promelas;Fathead minnow	28 D	96 H	LC_{50}	7,280,000		312448	84
	Pimephales promelas;Fathead minnow	0.12 g	96 H	LC_{50}	7,310,000		310183	83
	Pimephales promelas;Fathead minnow	33 D	96 H	LC_{50}	8,120,000		312448	84
	Pimephales promelas;Fathead minnow	32 D	96 H	LC_{50}	6,210,000		312448	84
	Pimephales promelas;Fathead minnow	3-4 WK	48 H	LC_{50}	15,000,000		310574	83
Acetone (c	Pimephales promelas;Fathead minnow	0.12 g	96 H	LC_{50}	8,140,000		310183	83
	Rasbora heteromorpha;Harlequinfish, red rasbora	1.3-3 cm	48 H	LC_{50}	4,000,000		210542	69

Table P-7
AQUIRE Toxicity Information[1]
(in ug/l)
AOC 69W

Remedial Investigation Report
Devens, Massachusetts

Chemical Name	Species	Age	Exposure	Effect	Effect Concentration		AQUIRE Reference Number	Year of Publication
					Lethal	Sublethal		
	Rasbora heteromorpha;Harlequinfish, red rasbora	1.3-3 cm	24 H	LC_{50}	5,700,000		210542	6
	Scenedesmus pannonicus;Green algae	LOG PHASE	48 H	GRO		4,740,000	310574	8
	Selenastrum capricornutum;Green algae	LOG PHASE	96 H	GRO		7,000,000	310574	8
	Semisulcospira libertina;Marsh snail	NR	48 H	LC_{50}	35,000,000		219158	7
	Tubificidae;Oligochaete family	NR	48 H	LC_{50}	15,000,000		315788	8
	Xenopus laevis;Clawed toad	3-4 WK	48 H	LC_{50}	24,000,000		219740	8
Ethylbenzene	Carassius auratus; Goldfish;	3.8-6.4 CM, 1-2 G	24 H	LC_{50}	94,440		210728	6
	Carassius auratus; Goldfish;	NR	48 H	LC_{50}	94,440		210728	6
	Carassius auratus; Goldfish;	NR	96 H	LC_{50}	94,440		210728	6
	Daphnia magna; Water flea;	24 H	24 H	LC_{50}	190,000		215718	7
	Daphnia magna; Water flea;	<24 H	24 H	LC_{50}	77,000		215184	8
	Daphnia magna; Water flea;	<24 H	48 H	LC_{50}	75,000		215184	8
	Daphnia magna; Water flea;	<24 H	48 H	MOR	6,800		215184	8
	Daphnia magna; Water flea;	NR	24 H	EC_{50}IM		2,200	313142	8
	Ictalurus punctatus; Channel catfish;	0.1 G	96 H	LC_{50}	210,000		210666	8
	Lepomis macrochirus; Bluegill;	0.2 G	96 H	LC_{50}	88,000		210666	8
	Lepomis macrochirus; Bluegill;	3.8-6.4 CM, 1-2 G	24 H	LC_{50}	35,080		210728	6
	Lepomis macrochirus; Bluegill;	3.8-6.4 CM, 1-2 G	48 H	LC_{50}	32,000		210728	6
	Lepomis macrochirus; Bluegill;	3.8-6.4 CM, 1-2 G	96 H	LC_{50}	32,000		210728	6
	Lepomis macrochirus; Bluegill;	JUVENILE, 0.32-1.2 G	24 H	LC_{50}	169,000		215590	8
	Lepomis macrochirus; Bluegill;	JUVENILE, 0.32-1.2 G	96 H	LC_{50}	150,000		215590	8
	Leuciscus idus; Ide, silver or golden orfe;	NR	NR	LC_{50}	44,000		210547	7
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	2.4 G	96 H	LC_{50}	14,000		210666	8
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	NR	96 H	LC_{50}	4,200		313142	8
	Pimephales promelas; Fathead minnow;	3.8-6.4 CM, 1-2 G	24 H	LC_{50}	42,330		210728	6
	Pimephales promelas; Fathead minnow;	3.8-6.4 CM, 1-2 G	24 H	LC_{50}	48,510		210728	6
	Pimephales promelas; Fathead minnow;	3.8-6.4 CM, 1-2 G	48 H	LC_{50}	42,330		210728	6
	Pimephales promelas; Fathead minnow;	3.8-6.4 CM, 1-2 G	48 H	LC_{50}	48,510		210728	6
	Pimephales promelas; Fathead minnow;	3.8-6.4 CM, 1-2 G	96 H	LC_{50}	42,330		210728	6
	Pimephales promelas; Fathead minnow;	3.8-6.4 CM, 1-2 G	96 H	LC_{50}	48,510		210728	6
	Pimephales promelas; Fathead minnow;	34 D	96 H	LC_{50}	12,100		312858	8
	Poecilia reticulata; Guppy;	6 M, 1.9-2.5 CM, 0.1-0.2 G	24 H	LC_{50}	97,100		210728	6
Ethylbenzene (cont.)	Poecilia reticulata; Guppy;	6 M, 1.9-2.5 CM, 0.1-0.2 G	48 H	LC_{50}	97,100		210728	6
	Poecilia reticulata; Guppy;	6 M, 1.9-2.5 CM, 0.1-0.2 G	96 H	LC_{50}	97,100		210728	6

Table P-7
AQUIRE Toxicity Information[1]
(in ug/l)
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Chemical Name	Species	Age	Exposure	Effect	Effect Concentration Lethal	Effect Concentration Sublethal	AQUIRE Reference Number	Year of Publication
	Rasbora heteromorpha;Harlequinfish, red rasbora	1.3-3 cm	24 H	LC_{50}	5,700,000		210542	69
	Scenedesmus pannonicus;Green algae	LOG PHASE	48 H	GRO		4,740,000	310574	83
	Selenastrum capricornutum;Green algae	LOG PHASE	96 H	GRO		7,000,000	310574	83
	Semisulcospira libertina;Marsh snail	NR	48 H	LC_{50}	35,000,000		219158	72
	Tubificidae;Oligochaete family	NR	48 H	LC_{50}	15,000,000		315788	83
	Xenopus laevis;Clawed toad	3-4 WK	48 H	LC_{50}	24,000,000		219740	80
Ethylbenzene	Carassius auratus; Goldfish;	3.8-6.4 CM, 1-2 G	24 H	LC_{50}	94,440		210728	66
	Carassius auratus; Goldfish;	NR	48 H	LC_{50}	94,440		210728	66
	Carassius auratus; Goldfish;	NR	96 H	LC_{50}	94,440		210728	66
	Daphnia magna; Water flea;	24 H	24 H	LC_{50}	190,000		215718	77
	Daphnia magna; Water flea;	<24 H	24 H	LC_{50}	77,000		215184	80
	Daphnia magna; Water flea;	<24 H	48 H	LC_{50}	75,000		215184	80
	Daphnia magna; Water flea;	<24 H	48 H	MOR	6,800		215184	80
	Daphnia magna; Water flea;	NR	24 H	EC_{50}IM		2,200	313142	88
	Ictalurus punctatus; Channel catfish;	0.1 G	96 H	LC_{50}	210,000		210666	80
	Lepomis macrochirus; Bluegill;	0.2 G	96 H	LC_{50}	88,000		210666	80
	Lepomis macrochirus; Bluegill;	3.8-6.4 CM, 1-2 G	24 H	LC_{50}	35,080		210728	66
	Lepomis macrochirus; Bluegill;	3.8-6.4 CM, 1-2 G	48 H	LC_{50}	32,000		210728	66
	Lepomis macrochirus; Bluegill;	3.8-6.4 CM, 1-2 G	96 H	LC_{50}	32,000		210728	66
	Lepomis macrochirus; Bluegill;	JUVENILE, 0.32-1.2 G	24 H	LC_{50}	169,000		215590	81
	Lepomis macrochirus; Bluegill;	JUVENILE, 0.32-1.2 G	96 H	LC_{50}	150,000		215590	81
	Leuciscus idus; Ide, silver or golden orfe;	NR	NR	LC_{50}	44,000		210547	78
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	2.4 G	96 H	LC_{50}	14,000		210666	80
	Oncorhynchus mykiss; Rainbow trout, donaldson trout;	NR	96 H	LC_{50}	4,200		313142	88
	Pimephales promelas; Fathead minnow;	3.8-6.4 CM, 1-2 G	24 H	LC_{50}	42,330		210728	66
	Pimephales promelas; Fathead minnow;	3.8-6.4 CM, 1-2 G	24 H	LC_{50}	48,510		210728	66
	Pimephales promelas; Fathead minnow;	3.8-6.4 CM, 1-2 G	48 H	LC_{50}	42,330		210728	66
	Pimephales promelas; Fathead minnow;	3.8-6.4 CM, 1-2 G	48 H	LC_{50}	48,510		210728	66
	Pimephales promelas; Fathead minnow;	3.8-6.4 CM, 1-2 G	96 H	LC_{50}	42,330		210728	66
	Pimephales promelas; Fathead minnow;	3.8-6.4 CM, 1-2 G	96 H	LC_{50}	48,510		210728	66
	Pimephales promelas; Fathead minnow;	34 D	96 H	LC_{50}	12,100		312858	86
	Poecilia reticulata; Guppy;	6 M, 1.9-2.5 CM, 0.1-0.2 G	24 H	LC_{50}	97,100		210728	66
Ethylbenzen[illegible] (cont.)	Poecilia reticulata; Guppy;	6 M, 1.9-2.5 CM, 0.1-0.2 G	48 H	LC_{50}	97,100		210728	66
	Poecilia reticulata; Guppy;	6 M, 1.9-2.5 CM, [illegible] G	96 H	LC_{50}	97,100		21072[illegible]	66

Table P-7
AQUIRE Toxicity Information[1]
(in ug/l)
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Chemical Name	Species	Age	Exposure	Effect	Effect Concentration		AQUIRE Reference Number	Year of Publication
					Lethal	Sublethal		
	Poecilia reticulata; Guppy;	NR	96 H	LC_{50}	9,600		313142	88
	Selenastrum capricornutum; Green algae;	NR	72 H	EC_{50}GR	$\boxed{4,600}$		313142	88
Toluene	Aedes aegypti; Mosquito;	4TH INSTAR LARVAE	24 H	EC_{50}IM	21520		215700	77
	Aedes aegypti; Mosquito;	4TH INSTAR LARVAE	24 H	MOR	9950		215700	77
	Brachionus calyciflorus; Rotifer; Rotifers;	NEONATE	24 H	LC_{50}	113000		219385	91
	Chlorella vulgaris; Green algae; Chlorophyta;	NR	24 H	EC_{50}GR	245000		212215	75
	Daphnia magna; Water flea;	1ST INSTAR	48 H	EC_{50}IM	19600		215087	79
	Daphnia magna; Water flea;	24 H	24 H	LC_{50}	470000		215718	77
	Daphnia magna; Water flea;	<24 H	24 H	LC_{50}	310000		215184	80
	Daphnia magna; Water flea;	<24 H	48 H	LC_{50}	310000		215184	80
	Daphnia magna; Water flea;	<24 H	48 H	MOR	28000		215184	80
	Daphnia magna; Water flea;	<= 24 H	21 D	REP	$\boxed{1000}$		210847	89
	Daphnia magna; Water flea;	<= 24 H	24 H	EC_{50}IM	84000		210847	89
	Daphnia magna; Water flea;	NR	24 H	EC_0	53		216628	88
	Daphnia magna; Water flea;	NR	24 H	EC_0	93		210707	82
	Daphnia magna; Water flea;	NR	24 H	EC_{100}	500		210707	82
	Daphnia magna; Water flea;	NR	24 H	EC_{50}	270		210707	82
	Daphnia magna; Water flea;	NR	24 H	EC_{50}	84		216628	88
	Daphnia magna; Water flea;	NR	24 H	EC_{50}IM	7000		313142	88
	Diaptomus forbesi; Calanoid copepod; Copepoda;	NR	96 H	LC_{50}	447000		311282	83
	Scenedesmus subspicatus; Green algae; Chlorophyta;	LOG GRO PHASE	48 H	EC_{50}BM	160000		212997	90
	Scenedesmus subspicatus; Green algae; Chlorophyta;	LOG GRO PHASE	48 H	EC_{50}GR	125000		212997	90
	Selenastrum capricornutum; Green algae; Chlorophyta;	EXPO GRO PHASE	8 D	EC_{50}GR	9400		213550	90
	Selenastrum capricornutum; Green algae; Chlorophyta;	NR	72 H	EC_{50}GR	12500		313142	88
Trichloroethylene	Aedes aegypti, mosquito	3RD INSTAR	48 H	LC_{50}	48,000		NA	83
	Ambystoma mexicanum, salamander	3-4 WK	48 H	LC_{50}	48,000		NA	80
	Asellus aquaticus, sowbug	NR	48 H	LC_{50}	30,000		NA	83
	Brachydanio rerio, zebrafish	NR	48 H	LC_{50}	60,000		NA	79
	Chironomus thummi, midge	NR	48 H	LC_{50}	64,000		NA	83
	Cloeon dipterum, mayfly	NR	48 H	LC_{50}	42,000		NA	83
	Corixa punctata, water boatman	NR	48 H	LC_{50}	110,000		NA	83
	Culex pipiens, mosquito	3RD INSTAR	48 H	LC_{50}	55,000		NA	83
	Daphnia magna, water flea	<=24 H	48 H	LC_{50}	18,000		NA	80
	Daphnia magna, water flea	NR	3 D	ABD	25,000		NA	84
	Daphnia magna, water flea	24 H	24 H	LC_{50}	1,000,000		NA	77

Table P-7
AQUIRE Toxicity Information[1]
(in ug/l)
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Devens, Massachusetts

Chemical Name	Species	Age	Exposure	Effect	Effect Concentration		AQUIRE Reference Number	Year of Publication
					Lethal	Sublethal		
Trichloroethylene (cont.)	Daphnia magna, water flea	NR	24 H	leth	110,000		NA	84
	Daphnia magna, water flea	NR	24 H	LC_{50}	1,313,000		NA	82
	Daphnia magna, water flea	<=24 H	24 H	LC_{50}	22,000		NA	80
	Daphnia magna, water flea	<=24 H	48 H		2,200		NA	80
	Dugesia lugubris, flatworm	NR	48 H	LC_{50}	42,000		NA	83
	Erpobdella octoculata, leech	NR	48 H	LC_{50}	75,000		NA	83
	Gammarus pulex, scud	NR	48 H	LC_{50}	24,000		NA	83
	Hydra oligactis, hydra	BUDLESS	48 H	LC_{50}	75,000		NA	83
	Hydra oligactis, hydra	NR	48 H	LC_{50}	75,000		NA	83
	Ischnura elegans, dragonfly	NR	48 H	LC_{50}	49,000		NA	83
	Lepomis macrochirus, bluegill	JUVENILE 75 D, 2.2 CM	1 H	RES	100		NA	90
	Lepomis macrochirus, bluegill	JUVENILE, 0.32-1.2 G	96 H	LC_{50}	45,000		NA	81
	Lepomis macrochirus, bluegill	JUVENILE, 0.32-1.2 G	24 H	LC_{50}	000 to 100,000		NA	81
	Lymnaea stagnalis, great pond snail	3-4 WK	48 H	LC_{50}	56,000		NA	83
	Lymnaea stagnalis, great pond snail	NR	48 H	LC_{50}	56,000		NA	83
	Moina macrocopa, water flea	5 D	3 H	LC_{50}	2,300		NA	86
	Nemoura cinerea, stonefly	NR	48 H	LC_{50}	70,000		NA	83
	Oncorhynchus mykiss, rainbow trout	NR	24 H	RES	5,000		NA	79
	Oncorhynchus mykiss, rainbow trout	5-8 WK	48 H	LC_{50}	42,000		NA	83
	Oryzias latipes, medaka	3 CM, 0.3 G	48 H	LC_{50}	$\boxed{1,900}$		NA	86
	Oryzias latipes, medaka	4-5 WK	48 H	LC_{50}	270,000		NA	83
	Pimephales promelas, fathead minnow	1.04 G, 49.0 MM	48 H	IMM	22,700		NA	78
	Pimephales promelas, fathead minnow	31 D	96 H	LC_{50}	44,100		NA	85
	Pimephales promelas, fathead minnow	30-35 D	24 H	LC_{50}	58,800		NA	83
	Pimephales promelas, fathead minnow	3-4 WK	48 H	LC_{50}	47,000		NA	83
	Pimephales promelas, fathead minnow	1.04 G, 49.0 MM	96 H	IMM	21,900		NA	78
	Pimephales promelas, fathead minnow	30-35 D	48 H	LC_{50}	57,900		NA	83
	Pimephales promelas, fathead minnow	1.04 G, 49.0 MM	72 H	IMM	22,200		NA	78
	Pimephales promelas, fathead minnow	1.04 G, 49.0 MM	24 H	LC_{50}	52,400		NA	78
	Pimephales promelas, fathead minnow	30-35 D	96 H	LC_{50}	45,000		NA	83
	Pimephales promelas, fathead minnow	1.04 G, 49.0 MM	24 H	IMM	23,000		NA	78
	Pimephales promelas, fathead minnow	0.12 G	96 H	LC_{50}	44,100		NA	83
	Pimephales promelas, fathead minnow	30-35 D	72 H	LC_{50}	55,400		NA	83
	Pimephales promelas, fathead minnow	1.04 G; 49.0 MM	96 H	LC_{50}	66,800		NA	78
	Pimephales promelas, fathead minnow	1.04 G, 49.0 MM	96 H	LC_{50}	40,700		NA	78

Table P-7
AQUIRE Toxicity Information[1]
(in ug/l)
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Chemical Name	Species	Age	Exposure	Effect	Effect Concentration Lethal	Effect Concentration Sublethal	AQUIRE Reference Number	Year of Publication
	Pimephales promelas, fathead minnow	1.04 G, 49.0 MM	72 H	LC_{50}	39,000		NA	78
	Pimephales promelas, fathead minnow	1.04 G, 49.0 MM	48 H	LC_{50}	53,300		NA	78
	Scenedesmus abundans, green algae	10E4 CELLS/ML	96 H	GRO	450,000		NA	85
	Selenastrum capricornutum, green algae	LOG PHASE	96 H	PGR	175,000		NA	83
	Tubificidae, tubificidae	NR	48 H	LC_{50}	132,000		NA	83
	Xenopus laevis, clawed toad	3-4 WK	48 H	LC_{50}	45,000		NA	80

NOTES:

[1]AQUIRE toxicity information was not available for heptachlor epoxide, acenaphthalene, diethylphthalate, naphthalene, phenanthrene, or xylene.

ABD = Abundance
ABN = Abnormalities
BCF = Bioconcentration factor
BEH = Behavioral change
BIO = Biochemical effect
BM = Biomass
BMS = Biomass
C = Celcius
CLR = Chlorophyll content
CM = Centimeter
D = Days
EC_{50} = Effect of concentration to 50% of the population
EMS = Emergance?
ENZ = Enzyme effect
F = Farenheit

G = Grams
GR = Growth
GRO = Growth
H = Hours
HAT = Hatchability
HEM = Hematological effect
HIS = Histological effect
IM = Immobilization
LC_{50} = Lethal concentration to 50% of test organisms
LET = Lethality
LOC = Locomotor Behaviour
LT_{50} = Lethal threshold to 50% of test organisms
MM = Millimeter
MOR = Mortality
NR = Not reported

OC = Oxygen consumption
OXC = Oxygen consumption
PGR = Population growth
PHY = Physiological effects
POP = Population, species diversity
PSE = Photosynthesis effect
RE = Reproduction
REP = Adverse effect to reproduction
RES = Respiratory effects
RN = Renewel
RSD = Residue
ST = Static
STR = Stress
THL = Thermal effect
VTE = Vertebral effect
$\mu g/L$ = micrograms per liter

[ ] = Lowest effect concentration (if a range is provided, the low end of the range is the lowest effect concentration).

Table P-8
Estimated Chronic Exposure to Terrestrial Receptors from Ingestion of RME Concentrations of CPCs in Food and Surface Soil

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Devens, Massachusetts

EXPOSURE CONCENTRATION DATA		ESTIMATED CONTAMINANT CONCENTRATIONS IN PRIMARY FOOD ITEMS				BAF VALUES FOR OTHER FOOD ITEMS	
ANALYTE	RME CONCENTRATION (mg/kg)	Invert BAF [a]	Concentration in Invertebrate Tissue [b] (mg/kg)	Plant BAF [a]	Concentration in Plant Tissue [c] (mg/kg)	Small Mammal BAF [a]	Small Bird BAF [a]
Beryllium	8.50E-01	NA	0.0E+00	2.0E-03	1.7E-03	5.0E-02	5.0E-02
Cobalt	5.40E+00	1.0E+00	5.4E+00	4.0E-03	2.2E-02	1.0E+00	1.0E+00
Copper	2.99E+01	1.6E-01	4.8E+00	7.8E-01	2.3E+01	6.0E-01	6.0E-01
Lead	2.38E+02	7.8E-02	1.9E+01	0.0E+00	0.0E+00	1.5E-02	1.5E-02
Mercury	7.80E-02	6.8E-02	5.3E-03	1.8E-01	1.4E-02	1.0E-02	2.3E+00
Nickel	1.81E+01	2.3E-01	4.2E+00	1.2E-02	2.2E-01	3.0E-01	3.0E-01
Selenium	5.10E-01	7.6E-01	3.9E-01	9.0E-03	4.6E-03	7.5E-01	5.1E-01
Zinc	7.17E+01	1.8E+00	1.3E+02	6.1E-01	4.4E+01	2.1E+00	2.1E+00
Acenaphthylene	2.00E+00	5.0E-02	1.0E-01	1.1E-02	2.3E-02	1.5E-01	1.5E-01
Anthracene	1.00E+00	5.0E-02	5.0E-02	1.1E-02	1.1E-02	1.5E-01	1.5E-01
Benzo[k]fluoranthene	2.00E+00	5.0E-02	1.0E-01	1.1E-02	2.3E-02	1.5E-01	1.5E-01
Chrysene	5.00E+00	5.0E-02	2.5E-01	1.1E-02	5.7E-02	1.5E-01	1.5E-01
Fluoranthene	9.00E+00	5.0E-02	4.5E-01	1.1E-02	1.0E-01	1.5E-01	1.5E-01
Fluorene	1.00E+00	5.0E-02	5.0E-02	1.1E-02	1.1E-02	1.5E-01	1.5E-01
Phenanthrene	9.00E+00	5.0E-02	4.5E-01	1.1E-02	1.0E-01	1.5E-01	1.5E-01
Pyrene	1.00E+01	5.0E-02	5.0E-01	1.1E-02	1.1E-01	1.5E-01	1.5E-01
Acetone	6.90E-02	NA	0.0E+00	NA	0.0E+00	NA	NA
Toluene	2.10E-03	NA	0.0E+00	NA	0.0E+00	NA	NA
Trichlorofluoromethane	7.70E-03	NA	0.0E+00	NA	0.0E+00	NA	NA
Xylenes	2.70E-03	NA	0.0E+00	NA	0.0E+00	NA	NA

CPC = Contaminant of Potential Concern
[a] Bioaccumulation data presented in: Appendix P, Table P-2
[b] CPC concentrations in invertebrate tissue equals the invertebrate BAF multiplied by the RME soil concentration of the CPC.
[c] CPC concentrations in plant tissue equals the plant BAF multiplied by the RME soil concentration of the CPC.

Table P-8
Estimated Chronic Exposure to Terrestrial Receptors from Ingestion of RME Concentrations of CPCs in Food and Surface Soil

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POTENTIAL DIETARY EXPOSURE (mg/kgBW/day) [d]

ANALYTE	*White-footed mouse*	*Short-tailed shrew*	*American robin*	*Red-winged blackbird*	*Raccoon*
Beryllium	2.3E-03	1.2E-02	9.2E-03	3.2E-03	1.1E-05
Cobalt	8.2E-02	6.7E-01	2.5E-01	1.8E-01	2.5E-04
Copper	2.6E+00	1.3E+00	1.9E+00	2.3E+00	2.5E-03
Lead	8.1E-01	5.4E+00	3.2E+00	1.4E+00	3.3E-03
Mercury	1.8E-03	1.9E-03	1.9E-03	1.7E-03	2.2E-06
Nickel	1.2E-01	7.2E-01	3.5E-01	2.1E-01	3.5E-04
Selenium	6.5E-03	5.0E-02	1.9E-02	1.3E-02	1.8E-05
Zinc	6.5E+00	1.6E+01	8.0E+00	7.9E+00	1.2E-02
Acenaphthylene	8.6E-03	4.0E-02	2.6E-02	1.2E-02	2.9E-05
Anthracene	4.3E-03	2.0E-02	1.3E-02	6.1E-03	1.5E-05
Benzo[k]fluoranthene	8.6E-03	4.0E-02	2.6E-02	1.2E-02	2.9E-05
Chrysene	2.1E-02	9.9E-02	6.6E-02	3.0E-02	7.3E-05
Fluoranthene	3.9E-02	1.8E-01	1.2E-01	5.5E-02	1.3E-04
Fluorene	4.3E-03	2.0E-02	1.3E-02	6.1E-03	1.5E-05
Phenanthrene	3.9E-02	1.8E-01	1.2E-01	5.5E-02	1.3E-04
Pyrene	4.3E-02	2.0E-01	1.3E-01	6.1E-02	1.5E-04
Acetone	1.7E-04	9.7E-04	7.4E-04	2.5E-04	8.6E-07
Toluene	5.1E-06	3.0E-05	2.2E-05	7.6E-06	2.6E-08
Trichlorofluoromethane	1.9E-05	1.1E-04	8.2E-05	2.8E-05	9.6E-08
Xylenes	6.6E-06	3.8E-05	2.9E-05	9.8E-06	3.4E-08

[d] Calculated by summing the products of individual prey type concentrations and percent in diet, multiplying by the ingestion rate, and dividing by body weight (Table 9E-7).

Table P-8
Exposure Parameters and Assumptions for Terrestrial Receptors [e]

Remedial Investigation Report, AOC 69W
Devens, Massachusetts

Representative Wildlife Species		Percent Prey in Diet: Inverts	Plants	Small Mammals	Small Birds	Soil	Home Range (acres)	ED [f]	Site Foraging Frequency [g]	Food Ingestion Rate (kg/day)	Body Weight (kg)
White-footed mouse	(Herb. mammal)	10%	88%	0%	0%	2%	0.147	1	1.00E+00	0.0049	0.040
Short-tailed shrew	(Omn. mammal)	78%	12%	0%	0%	10%	0.96	1	1.00E+00	0.0024	0.017
American robin	(Omn. bird)	33%	57%	0%	0%	10%	0.48	0.75	1.00E+00	0.011	0.077
Red-winged blackbird	(Herb. bird)	24%	73%	0%	0%	3%	0.54	0.75	1.00E+00	0.0087	0.054
Raccoon	(Omn. mammal)	14%	56%	19%	2%	9%	385	1	2.57E-03	0.214	3.99

NOTES:

SITE AREA:	1.0 acres

[e] Documentation of exposure parameters presented in: Table P-1
[f] ED = Exposure Duration (percentage of year receptor is expected to be found at study area).
[g] SFF = Site Foraging Frequency (calculated by dividing site area by receptor home range (cannot exceed 1.0)).

Table P-8
Risk from Potential Lethal or Sublethal Effects for Terrestrial Receptors from RME Concentrations of CPCs in Food and Surface Soil

Remedial Investigation Report, AOC 69W
Devens, Massachusetts

ANALYTE	White-footed mouse			Short-tailed shrew			American robin		
	PDE	RTV	HQ	PDE	RTV	HQ	PDE	RTV	HQ
Beryllium	2.3E-03	8.50E-01	2.7E-03	1.2E-02	8.50E-01	1.4E-02	9.2E-03	8.50E-01	1.1E-02
Cobalt	8.2E-02	4.20E+00	1.9E-02	6.7E-01	4.20E+00	1.6E-01	2.5E-01	4.20E+00	6.0E-02
Copper	2.6E+00	1.00E+02	2.6E-02	1.3E+00	1.00E+02	1.3E-02	1.9E+00	1.00E+02	1.9E-02
Lead	8.1E-01	2.50E+00	3.2E-01	5.4E+00	2.50E+00	2.2E+00	3.2E+00	7.50E+01	4.3E-02
Mercury	1.8E-03	9.00E-01	2.0E-03	1.9E-03	9.00E-01	2.1E-03	1.9E-03	6.40E-02	2.9E-02
Nickel	1.2E-01	1.30E+01	9.1E-03	7.2E-01	1.30E+01	5.5E-02	3.5E-01	5.00E+01	7.1E-03
Selenium	6.5E-03	2.00E-01	3.2E-02	5.0E-02	2.00E-01	2.5E-01	1.9E-02	6.00E-01	3.2E-02
Zinc	6.5E+00	2.00E+02	3.2E-02	1.6E+01	2.00E+02	8.0E-02	8.0E+00	2.00E+02	4.0E-02
Acenaphthylene	8.6E-03	1.00E+01	8.6E-04	4.0E-02	1.00E+01	4.0E-03	2.6E-02	1.00E+01	2.6E-03
Anthracene	4.3E-03	1.00E+01	4.3E-04	2.0E-02	1.00E+01	2.0E-03	1.3E-02	1.00E+01	1.3E-03
Benzo[k]fluoranthene	8.6E-03	1.00E+01	8.6E-04	4.0E-02	1.00E+01	4.0E-03	2.6E-02	1.00E+01	2.6E-03
Chrysene	2.1E-02	1.00E+01	2.1E-03	9.9E-02	1.00E+01	9.9E-03	6.6E-02	1.00E+01	6.6E-03
Fluoranthene	3.9E-02	1.00E+01	3.9E-03	1.8E-01	1.00E+01	1.8E-02	1.2E-01	1.00E+01	1.2E-02
Fluorene	4.3E-03	1.00E+01	4.3E-04	2.0E-02	1.00E+01	2.0E-03	1.3E-02	1.00E+01	1.3E-03
Phenanthrene	3.9E-02	1.00E+01	3.9E-03	1.8E-01	1.00E+01	1.8E-02	1.2E-01	1.00E+01	1.2E-02
Pyrene	4.3E-02	1.00E+01	4.3E-03	2.0E-01	1.00E+01	2.0E-02	1.3E-01	1.00E+01	1.3E-02
Acetone	1.7E-04	6.00E+02	2.8E-07	9.7E-04	6.00E+02	1.6E-06	7.4E-04	6.00E+02	1.2E-06
Toluene	5.1E-06	7.60E+01	6.8E-08	3.0E-05	7.60E+01	3.9E-07	2.2E-05	7.60E+01	3.0E-07
Trichlorofluoromethane	1.9E-05	3.50E+01	5.4E-07	1.1E-04	3.50E+01	3.1E-06	8.2E-05	3.50E+01	2.4E-06
Xylenes	6.6E-06	5.00E+02	1.3E-08	3.8E-05	5.00E+02	7.6E-08	2.9E-05	5.00E+02	5.8E-08
SUMMARY HAZARD INDEX			4.7E-01			2.8E+00			2.9E-01

PDE = Potential Dietary Exposure (mg/kgBW/day) RTV = Reference Toxicity Value (mg/kgBW/day) HQ = Hazard Quotient (calculated by dividing PDE by RTV)

Table P-8
Risk from Potential Lethal or Sublethal Effects for Terrestrial Receptors from RME Concentrations of CPCs in Food and Surface Soil

Remedial Investigation Report, AOC 69W
Devens, Massachusetts

ANALYTE	Red-winged blackbird			Raccoon		
	PDE	RTV	HQ	PDE	RTV	HQ
Beryllium	3.2E-03	8.50E-01	3.8E-03	1.08E-05	8.50E-01	1.27E-05
Cobalt	1.8E-01	4.20E+00	4.2E-02	2.48E-04	4.20E+00	5.90E-05
Copper	2.3E+00	1.00E+02	2.3E-02	2.53E-03	1.00E+02	2.53E-05
Lead	1.4E+00	7.50E+01	1.9E-02	3.32E-03	2.50E+00	1.33E-03
Mercury	1.7E-03	6.40E-02	2.6E-02	2.23E-06	1.00E-01	2.23E-05
Nickel	2.1E-01	5.00E+01	4.1E-03	3.47E-04	1.30E+01	2.67E-05
Selenium	1.3E-02	6.00E-01	2.2E-02	1.83E-05	2.00E-01	9.16E-05
Zinc	7.9E+00	2.00E+02	3.9E-02	1.16E-02	2.00E+02	5.81E-05
Acenaphthylene	1.2E-02	1.00E+01	1.2E-03	2.93E-05	1.00E+01	2.93E-06
Anthracene	6.1E-03	1.00E+01	6.1E-04	1.46E-05	1.00E+01	1.46E-06
Benzo[k]fluoranthene	1.2E-02	1.00E+01	1.2E-03	2.93E-05	1.00E+01	2.93E-06
Chrysene	3.0E-02	1.00E+01	3.0E-03	7.31E-05	1.00E+01	7.31E-06
Fluoranthene	5.5E-02	1.00E+01	5.5E-03	1.32E-04	1.00E+01	1.32E-05
Fluorene	6.1E-03	1.00E+01	6.1E-04	1.46E-05	1.00E+01	1.46E-06
Phenanthrene	5.5E-02	1.00E+01	5.5E-03	1.32E-04	1.00E+01	1.32E-05
Pyrene	6.1E-02	1.00E+01	6.1E-03	1.46E-04	1.00E+01	1.46E-05
Acetone	2.5E-04	6.00E+02	4.2E-07	8.56E-07	6.00E+02	1.43E-09
Toluene	7.6E-06	7.60E+01	1.0E-07	2.61E-08	7.60E+01	3.43E-10
Trichlorofluoromethane	2.8E-05	3.50E+01	8.0E-07	9.56E-08	3.50E+01	2.73E-09
Xylenes	9.8E-06	5.00E+02	2.0E-08	3.35E-08	5.00E+02	6.70E-11
SUMMARY HAZARD INDEX			2.0E-01			1.68E-03

PDE = Potential Dietary Exposure (mg/kgBW/day)

HQ = Hazard Quotient (calculated by dividing PDE by RTV)

Table P-9
Estimated Chronic Exposure to Terrestrial Receptors from Ingestion of Average Concentrations of CPCs in Food and Surface Soil

Remedial Investigation Report, AOC 69W
Devens, Massachusetts

EXPOSURE CONCENTRATION DATA		ESTIMATED CONTAMINANT CONCENTRATIONS IN PRIMARY FOOD ITEMS				BAF VALUES FOR OTHER FOOD ITEMS	
ANALYTE	AVERAGE CONCENTRATION (mg/kg)	Invert BAF [a]	Concentration in Invertebrate Tissue [b] (mg/kg)	Plant BAF [a]	Concentration in Plant Tissue [c] (mg/kg)	Small Mammal BAF [a]	Small Bird BAF [a]
Beryllium	4.10E-01	NA	0.0E+00	2.0E-03	8.2E-04	5.0E-02	5.0E-02
Cobalt	4.10E+00	1.0E+00	4.1E+00	4.0E-03	1.6E-02	1.0E+00	1.0E+00
Copper	1.20E+01	1.6E-01	1.9E+00	7.8E-01	9.4E+00	6.0E-01	6.0E-01
Lead	6.12E+01	7.8E-02	4.8E+00	0.0E+00	0.0E+00	1.5E-02	1.5E-02
Mercury	4.20E-02	6.8E-02	2.9E-03	1.8E-01	7.6E-03	1.0E-02	2.3E+00
Nickel	1.33E+01	2.3E-01	3.1E+00	1.2E-02	1.6E-01	3.0E-01	3.0E-01
Selenium	1.60E-01	7.6E-01	1.2E-01	9.0E-03	1.4E-03	7.5E-01	5.1E-01
Zinc	3.25E+01	1.8E+00	5.8E+01	6.1E-01	2.0E+01	2.1E+00	2.1E+00
Acenaphthylene	7.10E-01	5.0E-02	3.5E-02	1.1E-02	8.1E-03	1.5E-01	1.5E-01
Anthracene	5.40E-01	5.0E-02	2.7E-02	1.1E-02	6.2E-03	1.5E-01	1.5E-01
Benzo[k]fluoranthene	1.09E+00	5.0E-02	5.5E-02	1.1E-02	1.2E-02	1.5E-01	1.5E-01
Chrysene	2.04E+00	5.0E-02	1.0E-01	1.1E-02	2.3E-02	1.5E-01	1.5E-01
Fluoranthene	3.30E+00	5.0E-02	1.7E-01	1.1E-02	3.8E-02	1.5E-01	1.5E-01
Fluorene	5.40E-01	5.0E-02	2.7E-02	1.1E-02	6.2E-03	1.5E-01	1.5E-01
Phenanthrene	3.09E+00	5.0E-02	1.5E-01	1.1E-02	3.5E-02	1.5E-01	1.5E-01
Pyrene	3.80E+00	5.0E-02	1.9E-01	1.1E-02	4.3E-02	1.5E-01	1.5E-01
Acetone	1.90E-02	NA	0.0E+00	NA	0.0E+00	NA	NA
Toluene	9.10E-04	NA	0.0E+00	NA	0.0E+00	NA	NA
Trichlorofluoromethane	4.10E-03	NA	0.0E+00	NA	0.0E+00	NA	NA
Xylenes	1.10E-03	NA	0.0E+00	NA	0.0E+00	NA	NA

CPC = Contaminant of Potential Concern
[a] Bioaccumulation data presented in: Appendix P, Table P-2
[b] CPC concentration s in invertebrate tissue equals the invertebrate BAF multiplied by the RME soil concentration of the CPC.
[c] CPC concentrations in plant tissue equals the plant BAF multiplied by the RME soil concentration of the CPC.

Table P-9
Estimated Chronic Exposure to Terrestrial Receptors from Ingestion of Average Concentrations of CPCs in Food and Surface Soil

Remedial Investigation Report, AOC 69W
Devens, Massachusetts

POTENTIAL DIETARY EXPOSURE (mg/kgBW/day) [d]

ANALYTE	White-footed mouse	Short-tailed shrew	American robin	Red-winged blackbird	Raccoon
Beryllium	1.1E-03	5.8E-03	4.4E-03	1.6E-03	5.2E-06
Cobalt	6.2E-02	5.1E-01	1.9E-01	1.4E-01	1.9E-04
Copper	1.1E+00	5.4E-01	7.7E-01	9.2E-01	1.0E-03
Lead	2.1E-01	1.4E+00	8.2E-01	3.6E-01	8.5E-04
Mercury	9.5E-04	1.0E-03	1.0E-03	9.0E-04	1.2E-06
Nickel	8.7E-02	5.3E-01	2.6E-01	1.5E-01	2.6E-04
Selenium	2.0E-03	1.6E-02	6.1E-03	4.2E-03	5.7E-06
Zinc	2.9E+00	7.2E+00	3.6E+00	3.6E+00	5.3E-03
Acenaphthylene	3.0E-03	1.4E-02	9.4E-03	4.3E-03	1.0E-05
Anthracene	2.3E-03	1.1E-02	7.1E-03	3.3E-03	7.9E-06
Benzo[k]fluoranthene	4.7E-03	2.2E-02	1.4E-02	6.6E-03	1.6E-05
Chrysene	8.8E-03	4.0E-02	2.7E-02	1.2E-02	3.0E-05
Fluoranthene	1.4E-02	6.5E-02	4.3E-02	2.0E-02	4.8E-05
Fluorene	2.3E-03	1.1E-02	7.1E-03	3.3E-03	7.9E-06
Phenanthrene	1.3E-02	6.1E-02	4.1E-02	1.9E-02	4.5E-05
Pyrene	1.6E-02	7.5E-02	5.0E-02	2.3E-02	5.6E-05
Acetone	4.7E-05	2.7E-04	2.0E-04	6.9E-05	2.4E-07
Toluene	2.2E-06	1.3E-05	9.7E-06	3.3E-06	1.1E-08
Trichlorofluoromethane	1.0E-05	5.8E-05	4.4E-05	1.5E-05	5.1E-08
Xylenes	2.7E-06	1.6E-05	1.2E-05	4.0E-06	1.4E-08

[d] Calculated by summing the products of individual prey type concentrations and percent in diet, multiplying by the ingestion rate, and dividing by body weight (Table 9E-7).

Table P-9
Exposure Parameters and Assumptions for Terrestrial Receptors [e]

Remedial Investigation Report, AOC 69W
Devens, Massachusetts

Representative Wildlife Species		Percent Prey in Diet: Inverts	Plants	Small Mammals	Small Birds	Soil	Home Range (acres)	ED [f]	Site Foraging Frequency [g]	Food Ingestion Rate (kg/day)	Body Weight (kg)
White-footed mouse	(Herb. mammal)	10%	88%	0%	0%	2%	0.147	1	1.00E+00	0.0049	0.040
Short-tailed shrew	(Omn. mammal)	78%	12%	0%	0%	10%	0.96	1	1.00E+00	0.0024	0.017
American robin	(Omn. bird)	33%	57%	0%	0%	10%	0.48	0.75	1.00E+00	0.011	0.077
Red-winged blackbird	(Herb. bird)	24%	73%	0%	0%	3%	0.54	0.75	1.00E+00	0.0087	0.054
Racoon	(Omn. mammal)	14%	56%	19%	2%	9%	385	1	2.57E-03	0.214	3.99

NOTES:

SITE AREA: 1.0 acres

[e] Documentation of exposure parameters presented in: Table P-1

[f] ED = Exposure Duration (percentage of year receptor is expected to be found at study area).

[g] SFF = Site Foraging Frequency (calculated by dividing site area by receptor home range (cannot exceed 1.0)).

Table P-9
Risk from Potential Lethal or Sublethal Effects for Terrestrial Receptors from Average Concentrations of CPCs in Food and Surface Soil

Remedial Investigation Report, AOC 69W
Devens, Massachusetts

ANALYTE	White-footed mouse			Short-tailed shrew			American robin		
	PDE	RTV	HQ	PDE	RTV	HQ	PDE	RTV	HQ
Beryllium	1.1E-03	8.50E-01	1.3E-03	5.8E-03	8.50E-01	6.8E-03	4.4E-03	8.50E-01	5.2E-03
Cobalt	6.2E-02	4.20E+00	1.5E-02	5.1E-01	4.20E+00	1.2E-01	1.9E-01	4.20E+00	4.5E-02
Copper	1.1E+00	1.00E+02	1.1E-02	5.4E-01	1.00E+02	5.4E-03	7.7E-01	1.00E+02	7.7E-03
Lead	2.1E-01	2.50E+00	8.3E-02	1.4E+00	2.50E+00	5.6E-01	8.2E-01	7.50E+01	1.1E-02
Mercury	9.5E-04	9.00E-01	1.1E-03	1.0E-03	9.00E-01	1.2E-03	1.0E-03	6.40E-02	1.6E-02
Nickel	8.7E-02	1.30E+01	6.7E-03	5.3E-01	1.30E+01	4.1E-02	2.6E-01	5.00E+01	5.2E-03
Selenium	2.0E-03	2.00E-01	1.0E-02	1.6E-02	2.00E-01	7.8E-02	6.1E-03	6.00E-01	1.0E-02
Zinc	2.9E+00	2.00E+02	1.5E-02	7.2E+00	2.00E+02	3.6E-02	3.6E+00	2.00E+02	1.8E-02
Acenaphthylene	3.0E-03	1.00E+01	3.0E-04	1.4E-02	1.00E+01	1.4E-03	9.4E-03	1.00E+01	9.4E-04
Anthracene	2.3E-03	1.00E+01	2.3E-04	1.1E-02	1.00E+01	1.1E-03	7.1E-03	1.00E+01	7.1E-04
Benzo[k]fluoranthene	4.7E-03	1.00E+01	4.7E-04	2.2E-02	1.00E+01	2.2E-03	1.4E-02	1.00E+01	1.4E-03
Chrysene	8.8E-03	1.00E+01	8.8E-04	4.0E-02	1.00E+01	4.0E-03	2.7E-02	1.00E+01	2.7E-03
Fluoranthene	1.4E-02	1.00E+01	1.4E-03	6.5E-02	1.00E+01	6.5E-03	4.3E-02	1.00E+01	4.3E-03
Fluorene	2.3E-03	1.00E+01	2.3E-04	1.1E-02	1.00E+01	1.1E-03	7.1E-03	1.00E+01	7.1E-04
Phenanthrene	1.3E-02	1.00E+01	1.3E-03	6.1E-02	1.00E+01	6.1E-03	4.1E-02	1.00E+01	4.1E-03
Pyrene	1.6E-02	1.00E+01	1.6E-03	7.5E-02	1.00E+01	7.5E-03	5.0E-02	1.00E+01	5.0E-03
Acetone	4.7E-05	6.00E+02	7.8E-08	2.7E-04	6.00E+02	4.5E-07	2.0E-04	6.00E+02	3.4E-07
Toluene	2.2E-06	7.60E+01	2.9E-08	1.3E-05	7.60E+01	1.7E-07	9.7E-06	7.60E+01	1.3E-07
Trichlorofluoromethane	1.0E-05	3.50E+01	2.9E-07	5.8E-05	3.50E+01	1.7E-06	4.4E-05	3.50E+01	1.3E-06
Xylenes	2.7E-06	5.00E+02	5.4E-09	1.6E-05	5.00E+02	3.1E-08	1.2E-05	5.00E+02	2.4E-08
SUMMARY HAZARD INDEX			1.5E-01			8.8E-01			1.4E-01

PDE = Potential Dietary Exposure (mg/kgBW/day) RTV = Reference Toxicity Value (mg/kgBW/day) HQ = Hazard Quotient (calculated by dividing PDE by RTV)

Table P-9
Risk from Potential Lethal or Sublethal Effects for Terrestrial Receptors from Average Concentrations of CPCs in Food and Surface Soil

Remedial Investigation Report, AOC 69W
Devens, Massachusetts

ANALYTE	Red-winged blackbird			Raccoon		
	PDE	RTV	HQ	PDE	RTV	HQ
Beryllium	1.6E-03	8.50E-01	1.8E-03	5.19E-06	8.50E-01	6.10E-06
Cobalt	1.4E-01	4.20E+00	3.2E-02	1.88E-04	4.20E+00	4.48E-05
Copper	9.2E-01	1.00E+02	9.2E-03	1.02E-03	1.00E+02	1.02E-05
Lead	3.6E-01	7.50E+01	4.8E-03	8.54E-04	2.50E+00	3.42E-04
Mercury	9.0E-04	6.40E-02	1.4E-02	1.20E-06	1.00E-01	1.20E-05
Nickel	1.5E-01	5.00E+01	3.0E-03	2.55E-04	1.30E+01	1.96E-05
Selenium	4.2E-03	6.00E-01	7.1E-03	5.75E-06	2.00E-01	2.87E-05
Zinc	3.6E+00	2.00E+02	1.8E-02	5.27E-03	2.00E+02	2.64E-05
Acenaphthylene	4.3E-03	1.00E+01	4.3E-04	1.04E-05	1.00E+01	1.04E-06
Anthracene	3.3E-03	1.00E+01	3.3E-04	7.90E-06	1.00E+01	7.90E-07
Benzo[k]fluoranthene	6.6E-03	1.00E+01	6.6E-04	1.59E-05	1.00E+01	1.59E-06
Chrysene	1.2E-02	1.00E+01	1.2E-03	2.98E-05	1.00E+01	2.98E-06
Fluoranthene	2.0E-02	1.00E+01	2.0E-03	4.83E-05	1.00E+01	4.83E-06
Fluorene	3.3E-03	1.00E+01	3.3E-04	7.90E-06	1.00E+01	7.90E-07
Phenanthrene	1.9E-02	1.00E+01	1.9E-03	4.52E-05	1.00E+01	4.52E-06
Pyrene	2.3E-02	1.00E+01	2.3E-03	5.56E-05	1.00E+01	5.56E-06
Acetone	6.9E-05	6.00E+02	1.1E-07	2.36E-07	6.00E+02	3.93E-10
Toluene	3.3E-06	7.60E+01	4.3E-08	1.13E-08	7.60E+01	1.49E-10
Trichlorofluoromethane	1.5E-05	3.50E+01	4.2E-07	5.09E-08	3.50E+01	1.45E-09
Xylenes	4.0E-06	5.00E+02	8.0E-09	1.37E-08	5.00E+02	2.73E-11
SUMMARY HAZARD INDEX			9.9E-02			5.12E-04

PDE = Potential Dietary Exposure (mg/kgBW/day)

HQ = Hazard Quotient (calculated by dividing PDE by RTV)

Table P–10
Estimated Chronic Exposure to Semi–Aquatic Receptors from Ingestion of RME Concentrations of CPCs in Food and Sediment

Remedial Investigation Report, AOC 69W
Devens, Massachusetts

EXPOSURE CONCENTRATION DATA		ESTIMATED CONTAMINANT CONCENTRATIONS IN PRIMARY FOOD ITEMS				BAF VALUES FOR OTHER FOOD ITEMS	
ANALYTE	RME CONCENTRATION (mg/kg)	Invert BAF [a]	Concentration in Invertebrate Tissue [b] (mg/kg)	Plant BAF [a]	Concentration in Plant Tissue [c] (mg/kg)	Small Mammal BAF [a]	Small Bird BAF [a]
Cobalt	6.9E+00	1.0E+00	6.9E+00	9.3E–03	6.4E–02	1.0E+00	1.0E+00
Copper	2.3E+01	1.6E–01	3.7E+00	6.0E–02	1.4E+00	6.0E–01	6.0E–01
Nickel	1.8E+01	2.3E–01	4.2E+00	1.2E–02	2.2E–01	3.0E–01	3.0E–01
4,4–'DDD	1.2E–01	2.1E+01	2.5E+00	1.0E–02	1.2E–03	1.2E+00	2.9E+00
4,4–'DDE	1.5E–02	2.1E+00	3.2E–02	1.0E–02	1.5E–04	1.2E+00	2.9E+00
4,4–'DDT	4.6E–02	2.1E+00	9.7E–02	1.0E–02	4.6E–04	1.2E+00	2.9E+00
Benzo[k]fluoranthene	4.0E–01	5.0E–02	2.0E–02	1.1E–02	4.4E–03	1.5E–01	1.5E–01
Fluoranthene	1.0E+00	5.0E–02	5.0E–02	1.1E–02	1.1E–02	1.5E–01	1.5E–01
Phenanthrene	9.0E–01	5.0E–02	4.5E–02	1.1E–02	9.9E–03	1.5E–01	1.5E–01
Pyrene	1.0E+00	5.0E–02	5.0E–02	1.1E–02	1.1E–02	1.5E–01	1.5E–01
Trichlorofluoromethane	9.6E–03	NA	0.0E+00	NA	0.0E+00	NA	NA

CPC = Contaminant of Potential Concern
[a] Bioaccumulation data presented in: Appendix P, Table P–2
[b] CPC concentration s in invertebrate tissue equals the invertebrate BAF multiplied by the RME soil concentration of the CPC.
[c] CPC concentrations in plant tissue equals the plant BAF multiplied by the RME soil concentration of the CPC.

Table P-10
Estimated Chronic Exposure to Semi-Aquatic Receptors from Ingestion of RME Concentrations of CPCs in Food and Sediment

Remedial Investigation Report, AOC 69W
Devens, Massachusetts

POTENTIAL DIETARY EXPOSURE (mg/kgBW/day) [d]

ANALYTE	*Short-tailed shrew*	*Red-winged blackbird*	*Raccoon*
Cobalt	2.0E-02	9.0E-03	2.0E-05
Copper	1.7E-02	1.2E-02	1.6E-05
Nickel	1.6E-02	8.0E-03	1.6E-05
4,4-'DDD	6.4E-03	2.9E-03	6.7E-06
4,4-'DDE	8.4E-05	3.8E-05	8.8E-08
4,4-'DDT	2.6E-04	1.2E-04	2.7E-07
Benzo[k]fluoranthene	1.8E-04	9.4E-05	1.6E-07
Fluoranthene	4.5E-04	2.4E-04	4.0E-07
Phenanthrene	4.1E-04	2.1E-04	3.6E-07
Pyrene	4.5E-04	2.4E-04	4.0E-07
Trichlorofluoromethane	3.1E-06	1.4E-06	2.5E-09

[d] Calculated by summing the products of individual prey type concentrations and percent in diet, multiplying by the ingestion rate, and dividing by body weight (Table 9E-7).

Table P-10
Exposure Parameters and Assumptions for Semi-Aquatic Receptors [e]

Remedial Investigation Report, AOC 69W
Devens, Massachusetts

Representative Wildlife Species		Percent Prey in Diet: Inverts	Plants	Soil	Home Range (acres)	ED [f]	Site Foraging Frequency [g]	Food Ingestion Rate (kg/day)	Body Weight (kg)
Short-tailed shrew	(Omn. mammal)	78%	12%	10%	0.96	1	2.19E-02	0.0025	0.017
Red-winged blackbird	(Herb. bird)	24%	73%	3%	0.54	0.75	3.89E-02	0.0087	0.054
Raccoon	(Omn. mammal)	91%	0%	9%	385	1	5.45E-05	0.214	3.99

NOTES:

SITE AREA:	0.02 acres

[e] Documentation of exposure parameters presented in: Table P-1
[f] ED = Exposure Duration (percentage of year receptor is expected to be found at study area).
[g] SFF = Site Foraging Frequency (calculated by dividing site area by receptor home range (cannot exceed 1.0)).

Table P-10
Risk from Potential Lethal or Sublethal Effects for Semi-Aquatic Receptors from RME Concentrations of CPCs in Food and Sediment

Remedial Investigation Report, AOC 69W
Devens, Massachusetts

ANALYTE	Short-tailed shrew			Red-winged blackbird			Raccoon		
	PDE	RTV	HQ	PDE	RTV	HQ	PDE	RTV	HQ
Cobalt	2.0E-02	4.2E+00	4.7E-03	9.0E-03	4.2E+00	2.1E-03	2.0E-05	4.2E+00	4.8E-06
Copper	1.7E-02	1.0E+02	1.7E-04	1.2E-02	1.0E+02	1.2E-04	1.6E-05	1.0E+02	1.6E-07
Nickel	1.6E-02	1.3E+01	1.3E-03	8.0E-03	5.0E+01	1.6E-04	1.6E-05	1.3E+01	1.2E-06
4,4-'DDD	6.4E-03	2.0E-01	3.2E-02	2.9E-03	1.4E-01	2.0E-02	6.7E-06	1.2E+01	5.6E-07
4,4-'DDE	8.4E-05	2.0E-01	4.2E-04	3.8E-05	3.9E-01	9.8E-05	8.8E-08	1.2E+01	7.3E-09
4,4-'DDT	2.6E-04	2.0E-01	1.3E-03	1.2E-04	1.4E-01	8.4E-04	2.7E-07	1.2E+01	2.2E-08
Benzo[k]fluoranthene	1.8E-04	1.0E+01	1.8E-05	9.4E-05	1.0E+01	9.4E-06	1.6E-07	1.0E+01	1.6E-08
Fluoranthene	4.5E-04	1.0E+01	4.5E-05	2.4E-04	1.0E+01	2.4E-05	4.0E-07	1.0E+01	4.0E-08
Phenanthrene	4.1E-04	1.0E+01	4.1E-05	2.1E-04	1.0E+01	2.1E-05	3.6E-07	1.0E+01	3.6E-08
Pyrene	4.5E-04	1.0E+01	4.5E-05	2.4E-04	1.0E+01	2.4E-05	4.0E-07	1.0E+01	4.0E-08
Trichlorofluoromethane	3.1E-06	3.5E+01	8.8E-08	1.4E-06	3.5E+01	3.9E-08	2.5E-09	3.5E+01	7.2E-11
SUMMARY HAZARD INDEX			4.0E-02			2.4E-02			6.9E-06

PDE = Potential Dietary Exposure (mg/kgBW/day) RTV = Reference Toxicity Value (mg/kgBW/day) HQ = Hazard Quotient (calculated by dividing PDE by RTV)

Table P-10
Risk from Potential Lethal or Sublethal Effects for Semi-Aquatic Receptors from RME Concentrations of CPCs in Food and Sediment

Remedial Investigation Report, AOC 69W
Devens, Massachusetts

ANALYTE	PDE	0.0E+00 RTV	HQ
Cobalt	ERR		ERR
Copper	ERR		ERR
Nickel	ERR		ERR
4,4-'DDD	ERR		ERR
4,4-'DDE	ERR		ERR
4,4-'DDT	ERR		ERR
Benzo[k]fluoranthene	ERR		ERR
Fluoranthene	ERR		ERR
Phenanthrene	ERR		ERR
Pyrene	ERR		ERR
Trichlorofluoromethane	ERR		ERR
SUMMARY HAZARD INDEX			ERR

PDE = Potential Dietary Exposure (mg/kgBW/day)

HQ = Hazard Quotient (calculated by dividing PDE by RTV)

STATISTICAL ANALYSIS OF TOXICITY TESTING
(MIDGE GROWTH)

Springborn Laboratories, Inc.
Health and Environmental Sciences
Headquarters: 790 Main Street • Wareham, MA • 02571-1075 • Phone: (508) 295-2550 • Fax: (508) 295-8107

10 January 1997

Nancy Roka
ABB Environmental Services, Inc.
Corporate Place 128
107 Audubon road
Wakefield, MA 01880

RE: Final Report for ABB Fort Devens Project

Dear Nancy:

Enclosed please find the final report for ABB Fort Devens Project. Please do not hesitate to call me should you have any questions or comments concerning this report.

Sincerely,

SPRINGBORN LABORATORIES INC.

Arthur E. Putt
Environmental Toxicologist

Enclosure

cc: R.Biever

Other Locations: 640 N. Elizabeth Street • Spencerville, Ohio 45887-0143 • Phone: (419) 647-4196 • Fax: (419) 647-6560
Seestrasse 21 • Horn, CH-9326, Switzerland • Phone: (41) 71 844-6970 • Fax: (41) 71 841-8630

TOXICITY EVALUATION OF SEDIMENT COLLECTED FROM SITES AT FORT DEVENS, MASSACHUSETTS

ABB Environmental Services, Inc.
Corporate Place 128
107 Audubon Road
Wakefield, MA 01880

SLI Report # 96-3-6419
SLI Study # 13109-925-6131/6132/6133

PROGRAM MANAGER : Ronald C. Biever
STUDY DIRECTOR: Arthur E. Putt

Springborn Laboratories, Inc.
Environmental Sciences Division
790 Main Street
Wareham, Massachusetts 02571

January 10, 1997

FINAL REPORT

TABLE OF CONTENTS

1.0 INTRODUCTION

Decisions regarding the need for remediation and efficacy, of remedial alternatives at sites containing waste materials, often depend on information concerning the environmental risks posed by conditions at the site. As part of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), remedial alternatives or removal actions for hazardous waste sites should include an environmental impact study. An essential part of the environmental impact study is the assessment of the degree and spatial extent of contamination in sediments and/or soils at the site.

In recognition of these concerns, ABB Environmental Services, Inc. in Wakefield, Massachusetts included a battery of screening evaluation assays with benthic organisms as a part of the environmental impact study. The toxicity of the bulk sediment samples was measured using epibenthic and benthic organisms, *Hyalella azteca* and *Chironomus tentans*, respectively. The bioaccumulation of xenobiotics in the sediments were measured using, a freshwater oligochaete, *Lumbriculus variegatus*.

The objective of this testing program was to evaluate the toxicity of contaminated bulk sediments from nine sites at Fort Devens, Massachusetts and to evaluate the bioaccumulation of xenobiotics from three of the nine sites at Fort Devens. All biological testing was conducted at Springborn Laboratories, Inc., Wareham, Massachusetts. The oligochaete tissue samples were analyzed by ESE Inc., Gainsville, Florida. All original raw data from the biological testing and the final report produced during this study are stored at Springborn.

2.0 MATERIALS AND METHODS

2.1 Test Samples

The toxicity tests were conducted using sediment collected from Fort Devens, Massachusetts. Approximately 4 liters of sediment from each location were collected by ABB

Environmental Services, Inc. personnel, with an additional 8 liters of sediment collected from the three sites for the bioaccumulation exposure. The nine samples were identified as: ZWD-95-02X, ZWD-95-03X, ZWD-95-06X, 57D-95-04X, 57D-95-05X, 57D-95-06X, 57D-95-07X, 57D-95-08X, and 57D-95-10X. The samples were received at Springborn on 15 September 1995. Three of the six sample containers for sample 57D-95-06X had lost their lids during shipping and sample 57D-95-04X was not included in this shipment. These two samples were recollected by ABB Environmental Services and they were received on 20 September 1995 in tact. Following receipt at Springborn, any samples that were not immediately tested were stored refrigerated at approximately 4 ± 2°C. Refrigerated samples were warmed to room temperature before use in the toxicity tests. Prior to use in the toxicity test, all sediment samples were passed through a 2.0 mm stainless steel sieve to remove rocks, debris and large clumps of sediment. In addition, Springborn collected sediment from Strobs Folly Brook, Wareham, MA which was used as a reference control sediment.

2.2 Overlying Water

Laboratory water was used for the overlying water and culture water for the midge, *Chironomus tentans*. The laboratory water was well water which had been supplemented with untreated water from the Town of Wareham, Massachusetts. The laboratory water had a total hardness of 30 mg/L as $CaCO_3$, a pH range of 7.0 to 7.2, and a specific conductivity within the range of 110 to 130 µmhos/cm.

The laboratory water was fortified to a total hardness of 160 to 180 mg/L as $CaCO_3$; alkalinity 110 to 130 mg/L as $CaCO_3$; specific conductance of 400 to 600 µmhos/cm; and a pH of 7.9 to 8.3 for the overlying water and culture water for the amphipod, *Hyalella azteca* (U.S. EPA, 1975).

2.3 Monitoring Environmental Conditions of the Test Systems

Dissolved oxygen concentrations were measured using a Yellow Springs Instrument (YSI) Model #57 dissolved oxygen meter and probe; pH was measured with a Jenco Model

601A pH meter and combination electrode; and daily temperature was measured with a Fisher alcohol thermometer. Total hardness concentration was measured by the EDTA titrimetric method. Total alkalinity concentration was determined by potentiometric titration to an endpoint of pH 4.5 (APHA *et. al.*, 1985). Specific conductance was measured using a YSI Model #33 conductivity meter. The temperature of the test solutions was continuously monitored throughout the study using a Fisher Min/Max thermometer. Light intensity was measured with a General Electric type 217 light meter.

2.4 Subchronic Toxicity Test with Midges

2.4.1 Test Method and Conduct

Test organisms were placed in beakers containing the sediment and clean laboratory overlying water on 25 September 1995 and were incubated under standard conditions until 5 October 1995 (10 days). After the exposure, the surviving organisms were counted and weighed. Sediment toxicity was estimated by comparing the response of exposed organisms in the test sediment with the reference sediment. Procedures used in the subchronic toxicity test with midge followed those described in the Springborn test method entitled "Static-Renewal Partial Life-Cycle Toxicity Test with Midge *Chironomus tentans*" to Meet U.S. EPA Guidelines, Springborn Laboratories Test Method #SED-Ct-101. The procedures described in this test method meet the standard procedures described in the *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates* (U.S. EPA, 1994). A copy of the test method is an attachment to this report.

2.4.2 Test Organism

Chironomus tentans were obtained from cultures maintained at Springborn. The culture system was maintained under static conditions and consisted of 38-liter glass aquaria, which contained approximately 20 L of laboratory well water, and were maintained at a temperature of 23 ± 2 °C. The culture area received a regulated photoperiod of 16 hours of light and 8 hours of darkness. Light at an intensity of 30 to 100 footcandles was provided at the culture solutions' surface by Durotest Vitalite® fluorescent bulbs. The midge cultures were fed a combination of finely ground flaked fish food suspension (60 mg/mL) prepared at Springborn.

Midge egg masses were obtained from culture vessels by aspirating several adult male and females flies into a 250 mL flask approximately 12 to 14 days prior to test initiation. Egg masses deposited overnight, were removed and placed in a shallow glass pan with laboratory well water. Egg masses hatch occurs approximately 2 to 3 days after deposition. Larvae were fed a flaked fish food suspension (60 mg/mL) and overlying waster was replaced daily. test organisms, 9 to 11 days old (post hatch), were used to initiate the sediment exposures.

2.4.3 Test Procedures

Eight replicate test vessels (300-mL glass beakers) were maintained for each sediment sample and control. Each vessel contained 100 mL (wet weight) of sediment and 175 mL of laboratory water. The resultant sediment layer in each test vessel was 2 cm deep. Each sediment was tested as 100% with no dilutions. The test systems with sediment and water were allowed to sit overnight before introducing the test organisms. The test was initiated when ten midge larvae were introduced to each test vessel. Aeration was provided to each test vessel when dissolved oxygen dropped below 40% of saturation.

The test was conducted in a temperature controlled water bath designed to maintain the temperature of the test solutions at 23 ± 1 °C. The test area had a photoperiod of 16 hours of light and 8 hours of darkness, with a light intensity range of 30 to 70 footcandles. Lighting was provided by Sylvania Growlux® and Cool White® fluorescent bulbs.

The overlying water was renewed by adding two volume additions (350 mL total) per day, with a calibrated water-delivery system (Zumwalt *et al.*, 1994). Midge larvae were fed daily. The amount fed ranged between 0.5 mL and 1.5 mL of a suspension of finely ground Tetramin® flaked fish food (4.0 mg/mL), per test vessel, based on the amount of food collected on the sediment surface. The midge larvae were not fed on Day 8 since sufficient food was available on the sediment surface in the test vessels.

Total hardness, alkalinity, specific conductance, and ammonia were determined at test initiation and test termination in the overlying water from a composite sample from all replicates. The composite sample was taken form 1 to 2 cm from the sediment surface using a pipet. Dissolved oxygen, pH, and temperature were measured in all replicate vessels at test initiation and test termination. Dissolved oxygen, pH, and temperature were monitored daily in at least one alternating replicate during the course of the study. Temperature extremes were recorded daily from readings of a minimum/maximum thermometer place in the water bath. At test initiation and at each subsequent 24-hour interval, biological observations and the physical characteristics of the test solutions were observed and recorded.

Survival was determined at test termination by sieving the sediment from each replicate test vessel to remove the midges for observation. Midge larvae weight was determined by drying the surviving test organisms at 60 ° C for 24-hours then weighing them on a calibrated analytical balance.

2.4.4 Deviations to the Test Method

No deviations to the test methods occurred during this study.

2.5 Subchronic Toxicity Test with Amphipods

2.5.1 Test Method and Conduct

Test organisms were placed in beakers containing the sediment and clean laboratory water on 25 September 1995 and were incubated under standard conditions until 5 October 1995 (10 days). After the exposure, the surviving organisms were counted. Sediment toxicity was estimated by comparing the response of exposed organisms in the test sediment with the reference control sediment. Procedures used in the acute toxicity test with amphipod followed those described in the Springborn test method entitled "Static-Renewal

Acute Toxicity Test with *Hyallela azteca*" to Meet U.S. EPA Guidelines, Springborn Laboratories Test Method #SED-Ha-121. The procedures described in this test method meet the standard procedures described in the *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates* (U.S. EPA, 1994). A copy of the test method is an attachment to this report.

2.5.2 Test Organism

The test organisms, *Hyalella azteca*, used in this study were obtained from Environmental Consulting and Testing. The approximately 1000 amphipods, 7 days old were received on 19 September 1995 and assigned SLI lot number 95A79. The test population was split in two groups of 500 and held for 6 days under static conditions in 9.5-liter aquaria containing 6 L of water. Amphipods were held in fortified laboratory well water and fed a suspension of yeast, cerphyl and trout food suspension (YCT) and supplemented with flake fish food, daily. Temperature was maintained at 23 ± 1°C. The holding area received a regulated photoperiod of 16 hours of light and 8 hours of darkness. Light intensity of 30 to 100 footcandles was provided at the culture solutions' surface by Durotest Vitalite fluorescent bulbs. Amphipods used to initiate the exposure were 13 days old.

2.5.3 Test Procedures

Eight replicate test vessels (300-mL glass beakers) were maintained for each sediment sample and control. Each vessel contained 100 mL (wet weight) of sediment and 175 mL of laboratory water. The resultant sediment layer in each test vessel was 2 cm deep. Each sediment was tested as 100% with no dilutions. The test systems with sediment and water were allowed to sit overnight before introducing the test organisms. The test was initiated when ten amphipods were introduced to each test vessel. Aeration was provided to each test vessel when dissolved oxygen dropped below 40% of saturation.

The test was conducted in a temperature controlled water bath designed to maintain the temperature of the test solutions at 23 ± 1 °C. The test area had a photoperiod of 16 hours of light and 8 hours of darkness, with a light intensity range of 30 to 70 footcandles. Lighting was provided by Sylvania Growlux® and Cool White® fluorescent bulbs.

The overlying water was renewed by adding two volume additions (350 mL total) per day, with a calibrated water-delivery system (Zumwalt *et al.*, 1994). The amphipods were fed daily. They were fed 1.0 mL of YCT per test vessel, except on Day 0 when they were fed a 1.5 mL suspension of trout chow, per test vessel.

Total hardness, alkalinity, specific conductance, and ammonia were determined at test initiation and test termination in the overlying water form a composite sample from all replicates. The composite sample was taken form 1 to 2 cm from the sediment surface using a pipet. Dissolved oxygen and temperature were measured in all replicate vessels at test initiation and test termination. Dissolved oxygen and temperature were monitored daily in at least one alternating replicate during the course of the study. Temperature extremes were recorded daily from readings of a minimum/maximum thermometer place in the water bath. At test initiation and at each subsequent 24-hour interval, biological observations and the physical characteristics of the test solutions were observed and recorded.

Survival was determined at test termination by sieving the sediment from each replicate test vessel to remove the amphipods for observation. The amphipod weights were determined by drying the surviving test organisms at 60 ° C for 24-hours then weighing them on analytical balance.

2.5.4 Deviations to the Test Method

The following deviations from the test method occurred in this study.

1. Fortified well water was used for the overlying water rather than well water as stated in the test method. We do not believe this deviation adversely affected the results of this study.

2. There was 64% survival of organisms exposed to the control sediment. This was below the 80% acceptance criteria. This deviation alters statistical analysis of the data, however some inferences about sediment toxicity can still be drawn. These inferences are discussed further in the results section of the report.

2.6 Bioaccumulation Tests with Oligochaetes

2.6.1 Study Method and Conduct

Test organisms were placed in aquaria containing the sediment and laboratory water and were incubated under standard conditions for 28 days. After exposure, the surviving Oligochaetes from each sediment sample and control were placed in 1 liter glass beakers containing approximately 900 mL of laboratory water for a period of 24 hours. This 24 hour period allowed the test organisms to eliminate their gut contents. Following the 24 hour elimination period, all Oligochaetes from each sediment sample and control were frozen then shipped on dry ice for analyses. Procedures used in the bioaccumulation test with oligochaetes followed those described in the Springborn Laboratories test method entitled "Bioaccumulation Test with Oligochaete *Lumbriculus variegatus*", Springborn Laboratories Test Method #SED-Lv-160. The procedures described in this test method follow methodology presented in the *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates* (U.S. EPA, 1994).

2.6.2 Test Organism

Lumbriculus variegatus were obtained from cultures maintained at Springborn. Oligochaetes were cultured in 57-liter glass aquaria containing approximately 40 liters of laboratory water and a 3 to 5 cm layer of artificial substrate, which was maintained at a temperature of 22 ± 2 °C. The artificial substrate consists of shredded unbleached paper towel, conditioned in laboratory water. The cultures were maintained under flow through conditions. The culture area received a regulated photoperiod of 16 hours of light and 8 hours of darkness. Light at an intensity of 30 to 100 footcandles was provided at the culture solutions' surface by Durotest Vitalite® fluorescent bulbs. The overlying water was continuously aerated with oil free air. Each culture aquaria was fed, three times per week, a 10 mL suspension of salmon starter (5 mg/mL).

2.6.3 Test Procedures

The test vessels used during this test were 9.5-L aquaria. Three replicate aquaria were maintained for each sediment sample and a control. Each aquaria contained 1 liter of sediment and 4 liters of overlying laboratory water. The resultant sediment layer in each test vessel was 3 cm deep. Each sediment sample was tested as 100% (no dilutions). The test system with sediment and water were allowed to sit overnight before introducing the test organisms. The test was initiated on 19 September 1995, when 100 oligochaetes were introduced to each test aquaria. Aeration was provided to each test vessel throughout the exposure period. The exposure period ended after 28 days on 17 October 1995.

The test was conducted in a temperature controlled water bath designed to maintain the temperature of the test solutions at 23 ± 1 °C. The test area had a photoperiod of 16 hours of light and 8 hours of darkness, with a light intensity range of 30 to 100 footcandles. Lighting was provided by Durotest Vitalite® fluorescent bulbs.

Renewal of the overlying water in each replicate aquaria was performed weekly by carefully siphoning off 75% (approximately 3 liters) of the existing overlying water and gently replacing it with fresh site water. Oligochaetes were not fed during the 28 day exposure. Sufficient organic matter existed (>1.25% organic carbon) in each sample to eliminate feeding during the 28 day study.

At test initiation and at each subsequent 24-hour interval, biological observations and the physical characteristics of the test solutions were observed and recorded. The dissolved oxygen concentration, pH and temperature were measured daily in alternating replicate test aquaria. At test initiation and weekly thereafter, dissolved oxygen, pH and temperature were measured in all replicate aquaria of each test sediment and control. At test initiation and weekly thereafter until test termination, total hardness, total alkalinity, specific conductivity, and ammonia concentration of overlying water from each test sample and control were measured in alternating replicates.

Surviving biomass was determined at test termination. The oligochaetes were collected by sieving the sediment from each replicate aquaria. Following a 24 hour gut elimination period the oligochaetes were frozen awaiting shipping to the analytical laboratory.

2.6.4 Chemical Analysis of the Xenobiotic(s)

The three exposure oligochaete samples and one control oligochaete sample were frozen and shipped on dry ice to ESE, Inc. on 19 October 1995 via Federal Express overnight service. The chemical analysis of the samples was arranged by ABB Environmental Services.

2.6.5 Deviations to the Test Method

The tissue samples were delivered in a 48-hr period, rather than the 24-hr period stated in the test method. The delay in the delivery was due to a faulty fuel line on a Federal Express jet. The samples were still partially frozen upon arrival at ESE, Inc. We do not believe this deviations adversely affected the results of this study.

2.7 Statistical Analysis

The mean survival and growth of midge larvae and amphipods and total biomass of the oligochaetes from each test sediment and reference control sample were tested for normality and homogeneity of variance using Shapiro-Wilks Test or Chi-Square Test. Since the data passed the two qualifying tests, Dunnett's Test was used to evaluate the results of the mean survival and growth of each test sample for significant adverse effects.

3.0 RESULTS AND DISCUSSION

3.1 Toxicity Tests

3.1.1 *Chironomus tentans*

A summary of the water quality characteristics of overlying water during the 10-day subchronic tests with *Chironomus tentans* is presented in Table 1. A summary of the biological results from the screening tests with *C. tentans* is presented in Table 2. The midge survival and growth in the laboratory control sample exceeded acceptable test criteria. There were no statistically significant midge survival and growth effects observed in any of the study site samples, compared to the laboratory control data. However, samples ZWD-95-06X, 57D-95-04X, and 57D-95-05X had midge survival of less than 70%.

Comparison of study site samples with a reference sample (57D-95-08X) showed that no significant survival effects were observed in any samples. Midge growth in sample 57D-95-04X was significantly less than the growth observed in the reference sample. All other samples showed no significant growth effects when compared to the reference sample.

3.1.2 *Hyalella azteca*

A summary of the water quality characteristics of overlying water during the 10-day acute tests with *Hyalella azteca* is presented in Table 3. A summary of the biological results from the screening tests with *H. azteca* is presented in Table 4. The *H. azteca* survival in the laboratory control sample did not meet the acceptable test criteria. The cause of this failure to meet the acceptable criteria is not known. Three of the study site samples had amphipod survival which exceed 80%. All of the organisms used in this study came from the same source and were impartially distributed among the nine study site samples and the laboratory control.

Statistical comparisons of the study site samples against the laboratory control were conducted even though the control did not meet the survival acceptance criteria. Amphipod survival in sample ZWD-95-06X was significantly less than the control survival. Sample ZWD-95-06X also had the lowest midge survival (Table 2).

Comparison of study site samples with a reference sample (57D-95-08X) showed that amphipod survival in samples ZWD-95-02X and ZWD-95-06X was significantly reduced. No significant growth effects were observed when compared with the reference sample.

3.2 Bioaccumulation Study

A summary of the water quality characteristics of overlying water during the 28-day exposure with *Lumbriculus variegatus* is presented in Table 5. The mean oligochaete biomass from each sample at the termination is presented in Table 6. Results of the chemical analysis of the oligochaete tissue and sediment are presented in Table 7.

Tetrachloro-m-xylene and decachlorobiphenyl were found in the three study site tissue samples and the laboratory control. Aldrin was found in two of the study site tissue samples (57D-95-08X and 57D-95-06X) and the laboratory control. None of the analities found in the oligochaete tissue were measured in the sediments from the study site. There was an unusual correlation between the concentration of the three analities found in the oligochaete tissue samples and the order of the four tissue samples. The control tissue had the highest concentration of all three analities, sample 57D-95-08X had the second highest concentration of all three analities, sample 57D-95-06X had the third highest concentration of all three analities and sample 57D-95-05X had the lowest concentration of all three analities. This trend suggests that either the quantification limits of each compound for the small mass of tissue were unreliable, or that there was some sort of systematic sample contamination. In either event, since the three analities were not found in the sediment from the study site, the tissue concentrations appear to be artifactual.

4.0 REFERENCES

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Zumwalt, D.C., F.J. Dwyer, I.E. Greer, and C.G. Ingersoll. 1994. A water-renewal system that accurately delivers small volumes of water to exposure chambers. *Environmental Toxicology and Chemistry.* 13:1311-1314.

5.0 TABLES

Table 1. **Water quality parameters (dissolved oxygen, pH, temperature, total alkalinity, total hardness, specific conductivity) measured in the overlying water during the 10-day subchronic toxicity tests with *Chironomus tentans*.**

Sample Identification	Dissolved Oxygen (mg/L) Day 0	Dissolved Oxygen (mg/L) Day 10	pH Day 0	pH Day 10	Ammonia (mg/L as N) Day 0	Ammonia (mg/L as N) Day 10
Control	8.1-8.3	4.2-4.8	6.8	6.3-6.6	0.58	0.63
ZWD-95-02X	8.7	3.9-7.2	7.0-7.1	6.5-6.6	0.21	0.80
ZWD-95-03X	8.6-8.7	4.6-7.3	7.0	6.4-6.5	0.0	0.85
ZWD-95-06X	8.7-8.8	5.6-7.3	7.1	6.1-6.7	0.0	0.87
57D-95-04X	8.0-8.3	3.1-6.8	6.8-6.9	6.4-6.5	0.16	0.87
57D-95-05X	7.4-7.6	5.3-6.9	6.7-6.8	6.4-6.5	0.08	0.70
57D-95-06X	7.9-8.3	5.8-7.2	6.8-6.9	6.4-6.5	0.16	0.45
57D-95-07X	7.5-7.9	1.4-6.9	7.0	6.1-6.5	0.28	0.72
57D-95-08X	8.0-8.2	4.6-7.1	6.9-7.0	6.4-6.5	0.34	0.79
57D-95-10X	7.5-7.9	4.4-7.4	6.8-6.9	6.5	0.30	0.68

Sample Identification	Alkalinity (mg/L as $CaCO_3$) Day 0	Alkalinity (mg/L as $CaCO_3$) Day 10	Hardness (mg/L as $CaCO_3$) Day 0	Hardness (mg/L as $CaCO_3$) Day 10	Conductivity (µmhos/cm) Day 0	Conductivity (µmhos/cm) Day 10
Control	20	20	44	32	160	110
ZWD-95-02X	22	30	44	40	160	120
ZWD-95-03X	22	26	40	36	170	110
ZWD-95-06X	20	32	40	40	170	120
57D-95-04X	20	22	36	32	160	110
57D-95-05X	22	28	40	40	170	120
57D-95-06X	20	18	44	40	160	110
57D-95-07X	24	26	44	48	170	130
57D-95-08X	24	24	44	40	160	120
57D-95-10X	22	26	44	36	170	120

Table 2. Survival and average dry weights of *Chironomus tentans* at the termination of the 10-day subchronic toxicity tests.

Sample Identification	Mean Percent Survival (Standard Deviation)	Mean Dry Weight in mg (Standard Deviation)
Control	74(19)	1.70(0.32)
ZWD-95-02X	75(15)	2.24(0.85)
ZWD-95-03X	88(14)	2.94(0.67)
ZWD-95-06X	60(19)	2.41(0.93)
57D-95-04X	65(29)	1.36(0.30)[a]
57D-95-05X	64(29)	2.00(0.48)
57D-95-06X	90(8)	1.80(0.19)
57D-95-07X	71(24)	2.27(0.67)
57D-95-08X	84(12)	1.81(0.30)
57D-95-10X	83(12)	1.75(0.33)

[a] Midge growth in this sample was significantly less than the reference sample (57D-95-08X).

Table 3. **Water quality parameters (dissolved oxygen, pH, temperature, total alkalinity, total hardness, specific conductivity) measured in the overlying water during the 10-day acute toxicity tests with *Hyalella azteca*.**

Sample	Dissolved Oxygen (mg/L)		pH		Ammonia (mg/L as N)	
Identification	Day 0	Day 10	Day 0	Day 10	Day 0	Day 10
Control	6.8-7.1	5.9-6.2	7.3-7.4	7.5-7.7	0.72	0.36
ZWD-95-02X	7.4-7.8	5.5-6.4	7.6-7.8	7.4-7.7	0.28	0.41
ZWD-95-03X	7.5-7.7	5.4-7.8	7.6-7.7	7.5-7.8	0.0	0.21
ZWD-95-06X	7.2-7.5	5.0-6.4	7.6-7.7	7.2-7.6	0.02	0.33
57D-95-04X	7.5-7.8	5.6-6.5	7.5-7.6	7.4-7.7	0.13	0.10
57D-95-05X	6.2-6.6	4.7-6.0	7.3-7.4	7.4-7.6	0.07	0.23
57D-95-06X	6.5-6.6	5.5-6.2	7.3-7.4	7.3-7.7	0.25	0.32
57D-95-07X	6.1-6.6	4.8-6.2	7.6-7.7	7.4-7.7	0.32	0.20
57D-95-08X	6.3-6.5	5.4-6.5	7.5	7.4-7.8	0.42	0.38
57D-95-10X	6.5-7.7	5.1-6.3	7.4-7.6	7.6-7.8	0.28	0.21

Sample	Alkalinity (mg/L as ($CaCO_3$)		Hardness (mg/L as ($CaCO_3$)		Conductivity (µmhos/cm)	
Identification	Day 0	Day 10	Day 0	Day 10	Day 0	Day 10
Control	98	112	156	164	500	500
ZWD-95-02X	124	114	168	176	500	500
ZWD-95-03X	110	112	168	172	450	500
ZWD-95-06X	116	112	168	172	500	500
57D-95-04X	104	106	160	160	500	500
57D-95-05X	106	124	164	180	500	500
57D-95-06X	102	106	156	168	500	500
57D-95-07X	112	120	172	172	500	500
57D-95-08X	116	116	168	172	500	500
57D-95-10X	114	112	168	172	500	500

Table 4. Survival of *Hyalella azteca* at the termination of the 10-day acute toxicity tests.

Sample Identification	Mean Percent Survival (Standard Deviation)	Mean Dry Weight in mg (Standard Deviation)
Control	64(18)[a]	0.10(0.05)
ZWD-95-02X	55(24)[b]	0.15(0.07)
ZWD-95-03X	66(18)	0.10(0.05)
ZWD-95-06X	36(23)[b, c]	0.11(0.07)
57D-95-04X	83(7)	0.08(0.01)
57D-95-05X	70(19)	0.16(0.05)
57D-95-06X	84(9)	0.08(0.03)
57D-95-07X	74(7)	0.11(0.04)
57D-95-08X	80(21)	0.10(0.03)
57D-95-10X	71(18)	0.11(0.06)

[a] The control survival did not meet the acceptance criteria of 80%.

[b] Amphipod survival in this sample was significantly less than the reference sample (57D-95-08X).

[c] Amphipod survival in this sample was significantly less than the control.

Table 5. Water quality parameters (dissolved oxygen, pH, temperature, total alkalinity, total hardness, specific conductivity) measured in the overlying water during the 28-day exposure with *Lumbriculus variegatus*.

Sample Identification	Dissolved Oxygen (mg/L)	pH	Ammonia (mg/L as N)
	Day 0-28	Day 0-28	Day 0-28
Control	6.4-8.6	6.5-7.2	0.26-0.71
57D-95-05X	6.4-8.1	6.9-7.6	0.47-0.79
57D-95-06X	6.9-8.2	7.1-7.5	0.50-0.92
57D-95-08X	6.9-8.3	7.2-7.6	0.48-0.68

Sample Identification	Alkalinity (mg/L as $CaCO_3$)	Hardness (mg/L as $CaCO_3$)	Conductivity (µmhos/cm)
	Day 0-28	Day 0-28	Day 0-28
Control	16-38	24-56	90-220
57D-95-05X	22-82	32-88	110-300
57D-95-06X	20-63	40-76	140-250
57D-95-08X	24-50	44-80	150-250

Table 6. Mean biomass per aquarium of *Lumbriculus variegatus* at the termination of the 28-day exposure.

Sample Identification	Mean Biomass (g)/Aquarium (Standard Deviation)
Control	1.37(0.09)
57D-95-05X	1.43(0.11)
57D-95-06X	1.52(0.41)
57D-95-08X	1.18(0.25)

Table 7. Concentration of analities measured in sediment and tissue of *Lumbriculus variegatus* after the 28-day exposure.

Sample Number	Sample Type	Concentration (µg/kg) Wet Weight		
		Aldrin	Tetrachloro-m-xylene	Decachlorobipheny l
Control	tissue	39.7	2850	3380
57D-95-08X	tissue	21.6	919	1130
57D-95-06X	tissue	16.6	751	926
57D-95-05X	tissue	<6.67	454	558
Control	sediment	NA	NA	NA
57D-95-08X	sediment	ND	ND	ND
57D-95-06X	sediment	ND	ND	ND
57D-95-05X	sediment	ND	ND	ND

NA = not analyzed
ND = not detected

6.0 SIGNATURES AND APPROVAL

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10 January 1997

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1/10/97

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received
12-3-98

DEVENS
FINAL REMEDIAL INVESTIGATION

RESPONSE TO COMMENTS AND REVISIONS ON THE FINAL REMEDIAL INVESTIGATION REPORT FOR AREA OF CONTAMINATION (AOC) 69W DEVENS, MASSACHUSETTS

CONTRACT DAAA-31-94-D-0061
DELIVERY ORDER NO. 0001

U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
CONCORD, MASSACHUSETTS

DECEMBER 1998

Printed On Recycled Paper

RESPONSE TO COMMENTS AND REVISIONS ON THE FINAL REMEDIAL INVESTIGATION REPORT FOR AREA OF CONTAMINATION (AOC) 69W

DEVENS, MASSACHUSETTS DECEMBER 1998

MADEP Comments on the Final Remedial Investigation Report for AOC 69W August 1998

General Comment

1. Comment: The MADEP disagrees with the Army's contention that the groundwater underlying the site is not available as a source of potable drinking water.

AOC 69W is located within the zone II groundwater protection area for the Devens MacPherson Well and as such, it has the potential to contribute water to the well under severe pumping and recharge conditions.

Response: The Army's position is that the groundwater underlying AOC 69W is *unlikely* to be used as a source of potable water due to the hydrogeological limitations of the water table aquifer and the fact that the area is served by a public water supply.

The Army recognizes that AOC 69W lies within the delineated Zone II groundwater protection area for the MacPherson Well. A soil removal action was therefore conducted to help mitigate the source of the groundwater contamination. In addition, the Army intends to adopt a long-term groundwater monitoring plan for AOC 69W including installation of additional monitoring wells. Details of the long-term groundwater monitoring plan will be provided for discussion and review in the near future. These measures will ensure that residual contamination at AOC 69W will not be allowed to migrate towards the MacPherson Well and that both human health and the environment will be protected.

RESPONSE TO COMMENTS ON THE DRAFT REMEDIAL INVESTIGATION REPORT FOR AREA OF CONTAMINATION (AOC) 69W DEVENS, MASSACHUSETTS DATED APRIL 1998

DEVENS
DRAFT REMEDIAL INVESTIGATION

RESPONSE TO COMMENTS
ON THE DRAFT REMEDIAL INVESTIGATION REPORT
FOR AREA OF CONTAMINATION (AOC) 69W
DEVENS, MASSACHUSETTS

CONTRACT DAAA-31-94-D-0061
DELIVERY ORDER NO. 0001

U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DIVISION
CONCORD, MASSACHUSETTS

AUGUST 1998

RESPONSE TO COMMENTS
ON THE DRAFT REMEDIAL INVESTIGATION REPORT
FOR AREA OF CONTAMINATION (AOC) 69W

DEVENS, MASSACHUSETTS
AUGUST 1998

Harding Lawson Associates (HLA) formerly ABB Environmental Services, Inc. (ABB-ES') responses to regulatory comments are organized following the format in which the agencies provided comments to the Army. Responses have been provided for each comment.

EPA Comments on Draft Remedial Investigation Report
Area of Contamination (AOC) 69W, Devens, MA
April 1998

General Comments

1. Comment: The risk assessment should mainly present technical information (e.g., methodology, results, uncertainty, etc.). Risk management should be used to determine which information presented in the risk assessment requires mitigation and/or various other risk-related decisions. This risk assessment often makes risk management decisions either instead of or in conjunction with risk results. Unless all regulatory parties are in agreement with a change of standard evaluation practices (e.g., this report includes general practice/guidance changes such as: -1-use of background concentrations above risk-based regulatory standards for a means to evaluate discarding contaminants of concerns; -2- not performing risk assessment because pathway is only potentially complete; etc.), then the risk assessment should present all risk results with out any caveats.

   The uncertainty section should clearly define all variables (e.g., issues such as the unlikely use of groundwater as drinking water). Of course, uncertainty in the risk results may skew results either in a conservative or non-conservative fashion. The conclusions may also present some risk management concerns/recommendations. However, the risk assessment should remain straight forward and present all results.

   Response: There were no analytes selected as COPCs because they are detected at concentrations greater than RBCs but less than background.

   Please refer to Responses to USEPA Specific Comments 23 and 29 for further discussion.

2. Comment: The surface soil inhalation pathway should be evaluated because analytes were detected above the Region III Risk-Based Concentrations (RBCs). Beryllium respirated through particulate may be a health concern.

   Response: The soil-derived particulate inhalation pathway was evaluated for the site maintenance worker and excavation worker; it was not evaluated for the pupil or trespasser. This exposure pathway was not evaluated for these two receptors because the area of the site where soil samples were collected is small and grass-covered; no recreational or other activities that may generate dust are expected. However, the Army agrees that beryllium respirated through particulates may be a health concern and, therefore, will include quantitative evaluation of the particulate inhalation exposure pathway for the pupil and trespasser receptors.

3. Comment: Antimony analytical results could not be found in the report. Possibly all the antimony results were "not detected". Please provide a table of the analytes, along with the analytical method detection limits, that were excluded from the general tables because they were not detected.

   Response: Antimony was analyzed for as part of the PAL inorganics analysis and was not detected during the course of the RI investigation. A summary of target analytes and detection limits is provided in Appendix D and tabulated in Appendix J of the RI. Antimony results for all samples are included in Appendix L.

4. Comment: From the data validation information presented, the laboratory appears to have had problems with antimony recovery. Please evaluate this issue in terms of the potential effect on the risk evaluation. The Region III Risk-Based-Concentrations for antimony are 31 mg/Kg in soil and 15 ug/L in drinking water. Since they are non-cancer risk-based, the RBCs are adjusted to 3.1 mg/Kg for surface soil and 1.5 ug/L for drinking water.

   Response: It is not clear to what data the commentor is referencing. The Army is not aware of any problems with antimony recoveries in any of the data sets.

5. Comment: Since sampling location ZWB-96-03X is inside the courtyard it would be representative of potential surface soil exposure. However, the location appears to have initial analytical results at the 6 feet below ground surface level. Are there 0 to 1 foot analytical results? If so, please include these in the report.

   Response: Off-site analytical laboratory samples from boring ZWB-96-03X were collected 6 to 8 feet below ground surface (bgs) and 10 to 12 feet bgs in order to delineate potential source area contamination. A surface soil sample within the courtyard would not be representative of surface soil exposure as the courtyard is primarily paved and the small unpaved areas are heavily vegetated.

6. Comment: While the data obtained in the RI tend to support the conclusions drawn, the presentation is sometimes rather sketchy on the reasoning that leads from the data to the conclusions. For example, the RI simply asserts that that contamination attributed to the 1978 spill "... does not appear to be migrating

hydrogeologically downgradient" (e.g., p. 10-4, para. 2). While this appears to be the case upon inspection of, say, Figure 7-3, the specific evidence and the logical arguments behind the conclusion are not developed in detail. Another example is the conclusion with regard to arsenic transport (e.g., p. 10-11, first bullet), which appears to be reasonable, but is not supported by adequate discussion of controls on transport of arsenic and their relationship to site-specific conditions.

Response: The commentor references conclusions presented in Section 10. Section 10 is intended to be a synopsis of the RI findings as well as a summary of recommendations for further action at the site. Section 10 is not intended to defend all of the findings and conclusions as the supporting data and rationale is presented in preceding sections. Sections 7.2.2.1, 7.2.2.2, 7.2.3.1 and 7.2.3.2 as well as the supporting Figures detail the results of the soil and groundwater analysis program. In these sections the analytical results are discussed in detail and the rationale for the conclusion that contaminants related to the old boiler room are not migrating is developed. Likewise, arsenic in groundwater and its fate and transport is discussed in both Sections 7 and 8. In an effort to better support the conclusions and clarify the rationale behind them, additional text will be added to the Executive Summary and Section 10.

7. Comment: The human health risk assessment analysis of risks from exposure to subsurface soil are based on the analytical results from two samples. Two samples provide inadequate information to properly characterize subsurface soil. The inadequacy of two subsurface samples should be more thoroughly discussed in the uncertainty section.

Response: The risk assessment analysis of risks from exposure to subsurface soils are based on the analytical results from 2 samples for inorganics, but the results from 30 samples for volatile organic compounds, semivolatile organic compounds, and total petroleum hydrocarbons. Although the results for VOCs in Table 9-2 indicate a frequency of detection out of only 2 samples, BTEX were analyzed, but not detected in any of the 30 samples from the soil remedial action. Since the site has been investigated and remediated to address a fuel oil release, exposures to the primary chemicals of concern at the site (i.e., petroleum-related constituents) have been adequately evaluated. Uncertainties associated with characterization of exposure to VOCs and inorganics based on the results of 2 samples will be discussed in the uncertainty section.

8. Comment: Inhalation exposures for the child receptor are not evaluated in the human health risk assessment. It is likely that children will be outside playing when or shortly after grass is being mowed. The likelihood that children will be exposed to particulates at the site should be addressed in the risk assessment. Please include in appropriate sections EPAs air results and risk assessment along with interpretations.

Response: Please see the Response to USEPA General Comment 2. Regarding the USEPA indoor air sampling, the Army will include references to and results from USEPA's indoor air assessment as appropriate. The USEPA indoor air sampling and evaluation will be included as an appendix to the RI Report for AOC 69W.

9. Comment: The RI recommendations seem reasonable considering the results of the risk assessment. However, the baseline risk assessment and RI conclusion sections need to be enhanced to better reflect the risk assessment results and justify the recommendations.

   Response: The Final RI will incorporate suggested changes to the risk assessment and conclusions as previously noted.

Specific Comments

10. Comment: **Section 2.2.8, Page 2-27, Paragraph 2.** The text (here and in subsequent sections, e.g., p. 6-9, para. 2; also Table E-1) refers to hydraulic conductivity values in cm/s, and then reports transmissivity values in units of feet squared per day, and groundwater velocities in units of feet per day. Please provide these data in consistent units. The simplest revision would be to give the conductivities in feet per day (if only parenthetically, recognizing that the slug test results are reported in cm/s).

    Response: Hydraulic conductivities will be provided in units of feet per day and cm/s for the sake of consistency.

11. Comment: **Figure 6-3.** The figure includes interpreted groundwater potential contours and flow-direction vectors. The flow directions indicated are not orthogonal to the equipotentials, which violates Darcy's Law (at least for a horizontally isotropic aquifer). The figure should be revised to correct this inconsistency.

    Response: The flow direction arrows were intended to assist the reader in ascertaining the general flow direction. The arrows were not intended as vectors as they have no relationship to flow rate. The groundwater flow direction arrows will be removed from Figure 6-3.

12. Comment: **Section 7.2.1.3, Page 7-24, Paragraphs 1 and 2.** The text notes that several metals are above MCP standards, but the metals are not discussed in any depth in subsequent sections. A conceptual model

for the presence of elevated metals concentrations should be developed, and its implications for the site remediation should be discussed.

Response: The analytical results that the commentor refers to are from samples that were collected in 1993 and 1994 as part of the AREE 69 investigation. Since that time four additional groundwater sampling rounds have been conducted as part of the RI of which Rounds 1 and 2 were analyzed for inorganics. Results of the inorganic analyses for all subsequent rounds are discussed in Section 7.2.3.2.

13. Comment: **Section 7.2.2.4, Page 7-39, Paragraph 2.** The text asserts, "Contaminants do not appear to be migrating to downgradient soils" from the 1978 spill near the old boiler room. While this conclusion is generally consistent with the data (e.g., Figure 7-3, which shows contours of TPHC suggesting that the contamination remained fairly local to the spill area in soils; and the groundwater data, which indicate minimal impact on groundwater), the logical connection between the data and the conclusion is not developed in detail. The reasoning behind this important conclusion should be presented.

Response: The final sentence of Section 7.2.2.4 will be changed to "Contaminants appear to be localized in the area immediately adjacent to the school based upon the absence of site related contaminants in downgradient explorations (e.g., ZWR-95-27X, ZWR-95-54X, and ZWR-95-55X)." Additional text will be added which will discuss the effect of the asphalt parking lot and the age of the release. Soil contamination distribution in the vicinity of the old boiler room is also discussed in Section 7.2.2.1.

14. Comment: **Figures 7-1 through 7-6**: Only organic results appear to be tabulated in these figures. Please add other results (e.g., inorganics are missing) or change the titles of the figures.

Response: Figures 7-1 through 7-4 provide field analytical results for which there were no inorganics analyses performed. The titles of Figures 7-5 and 7-6 will be changed to "Organic Analytes in Surface Soils" and "Organic Analytes in Subsurface Soils", respectively.

15. Comment: **Table 7-15, Page 2 of 9.** The entry for the depth of the screen in monitoring well 69W-94-10 on 10/01/96 is given as 0 feet. All other sampling events for this well record a depth of 9.5 feet. The table should be checked and corrected if appropriate.

Response: The entry for depth of screen will be changed to 9.5 feet.

16. Comment: **Tables 7-15 and 8-2.** Table 7-15 indicates high levels of iron and manganese in wells 69W-94-10, 69W-94-13, and 69W-95-16X (Mn only). The implications should be discussed in the sections

covering fate and transport (sec. 8) and human health risk (sec. 9). The connection between elevated iron and manganese and the biodegradation of petroleum hydrocarbons should be developed in this discussion. The observed redox potentials and dissolved oxygen (Appendix G) and their relationship to the degradation process should be included in the discussion, as well.

Response: A discussion of the relationship between biodegradation, redox potential, and observed inorganic concentrations will be added to Subsection 8.2.

17. Comment: **Section 8.2, Page 8-18.** The text states, "The detection of these inorganics ... could not be correlated with the presence of fuel related compounds." As noted above, there are some strong associations between the inorganics and the presence of hydrocarbons, most notably in well 69W-94-10, which shows some of the highest hits of TPHC (in both subsurface soils and groundwater), lowest redox potential (Appendix G), and highest arsenic, iron, and manganese. The statement in this paragraph is at odds with these observations, and is inconsistent with concluding statements (e.g., sec. 10.2, p. 10-11) suggesting that the removal of hydrocarbon-contaminated soils will eventually lead to a mitigation of the aerobic microbiological activity, the tendency toward reducing conditions, and high metals in groundwater. The text should be revised to highlight these associations and to improve internal consistency.

Response: The sentence, "The detection of these inorganics, it should be noted, could not be correlated with the presence of fuel-related organic compounds." will be removed. Additional text outlining the relationshop between biodegradation, redox potential and observed inorganic concentrations will be added to the end of Subsection 8.2.

18. Comment: **Table 8-1.** The footnote entries defining the abbreviations used should be completed.

Response: . The suggested additions will be made.

19. Comment: **Section 9.1, Page 9-6, Lines 4 through 7.** The text asserts that the recent soil removal action will limit migration of contaminants to the current site boundaries. No reference is provided to support this assertion. This statement should be supported, or discussion of groundwater migration should be eliminated from this section.

Response: This discussion will be supported by references to discussions in Section 7.

20. Comment: **Page 9-6, lines 6-8**: Why were only two of the indoor air samples chosen for risk analyses? Toluene should be included in the risk analysis since the migration potential exists.

    Response: Appendix O-1 presents a detailed analysis of indoor air migration and exposure pathways. The discussions presented in that appendix provide technical justification for the chemicals selected for quantitative evaluation in the risk assessment. Please refer to USEPA Specific Comment 29 for additional discussion.

21. Comment: **Page 9-16, Indoor Air**: It is not clear why the Appendix O data is not evaluated quantitatively or presented in this section. Please expand the text.

    Response: The evaluation presented in Appendix O-1 is of a level of detail considerably greater than the discussions for other media provided in subsection 9.2.1.1. Please refer to the Response to USEPA Specific Comment 29 for additional discussion.

22. Comment: **Page 9-56, 1st paragraph**: Arsenic can be associated with fuel releases because it changes the soil so that arsenic originally bound to soil is released. Therefore, arsenic should not be ruled out as a site related contaminant. Please change the paragraph and reflect this change in other appropriate area of the RI.

    Response: The reference to arsenic not being directly related to the release has been removed from the paragraph.

23. Comment: **Page 9-66, 1st paragraph, last sentence**: This sentence is stating information that should be reserved for risk management. The risk assessment should report all the information along with uncertainty. Risk management should review the risk assessment results along with appropriate policy, regulations, potential future land use, cost and other issues. With all the information, risk management should determine what risks should be mitigated, to what goal, and how to meet and keep that goal most effectively. Therefore, although future use of groundwater as drinking water may appear unlikely to the risk assessor, this information should be presented apart from the risk assessment.

    Response: The referenced text is in the summary and conclusions section, and states "In addition, future use of the groundwater as a potable water source was evaluated. Since groundwater at and beneath AOC 69W is not used as a source of drinking or industrial water, evaluation of potable use represents a hypothetical worst-case evaluation of potential risks." The text states that groundwater is not used a source of potable water; it does *not* state that groundwater at AOC 69W will not be used as a source of potable water. The fact that groundwater at the site is not used as a source of potable water under present land use, and the future use of the site is a school with off-site municipal water supply, suggests that it is unlikely that groundwater at the site will be used as a source of potable or industrial water in the future. The uncertainty with this assessment is associated with the possible use of groundwater as potable water in the future; because that future use cannot be ruled out, this uncertainty was addressed by evaluating future residential use of the groundwater. Therefore, these statements do not require revision.

However, the statements presented in the uncertainty section, page 9-61, second paragraph, indicate that groundwater will not be used as a source of potable water. Although this section was not the subject of this comment, it will be revised to communicate the information presented in this comment response.

24. Comment: **Section 9.3, Page 9-69.** The BERA does not list the most recent EPA ecological risk assessment guidance document. The following document should be added to the list and incorporated as appropriate. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*, Interim Final, USEPA ERT. June 1997.

    Response: Agreed. The approach used in the AOC 69W ERA is generally consistent with the guidance cited by the reviewer. The guidance will be listed at the beginning of the document.

25. Comment: **Section 9.3.1.1, Page 9-73.** It is not clear why the aquatic habitat characterization is presented in a section entitled "vegetative cover", it would be more appropriate to for a section to be dedicated to aquatic and wetland habitat characterizations. Also, the following should be presented in the text presentation of the aquatic habitat characterization; general composition of substrate (e.g, cobble, sand), condition of bank (e.g., percent vegetative cover and erosion), and presence of aquatic vegetation, even though additional information is provided in an appendix.

    Response: Agreed. The first half of the first paragraph (ending with "... little to no organic matter.") and the second paragraph in subsection 9.3.1.1 will be moved to a new subsection 9.3.1.2, entitled "Ditch and Wetland Habitat". The remainder of subsection 9.3.1.1 will remain as is since it describes the vegetative cover at AOC 69W. Other information about ditch substrate and bank condition is provided. There is no aquatic vegetation in the AOC 69W ditch (Willow Brook).

26. Comment: **Section 9.3.6.4, Page 9-110.** The discussion of problems related to the toxicity testing should be focused on the survival of organisms in the performance control. The control survival did not meet the acceptance criteria in the *Hyalella azteca* 10-day acute toxicity test. However, the control survival for the

Chironomus tentans 10-day subchronic toxicity test met the acceptance criteria: The discussion should highlight that the *Hyalella azteca* results are suspect but that the *Chironomus tentans* are acceptable.

The discussion of the poor habitat quality or "unfavorable habitat" is out of place in this section. When interpreting toxicity test results, the grain size can make a difference, but the discussion should focus solely on whether the grain size in the sediment samples was outside of the toxicity test organism tolerance.

Also, the interpretation of toxicity test results should indicate that the difference in organic carbon within the reference sediment and the site sediment could influence the bioavailability of some contaminants and therefore influence the comparative results of the toxicity tests.

Response: The Army believes that the text does highlight that the *Hyalella azteca* results are suspect, but that the *Chironomus tentans* results are acceptable. Subsection 9.3.5.3 (the ecological effects assessment) states that the control results for the amphipod toxicity test did not meet acceptance criteria, but that the control results for the midge toxicity test did meet acceptance criteria. In addition, both subsections 9.3.5.3 and 9.3.6.4 question the reliability of the amphipod toxicity test results because of the reduced survival for the control.

The statement about the "unfavorable habitat" will be revised to say the following:

"In addition, the sandy nature (i.e., low organic carbon content) of the ditch substrate may have contributed to the reduced survival observed in the amphipod toxicity tests as compared to the reference sample collected from Cold Spring Brook."

27. Comment: **Section 9.3.8, Page 9-116.** This section summarizes the results of the ecological risk assessment. The section states, "HIs for these taxa [small birds, small mammals, and predatory mammals] were all less than one." This is not accurate, the risk to the shrew from surface soil exposure calculated with the RME concentration is an HI of 2.8. This discrepancy should be corrected.

Response: Agreed. This discrepancy will be corrected in the final AOC 69W RI.

28. Comment: **Section 9.3.8, Page 9-117.** The summary of results relative to benthic macroinvertebrates only discusses the toxicity test results. The conclusion from the comparison to sediment benchmarks should also be summarized in this section. The maximum concentrations of copper, nickel, DDT, DDE, DDD, and PAHs exceed sediment benchmarks. The average concentrations of DDT, DDE, DDD, and PAHs exceed ecological sediment benchmarks.

Response: Whereas the second to last bullet discusses the results of the sediment toxicity test results, the last bullet in subsection 9.3.8 discusses the conclusions regarding potential risks to aquatic organisms from exposure to copper, nickel, and PAHs in groundwater and in sediment. The text in the last bullet will be revised to state the following: "*Based on the benchmark comparisons for aquatic receptors*, risks to aquatic receptors from exposure to...".

The risk conclusions are intended to focus on those chemicals that may be site-related. Since the presence of DDT_R in sediment is not likely related to the fuel oil spill at AOC 69W (as mentioned in Subsection 9.3.6.4 under Sediment - Benchmark Comparison), the Army feels it is not appropriate to mention these chemicals in the ERA conclusions.

29. Comment: **Table 9-2**: This table presents the data summary and selection of contaminants of potential concern (COPCs) for AOC 69W. The surface and subsurface soil tables do not include all of the chemicals that were detected. For example, beryllium was detected in one of the two subsurface soil samples and is not included in the analysis presented in the table for subsurface soil. The table should be revised to include all chemicals that were detected in soil.

The table also presents a data summary for indoor air. The analytical data results also present detected values for chemicals that are not presented in this screening analysis (e.g., 3-methylheptane, octane and tetrachloroethylene). The table should be revised to include all chemicals that were detected in air.

The RBCs for ambient air that are used in the selection of COPCs appear to be incorrect. The values presented in the table are not consistent with the referenced Region III RBC table. For example the table presents values of 100 mg/m^3 and 31 mg/m^3 for ethylbenzene and xylene respectively. The table should be corrected to present the correct values of 110 mg/m^3 and 730 mg/m^3 for ethylbenzene and xylene, respectively. The indoor air selection of COPCs should also be included in this table.

Response: Beryllium was detected in one subsurface soil sample (ZWB-95-02), but this sample was not included in the risk assessment data set because the sample was excavated during the soil removal action. The Army has not identified any chemicals or samples that were mistakenly excluded from the risk assessment data sets.

As described in Appendix O-1, the analytical indoor air data were evaluated with respect to potentially complete vapor migration pathways in order to segregate the chemicals that are potentially related to the subsurface fuel oil release at AOC 69W from those that are not. The evaluation determined that some chemicals (e.g., acetone, methylene chloride, and tetrachloroethene), although detected in indoor air, are not related to the fuel oil release because they are not constituents of fuel oil. For other chemicals that are present in fuel oil, the evaluation demonstrated that, in most cases, their detection in indoor air could not reasonably be attributed the presence of those chemicals in subsurface soil and/or groundwater beneath the school because one or more of the components required to demonstrate the presence of a complete exposure pathway was not present (e.g., chemical not present in subsurface in vicinity of indoor air sampling point; chemical not present in crawl space air (the soil-to-air transfer medium)). The analytical data for indoor air samples presented in Table 9-2 represent chemical concentrations that are associated with a potentially complete vapor migration pathway, as described in Appendix O-1. Chemicals and data not included in the data set summarized in Table 9-2 were determined to be associated with vapor migration pathways that are incomplete, as described in Appendix O-1.

The Army understands that USEPA views this approach as an exercising of risk management decision making at an inappropriate phase of evaluation. The Army agrees that the selection of COPCs should be used to identify those chemicals that are potentially site-related and could be associated with more than negligible risk based on comparisons to background concentrations and/or risk-based screening levels, and not based on a determination of potentially complete exposure pathways. However, considering the ambient interference that indoor air sampling is subject to (e.g., outdoor and off-site sources, indoor sources such as paint and carpeting that unrelated to fuel oil release) the Army strongly believes that the risk assessment should reflect the risks that are attributable to site-related contamination, and not those that are attributable to ambient sources unrelated to the fuel oil release at AOC 69W. To accommodate USEPA concerns, the Army will include all chemicals detected in indoor air in the COPC selection. In addition, results of USEPA's indoor air assessment will be referenced as appropriate.

RBCs used for COPC screening will be consistent with those presented in the most recent USEPA Region III RBC table, adjusted for a hazard quotient of 0.1.

30. Comment: **Table 9-4, & page 9-4, Body Weight** : Since the school was formerly an elementary school and future reuse of the facility is currently unclear (i.e., what age the pupils will be), please use 35 Kg for the average pupil body weight. This value is based on the average of the average lowest 5 year old body weight and average highest average 13 year old body weight (based on data presented in EPA's Exposure Factors Handbook, EPA/600/P-95/002Fa Aug '97, Table 7-3). If you propose to keep a higher body weight for the risk assessment than institutional controls might be required.

Response: The intended future use of the school is as a Charter School, which includes elementary, junior high, and high school-aged children. Therefore, the risk assessment will remain based on exposure parameters for children within these ages. However, an assessment of risks for pupils ages 5 to 13, based on the body weight recommend by USEPA for this age group, will be included in the risk assessment uncertainty section in order to provide additional information for making risk management decisions.

31. Comment: **Table 9-4**: Please add units to appropriate variables.

    Response: Units have been provided in Table 9-4; no revisions are required.

32. Comment: **Table 9-9.** This table presents the inhalation dose/response information for noncarcinogenic effects. RfCs are not provided for several chemicals because no data were available. However for 2-methylnaphthalene, arsenic, bis(2-ethylhexyl)phthalate, chloroform, trichloroethene and naphthalene, inhalation RfDs are presented in the referenced MCP document from which the VPH/EPH chemicals' parameters were taken. This inconsistency should be corrected. These RfDs can be converted into RfCs.

    The second footnote states that RfDs are calculated from RfCs. It is unclear why this footnote is included as it is not referenced in the table. The footnote should be removed or the table amended to properly address the footnote.

    Response: USEPA risk assessment guidance states that dose-response values should be obtained from IRIS or HEAST, or from the National Center for Environmental Assessment (NCEA) when a dose-response value is not presented in IRIS or HEAST. USEPA Region I risk assessment guidance does not indicate that dose-response values derived from the Massachusetts Department of Environmental Protection (MADEP) should be used when values are not available in IRIS or HEAST. Therefore, dose-response values for COCs with no values published in IRIS or HEAST will not be obtained from MADEP sources. However, the risk assessment uncertainty section will be revised to present a discussion of risk estimates that include non-cancer dose-response values developed by MADEP for the inhalation exposure pathway.

    Because the primary chemicals of concern at AOC 69W are associated with a historical fuel oil release, the dose-response values developed by MADEP for total petroleum hydrocarbons and hydrocarbon fractions, for which IRIS and HEAST do not publish values, were used in order to provide a conservative assessment of risks which does not overlook the primary chemicals of concern at the site. This evaluation also addressed concerns of MADEP. Had USEPA Region I risk assessment guidance been strictly followed, the toxicity of these COCs would not have been quantitatively evaluated in the risk assessment.

    Because RfCs, and not RfDs, were used to evaluate inhalation toxicity, the second footnote will be removed the table.

33. Comment: **Table 9-11.** This table summarizes the quantitative risk results. In addition to the summary presented in this table, all risks to each receptor should be summed. For example, risks to the pupil from exposure to surface soil, sediment and groundwater should be totaled to provide a total risk value to the receptor. The NCP states that the total risks to receptors from all media simultaneously should be

considered when evaluating the relationship of site risks to the 10E-4 to 10E-6 risk range. For all current and future scenarios, risks should also be totaled on a receptor-basis.

Response: The risk summary table will be edited to present total receptor risks for exposures to multimedia. The total receptor risks will be evaluated by comparison to NCP risk criteria, and discussed in the risk characterization section.

34. Comment: **Section 10.1, Page 10-4, Bullet 11.** The text acknowledges that "...EPH-VPH concentrations immediately adjacent to the school still exceed MCP S-1/GW-1 soil standards." However, no rationale is given for neglecting this in recommending no further remedial action (e.g., sec. 10.2, p. 10-10, para. 1). Justification should be given for leaving in place soils with contamination in exceedance of standards.

Response: The soil removal action excavated soils as close to the school as possible without jeopardizing the structural integrity of the school building. The Method 1 standards were used for comparative purposes only. The area of soil in question would be better described by S-2 or S-3 standards based on depth and proximity to the school foundation. In addition, the referenced analytical results were used in the calculation of the human health risk assessment which showed no unacceptable levels of risk as no completed exposure pathways exist.

35. Comment: **Section 10.1, Page 10-8, Paragraph 1.** The text states that the arsenic in groundwater, which is a driver for the human health risk in drinking water use, "is not interpreted to be directly related to the release of fuel oil at AOC 69W." While the high arsenic in groundwater appears not to be due to, say, a direct release of arsenic containing compounds associated with the fuel spill, the report acknowledges elsewhere (e.g., sec. 10.2, p. 10-11, bullet 1) that the high arsenic may be due to the low redox potential that results from aerobic biodegradation of the hydrocarbons. The statement that the As in groundwater is not "directly related" to the fuel spill is somewhat at odds with the later statement that recognizes the link between the two. The statement should be revised for internal consistency.

Response: The referenced statement will be removed from the text

36. Comment: **Section 10, Page 10-9.** The first bullet should be revised to state that the ERA concluded no unacceptable risk to terrestrial wildlife receptors exposed to surface soil and no unacceptable risk to semi-aquatic wildlife receptors exposed to Willow Brook sediments. Currently the statement, "no risks to wildlife receptors exposed to chemicals in Willow Brook sediment" is too broad and is not reflective of the aquatic organism risk conclusions.

The last bullet should be revised so that it is more consistent with the results discussion presented in Section 9. Also, see comments on Section 9.

The discussion should highlight that the *Hyalella azteca* results are suspect but that the *Chironomus tentans* toxicity test results are acceptable. The *Chironomus tentans* toxicity test results indicate a minimal likelihood of risk to aquatic receptors.

Response: The first bullet regarding conclusions of the ERA will be revised to include the terms "terrestrial wildlife" and "semi-terrestrial wildlife" in terms of discussing wildlife risks from exposure to surface soil and sediment, respectively. Aquatic organism risks are discussed in the third bullet regarding the ERA conclusions.

The Army believes that the last bullet regarding ERA conclusions is consistent with the evidence presented in Subsection 9.3. The second-to-last bullet will be revised to state that "although significantly reduced amphipod survival was observed in toxicity tests, the reliability of these tests are questionable" and that "the *Chironomus tentans* toxicity test results indicate a minimal likelihood of risk to aquatic receptors".

37. Comment: **Section 10.2, Page 10-11, Bullet 1.** The text discusses the relationship of elevated arsenic in groundwater and the aerobic degradation of hydrocarbons, which leads to reducing conditions and mobilization of arsenic. While this conclusion is consistent with what is known about arsenic mobility (e.g., Bhumbla, D. K., and R. F. Keefer, "Arsenic mobilization and bioavailability in soils," in Nriagu, J. O., ed., Arsenic in the Environment, Part I: Cycling and Characterization, Wiley, 1994, 51-82), it seems to be at odds with the information tabulated in Table 8-2. The table indicates that arsenic is "immobile" under reducing conditions, and "relatively mobile" under oxidizing conditions. Either the table should be revised to be consistent with the statements regarding arsenic mobility, or the text should be expanded to discuss the special conditions to which the table summary applies and to which the conclusions of the RI apply.

Response: Table 8-2 will be revised to be consistent with the statements in the text regarding arsenic mobility. A footnote will be added stating that As^{+3} is mobile under reducing conditions in the absence of sulfides and As^{+5} is immobile under reducing conditions.

38. Comment: **Appendix E.** The Bouwer-Rice analyses of the slug test data for wells 69W-94-09, ZWM-96-19X, ZWM-96-20X, and ZWM-96-21X fit to a second linear segment of the data, in accord with standard practice when a high-conductivity sand or gravel pack around the well is manifested in the earliest response. In the present case, however, it is noted that the data in the second segment are not

convincingly linear, particularly for ZWM-96-19X, ZWM-96-20X, and ZWM-96-21X. Furthermore, it is curious that these particular wells should exhibit a response so different from the other wells tested, for which the analyst used the earliest data. The wells for which the second linear segment of data was analyzed show consistently low conductivities in comparison to the remaining wells. These slug test analyses should be revisited, and the assumptions regarding the early-time response should be re-examined. In particular, the conductivity implied by the earliest linear segment should be evaluated and compared to both the other wells at the site and the expected conductivity for the sandpack material used in the well installation. The fits shown in Appendix E may bias the conductivity on the low side, resulting in a low bias to the inferred groundwater velocity. It is acknowledged that the conductivity and groundwater velocity for the site are not critical parameters for the purposes of the RI, which makes no use of them beyond the general description of the site hydrogeology. However, quantitative values and realistic uncertainties may be of interest in future studies of this site, and are likely to be sought out in investigations of other sites and the regional setting at Devens.

Response: After review of the slug test data the Army stands by the interpretation and analyses presented in the RI, although the reviewer makes valid points regarding use of early time response and sandpack drainage. The straight line segments were chosen based upon the amount of drawdown/displacement measured and the elapsed time covered by a straight line segment. In general, well responses prior to 0.1 minutes were not considered representative of aquifer response. Likewise, well recoveries (H) less than 0.1 feet in magnitude were not considered as reliable as straight line segments incorporating greater magnitudes of displacement.

Furthermore, the estimated hydraulic conductivities for the three wells in question are not that disparate from the other calculated conductivity values. The difference that does exist may be attributed to the fact that the three wells in question all are located within the footprint of the school building foundation or courtyard.

39. Comment: **Appendix G.** The geochemistry of the groundwater is central to understanding the distribution of metals at the site. In particular, there is some discussion of high arsenic in groundwater, and its impact on the human health risk assessment (e.g., sec. 10.1, p. 10-8, para. 1). Also, Table 7-15 indicates high levels of iron and manganese in wells 69W-94-10, 69W-94-13, and 69W-95-16X (Mn only). The redox state of the groundwater is critical to understanding these issues. Dissolved oxygen (DO), redox potential, and pH were recorded (not all of these parameters are available for every well and sampling event) in the field logs reproduced in Appendix G. The data are of sufficient importance that they should be extracted from the field log sheets, tabulated, and included in the Tables section of the RI. This would enable readers to assess, for example, the association of high TPHC, low Eh, and high metals, observed, for example, in 69W-94-10, a strong indicator of biodegradation. This association is important

to the conclusion, for example, that the soils removal will eventually facilitate the lowering of metals concentrations in groundwater (e.g., (e.g., sec. 10.2, p. 10-11, bullet 1).

Response: The Army agrees that the DO, redox potential, and pH data are valuable to the understanding of the geochemistry at the site. However, because the data were collected from several different sampling events incorporating both conventional and low-flow sampling protocol and different types of monitoring equipment the Army feels that it could be misleading to tabulate all of the data together. The field measurements will be available in Appendix G of the Final RI. A qualitative discussion of the field measurements and their relationship to site geochemistry will be added to Subsection 8.2.

40. Comment: **Appendix O, Page O-6 & O-7**: Please review the RBCs for indoor air and adjust those that are based on non-cancer risk by applying a factor of 0.1 as stated on page 9-21 of the report. When indoor air information is added to Table 9-2 and the RBCs are adjusted, some indoor air contaminants (e.g., toluene and ethyl benzene) may require quantitative risk assessment.

Response: Please refer to the Response to USEPA Specific Comment 29.

41. Comment: **Appendix O-3, Tables 5 and 6**. These tables present the inhalation exposure calculations for the maintenance worker receptor for the RME and CT scenarios. Arsenic, beryllium and iron are presented in the noncarcinogenic risk calculations but are excluded due to lack of toxicological data. It is inappropriate to exclude chemicals from quantitative analysis based on lack of toxicological data. Also, it is unclear why the values from IRIS were not used. These chemicals should be reassessed for toxicological parameters and included in the quantitative analysis.

Response: Arsenic, beryllium, and iron were not excluded from the risk assessment; inhalation and ingestion exposures were quantified for these COCs. However, non-cancer inhalation dose-response values for arsenic and iron are not published in IRIS or HEAST. The inhalation dose-response value for beryllium was published in IRIS after compilation and publication of the Draft RI Report. The inhalation RfC for beryllium will be included in the revised risk assessment.

42. Comment: **Appendix O-3, Table 18.** This table presents the inhalation exposure calculations for the future utility/construction worker receptor for the RME scenario. Several chemicals, including arsenic, beryllium and iron, are presented in the noncarcinogenic risk calculations but are excluded due to lack of toxicological data. It is inappropriate to excluded chemicals from quantitative analysis based on lack of toxicological data. Also, it is unclear why the values from IRIS were not used. These chemicals should be reassessed for toxicological parameters and included in the quantitative analysis.

Response: Please refer to the Response to USEPA Specific Comment 41.

43. Comment: **Appendix P, Table P-2.** This table presents bioaccumulation factors (BAFs) for terrestrial invertebrates, terrestrial plants, mammals, birds, aquatic invertebrates, and aquatic plants.

- The terrestrial invertebrate BAFs for PAHs are referenced as being the average of values presented in Beyer 1990. It would be preferable to use the individual PAH BAFs presented in Beyer 1990 instead of an average. In cases where an individual value is not presented, then use of an average PAH BAF as a surrogate is appropriate.

- The terrestrial plant BAFs for PAHs are derived by using the Travis and Arms equations; however, an average log Kow value is used. The usefulness of averaging log Kow values is questionable. Since Kow values are chemical specific and can differ among PAH congeners, individual Kow values should be used to derive BAFs.

- A terrestrial plant BAF is not calculated for lead. Footnote "o" states, "lead does not accumulate in plant tissue, therefore, a BAF of zero was assigned. The literature varies regarding lead accumulation in vascular plants. ERAs performed for other AOCs at Fort Devens have utilized a terrestrial plant BAF for lead.

- Footnote "e" states that small mammal and bird BAFs for analytes with a log Kow less than 5 were assumed to be 0.15. Benzo(k)fluoranthene, chrysene, and pyrene have log Kow values that exceed 5, but the BAFs are presented as 0.15. Individual Kow values should be used to derive BAFs.

Response: Comment noted. The Army averaged individual BAFs and log K_{OW}s to obtain one value for the entire class of PAHs. This approach was adopted assuming that PAHs generally have equivalent bioaccumulation potential for receptors, particularly since some of the BAFs (e.g., for plants and mammals) were calculated using a regression equation. Since the individual BAFs presented in Beyer (1990) and the log K_{OW}s presented in Table P-2 are all fairly close in value to the average, and because

Food chain risk estimates for PAHs generally range from 10^{-2} to 10^{-8}, revised PAH BAFs will not substantially increase risk estimates. Individual BAFs and log K_{OW}s will be considered for use in future ERAs.

With regard to plant accumulation of lead, the reviewer is correct that the literature varies on this subject. However, the study cited has been reviewed and the conclusions are reasonable. An uncertainty will be added to the ERA stating that the bioaccumulation potential of lead in surface soil to terrestrial plants may have been underestimated, but that risk conclusions are not likely to be changed substantially by using other lead BAFs.

44. Comment: **Tables P-3 and P-4**. Table P-3 presents toxicity information for wildlife generated from a literature search. Table P-4 presents the reference toxicity values (RTVs) for a small mammal, small bird and predatory mammal. The column titles on Table P-4 should reflect the ecological receptors assessed in this risk assessment, i.e., shrew, mouse, robin, blackbird, and raccoon. The title of Table P-4 indicates that the table presents RTVs selected for the AOC 69 risk assessment. However, there is not good correlation between tables P-3 and P-4 for some COPCs. For example, Table P-3 presents one toxicity value for chrysene. The chrysene value is a sublethal LOAEL (99mg/kgBW-day) for a rodent test species. Table P-4 presents a lethal RTV for chrysene of 120 and a sublethal RTV of 10 mg/kgBW-day. The footnote in Table P-4 states that the toxicity value for benzo(a)pyrene was used as a surrogate for the chrysene RTV, but Table P-3 does not present toxicity information for benzo(a)pyrene. Since Table P-3 presents the results from a literature search, it should present more toxicity values than presented on Table P-4. All of the selected toxicity values in Table P-4 should be presented with supporting information on Table P-3.

The tables need to be revised so that Table P-3 presents supporting literature toxicity information for the selected RTVs and Table P-4 presents RTVs for the ecological receptors modeled in this AOC ecological risk assessment.

Response: The derivation of toxicity values presented in Table P-4 is generally described in footnote [a] of Table P-4. The difference between many toxicity values presented in Tables P-3 and P-4 may be the factor of 0.2 applied to LD_{50} values (as explained in footnote [a]). Footnotes [b] through [d] explain what receptors are represented by the general classes of wildlife receptors described in the headings of Table P-4; a separate column of RTVs for each individual wildlife receptor would be repetitive and difficult to present legibly.

The toxicity data for benzo(a)pyrene will be included in Table P-3 of the final AOC 69W RI.

45. Comment: **Table P-10.** This table presents exposure assumptions for semi-aquatic ecological receptors. The percent sediment ingestion is erroneously titled as percent soil.

Response: Comment noted. This discrepancy will be corrected in the Final AOC 69W RI.

MADEP Comments on the Draft Remedial Investigation Report
Area of Contamination (AOC) 69W, Devens, MA
April 1998

GENERAL COMMENTS

1. Comment: The Draft Remedial Investigation Report (RI) and the May 1998 Phase II Report prepared by Roy F. Weston (Weston Report) have some data limitations with respect to definition of the nature and extent of soil and groundwater contaminants. However, the available data may be adequate to finalize the RI on the conditions that the Draft RI is revised as requested in subsequent comments and that supplemental data is collected as part of a long term monitoring program. Specifically, additional downgradient groundwater monitoring wells and additional sampling of groundwater for petroleum and inorganics.

   Response: The Army is willing to discuss the potential of installing additional downgradient monitoring wells to support the long term groundwater monitoring remedy. The Army is of the opinion that the details of additional monitoring points would be most appropriately dealt with as part of the Long-Term Monitoring Plan and not the Final RI.

2. Comment: The Draft RI and the Weston Report do not clearly present the amount of residual petroleum contamination in soil beyond the limits of the 1998 remedial excavation. The Draft RI Report also includes a misleading conclusion: the source of soil and groundwater contamination was removed in 1998.

   Post excavation soil sample analytical data collected as part of both the Draft RI and the Weston Report, indicate that significant concentrations (i.e., greater than 5,000 ppm) of petroleum contaminated soil remain adjacent to the northern end of the School (near the southern portion of the remedial excavation). High concentrations of petroleum were also reported in soil and groundwater near well ZWM-96-19X and other locations indicate residual contamination is present beneath the existing school building. Field screening and/or laboratory confirmation sample analyses also indicate petroleum concentrations in excess of 1,000 ppm remain in subsurface soil, downgradient of the former fuel oil UST source areas. There are also apparently no soil petroleum data for the northwestern terminus of the remedial excavation. Therefore, although the primary sources of contaminated soil and groundwater (i.e., USTs and piping) have been removed, significant residual contamination remains in the subsurface.

   A figure depicting isoconcentration contours of residual soil TPHC concentrations should be included in the summary of soil impacts section. The Draft RI Report should be revised accordingly.

Response: The statement on page 10-5 "The soil removal has removed the source of fuel oil contamination to groundwater,..." will be changed to " The soil removal action has removed the majority of the source of fuel oil contamination to groundwater,..."

All soil and groundwater data collected as part of the AREE 69W investigation, the RI, and the soil removal excavation are provided in the report. The bulk of the data is provided in chem-box format in order to more clearly illustrate the effect of the Removal Action. A post removal EPH concentration contour figure will be added to Section 7.

It is true that data suggests that residual petroleum contamination exists beneath the school. The soil removal excavated as close to the school building as possible without sacrificing the integrity of the foundation. There was no intent to excavate beneath the school building.

Soil analytical data is available for locations ZWR-95-37X, -38X, -40X, -41X, -42X, -43X, -49X, and -53X, all located near the northwestern terminus of the excavation.

The Army does not dispute that residual contamination exists in the subsurface. The Army is of the opinion that the bulk of the contaminant source has been removed and the residual contamination has been adequately defined. The residual contamination is the rationale for the Army to propose limited action consisting of long term monitoring of downgradient groundwater quality.

3. Comment: The expansion of the Phase II remedial excavation from the proposed volume of 1,200 cubic yards (cy) to the final amount of 3,500 cy as presented in the Weston Report, was not fully discussed in the Draft RI Report. According to the Weston Report, the expansion of the remedial excavation in the vicinity of 69W-94-10, was necessary to address "heavy staining and strong petroleum odor in soils immediately above and below the watertable". The area around 69W-94-10 is described as the "hot spot excavation" in the Weston Report. The "hot spot excavation" was not fully discussed in the Draft RI Report. Other important details regarding the location and condition of the USTs and underground piping that were included in the Weston report should also be included in the Draft RI Report. The Draft RI Report should be revised accordingly.

Response: The discussion of the soil removal in Section 5 and Section 7 will be augmented. The soil removal action memorandum which includes discussion of the USTs, expansion of the remedial excavation, and the 'hot spot excavation, was included with the Draft RI as Appendix N.

4. Comment: The expansion of the remedial excavation northeast beyond well 69W-94-10, and the relatively high concentrations of petroleum contamination in groundwater and soil in this vicinity indicate a northeasterly component of shallow groundwater flow is or was present at AOC 69W. This apparent northeasterly groundwater flow direction varies nearly 90 degrees from the groundwater flow direction presented by the Army. Because the site monitoring wells are aligned in a northwest trending linear fashion, it is difficult to identify the northeastern groundwater flow component. There appear to be seasonal fluctuations in groundwater flow directions, which have not been identified in the relatively limited groundwater monitoring completed to date. Future groundwater monitoring at AOC 69W should include enough wells and sampling events to cover the entire range of groundwater flow directions from northwest to northeast. The Draft RI should be revised to acknowledge the groundwater flow variations and include recommendations for additional groundwater monitoring.

   Response: The Army does not acknowledge any groundwater flow variations at AOC 69W. Five water level measurement rounds are presented in the Draft RI, all of which support the interpreted north-northwest flow direction. If there were a northeasterly flow component the existing monitoring well network is sufficient to identify it.

   The observed contaminant distributions in groundwater support the interpreted flow direction as is evidenced by Figures 7-8, 7-9, and 7-10. Observed staining in soils does not adequately support variations in flow directions as these may be explained by mechanical dispersion and diffusion of contaminants. Local aquifer heterogeneities beneath the parking area may also be responsible for dispersion of contaminants.

   Future groundwater monitoring will include additional water level measurements and monitoring of groundwater flow directions.

5. Comment: The Army has concluded that the 1978 release has not impacted site groundwater quality. However, less than 3,000 gallons of fuel were recovered from the estimated 7,000 to 8,000 gallon release. Given the quantity of the release, permeable subsurface soils and high groundwater table, it does not seem plausible that fuel from this release did not result in a significant source of subsurface contamination.

   Response: Significant sampling both inside the school building and downgradient of the area of the reported 1978 release indicates that there is no significant contamination other than that identified immediately adjacent to the building (ZWR-95-26X and ZWM-95-16X). Also please refer to the Response to USEPA Comment 13.

6. Comment: The natural attenuation of residual petroleum contamination in the subsurface has been alluded to but not adequately documented for AOC 69W. As the Army recommended a no-action, monitoring only remedy for the site, additional characterization will be required to demonstrate natural attenuation of the significant concentrations of residual contamination is acceptable.

   Response: The Army acknowledges that residual soil contamination exists at AOC 69W but no completed exposure pathways exist to the soils in question. The Army proposes a limited action remedy of long term groundwater monitoring and does not feel that additional characterization of aquifer properties is necessary. Natural Attenuation is not proposed as a remedy in the RI.

7. Comment: Although inorganics were reported in groundwater in excess of background concentrations and MCP Method 1 GW-1 Standards in Round 1 and Round 2 sampling events, inorganics were apparently not analyzed for in the subsequent Round 3 and Round 4 events. Please clarify and justify that the nature and extent of inorganics have been adequately assessed at the site.

   Response: The reviewer is correct. Inorganics were not analyzed for during Rounds 3 and 4 sampling. The Army is of the opinion that the distributions of inorganics in groundwater was adequately delineated during the Rounds 1 and 2 sampling. In addition, the removal of the bulk of the soil contaminants will act to mitigate reducing conditions in the aquifer thereby decreasing concentrations of inorganics in groundwater. Method 1, GW-1 standards for inorganics were only exceeded in wells 69W--94-10 and 69W--94-13, both of which were removed, along with the surrounding soil contamination during the soil removal.

8. Comment: Installation and sampling of additional downgradient groundwater monitoring wells will be required to adequately assess the impacts of residual subsurface contamination at AOC 69W.

   Response: Please refer to the Response to MADEP General Comment 1.

9. Comment: Total risks (Cancer and Hazard Index) were not calculated for AOC 69W. Based on both EPA and DEP risk assessment guidance, quantitative estimation of risk, for cancer and non-cancer risks are additive for the various exposure routes. The risks presented for AOC 69W are for individual exposure media only. In order to correctly calculate risk associated with each exposure scenario, the calculated risks from each exposure media must be added together. For example, for the child trespasser, cancer and non-cancer risk associated with incidental ingestion of surface soil, incidental ingestion and dermal contact with surface water, and incidental ingestion and dermal contact with sediments must be added together to give a total cancer and non-cancer risk for the child trespasser. Table 9-11 needs to be

revised to show the cumulative Excess Lifetime Cancer Risk (ELCR) and Hazard Index (HI) for each exposure scenario. In addition, Section 9.2.4.2 Risk Characterization Results, needs to be rewritten to evaluate additive risks associated with each exposure scenario (i.e., child trespasser, site maintenance worker, school occupants (children/faculty), utility/construction worker, and general public).

The cumulative Reasonable Maximum Exposure (RME) cancer risk calculated from tables presented in Appendix O-3, for the child trespasser, is 1.96E-5. The RME and Central Tendency (CT) cancer risks for the adult resident are 3.0E-03 and 1.0E-04 respectively. These values exceed the MCP cancer risk level of 1.0E-05. In addition, the RME and CT HIs for the adult resident are 25 and 4 respectively. These values exceed the Massachusetts Contingency Plan (MCP) non-cancer risk level of 1. These results indicate that a condition of "No Significant Risk" does not exist for AOC 69W Site. A Response Action per MCP 40.0840 is required.

Response: The risk summary table will be edited to present total receptor risks for exposures to multi-media. As AOC 69W is a CERCLA site, the total receptor risks will be evaluated by comparison to NCP risk criteria, and discussed in the risk characterization section.

10. Comment: In comments dated February 11, 1997, regarding the draft Risk Assessment Approach Plan (RAAP), MADEP stated that the Massachusetts Contingency Plan (MCP) risk guidance should be used in conjunction with U.S. EPA guidance in order to ensure that the risk assessment is "essentially equivalent" (adequately regulated) to assessments conducted in accordance with the MCP. It was specifically stated in MADEP's comments, that a quantitative evaluation of dermal exposure should be completed rather than presenting a qualitative evaluation for this exposure pathway and that MADEP published toxicity values should be used for those chemicals which lack published EPA values. Total cancer risks can not currently be calculated for all pathways because dermal exposure to surface soil and sediment were not evaluated in this risk assessment. These comments need to be addressed and incorporated in the Final Risk Assessment for AOC 69W.

Response: Dermal exposures will be quantitatively evaluated in the revised risk assessment using MADEP dermal exposure absorption factors.

11. Comment: The sediment toxicity testing and contaminant concentrations within Willow Brook indicate possible impairment to macroinvertebrate species. Due to the uncertainties associated with the sediment toxicity testing (less than acceptable survival of *Hyalella azteca* in the control sample and the absence of a suitable reference sample), it is recommended that sediment toxicity testing with *H. azteca* be repeated using an up gradient sediment sample(s) from Willow Brook as a reference sample.

Response: : The Army does not plan on conducting any additional toxicity testing in Willow Brook. During the planning stages of the AOC 69W ERA, it was decided that toxicity test samples would be collected in this ditch concurrently with a similar effort being planned for AOC 57, and that one reference sample from Cold Spring Brook would serve as the reference sample for both AOCs. However, the decision to collect toxicity test samples in Willow Brook was conservative since this ephemeral ditch provides marginal aquatic habitat. The uncertainties surrounding the results of the amphipod toxicity tests have been identified, and the focus of the aquatic invertebrate evaluation has been on the results of the midge toxicity test (refer to Response to USEPA Comments 26 and 36) and the benchmark comparison. This response also pertains to MADEP Specific Comment 31.

PAGE-SPECIFIC COMMENTS

1. Comment: **Page 6-8, Para. 2** The Army's comparison of the groundwater flow presented in Figure 6-3 with the basewide overburden groundwater flow model output (Figure 2-6) is not appropriate. The significant difference in the scale of these two figures and the lack of groundwater flow vectors in the vicinity of AOC 69W in Figure 2-6 makes such a comparison difficult to support. The text should be revised accordingly.

   Response: The referenced comparison will be removed from the text.

2. Comment: **Page 6-8, Para. 2.** The nature of vertical hydraulic gradients in site groundwater are apparently not well understood given the limited data available. This should be discussed in the text.

   Response: The following will be added to the end of Page 6-8, Para. 2, "It was not possible to calculate vertical gradients at AOC 69W as there are no deep overburden wells; however, data collected from the streamside piezometer and gaging station show that groundwater discharges to Willow Brook indicating upward vertical gradients (see Section 6.1, Hydrology)."

3. Comment: **Page 6-10, Para. 2.** A more thorough discussion of the site hydrostratigraphy and the relationship to the MacPherson production well should be provided. The MacPherson well appears to be screened in the overburden deposits and may be affected by AOC 69W contaminants. Please clarify.

   Response: Downgradient monitoring wells and Terraprobe points have shown the petroleum contamiantion has not migrated beyond ZWM-95-15X (see Figures 7-9, 7-10 and 7-11). The contaminant distributions indicate that the only reason contaminants migrated this far was because of the piping from the oil recovery system installed in 1972. This conduit was removed during the Soil Removal Action in 1998. Based upon this and the age of the release the Army is of the opinion that the MacPherson well, located 3,000 feet away has not, and will never be affected by AOC 69W contaminants.

4. Comment: **Page 7-24, Para. 1.** The inorganics arsenic, lead, beryllium, chromium and nickel were reported in groundwater at concentrations which exceed MCP Method 1 GW-1 Standards. However, the it is not clear whether the nature and extent of these contaminants were fully defined. Please clarify.

   Response: Please refer to the Responses to USEPA Comment 12 and MADEP General Comment 7. A discussion of inorganic analytes detected in groundwater will be added to Section 7.2.3.3, Summary of Groundwater Impacts.

5. Comment: **Page 7-50, Para. 1.** The text does not include a discussion of inorganic impacts to groundwater, particularly arsenic and manganese. Although the arsenic and manganese may not be directly attributable to site activities, the occurrence of these contaminants is likely the result of reducing conditions produced by the aerobic degradation of residual petroleum fuels in the subsurface.

   Response: The results of inorganic analyses for Rounds 1 and 2 are provided in Section 7.2.3.2 Page 7-42. A discussion of inorganic analytes detected in groundwater will be added to Section 7.2.3.3, Summary of Groundwater Impacts.

6. Comment: **Page 7-50, Para. 2.** The text does not include a discussion of groundwater impacts northeast of the UST source area which are apparently a result of the variations in groundwater flow directions. The text should be revised.

   Response: Please refer to the Response to MADEP General Comment 4.

7. Comment: **Page 7-50, Para. 3.** Please elaborate on the highly variant nature of groundwater contaminant concentrations reported from round to round and between samples and duplicates.

   Response: Variations of contaminant concentrations between rounds, and in sample duplicate pairs, will be discussed in the revised report.

8. Comment: **Page 8-15, Para. 2.** Although aromatic hydrocarbons may be rapidly degraded as long as dissolved oxygen and sufficient microorganisms (and nutrients) are available, the availability of these items has not been presented for AOC 69W. Therefore, the amount of contaminant reduction due to biodegradation at the site is not well understood.

   Response: Comment noted. Also please refer to the Response to MADEP General Comment 6.

9. Comment: **Page 8-17, Para. 2.** Although PAHs may be degraded as long as dissolved oxygen and sufficient microorganisms (and nutrients) are available, the availability and ability of these items to degrade PAHs has not been demonstrated for AOC 69W. Therefore, the amount of PAH reduction due to biodegradation at the site is not known.

   Response: Comment noted. Also please refer to the Response to MADEP General Comment 6.

10. Comment: **Page 8-19, Para. 2.** The fate and transport discussion for inorganic compounds is not adequate. A discussion of the mobility and fate of arsenic and manganese should be included in the text. The fate and transport of these inorganics are related to the presence of fuel contamination related to the site.

    Response: Please refer to the Responses to USEPA Comment 16 and 17. Discussion of the mobility and fate and transport of inorganics will be provided in Subsection 8.2 of the Final RI.

11. Comment: **Page 8-20, Para. 3.** The text should clearly indicate that residual soil contamination at and below the water table will continue to serve as a secondary source of groundwater contamination at the Site.

    Response: The Army acknowledges that residual soil contamination exists at AOC 69W. However, it does not follow that said soil will act as a source to groundwater contamination. The Army's proposal of long term downgradient groundwater monitoring is sufficient to ensure that the residual contamination will not eventually pose a risk to human health or the environment. Groundwater contamination at the site is attributed to a release that occurred over 25 years ago yet multiple sampling rounds indicate that no significant downgradient groundwater contamination exists. It is unlikely that the soil contamination remaining following the removal action will now cause a downgradient groundwater problem.

12. Comment: **Page 8-26, Para. 3.** The text notes that dissolved phase transport of SVOCs in groundwater is considered a significant transport mechanism at AOC 69W. However, there is no discussion of how site related SVOCs may have impacted sediments in Willow Brook. The pathway from contaminated groundwater to sediments and biota is confirmed in Figure 8-1. Please modify the text accordingly.

    Response: Sediment quality and SVOC concentrations in Willow Brook are discussed in Subsection 7.2.4.

13. Comment: **Page 9-26, Para. 2.** Clarify in the text that although Willow Brook is not ideal for swimming or wading, evaluation of pathways involving Willow Brook are considered in the Exposure Pathway and Scenarios discussions.

    Response: The text will be clarified as recommended.

14. Comment: **Page 9-29, Para. 2.** The text should note that the groundwater under the site is in a Zone II groundwater protection area and is therefore a potentially productive aquifer and is treated as such regardless of its current or anticipated future use.

    Response: The text will be edited to note that the site is within a Zone II, potentially productive aquifer.

15. Comment: **Page 9-37, Para. 1.** See General Comment 10 above. MCP risk guidance should be used in order to quantify risks associated with dermal exposure with soil/sediment .

    Response: Please refer to the Response to MADEP General Comment 10.

16. Comment: **Page 9-40, Para. 2.** Clarify why an exposure duration of April - November is used for the child trespasser exposure to surface soil and an exposure duration of April - October is used for the maintenance worker. The rationale for both exposure durations appears to be that contact with the soil is negligible when the ground is frozen or snow-covered. The exposure durations should therefore be the same for both the child trespasser and the maintenance worker.

    Response: The exposure duration for the maintenance worker will be revised to reflect exposures for April through November.

17. Comment: **Page 9-40, Para. 2.** In review of the assumptions made for the exposure durations for the future child trespasser and future pupil, it appears reasonable to combine the two pathways. A pupil may also be a child trespasser after school, during school vacations, and on weekends. This evaluation should be conducted because it will provide a worst case exposure scenario for any one child.

    Response: The trespasser scenario will be retained to represent the potential exposures and risks under the current land use (i.e., school not yet re-opened). However, the exposure parameters for the future pupil scenario will be modified to include exposures to surface soil, surface water, and sediment during the summer months.

18. Comment **Page 9-51, Para. 2.** See General Comment 9 above. This section of the RI Report should be structured such that it provides a summary of the total cancer risks and HIs for each exposure scenario evaluated (e.g., current child trespasser). As presented, it only discusses risks associated for individual exposure media. In order to quantify estimation of risk, the cancer and non-cancer risks from various exposure routes must be added together.

    Response: Please refer to the Response to MADEP General Comment 9.

19. Comment: **Page 9-55, Para. 2.** The Army's evaluation of risks associated with groundwater as a potential drinking water source only addresses risks associated with adults. Both the "adult" and "child" residential scenarios need to be evaluated for groundwater.

    Response: A child residential scenario will be added to evaluate risks associated with groundwater at the site as a potential future drinking water source.

20. Comment: **Page 9-56, Para. 1.** Arsenic, iron, and manganese are present at concentrations above background and are demonstrating a level of significant risk. Therefore, their presence in groundwater at the site needs to be addressed by recommending some type of Response Action per MCP 40.0840.

    Response: The recently completed soil removal action was intended to address this issue. Clarification is requested.

21. Comment: **Page 9-61, Para. 1.** See General Comment 10 above regarding dermal absorption values. MADEP published toxicity values should be used for those chemicals which lack published EPA values.

Response: Please refer to the Response to MADEP General Comment 10.

22. Comment: **Page 9-61, Para. 2.** See Comment 19, above. Based on the total cancer and non-cancer risk, a total RME cancer risk of 3E-03 and a HI of 25 exists for the adult resident. These values exceed the MCP cancer (1×10^{-5}) and non-cancer (HQ=1) risk levels, indicating that a condition of "No Significant Risk" has not been achieved for this site.

    Response: Please refer to the Response to MADEP Page-Specific Comment 19.

23. Comment: **Page 9-66, Para. 1.** See Comment 20 above. The groundwater under the site is in a Zone II groundwater protection area and is therefore a potentially productive aquifer and is treated as such regardless of its current or anticipated future use. A Response Action per MCP 40.0840 is required.

    Response: Please refer to the Response to MADEP Page-Specific Comment 20.

24. Comment: **Page 9-68, Para. 1.** The information in this paragraph and the paragraph that follows need to be revised once total risks are calculated to adequately characterize risk associated with each exposure scenario.

    Response: Please refer to the Response to MADEP General Comment 9.

25. Comment: **Page 9-84, Para. 1.** Analytes detected in sediment of Willow Brook were eliminated as COCs if detected at concentrations less than background surface soil concentrations (mean plus standard deviation). All sediment analytes detected above screening values (e.g., MOE or NOAA sediment quality values) should be retained as COCs. The comparison of detected analyte concentrations with up gradient sediment concentrations should be discussed in the risk characterization. It is inappropriate to eliminate sediment analytes based on a comparison with surface soil background concentrations.

    Response: The Army maintains that the surface soil background data set for inorganic analytes is appropriate for screening sediment CPCs since the sediment in Willow Brook more closely resembles surface soil; this enables the ERA to be more focused on the issue of real concern at AOC 69W (i.e., fuel-related compounds). The analytes that were eliminated as CPCs based on this screen were aluminum, arsenic, barium, cobalt, iron, magnesium, manganese, potassium, and vanadium. Few of these analytes actually have sediment guidelines for evaluating effects to aquatic organisms. However, of the few for which there are sediment guidelines, only arsenic (detected at a maximum concentration of 10 ppm) slightly exceeds a sediment guideline (the OME LEL of 6 ppm). Rather than keep these analytes in the ERA, the Army will provide an uncertainty in Subsection 9.3.7 regarding the potential underestimate of risk from exposure to arsenic in sediment.

26. Comment: **Page 9-93, Para. 3.** The Risk Assessment Approach Plan (RAAP) for AOC 69W proposed to compare average and maximum concentrations of groundwater contaminants with surface water benchmarks protective of aquatic life. Although the risk assessment only discusses this exposure pathway qualitatively, a quantitative evaluation was, in fact, conducted as discussed in subsection 9.3.4.4. The groundwater exposure pathway discussion should clarify this discrepancy. In addition, uncertainties associated with this pathway (e.g., dilution and limited exposure period) should be discussed in the uncertainty section of the risk assessment.

    Response: The text provided in paragraph 3 on page 9-93 regarding groundwater exposures to wildlife refers only to terrestrial wildlife receptors (i.e., mammals and birds). Subsection 9.3.4.4 states that exposures to aquatic life are evaluated using detected concentrations in groundwater and sediment.

27. Comment: **Page 9-96, Para. 1.** It is stated that a summary of the sediment toxicity testing is presented in Subsection 9.2.5.3. The summary is actually presented in Subsection 9.3.5.3. Please correct.

    Response: Comment noted. This discrepancy will be corrected in the Final AOC 69W RI.

28. Comment: **Page 9-98, Para. 1.** It is stated that a discussion of the uncertainties associated with using inter-taxonomic surrogates is presented in Subsection 9.2.7. This discussion is actually presented in Subsection 9.3.7. Please correct.

    Response: Comment noted. This discrepancy will be corrected in the Final AOC 69W RI.

29. Comment: **Page 9-106, Para. 2.** The statement that average concentrations of lead and zinc are more representative of actual exposure to plants (rather than maximum concentrations) is confusing. Unlike the selected terrestrial wildlife indicator species, individual plants cannot shift their locations in order to reduce their exposure to maximum soil contaminant concentrations. The statement should either be deleted or clarified further.

Response: Comment noted. The text will be revised to state that average concentrations, rather than maximum concentrations, of lead and zinc are more representative of actual exposures to plant *populations*.

30. Comment: **Page 9-109, Para. 3.** The risk assessment for sediment contaminants states that the evidence (i.e., maximum concentrations of sediment contaminants slightly exceed sediment levels associated with adverse effects while average sediment contaminant concentrations are below these effect levels) suggests that copper and nickel may not cause effects to aquatic organisms. However, the evidence presented indicates significant mortality of *H. azteca* at the two sediment samples (ZWD-95-06X and ZWD-95-02X) having elevated inorganic concentrations above levels associated with adverse effects to macroinvertebrate species. Please revise the text accordingly.

Response: The maximum concentrations of copper and nickel only slightly exceed (i.e., by less than a factor of 2) their OME LELs, which represent sediment concentrations that can be tolerated by the majority of benthic organisms (Persaud et al., 1996). These exceedances are *not* examples of high concentrations associated with adverse effects. The text will be revised accordingly.

Please refer to Response to USEPA Comments 26 and 36 regarding the interpretation of the toxicity test results for amphipods.

31. Comment: **Page 9-110, Para. 2.** The statement that the sand/gravel substrate of the sediment may be a greater factor in the observed *Hyalella azteca* mortality than contaminant concentrations is unsubstantiated. *H. azteca* tolerates a wide range of sediment grain sizes including a substrate comprised of 100% sand without any reduction in survival or growth. It seems more likely that the elevated concentrations of contaminants (PAHs and inorganics including arsenic, copper, and nickel) within the sediment samples at ZWD-95-06X and ZWD-95-02X are the cause of the reduced survival.

Due to the poor survival of *H. azteca* in the control sample (less than 80 percent) and the lack of a suitable up gradient reference sample from Willow Brook, it is recommended that the toxicity tests be redone. A minimum of one up gradient sediment sample (reference) should be tested along with samples ZWD-95-06X and ZWD-95-02X for effects on *H. azteca* mortality and growth.

Response: The Army does not propose collecting additional toxicity test samples from Willow Brook. Although originally thought to be suitable and protective of receptors at the site, the toxicity test evaluation was actually an overly conservative means of evaluating potential risks because Willow Brook (an ephemeral, asphalt-lined ditch comprised of a low organic-containing sandy substrate) provides marginal habitat for aquatic receptors.

Furthermore, the Army disagrees that the concentrations of PAHs, arsenic, copper, and nickel are the cause of the significant amphipod mortality observed in sediment toxicity tests. The metals were detected at concentrations that only slightly exceed toxicity benchmarks (refer to MADEP response to comments #25 and 30). The same is true for PAHs. There is no clear cause for the significant amphipod mortality observed in toxicity tests. However, it is clear than Willow Brook provides marginal habitat for aquatic invertebrates. Therefore, the results of the amphipod toxicity test are questionable, and the ERA focuses primarily on the results of the midge toxicity test and benchmark comparisons for evaluating risks to aquatic life. No additional toxicity testing is planned for Willow Brook in the vicinity of AOC 69W.

32. Comment: **Page 10-3, Para. 2.** The text should clearly indicate that site contamination extends in to the wooded area approximately 300 feet northwest of the school, and acknowledge this area is a wetland.

    Response: Comment noted.

33. Comment: **Page 10-3, Para. 3.** The text implies the source of soil and groundwater contamination was removed in 1998, while significant residual contamination remains. The text should be modified accordingly, as noted in General Comment 2.

    Response: The last sentence on Page 10-3 will be revised to "...thus removing the majority of the source of soil and groundwater contamination."

34. Comment: **Page 10-5, Para 2.** Again, although much of the residual contamination was removed in 1998, significant petroleum impacts remain and the reducing conditions which have mobilized arsenic and metals may not be reversed. Please revise the text.

    Response: Please refer to the first paragraph of the Response to MADEP General Comment 2.

35. Comment: **Page 10-8, Para. 1.** The risk assessment assumptions include groundwater beneath AOC 69W will not be used as a source of drinking or industrial water. The Army must ensure this assumption will remain valid through institutional controls.

    Response: The referenced text states that groundwater is not currently used as a source of drinking or industrial water. Future use of this aquifer for either of these uses is unlikely.

36. Comment: **Table 9-1, Para. 1.** Revise Table 9-11 to show the total quantitative estimation of risks associated with each exposure scenario evaluated.

    Response: Please refer to the Response to MADEP General Comment 9.

37. Comment: **Appendix O-3, Table 18.** Provide the CT cancer and non-cancer risk calculations for the inhalation exposure to particulates from surface and subsurface soil for the future utility/construction worker.

    Response: CT cancer and non-cancer risks will be provided for the utility/construction worker.

RESPONSE TO COMMENTS
ON THE DRAFT REMEDIAL INVESTIGATION
FOR AREA OF CONTAMINATION (AOC) 69W

DEVENS, MASSACHUSETTS
AUGUST 1998

(continued)

USACHPPM Comments on the Draft Remedial Investigation Report,
for Area of Contamination (AOC) 69W, Devens, MA
April 1998

General Comments, L. Tannenbaum

1. Comment: The installation name (i.e., Devens Reserve Forces Training Area) doesn't appear on the cover of any of the volumes of the report, nor in the glossary of acronyms and abbreviations. Neither the first page of the executive summary nor that of Section 2.0 clearly indicate the year of the renaming of the installation. Names of the entire installation or parts thereof are inconsistently applied, confusing the reader. Examples are "the Former Fort Devens", "Devens", "Fort Devens", and "Devens' Main and North Post".

   Recommendation: Provide the current installation name (Devens Reserve Forces Training Area) and its acronym (RFTA) on the cover of all volumes of the report, and include this in the glossary. Make the revised report internally consistent by utilizing a singular term as often as possible, when referring to the installation. Consider moving the glossary of acronyms and abbreviations to the front of the report, just prior to the executive summary.

   Response: The installation name will be included on the cover of the report as well as the glossary of acronyms. Different names are used for the installation (e.g., Devens, Fort Devens, etc...) in an effort to accurately describe the status of the installation at a given time. An effort will be made to use a singular term as often as possible without sacrificing accuracy.

2. Comment: A number of overly conservative and unnecessary practices were conducted as part of the remedial investigation. As examples, no dilution factor was assigned to the ground water that is present downgradient at the AOC 69W location, nor at the discharge to Willow Brook. The practices give rise to unfounded recommendations, such as the proposed "limited action consisting of long term monitoring of downgradient groundwater quality". Note that the second bullet point of page ES-11 (that finds no unacceptable human health risks at the site) conflicts with all recommendations to take limited and other actions. See Comment #3.

   Recommendation: In the revised report, delete evaluations for media that are in actuality absent, rather than including such evaluations and labeling them overly conservative approaches to evaluation.

   Response: We agree that evaluation of groundwater discharge to surface water in Willow Brook is conservative (because discharge only occurs during periods of high groundwater level, which are not times of the year when people would swim in the brook), and the method of developing EPCs for groundwater discharge was conservative (because no dilution modeling was used). However, this assessment was performed because USEPA required it. The uncertainties associated with the conservative nature of the assessment were explained in the exposure assessment. Likewise, the evaluation of groundwater beneath the site as potential future source of potable water is required by the USEPA.

The proposed response action of groundwater monitoring is recommended in response to the existence of the MacPherson public supply well, which is located downgradient of AOC 69W. This response action was recommend primarily due to the location of AOC 69W with respect to the well, and the risk associated with on-site use of the groundwater as a source of potable water; it was not recommended in response to the assessment of groundwater discharge to Willow Brook.

3. Comment: **Pages 1-2 and 1-7, Sections 1.1 and 1.3.** Toxicity tests are not conducted as a matter of routine in remedial investigations. They usually proceed only after there has been a preliminary data screening against appropriate benchmarks that indicates a risk condition. Conducting toxicity tests when a risk condition is not evident can lead to spurious results, that are both difficult to interpret, and that may falsely indicate a potential case of (unacceptable) risk. This was the case at the evaluation of AOC 69W. Specifically, the control sample in the amphipod survival test did not meet its 80% acceptance criteria (page 9-100), complicating the interpretation of test results. The reality is that the test should not have been run altogether. Had it not been the difficulty in the interpretation of the data would not be an issue. Note that the RI's purpose as stated on page 1-7 does not mention sediment as a medium to be evaluated. See Comments #6 and #10.

Recommendation: In the revised report, consider deleting all references to the toxicity test work that was conducted. If it is to remain in the report, supply appropriate text that explains that the justification for conducting the procedure was not initially present.

Response: The Army agrees that toxicity tests should not be conducted as a matter of routine in remedial investigations. However, initial work at AOC 69W indicated that Willow Brook might potentially receive contaminants via groundwater discharge. Given the nature of contamination (i.e., petroleum), toxicity testing was thought to be the only means by which risks could be evaluated because few sediment toxicity benchmarks for petroleum related compounds were available during the planning stages of the evaluation. It was therefore decided that toxicity testing would be completed in the ditch concurrently with a similar effort being planned for another AOC, and that one reference sample would serve as the reference sample for both AOCs. It was later decided that collecting toxicity test samples from Willow Brook was overly conservative since this ephemeral ditch provides marginal aquatic habitat. The Army believes that all data available for AOC 69W should remain in the remedial investigation.

4. Comment: **Page 2-10, Section 2.2.3.** The bald eagle is a federally listed threatened species, and not an endangered species.

   Recommendation: Please make the correction.

   Response: The RI will be corrected to change the federal status of the American bald eagle from endangered to threatened.

5. Comment: **Page 4-6, Section 4.1.3.** There text of the Section is confusing regarding relevant regulations. The "NCP" is mentioned initially, followed by multiple usages of the "MCP". Is the usage of "NCP" a mistake? Also, does the MCP address CERCLA response actions, as the text presently indicates?

   Recommendation: Clarify the usage of "NCP". Verify that the statements regarding CERCLA provisions within the "MCP" are accurate.

   Response: The usage of NCP (National Contigency Plan) and MCP (Massachusetts Contingency Plan) are correct as are the statements regarding the relationship between CERCLA and the MCP. The MCP does contain provisions that may be ARARs. There is an agreement between the USEPA, MADEP, and the Army to handle these provisions on a "case by case" scenario. In terms of AOC 69W the MCP Method 1 provisions are not ARARs.

6. Comment: **Page 5-34, Section 5.4.9.** What purpose was there in collecting sediment samples at the depth of 2 to 2.5 feet below surface, in the evaluation of potential ecological risks? Ecological receptors have no exposure to sediments of this zone.

   Recommendation: Delete references to collecting sediment data of the 2 to 2.5 foot below surface depth, as such data is irrelevant in the evaluation of ecological effects at the site.

   Response: The 2 to 2.5 ft. bgs sediment samples were collected to fully characterize the nature and extent of contamination. These samples were not used in the ERA for characterizing risks to ecological receptors

7. Comment: **Page 7-22, Section 7.2.1.2.** Subsurface soils are defined in part as being of 0 to 2 feet in depth. This is not correct. Samples from the surface to 2 feet below surface are termed "surficial", as per RAGS and other guidance.

Recommendation: In the revised report, define surface soil as that from ground surface to a maximum of 2 feet below surface, and define subsurface as that soil below a depth of 2 feet. Ensure that evaluated subsurface exposures did not include surface soil data, as defined in this comment and recommendation. Make all necessary corrections.

Response: The reviewer is correct. The depth interval from 0 to 2 feet below ground surface were erroneously included in Section 7.2.1.2, Subsurface Soils. The references to this depth interval will be removed from this Section. Evaluated subsurface soil exposures in the risk assessments did not include soils from 0 to 2 feet.

8. Comment: **Page 7-51, Section 7.2.4.** There is no basis for comparing background soil concentrations at the installation to onsite sediment concentrations (for any site). The media themselves, the manner in which contaminants in each exert toxicitics, and the species that can be potentially affected at each medium are radically different. Why is there "no established set of background concentrations for sediments at Devens"?

Recommendation: Delete all mention of soil and sediment chemical concentration comparisons that were performed. Explain why background sediment data does not exist. Include in the explanation, why there was not available nearby stream, etc. that could have supplied the critical background dataset.

Response: The Army maintains that the surface soil background data set for inorganic analytes is appropriate for screening sediment CPCs since the sediment in Willow Brook more closely resembles surface soil; this enables the ERA to be more focused on the issue of real concern at AOC 69W (i.e., fuel-related compounds). The analytes that were eliminated as CPCs based on this screen were aluminum, arsenic, barium, cobalt, iron, magnesium, manganese, potassium, and vanadium. With the exception of arsenic, none of these analytes actually have sediment guidelines for evaluating effects to aquatic organisms.

9. Comment: **Page 9-8, Section 9.1.** The dimensions of AOC 69W are not clearly provided anywhere in the report, although the AOC is described in terms of its associated properties (i.e., former elementary school and adjacent parking lot and lawn). Are the dimensions 120 feet by 180 feet (the area encompassed by the removal action) the dimensions for all of AOC 69W? If so, could there be significant ecological risk at an area of this size, given that the territorial range of the ecological receptors considered? Would the receptors considered be exposed to the location on the basis of the habitat it currently supplies?

Recommendation: In the revised report, provide the exact site size in acres. Indicate that relevance of the risk assessment modeling for ecological receptors under post-removal actions, and given the size of the site relative to territorial ranges, and overall attractiveness.

Response: We agree; the size of the site will be included in appropriate areas of the report, including the human health and ecological risk assessments.

10. Comment: **Page 9-15, Section 9.2.1.1.** There is no utility to the surface water evaluation as described here and in other parts of the Section. If, as stated, the surface water is absent, there is no purpose to evaluating the medium as though it was there. The exercise, said to be conservative, is better described as imaginary.

Recommendation: Delete all mention of the surface water evaluation.

Response: Please refer to the response to general comment 2.

11. Comment: **Page 9-17, Section 9.2.1.2.** This Section makes a number of sweeping statements, and doesn't provide critical details to clarify these points. As an example, the statement "blank-contaminated (data) were used in the risk assessment", does not provide an indication that RAGS guidelines on blank contamination were applied. On page 9-19, the text doesn't indicate what statistic was used when the there were fewer than 10 samples (precluding a calculation of the 95% UCIs). Presumably the maximum value was used in that instance.

Recommendation: Provide clarifications for the points raised in the comment.

Response: These sections will be reviewed, and the suggested clarifications will be added as appropriate. The 95 percent UCL statistic and the selection of EPCs is further discussed in Subsection 9.2.2.2.

12. Comment: **Page 9-17, Section 9.2.1.2.** It is presumed that the data summary procedures do not apply to the indoor air samples.

Recommendation: In the revised report, state that the presumption is correct.

Response: The data summary procedures do apply to indoor air. References to this were inadvertently excluded from the text. The text will be revised as appropriate.

13. Comment: **Page 9-45, Section 9.2.3.** A qualifier is needed for the absorption efficiencies mentioned in the discussion on the adjustment of oral toxicity factors.

    Recommendation: In the revised text, indicate that gastric absorption efficiencies are intended.

    Response: The requested qualifier will be inserted into the text.

14. Comment: **Page 9-47, Section 9.2.3.** It is stated that MADEP approach of evaluating risk by applying RfDs for indicator compounds to various fractions of petroleum products was used. It is then stated that when there is no information concerning the concentrations of the various fractions, but there are data for TPHC, pyrene is used as a surrogate. While there are some quantities of PAHs in weathered fuel, they are certainly not the most likely choice as a "default". Additionally, pyrene is carcinogenic, whereas not all components of TPHC are.

    Recommendation: Further explain this choice.

    Response: The MADEP approach for evaluating risk to constituents of petroleum hydrocarbon includes using the pyrene non-cancer dose-response value as a surrogate dose-response value for some of the petroleum fractions. Specifically, the RfD for pyrene is used to evaluate the petroleum hydrocarbon fractions that are considered "most-toxic" (e.g., C11-C22 aromatic EPH). Therefore, application of this dose-response value to petroleum hydrocarbon data quantified as "TPH" (i.e., no petroleum fractionation determined) provides a conservative approach because it considers all the petroleum quantified as "TPH" to be present as the most toxic petroleum fraction. In addition, pyrene is not considered carcinogenic by the USEPA; there are no cancer slope factors for pyrene published in IRIS or HEAST.

15. Comment: **Page 9-75, Section 9.3.1.2** The robin's habitat description is not fully correct. At best only forest edge habitat is used by the robin.

    Recommendation: Please notify the habitat description indicating that preferred areas for the robin include open areas along habitat edges, orchards, parks, lawns, and edges of streams.

    Response: Robins are ubiquitous, and as described in the Exposure Factors Handbook (USEPA, 1992), forage in a variety of habitats including forests. The habitat description in Subsection 9.3.1.2 will be revised to include "*moist forests, swamps, open woodlands, orchards, parks, lawns, habitat edges, and streams*". Regardless, the Army believes that the removal action at AOC 69W has mitigated the source of contamination and, therefore, the significant risks associated with the fuel spill at AOC 69W.

16. Comment: **Page 9-84, Section .3.3.** The specifics of the comparison of onsite and background chemical concentrations are not provided. In particular, the phrase "if the maximum detected concentration is less than the background" is vague.

Recommendation: Indicate the background dataset statistic that was compared with the maximum onsite concentration.

Response: The sentences immediately following that cited by the reviewer explain what the background statistics represent, which state that "the background surface soil and groundwater data sets consist of chemical data gathered from locations designed to establish background concentrations of inorganic analytes for Group 1A sites. The values approximately represent the 68^{th} percentile upper bound limits (the mean values plus one standard deviation) of these chemicals..." Regardless, the Army believes that the removal action at AOC 69W has mitigated the source of contamination and, therefore, the significant risks associated with the fuel spill at AOC 69W

17. Comment: **Page 9-97 and 9-98, Section 9.3.5.1.** The text should note the favored toxicity reference value (the NOAEL for a relevant toxicological endpoint) rather than state the awkward "lesser of the lethal or sublethal RTVs derived from the literature." The implication is that lethal levels are more useful than they in fact are, in ecological risk assessments. Also, the use of sublethal toxicity information from "another taxonimic group" is potentially problematic. USACHPPM does not endorse interclass extrapolation of toxicity reference values.

Recommendation: Modify the text of the Section to clarify the suitability of certain toxicity reference values, following the concerns expressed in the comment.

Response: The "lesser of the lethal or sublethal endpoints" more accurately describes the selected RTV since in some cases the lethal RTV (which may be one-fifth of an LD_{50}) may be less than the sublethal RTV (LOAEL or NOAEL). The text will be clarified to make this point. The Army agrees that using inter-taxonomic surrogates is potentially problematic. However, most toxicological studies are conducted on laboratory rats, and there are few studies that are conducted on species that are often selected as representative receptors. Therefore, this is addressed as an uncertainty in Subsection 9.3.7. Regardless, the Army believes that the removal action at AOC 69W has mitigated the source of contamination and, therefore, the significant risks associated with the fuel spill at AOC 69W.

18. Comment: **Page 9-105, Section 9.3.6.2.** The text makes a number of sweeping statements that many not be founded. Noting that the concentrations of chemicals are "extremely low" is insufficient to conclude that phytotoxic effects are likely to be absent. Also, the text assumes that acetone should be summarily dismissed because it is a common laboratory contaminant. RAGS however provides guidance on legitimate screening of such compounds, and these may not have been followed.

    Recommendation: Modify the text to clarify the vague statements. Cite references for procedures followed to indicate that appropriate guidelines were used.

    Response: The text will be modified to state the following: "There are no data available relating plant exposures to acetone, trichlorofluoromethane, or TPHC with adverse responses; *therefore, risks to plants from exposure to these chemicals could not be evaluated.*" Since risks to plants could not be evaluated for these analytes, the remainder of the discussion was provided to reduce concerns associated with the presence of these chemicals in soil. Regardless, the Army believes that the removal action at AOC 69W has mitigated the source of contamination and, therefore, the significant risks associated with the fuel spill at AOC 69W.

19. Comment: **Page 9-107, Section 9.3.6.3.** The text indicates that Table 9-23 provides the results of surface soil evaluations for invertebrates but Table 9-23 does not do this. Additionally, the table is not understandable to the reader.

    Recommendation: Modify the text so as to reference a table that provides the analysis described. Provide a full explanation of the summary information Table 9-23 is providing.

    Response: Table 9-23 does provide results of the surface soil evaluation for soil invertebrates. The middle two columns provide RTVs for both plants and invertebrates, and the last two columns provide the results of the evaluation for both plants and invertebrates (i.e., whether or not the soil concentrations exceed plant or invertebrate benchmarks).

20. Comment: **Appendix M.** The source of the indoor background air sample is not discussed in the report. From the map, it appears to be on the upwind side of the school, but the function of the room is not provided. While it is clear that it is not from a crawl space, it is not clear why this sample represents appropriate background.

    Recommendation: Please provide a clarification.

Response: The indoor air background location will be identified in the text, and the rationale for why this location represents indoor background will be provided.

21. Comment: **Appendix M.** Although the report provides a rationale as to why it is not believed that contaminants in soil and groundwater are impacting the air, and also discusses the possibility of blank contamination, some of the values approach or exceed the inhalation toxicity values. These were not COPCs evaluated in the text by comparison with Region III RBCs.

    Recommendation: Supply text addressing the concern in the comment.

    Response: Appendix O presents a detailed explanation and rationale for the selection of indoor air data evaluated in the risk assessment. Per USEPA comments on the human health risk assessment, all indoor air data (collected from classrooms, kitchen, and library) will be screened in the COPC selection process.

**HTRW Comments on the Draft Remedial Investigation Report,
for Area of Contamination (AOC) 69W**
April 1998

1. Comment: **P. ES-1.** The section titled "Recommendations" should state what contaminants should be monitored in the groundwater down gradient to the site (e.g., TPHs as opposed to metals).

    Response: The details regarding specific analytes, frequency of sampling, and specific monitoring wells will be addressed in the Long Term Monitoring Plan following the Proposed Plan and Record of Decision

General Comments

2. Comment: The body of the report (e.g., Section 3.1.5) states that method blank contamination was evaluated using the PQL (Practical Quantitation Limit) for the on-site analyses. However, Appendix D states that method blank contamination was evaluated using the CRL (certified reporting limit) for the off-site analyses. However, the terms CRL and PQL are not well defined in the body of the report (e.g., in Section 3.1.6). The PQLs and CRLs should be defined in terms of detection and quantitation limits. The quantitation limit should be established by the low calibration standard and should be 5 to 10 times higher than the detection limits (as defined by 40 CFR, Part 136, Appendix B). Reporting limits should be less

than the decision limits but no lower than two to three times the MDL. Detections between the reporting limits and quantitation limits should be qualified as estimated.

It should also be noted that, contrary to what is implied on page 3-12, the requirements that the MDL be below the reporting limit is a necessary but is not a sufficient condition to meet DQOs for sensitivity. The reporting limits should be no lower than two to three times the MDL and the quantitation and reporting limits must be below the action levels (i.e., decision limits). This is not explicitly stated in Section 3.1.6.

Response: Separate analytical goals for the on-site and off-site programs were established for the program. On-site laboratory PQLs were defined to establish reporting levels for the screening phase of the field program. The PQL was equivalent to the low concentration standard in the initial calibration. The off-site program was completed in accordance with the USATHAMA QA Program and CRLs were defined in accordance with USATHAMA guidelines and calculations specified in the USATHAMA QA Plan. A reference to the QA Plan will be included in the revised discussion. The origins and objectives of the PQL and CRL will be clarified in Section 3.1.5, and Section 3.2 in the revised RI.

3. Comment: Acceptance limits for surrogates should be comparable to the acceptance limits for target analytes. For example, page 3-10 indicates that the acceptance range for the surrogate BFB is 30% - 170%. However, the error tolerance for the VOC analytes is +/-30% (e.g., for the CCVs). The error tolerance for the surrogate was is over twice as high as that for the VOC analytes. Similarly, the acceptance window for the surrogate for the pesticide/PCB analyses is 30% - 170% (e.g., refer to page D-24). However, PCBs, spike recoveries typically fall within 80% - 120% in a clean matrix.

Response: Surrogate recovery limits were established in the Devens Project Operation Plan (POP), Section 4.64 and Appendix D of the POP, based on the need to analyze a large number of screening quality samples with a 24 hour turnaround to direct field investigations. Data usability goals for the screening samples in the field program allowed for a wider range of accuracy because providing real time Level II quality data was the goal. The objectives and QC goals for the on-site laboratory program will be specified more clearly in the revised report. This field program need was the basis for the wide surrogate limits. Matrix spike results were used for interpretation of accuracy after the field program was completed; therefore, the limits were more comparable to what would be expected in an off-site laboratory.

4. Comment: Appendix D (e.g., Section D.3.0) discusses the matrix spike recoveries. However, it is not clear how matrix interference can be evaluated without also addressing the laboratory control sample (LCS) recoveries. Matrix interference is demonstrated when the surrogates and target analytes in the LCS are acceptably recovered but the surrogates and target analytes in the MS are not. For example, page D-

31 states that several surrogate recoveries were unacceptable but does not discuss the surrogate recoveries of the environmental samples relative to the surrogate recoveries of the associated LCSs.

Response: In the USATHAMA program LCS recoveries are evaluated by the USAEC Chemistry Branch and results are qualified if LCS recoveries are outside established control limits. The review of LCS control chart data is discussed in Section 3.2.4. These qualifiers would be discussed if present. Section 3.2.3 will be revised to include a discussion of the USAEC control chart reviews. The revised report will contain a statement on the LCS trends and identification of any data qualifier issues in the accuracy discussions

5. Comment: The process USACE uses to determine CRLs is not clear. CRLs are not determined as part of the USACE laboratory validation process. Reporting limits should be determined by the project-specific action levels that need to met.

   Response: The process used to determine CRLs is outlined in the USATHAMA QA Program. A reference to the QA Program and applicable sections describing the calculations will be included in Section 3.2.1 of the revised report.

6. Comment: The report implies that the data was validated but validation typically involves an evaluation all batch QC an instrument QC results (e.g., the initial calibration results) to the level of the raw data. However, Appendix D primarily discusses only the batch QC results. For example, matrix spike and method blank results are discussed for the 1995 field program but instrument QC results are not. Although the data was reviewed, it is not clear that the data were actually validated.

   Response: With the exception of a subset of data packages for Massachusetts hydrocarbon methods and USEPA air methods which were completed without using USAEC methods and data reporting procedures, data validation using USEPA guidelines was not done in this program. Data review procedures outlined by the USATHAMA QA Program and USAEC Chemistry Branch were conducted on the data sets. This includes a combination of laboratory reviews and use of flagging codes, USAEC reviews of control chart data and use of data qualifier codes, and subcontractor reviews of field and laboratory QC sample results obtained from the IRDMIS data base. Demonstrations of comparability of the USAEC process to USEPA validation were conducted early in the RI process at Fort Devens, and the USATHAMA/USAEC data evaluation process was accepted for use in future RI programs.

7. Comment: Page D-57 states: "The primary assumption of the comparison was that the off-site data represented the accurate definitive data when comparing results."

However, if the VOC (and TPH-GRO) soil samples were prepared per Method 5030/5030A (e.g., rather than by Method 5035), it is more probable that the on-site VOC soil results are the more accurate. A large negative bias (e.g. several orders of magnitude) is associated with the sample preparatory procedure.

Response: Comment noted. A statement will be added to Appendix D-1 indicating the potential for low biased off-site data. This statement will be identical to a statement contained in Appendix D-2, page 10. The basic interpretation and assumption that the on-site data are potentially high biased due to hydrocarbon interferences will remain.

8. Comment: The reference section of Appendix D, Section D.3.3.3, could not be found. Is this a typo?

Response: Appendix D should have a reference section, and it will be included in the revised report.

9. Comment: Table 4-1 lists Ambient Water Quality Criteria (AWQC) as ARARs for the site. This is not correct. Federal AWQC are only legally enforceable in States that do not have EPA approved state programs. (See 40 CFR Part 131.4, 131.5, and 131.36 for clarification on this issue).

Massachusetts has an EPA approved state plan and therefore the State AWQC should be listed as the ARAR rather than federal AWQC.

Response: The suggested edit will be incorporated.

NED Comments on the Draft Remedial Investigation Report,
for Area of Contamination (AOC) 69W
April 1998

Geology Review Comments - Young

1. Comment: **5-32/para 1.** State rationale why ground water sampling Round 4 was conducted so soon after Round 3.

   Response: Round 3 groundwater sampling was conducted in September and October of 1996 while Round 4 sampling was conducted over a year later in December of 1997.

2. Comment: **5-41/para 2.** Please give details regarding the construction of the stockpile area in the text. Was the soil pile covered with polyethylene? Were hay bales or some type of filter fabric placed around the perimeter of the stockpile to prevent runoff of soil into the adjacent manhole?

   Response: The completed Soil Removal Action Report containing all of the requested information will be provided as Appendix N of the Final RI. The Appendix will be referenced in Section 5.

3. Comment: **6-6/top of page.** State distance of Shepley's Hill Landfill from AOC 69W.

   Response: The referenced text will be changed to indicate that Shepley's Hill Landfill is approximately 2,500 feet to the northeast.

4. Comment: **7-41/7.2.3.2.** Please show the different Areas on Figure 3.

   Response: The reference in Section 7.2.3.2 to Area 2 is in error. The text will be changed to indicate that "...HLA installed four monitoring wells at *AOC 69W* in 1995..."

5. Comment: **7-42/para 1.** The text compares filtered/unfiltered ground water samples for arsenic but, in looking at Table 7-15, there are no footnotes that describes which ground water samples were/were not filtered. Please clarify.

Response: Footnotes describing the flagging codes and data qualifiers will be added to Table 7-15.

6. Comment: **7-50/last sentence** It is stated in the text that the TPHC ground water data is highly variable from round to round and between samples and duplicates. Please discuss in the final document, if possible, any factors that may have been an influence on this variability.

   Response: Variance in sample results from round to round and between duplicates will be discussed in the Final RI.

7. Comment: **10-10/10.2** . Does the recommendation for long term monitoring of down gradient ground water quality equate to a specific number of years or is it dependent on a yearly data review of contaminants that exceed specific State & Federal criteria? Please clarify in the narrative.

   Response: Please refer to the Response to HTRW Comment 1 as well as well as MADEP General Comment 1.

General Comment - Geology concurs with the A-E's recommendation for a limited action consisting of long term monitoring of down gradient ground water quality.

Chemistry Review Comments - Wojtas

8. Comment: **3-18/3.2.3.** In the fifth bullet on page 3-18, "matrix spike" should be changed to "mass spectrometer".

   Response: . Corrections will be made to Section 3.2.3.

9. Comment: **Appendix D-1/D-56/D.5.4**. Table D-24 (as referenced) is not included. Please add.

   Response: Table D-24 will be added in the revised report.

10. Comment: **Appendix D-1/D-59/D.5.4.2.** Include discussion of high bias of on-site results possibly attributed to volatilization of VOCs during shipment to the off-site laboratory (see page 10 of Appendix D-2).

    Response: A statement will be added to Appendix D-1 indicating the potential for low biased off-site data. This statement will be identical to a statement contained in Appendix D-2, page 10. The basic interpretation and assumption that the on-site data are potentially high biased due to hydrocarbon interferences will remain.

11. Comment: **Appendix D-1/Table D-5**. Include a definition for footnote 1.

    Response: Footnote will be included on Table D-5, Appendix D-1.

12. Comment: **Appendix D-4/Air Sample Data Review and Validation.** At the end of Appendix D-4, there are two reports titled "Air Sample Data Review and Validation, AOC 69W Fort Devens, March 1998". The first report appears to be superseded by the second report. Please remove unapplicable reports.

    Response: The Appendix will be reviewed and corrected to include only the final report.

USEPA INDOOR AIR SAMPLING STUDY

FINAL REPORT

INDOOR AIR SAMPLING STUDY

AREA OF CONTAMINATION 69W
DEVENS ELEMENTARY SCHOOL
DEVENS, MASSACHUSETTS

JUNE 1998

Prepared for: Office of Site Remediation & Restoration, Federal Facilities
U.S. Environmental Protection Agency, New England

Prepared by: Peter R. Kahn Date: 6/4/98
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1.0 Introduction

The EPA New England, Office of Environmental Measurement and Evaluation, at the request of Jerry Keefe and Jim Byrne, Project Managers for the Fort Devens Superfund Federal Facilities Site in Devens, Massachusetts, performed an indoor air sampling study inside the Devens Elementary School for volatile and semi-volatile organic compounds on April 21, 1998, between 08:33 and 16:54 hours.

Fort Devens is located in Devens, Massachusetts approximately 35 miles northwest of the city of Boston, within the towns of Ayer, Shirley, Harvard, and Lancaster, and occupies approximately 9,280 acres of land area. Area of Contamination (AOC 69W), Devens Elementary School, is specifically located in the northwest portion of the former Main Post, on the corner of Antietam and MacArthur Streets. The area is comprised of an unoccupied elementary school, an associated parking lot, and surrounding grassy areas.

In 1972 and 1978, fuel oil No. 2 was accidently released into subsurface soils at the school. The source of the release is assumed to be from damaged piping near and within the footprint of the school. Results of investigation activities have shown the presence of petroleum contamination in subsurface soils primarily at the water table, adjacent to and down gradient of the school's foundation. In addition, soil and groundwater contamination have been detected directly beneath the school, in the immediate vicinity of the new boiler room.

In 1996 and 1997, the Army conducted air monitoring in the school to evaluate whether contaminants in the soil and groundwater were impacting indoor air quality. The results of the air monitoring efforts did indicate the presence of various volatile organic compounds (VOCs), however, due to questionable data quality no definitive conclusions could be derived. In addition, the methods used were not able to identify and quantitate the target semi-volatile organic compounds (SVOCs). As a result, further air sampling was requested to be performed within the school.

2.0 Sampling Objectives

The study focused on collecting indoor and ambient air samples for VOCs and SVOCs at locations previously used during the October 20, 1997 study performed by ABB Environmental Services. The objective of the study was to collect quality data that would help determine if fuel-related contaminants present in the soil and groundwater adjacent to and beneath the school were volatilizing and migrating up through the soil and into the school's class rooms. The data presented in this report will be used by risk assessors to determine if contaminant levels in the school are a health risk to potential occupants of the building.

2.1 Target Compounds and Reporting Limits

The list of target analytes for this project is presented in Table 1. They are taken from the October 1997, ABB Environmental Services, Inc. Final Remedial Investigation/Feasibility Study Work Plan Addendum for Supplemental Air Sampling at AOC 69W. This list was compiled based on fuel-related compounds that have been detected in soil and groundwater in the immediate vicinity of the school and contaminants expected to be present in weathered No. 2 fuel oil. Table 2a and Table 2b lists the VOCs and Table 3 lists the SVOCs that were sampled and analyzed for using the methods described in this report.

2.2 Data Use and Reporting

This report will be provided to Jerry Keefe and Jim Byrne for their review. They will forward the report to the appropriate parties for risk assessment analysis. This report describes where samples were collected, the sampling and analytical procedures used for the survey, and the meteorological conditions during the sampling event. In addition, all the sampling and quality assurance/quality control (QA/QC) data are reported in tabular form. The results have been summarized and an evaluation performed to assess the quality of the data and what compounds were present at concentrations above background levels that could be impacting indoor air quality. This information is discussed in greater detail further on in the report.

3.0 Sampling Locations

The sampling locations described below and shown on Figure 1 were used during the April 21, 1998 study. Eleven sampling locations were established as follows to collect VOCs: six locations in various rooms throughout the school; three outdoor locations for collecting background data; one sampling station in the crawlspace beneath the kitchen; and one sampling station in the crawlspace near the old boiler room. Two samples were collected side-by-side at the kitchen crawlspace sampling location to serve as duplicate samples for obtaining precision data.

The following three sampling locations were established to collect SVOCs: one sampling station in the crawlspace beneath the kitchen, one station in the room adjacent to and immediately south of the new boiler room, and one sampling station located outside the building to collect ambient background data. Two samples were collected side-by-side at the kitchen crawlspace sampling location to serve as duplicate samples for obtaining precision data.

Descriptions of the sampling stations used for this survey are provided below.

Sampling Station #1

This station was located in the middle of the room across the hall from the new boiler room. The oil supply line from the under ground storage tank to the new boiler room is located under this room. The area under this room was identified to contain subsurface soil contamination. Both VOC and SVOC samples were collected from this room.

Sampling Station #2

This station was positioned in the kitchen area adjacent to the access point to the crawlspace sampling station (Station 4). Subsurface soil contamination was identified in the parking lot adjacent to the school foundation which is located in the vicinity of this station. A VOC sample was collected from this location.

Sampling Station #3

This sampling location was placed in the middle of the first room on the left-hand side of the northeast wing (Room 113). This room was chosen because it is close to the old boiler room and is representative of conditions in the northeast portion of the building. A VOC sample was collected from this room.

Sampling Station #4

This station was located in the crawl space beneath the kitchen area. VOC and SVOC samplers were placed adjacent to this access point on the dirt floor. This location collected two VOC and two SVOC samples side-by-side to serve as duplicate samples for obtaining precision data. This location was chosen to measure contaminant migration from the ground and to represent worse case concentrations.

Sampling Station #5

This station was placed in the crawl space adjacent to the old boiler room. Access into the crawl space was thorough a door located in the old boiler room. A VOC sample was collected on the dirt floor, adjacent to this access point. This location was chosen to measure contaminant migration from the ground and to represent worse case concentrations.

Sampling Station #6

This sampling location was positioned in a room located in the southwest portion of the school. A VOC sample was collected from the middle of the room to collect data representative of indoor air background levels.

Sampling Station #7

This station was located in the room adjacent to and immediately south of the New Boiler Room. A VOC sample was collected from the middle of the room. This room is close to the area where subsurface soil contamination was identified.

Sampling Station #8

This sampling station was placed in a class room located in the northwest corner of the school. A VOC sample was collected from the middle of the room. This room is located over subsurface soils identified as containing elevated levels of TPHC.

Sampling Station #9

This station was located outside and along the northern side of the school building, approximately 35 feet south of monitoring well 69W-94-11. A VOC ambient air sample was collected to obtain background data.

Sampling Station #10

This station was located outside and along the western side of the school building near the front parking lot area. Station #10 was approximately 48 meters from the southwest corner of the building, 56 meters from the northwest corner of the building, and 43 meters west of the main entrance to the building. A VOC ambient air sample was collected to obtain background data.

Sampling Station #11

This station was located outside and along the eastern side of the school building near the playground area. Station #11 was approximately 52 meters from the northeast corner of the building, and 136 meters from the southeast corner of the building. VOC and SVOC ambient air samples were collected to obtain background data.

4.0 Canister VOC Air Sampling and Analytical Methodology

4.1 Description

EPA Region I Standard Operating Procedure for the Sampling of Trace Volatile Organic Compounds using SUMMA Polished Stainless Steel Canisters, EPA-REG1-ESD/CAN-SAM-SOP, March 1994, Revision 1, was used as the procedure to collect the ambient air samples. Sub-atmospheric samples were collected in evacuated 6 liter canisters using the procedure described in Part 2 of the Region I SOP, described above. Detailed descriptions of the quality assurance procedures are provided in Part 4.

Canister samples were brought back to the EPA laboratory properly logged in and analyzed using a gas chromatograph/ion-trap mass spectrometer (GC/MS) following the EPA Region I standard operating procedure entitled, "The Determination of Volatile Organic Compounds in Ambient Air using Summa Passivated Canisters," a modification of EPA Method TO14 - The Determination of Volatile Organic Compounds in Ambient Air using SUMMA Passivated Canister Sampling and Gas Chromatographic Analysis, from the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA-600/4-84-041, May 1987. This analytical procedure was used to identify and quantify the VOCs listed on Table 2a and 2b.

4.2 Canister Cleaning and Leak Certification Procedures

4.2.1 Canister Cleaning Procedure

Prior to the sampling event, the canisters were cleaned by placing them in ovens maintained at 150°C, evacuated to at least 10^{-3} Torr, and then pressurized with humidified nitrogen to approximately 30 psig. This process was repeated three times. Detailed descriptions of these procedures are provided in the document entitled, "Canister Cleaning Standard Operating Procedures, EPA-REG1-OEME/CANISTER-CLEANING-SOP, April 1998, Revision 2."

4.2.2 Canister Leak Certification Procedure

At the end of the cleaning process described above, the canisters were evacuated to less than 10^{-3} Torr, with a Pirani sensor the vacuum in each canister was measured. The canisters were then placed on a shelf for at least 24 hours. At the conclusion of this period, the Pirani sensor was used again to measure the final canister vacuum which was then compared to the initial reading to determine if the canisters show signs of leaking. No leaks were detected in any of the canisters, therefore, they were certified leak free on April 2, 1998. Detailed descriptions of these procedures are provided in the document entitled, "Canister Leak Certification Standard Operating Procedures, EPA-REG1-OEME/ CANISTER-LEAK-CERT-SOP, April 1998, Revision 2."

4.2.3 Canister Cleanliness Certification Procedure

After all the canisters were certified to be leak free, each canister was pressurized with nitrogen at 25% relative humidity and then analyzed for contamination using a GC/FID. After the first cleaning, the canisters did not satisfy the clean certification criteria (levels greater than 10 ppb/c TNMOC and greater than 1 ppb/c of any target compound). As a result, all the canisters were cleaned a second time using the procedure described in Section 4.2.1. The canisters were certified clean on April 20, 1998. Detailed descriptions of these procedures are provided in the document entitled, "Pressurized Canisters for Clean Certification Standard Operating Procedures, EPA-REG1-OEME/CANISTER-PREP-SOP, April 1998, Revision 2."

Canisters were stored under pressure until April 20, 1998, when they were re-evacuated to less than 10^{-3} Torr. Detailed descriptions of these procedures are provided in the document entitled, "Canister Evacuation Standard Operating Procedures, EPA-REG1-OEME/CAN-EVACUATION-SOP, May 1996."

4.3 Canister Flow Controller Cleaning and Calibration Procedures

4.3.1 Flow Controller Calibration Procedure

All flow controllers were calibrated to 9 milliliters per minute (ml/min.) in the EPA laboratory on April 1, 1998 following the procedures provided in the EPA Region I Standard Operating Procedure for the Sampling of Trace Volatile Organic Compounds using SUMMA Polished Stainless Steel Canisters, EPA-REG1-ESD/CAN-SAM-SOP, March 1994, Revision 1, Section 4.1.2 . The flow controller was connected to a "dummy" evacuated canister and an Aalborg Electronic Mass Flow Meter, Model GFM-1700 was attached to the flow controller's inlet port. As room air was being drawn into the canister, the flow controller needle valve was adjusted until the mass flow meter read 9 ml/min.

In the field, after all the canister samplers were placed at their sampling locations and collecting samples, the flow rate was checked using the Aalborg Electronic Mass Flow Meter. All canister samplers were collecting samples at the target flow rate of 9 ml/min. In addition, midway through the sampling period the flow rate was checked again and all the samplers continued to collect samples at 9 ml/min. The target ending pressure for the canisters was between -6 inches of Hg and -8 inches of Hg vacuum. At the end of the sampling event, the pressures in the canisters were between -13 inches of Hg and -6 inches of Hg vacuum. This indicates a representative sample was collected over the eight-hour sampling period.

4.3.2 Flow Controller Cleaning Procedure

After the flow controllers were calibrated they were cleaned on April1, 1998. The flow controllers were placed in ovens maintained at 100 °C and purged with humidified nitrogen for approximately one hour. After a cool down period the controller inlet and outlet ports were capped and placed in a shipping case.

4.4 Canister Analysis Quality Control/Quality Assurance

4.4.1 Laboratory Blank

Humidified nitrogen was introduced into the analytical instrument inlet line prior to analyzing the canisters to serve as a laboratory blank. Laboratory Blank #1 was run prior to analyzing canisters #1584, #1576, 1582, 1560, and 1577. Laboratory Blank #2 was run prior to analyzing canisters #1574, 1565, 1594, 1577(duplicate), and 1587. Laboratory Blank #3 was run prior to analyzing canisters #1589, 1592, 1586, and 22689. The laboratory blank was analyzed to determine the background contamination present in the analytical instrumentation. If the canister samples detect compounds below three times the blank value, they were qualified as estimated values with a "B". If a compound concentration was not qualified, the blank value was not subtracted from the sample value.

The blank results are presented in Appendix A for the TO-14 compounds and in Appendix B for the PAMS compounds. There were no compounds detected above their reporting limit except for benzene, toluene, 4-ethyltoluene, and 1,2,4-trimethylbenzene in Lab blank #1; benzene, toluene, 1,3,5-trimethylbenzene, 1,3-dichlorobenzene, chloromethylbenzene, and 1,2-dichlorobenzene in Lab Blank #2; and methylene chloride, benzene, toluene, 4-ethyltoluene, chloromethylbenzene, and 1,2-dichlorobenzene in Lab blank #3. The following compounds are qualified as estimated values with a "B" for one or more samples: 1,2-dichloro-1,1,2,2-tetrafluoroethane, vinyl chloride, acetone, trichlorofluoromethane, benzene, toluene, m,p-xylene, styrene, 4-ethyltoluene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, 1,4-dichlorobenzene, n-decane, and n-undecane.

4.4.2 Field/Trip Blank

Canister # 22689 went through all the procedures described in Section 4.2 and accompanied the canisters to the field and back to the laboratory to serve as a field /trip blank. The canister was pressurized by the laboratory along with the other samples prior to analysis. The canister was analyzed to determine if any cross contamination had occurred after the cleaning process and before analysis. If canister samples detect compounds below three times the blank value, they were qualified as estimated values with a "B". If a compound concentration was not qualified, the blank value was not subtracted from the sample value.

The blank results are presented in Appendix A for the TO-14 compounds and in Appendix B for the PAMS compounds. There were no compounds detected above their reporting limit except for methylene chloride and benzene. These compounds were qualified as estimated values with a "B".

4.4.3 Data Reproducibility/Precision Procedures

Canister #1577 was analyzed a second time for assessing analytical precision. Two 0.5 liter aliquots' were withdrawn from the canister and analyzed in a similar manner. Those compounds having values above their report limits are reported in Table 4. The relative percent differences were calculated and all were below 9%, which is well within the $\pm$ 25% performance criteria, showing excellent analytical precision.

In addition, Canister #1577 and #1587 were collected simultaneously in parallel from Sampling Station #4 (Kitchen crawl space) to determine sampling precision. Those compounds having values above their report limits are reported in Table 5. The relative percent differences were calculated and all were within $\pm$ 25%, except for methylene chloride, 1,1,1-trichloroethane, and 2-methylpentane. The values detected for 1,1,1-trichloroethane (0.11 and 0.46 ppb/v) were not 10 times the reporting limit (0.11 x 10 = 1.1 ppb/v), therefore, the $\pm$ 25% performance criterion does not apply.

The values reported in Table 5 for methylene chloride are estimated because they are above the analytical instruments calibration range and the data suggests the high levels detected in the canister samples are associated with the methylene chloride used to clean the XAD sampling tubes. Therefore, the data reported for methylene chloride probably does not represent what was present in the indoor or outdoor air during the sampling event.

The concentrations reported for 2-methylpentane are quantified with a "J" to show they are estimated values. All the PAMS data reported in Appendix B are reported as estimated because a one-point calibration curve was used for quantitation. Therefore, qualifying the 2-methylpentane data as estimated because the relative percent difference of 59% was outside the performance criterion window, will not change how the data quality is evaluated.

4.4.4 Data Accuracy Procedures

A quality control canister sample (AAL-21380) containing selected VOCs was analyzed with the canister samples to determine analytical accuracy. The results of the observed concentrations were compared to the known acceptable range and are reported on Table 6. The observed concentrations did not fall outside of the acceptable QC range, therefore, the data does not need to be qualified as estimated values.

4.4.5 Canister Surrogate Spiking Procedure

Prior to analysis, surrogate compound's dichloroethene d4, toluene d8, and p-bromofluoro-benzene were added to the analytical system prior to analyzing each sample. The percent recovery data for the surrogate compounds are reported with the data in Appendix A. The results were evaluated to determine if they were within the acceptable range (60% - 140%). All the surrogates were between 91% and 102%, which is well within the acceptable range, therefore, the data does not need to be qualified as estimated values.

5.0 SVOC Air Sampling and Analytical Methodology

5.1 Description

EPA Region I Standard Operating Procedure for using the BGI PQ100 air sampling pump, EPA-REG1-OEME/PM-SAM-SOP, February 1998, Revision 0, were used as the procedure to collect ambient air samples for SVOCs on solid adsorbent sampling cartridges consisting of a layer of XAD-2 resin (approximately 2 inches) sandwiched between two layers of glass wool to hold the XAD-2 in place. The XAD-2 resin and glass wool were fitted into custom-made glass tubes capable of being connected to the PQ100 sampling pumps. The sampling cartridges were transported into the field and brought back to the EPA laboratory wrapped in hexane rinsed aluminum foil and stored in screw-capped glass jar. At the conclusion of the sampling event the sampled cartridges were placed in a cooler with ice to help minimize loss of sample.

The XAD-2 cartridge samples were brought back to the EPA laboratory properly logged in and placed in a refrigerator for storage. The cartridges were then extracted by soxhlet extraction with methylene chloride and concentrated by Kuderna-Danish (K-D) evaporation on May 15, 1998. The eluent was then analyzed later by gas chromatography equipped with mass spectrometer (MS) detection. The EPA Region I standard operating procedure entitled, "Standard Operating Procedure for the Analysis of Polynuclear Hydrocarbons (PAHs) in Ambient Air", a modification of EPA Method TO13 - The Determination of Benzo (a) Pyrene and other Polynuclear Aromatic Hydrocarbons in Ambient Air using Gas Chromatographic and High Performance Liquid Chromatographic Analysis, from the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA-600/4-84-041 was used to identify and quantify the SVOCs listed on Table 3.

5.2 SVOC Quality Control/Quality Assurance

5.2.1 BGI PQ100 Sample Pump Flow Rate Calibration

The PQ100 sampling pump flow rate is maintained by a mass flow controller. Each sampler was calibrated using a primary flow calibrator manufactured by Gilian Instrument Corp., called the Gilibrator, on April 3, 1998. A "Dummy" sampling cartridges was connected to each sampling pump and calibrated to a flow rate of 15 liters per minute. After the pumps were calibrated, they maintained the flow rate within $\pm$2% over the eight-hour sampling period, regardless of changes in temperature and atmospheric pressure. The PQ100 displayed the current flow rate during the sampling event.

5.2.2 Solvent Blank

A laboratory blank (only the solvents, internal standard, and glassware) was processed with the samples and analyzed before the sample analysis. If the sample cartridges detect compounds below three times the laboratory blank value, they were qualified as estimated values with a "B". The laboratory blank results are reported in Appendix C. There were no compounds detected above their reporting limits.

5.2.3 Field/Trip Blank

One clean sampling cartridge accompanied the sample cartridges to the field and back to the laboratory to serve as a field /trip blank. The blank cartridge was not exposed to the atmosphere. If the sample cartridges detected compounds below three times the blank value,. they were qualified as estimated values with a "B". If a compound concentration was qualified, the value was reported as is. The field/trip blank results are reported in Appendix C. Undecane, dodecane, naphthalene, docosane, tricosane, tetracosane, and pentacosane were detected in the field/trip blank. As a result, the following compound concentrations are estimated and qualified with a "B": undecane- sample #11; dodecane - samples #4(primary), #4(duplicate), and #11; naphthalene - samples #4(secondary), and #11; docosane - sample #11; tricosane - samples #4(primary), #4(duplicate), and #11; tetracosane - #1, #4(primary), #4(secondary), and #4(duplicate); and pentacosane - samples #1, #4(primary), #4(secondary), #4(duplicate), and #11.

The XAD-2 resin is extremely difficult to clean even after two overnight washings with methylene chloride. Therefore, the tentatively identified compounds reported for each sample must be used with caution, especially the adiapates (bialkyhexanedioic acid) and phthalates (bialkyl 1,2-benzenedicarboxylic acid).

5.2.4 Surrogate Standard Recovery

A surrogate standard is a chemically inert compound not expected to be detected in the environmental sample. The surrogates fluorobiphenyl and p-terphenyl,d-14 were added to each XAD-2 cartridge in the laboratory on April 21 prior to the sampling event. The percent recovery data for the surrogate compounds are reported in Appendix C with each sample. The EPA Method TO-13 recommends adding the surrogate compounds after sample collection with an acceptable range of 80% - 120%. EPA Region I procedure is to add the surrogates before collection which helps evaluate any loses during collection and storage. At this time the Region I method does not have an acceptable range, more data is needed to calculate performance windows. The percent recovery data for fluorobiphenyl were between 64% and 95% and for p-terphenyl the recoveries were between 79% and 105%.

5.2.5 Breakthrough Determination

At Sampling Location #4 (kitchen crawl space), a sampling train was configured with a primary and secondary cartridge connected in series. The secondary (backup) cartridge was analyzed separately for determining if any compounds had migrated through the primary cartridge into the secondary during sampling. The results are presented in Appendix C. The secondary trap detected naphthalene at 12 ng/m^3, tetracosane at 24 ng/m^3 , and pentacosane at 57 ng/m3. All three of these values are qualified with a "B" and the concentrations for naphthalene and tetracosane are below the reporting limit (40 ng/m^3). The primary trap detected naphthalene at 1000 ng/m^3, tetracosane at 88 ng/m^3 , and pentacosane at 210 ng/m^3 and both tetracosane and pentacosane values are qualified with a "B". Therefore, given the backup cartridge showed both tetracosane and pentacosane had levels greater than 20% of those found on the primary cartridge, the reported values for these compounds are estimated and are probably biased low.

5.2.6 Data Reproducibility/Precision Procedures

At Sampling Station #4, one set of duplicate sample cartridges (#4 primary/secondary and #4 duplicate), two samples simultaneously collected at approximately the same flow rate were collected to determine data precision. The results are presented on Table 7. The relative percent differences were calculated and all were below the $\pm$ 25% performance criteria except for 1-methylnaphthalene, hexadecane, fluoranthene, tricosane, tetracosane, and pentacosane. The values reported are all below 10 times the reporting limit, therefore, the performance criterion does not apply.

5.2.7 Sample Storage and Transport

Each XAD-2 sample cartridge was wrapped in hexane rinsed aluminum foil and placed in a sealed glass jar for storage and transport before and after the sampling event. In addition, after the sampling event each cartridge was placed in a cooler containing ice to minimize loss of sample.

5.2.8 Chain of Custody

Chain of custody documentation was completed by the field engineer. All samples were logged into the laboratory on April 22, 1998, transferring the sample custody to the laboratory personnel.

6.0 Meteorological Measurement Method

6.1 Description

A portable meteorological measuring system was located in an open area outside the school, approximately 38 meters north of Sampling Station #11 and 36 meters from the northeast corner of the building. The system measured wind speed, wind direction, ambient temperature, relative humidity, and atmospheric pressure continuously from 07:50 to 16:05 hours. The meteorological station operating and data reporting procedures in the manufacturers manual were followed. The system's sensors were attached to a 10 to a 15-foot high portable tripod.

Components of the measuring system are described below:

- The data recording system consists of an Omnidata International Easy Logger Field Unit, Easy logger Terminal, and a 32K EPROM Data Storage Pack. The Easy Logger Field Unit is housed in a 14.96" x 14.96" x 8.27", 25.3 pound, steel constructed FE Mental Field Enclosure.

- The atmospheric pressure sensor is a Weathertronics Model 7105-A Barometer housed inside the enclosure described above.

- Relative humidity and temperature are measured with an ES-120 Vaisala Temperature and relative Humidity Probe housed inside an EA-130 RM Young Radiation Shield.

- Wind direction and horizontal wind speed are measured with an R.M. Young Wind Monitor - AQ, Model 05305. The wind sensors will be oriented to magnetic north using a magnetic compass and checked for proper orientation prior to the sampling event.

6.2 Meteorological Results

Temperature, atmospheric pressure, relative humidity, wind direction, and wind speed data were collected every 5 minutes from 05:50 to 16:05 hours. The recorded 15 minute average data are reported on Table 8. The ambient temperature measurements ranged from 6 °C to 17 °C with an average of 13 °C (55 °F), atmospheric pressure ranged from 29.92 "Hg to 29.97 "Hg with an average of 29.95 "Hg (760 mm Hg), relative humidity measurements ranged from 90% to 27% with an average of 44%, wind speed ranged from 0 mph to 11 mph with an average of 6 mph, and the average wind direction was from the west northwest (280 degrees) relative to magnetic north. The wind was blowing from the west northwest 36 percent of the time, from the north-northwest 27 percent of the time, from the west southwest 24 percent of the time; so during the sampling period there was a westerly flow of air moving across the school property. Therefore, Sampling Stations #9 and #10 were upwind of the building and Station #11 was downwind of the building during the sampling period.

7.0 Air Sampling Results and Discussions

On April 21, 1998, volatile organic and semi-volatile organic compound air samples were collected over an eight-hour period both inside and outside the former Fort Devens Elementary School. Sampling locations were established to collect data that would help determine if fuel-related contaminants present in the soil and groundwater adjacent to and beneath the school were volatilizing and migrating up through the soil and into the school's class rooms. The school was closed up with no heating/air-conditioning ventilation systems in operation prior to and during the sampling event to simulate a worse case situation. The data collected during the study are presented in Appendices A, B, and C and summarized on Tables 9, 10, and 11. The data reported on these tables are only the values which were detected above the reporting limits.

The volatile organic compound (VOC) summary data presented on Table 9 shows a comparison of the data collected from each sampling station. Stations #9, #10, and #11 were positioned outside the school to collect ambient background data. The wind direction during the sampling event was generally from a westerly direction, which put stations #9 and #10 upwind of the school and station #11 downwind of the school. The target compounds, methyl-t-butyl-ether, toluene, ethylbenzene, m,p-xylene, and 1,2,4-trimethylbenzene were not detected above their reporting limits at Stations #9, #10, and #11. Sampling Stations #4 and #5 were positioned beneath the school in the crawl space to measure contaminant migration from the ground and to represent worse case concentrations. At Station #4 and #5, methyl-t-butyl-ether and ethylbenzene were not detected above the reporting limit, Station #4 detected toluene at 2 ug/m^3

and 0.9 ug/m^3 at Station #5, Station #4 detected m,p-xylene at 1 ug/m^3 and 0.6 ug/m^3 at Station #5, and 1,2,4-trimethylbenzene was not detected at Station #4 but 0.7 ug/m^3 (B) was measured at Station #5. Indoor air background Station #6 measured the following: methyl-t-butyl-ether, ethylbenzene, and 1,2,4-trimethylbenzene were not detected, toluene was detected at 2 ug/m^3, and m,p-xylene at 2 ug/m^3. The data collected from Station #6 is the same or higher than what was collected from Stations #4 and #5. In addition, the target compound data collected from the other five rooms in the school show relatively the same concentrations as those from Stations #4, #5, and #6. Therefore, the results described above show that the target compounds were not migrating up through the soil and into the class rooms during the April 21 sampling event.

Reviewing the other non-target VOC data presented on Table 9, take note that methylene chloride was detected at very high concentrations at several of the sampling locations. This has been determined to be associated with the methylene chloride used to clean the XAD sampling tubes. At Stations #1, #4, and #11 where canisters and XAD cartridge samples were collected side-by-side, the outlet of the sampler emitted the methylene chloride which was then drawn into the canister. The methylene chloride detected in the other canister samples was most likely related to handling the XAD cartridges and the canisters concurrently. Therefore, the data reported for methylene chloride probably dose not represent what was present in the indoor or outdoor air during the sampling event. Trichlorofluoromethane concentrations were also detected at relatively high levels in all of the indoor air samples compared to the outdoor samples. This compound is also called F11, which is a Freon used in aerosol sprays, commercial refrigeration equipment, fire extinguishers, and as a blowing agent for polyurethane foams. It is apparent from the data that F11 is present in the building and crawl space. The source cannot be determined from this data set. The other compounds presented on Table 9 did not vary in concentration over the sampling stations to indicate they were migrating up through the soil and into the class rooms during the April 21 sampling event. One exception might be 1,4-dichlorobenzene, which was detected between 1 and 3 ug/m^3 at Sampling Stations #1, #2, #3, #4, and #5. The rest of the sampling stations did not detect 1,4-dichlorobenzene above the reporting limit.

The additional volatile organic compound (VOC) summary data presented on Table 10 like Table 9, shows a comparison of the data collected from each sampling station. The target compound, n-decane was not detected above the reporting limit at any of the sampling stations. However, 2-methylpentane had detectable levels at all of the sampling stations. At outside upwind Station #9 and #10 the concentrations were 6 ug/m^3 and 7 ug/m^3, respectively and at downwind Station #11, 16 ug/m^3 was detected. Indoor air background Station #6 measured 2-methylpentane at 10 ug/m^3. In the crawl space at Sampling Stations #4 and #5 the concentrations were 170 ug/m^3 (E) and 17 ug/m^3, respectively. The 2-methylpentane data collected from Stations #2, #3, and #7 were between 10 ug/m^3 and 14 ug/m^3. There is some indication from the data, particularly from the crawl space beneath the kitchen area that 2-methylpentane may be moving up through the soil into the crawl space. However, in other areas the levels are similar to or below what was detected at the indoor air background station (#6) and at one of the outside background stations (#11) with the exception of Station #1 where 56 ug/m^3 was detected. The non-target compounds reported on Table 10 were either not detected or were slightly below the reporting limits at all sampling stations.

The semi-volatile organic compound (SVOC) summary data presented on Table 11 shows a comparison of the data collected from Sampling Stations #1, #4, and #11. Station #11 was positioned outside the school to collect ambient background data and was downwind of the school during the sampling event. The target compounds, decane, dodecane, naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, and tetradecane were not detected above their reporting limits at Stations #11. Sampling Stations #4 was positioned beneath the kitchen area in the crawl space to measure contaminant migration from the ground and to represent worse case concentrations. At Station #4, decane was detected at 0.15 ug/m^3, dodecane at 0.08 ug/m^3 (B), naphthalene at 0.90 ug/m^3, 1-methylnaphthalene at 0.11 ug/m^3, 2-methylnaphthalene at 0.12 ug/m^3, and tetradecane was detected at 0.03 ug/m^3 (L). In the room near the old boiler room (Station #1), decane was detected at 0.43 ug/m^3, dodecane at 0.17 ug/m^3 (B), naphthalene at 1.4 ug/m^3, 1-methylnaphthalene at 0.19 ug/m^3, 2-methylnaphthalene at 0.10 ug/m^3, and tetradecane was detected at 0.19 ug/m^3 (L). The data described above shows the target compound concentrations in the crawl space to be generally lower than the concentrations found at Station #1. For the non-target semi-volatile organic compounds the concentrations were all well below 1 ug/m^3 and generally did not show any significant variability among the sampling stations. There were a number of tentatively identified compounds detected at the three sampling stations and their estimated concentrations are reported in Appendix C. In general, the SVOC results described above show that the compounds were not migrating up through the soil and into the class rooms during the April 21 sampling event.

The data presented in this report are of acceptable quality to represent the levels of volatile and semi-volatile organic compounds present at the sampling locations under the specific conditions prevailing during the sampling event on April 21, 1998. These levels may vary given differing site activities and meteorological conditions.

FIGURES

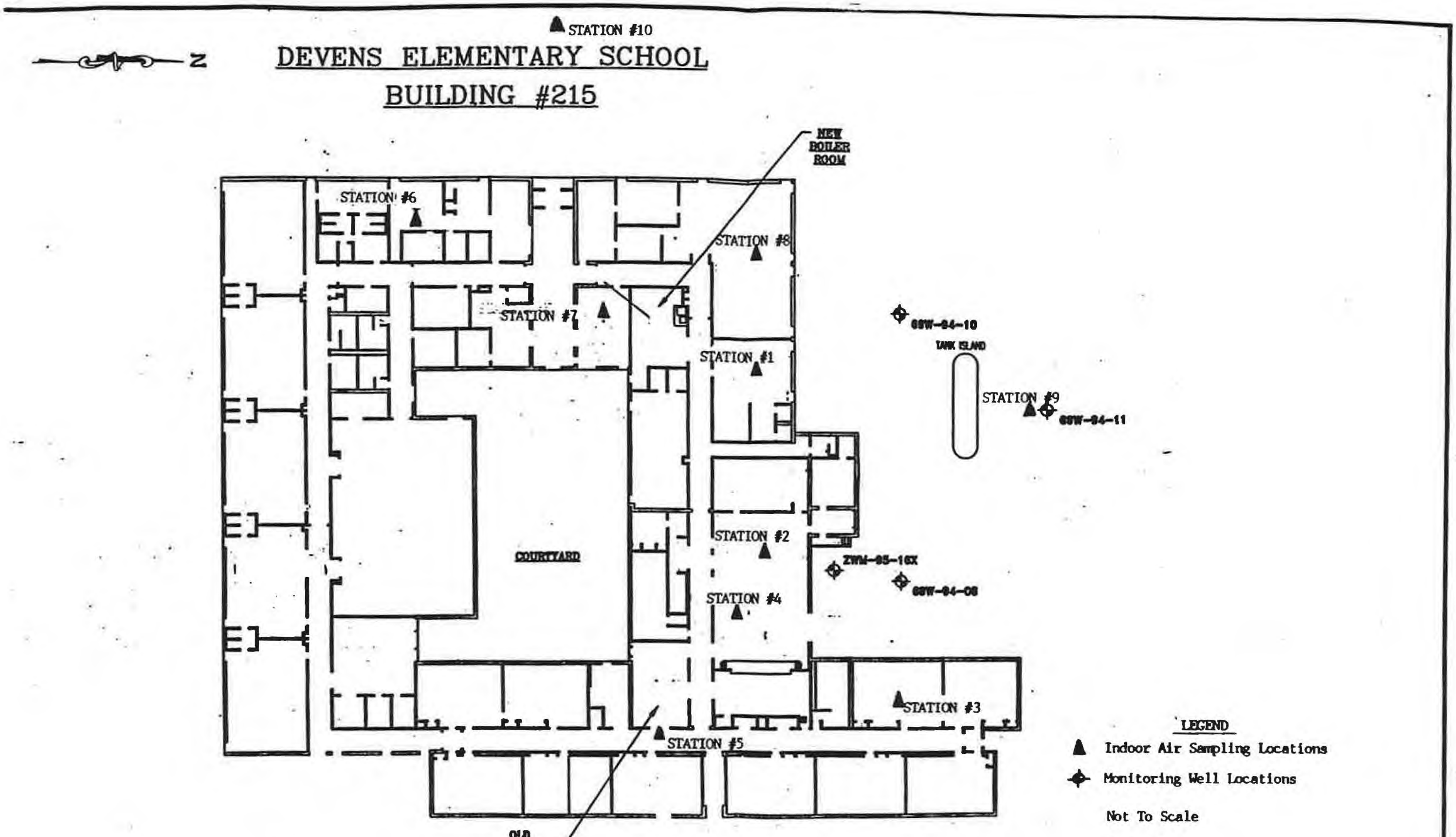

FIGURE 1
Air Sampling Locations
AOC 69W
FORT DEVENS, MA

TABLES

TABLE 1

AOC 69W DEVENS ELEMENTARY SCHOOL TARGET ANALYTES

COMPOUND
1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
1-Methylnaphthalene
2-Methylheptane
2-Methylnaphthalene
3-Methylheptane
Decane
Dodecane
Ethylbenzene
Methyl-t-butyl ether
Naphthalene
Nonane
Octane
Tetradecane
Toluene
p-Xylene

TABLE 2a

EPA METHOD TO14 TARGET VOC LIST

<u>**COMPOUND**</u>

Dichlorodifluoromethane (F12)
Chloromethane (Methyl Chloride)
1,2-Dichloro-1,1,2,2-Tetrafluoroethane (F114)
Vinyl Chloride
Methyl Bromide (Bromomethane)
Chloroethane
Acetonitrile
Acrolien
Acetone
Trichlorofluoromethane
Acrylonitrile
1,1-Dichloroethylene
Methylene Chloride
3-Chloropropene
1,1,2-Trichloro-1,2,2-Trifluoroethane (F113)
1,1-Dichloroethane
Methyl-t-butyl ether (Target Compound)
Vinyl Acetate
Methyl Ethyl Ketone
cis-1,2-Dichloroethene
Chloroform
Ethyl Acetate
Tetrahydrofuran
1,2-Dichloroethane
1,1,1-Trichloroethane
Benzene
Carbon Tetrachloride
1,2-Dichloropropane
Trichloroethene
Methylmethacrylate
cis-1,3-Dichloropropene
Methyl Isobutyl Ketone
trans-1,3-Dichloropropene
1,1,2-Trichloroethane
Toluene (Target Compound)
1,2-Dibromoethane
Tetrachloroethene
Chlorobenzene
Ethyl Benzene (Target Compound)
m,p-Xylene (Target Compound)
Styrene
1,1,2,2-Tetrachloroethane
o-Xylene
4-Ethyl Toluene
1,3,5-Trimethylbenzene (Target Compound)
1,2,4-Trimethylbenzene (Target Compound)
1,3-Dichlorobenzene
Chloromethylbenzene
1,4-Dichlorobenzene
1,2-Dichlorobenzene
1,2,4-Trichlorobenzene
Hexachlorobutadiene

TABLE 2b

PAMS TARGET VOLATILE ORGANIC COMPOUNDS

COMPOUND	COMPOUND
Propylene	2,2,4-Trimethylpentane
Propane	n-Heptane
Isobutane	Methylcyclohexane
1-Butene	2,3,4-Trimethylpentane
n-Butane	**2-Methylheptane (Target Compound)**
trans-2-Butene	**3-Methylheptane (Target Compound)**
cis-2-Butene	**n-Octane (Target Compound)**
Isopentane	**n-Nonane (Target Compound)**
1-Pentene	Isopropylbenzene
n-Pentane	n-Propylbenzene
Isoprene	m-Ethyltoluene
cis-2-Pentene	o-Ethyltoluene
2,2-Dimethylbutane	**n-Decane (Target Compound)**
Cyclopentane	1,2,3-Trimethylbenzene
2,3-Dimethylbutane	1,3-Diethylbenzene
2-Methylpentane	1,4-Dimethylbenzene
3-Methylpentane	n-Undecane
1-Hexene *	**Dodecane * (Target Compound)**
n-Hexane	
Methylcyclopentane	
2,4-Dimethylpentane	
Cylcohexane	
2-Methylhexane	
2,3-Dimethylpentane	
3-Methylhexane	

NOTE: * These compounds have been added as calibration and retention time standards primarily for the purpose of retention time verification. They can be quantitated at the discretion of the user.

TABLE 3

SEMI-VOLATILE ORGANIC COMPOUNDS

PAH COMPOUNDS

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthacene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
Naphthalene (Target Compound)
Phenanthrene
Pyrene

OTHER SVOCS

1-Methylnaphthalene (Target Compound)
2-Methylnaphthalene (Target Compound)
Decane (Target Compound)
Tetradecane (Target Compound)
Hexadecane
Octadecane
Eicosane
Tricosane
Pentacosane
Undecane
Dodecane (Target Compound)
Tridecane
Pentadecane
Heptadecane
Nonadecane
Docasane
Tetracosane
Heneicosane

TABLE 4

DUPLICATE ANALYSIS RESULTS

The following are the results of duplicate analyses performed on canister #1577. Note that only those compounds detected above the reporting limit (RL) are presented in this table for comparison, the other compounds are reported as none detected. The RL for the nonpolar compounds is 0.11 ppb,v/v and for the polar compounds they are 22, 11, and 5 (methyl-t-butyl ether) ppb,v/v.

COMPOUND	SAMPLE CONCENTRATION (ppb,v/v)	DUPLICATE CONCENTRATION (ppb,v/v)	RELATIVE PERCENT DIFFERENCE (%)	AVERAGE (ppb,v/v)
Dichlorodifluoromethane	0.68	0.66	3	0.67
Chloromethane	0.38	0.37	3	0.38
Trichlorofluoromethane	20	20	0	20
Methylene Chloride	2020 **E**	2037 **E**	1	2028 **E**
1,1,1-Trichloroethane	0.11	0.11	0	0.11
Benzene	0.18 **B**	0.19 **B**	5	0.18 **B**
Carbon Tetrachloride	0.12	0.13	8	0.12
Toluene	0.37	0.38	3	0.38
m,p Xylene	0.21	0.22	5	0.22
1,4-Dichlorobenzene	0.56	0.54	4	0.55
2-Methylpentane	26 **J**	26 **J**	0	26 **J**

Notes: B = Analyte is associated with blank contamination. Value is qualified when the observed concentration in the sample is less than three times the blank level.
E = Estimated value, above the calibration range.
J = Estimated value

TABLE 5

DUPLICATE SAMPLING RESULTS

The following are the results of duplicate/replicate canister samples (#1577 and #1587) collected from sampling Station #4. Only those compounds detected above the reporting limits are provided below for comparison. The average concentrations reported for sample #1577 on Table 2 - Duplicate Analysis Results are used for comparing the concentrations detected in duplicate sample #1587.

COMPOUND	CANISTER #1577 (ppb,v/v)	CANISTER #1587 (ppb,v/v)	RELATIVE PERCENT DIFFERENCE (%)	AVERAGE (ppb,v/v)
Dichlorodifluoromethane	0.67	0.67	0	0.67
Chloromethane	0.38	0.38	0	0.38
Trichlorofluoromethane	20	19	5	20
Methylene Chloride	2028 E	3007 E	39	2518 E
1,1,1-Trichloroethane	0.11	0.46	123	0.28
Benzene	0.18 B	0.18 B	0	0.18 B
Carbon Tetrachloride	0.12	0.12	0	0.12
Toluene	0.38	0.46	19	0.42
m,p-Xylene	0.22	0.20	10	0.21
1,4-Dichlorobenzene	0.55	0.51	8	0.53
n-Pentane	ND (1.1)	1.7 J	NA	1.7 J
2,2-Dimethylbutane	ND (1.1)	1.6 J	NA	1.6 J
2-Methylpentane	26 J	48 E,J	59	37 E,J
3-Methylpentane	ND (1.1)	1.3 J	NA	1.3 J

Notes:
- B = Analyte is associated with blank contamination. Value is qualified when the observed concentration in the sample is less than three times the blank level.
- E = Estimated value, above the calibration range.
- ND = Not detected above reporting limit (1.1 ppb/v).
- J = Estimated value,
- NA = Not applicable, RPD cannot be calculated.

TABLE 6

AUDIT CYLINDER RESULTS

The following are the results of analyzing QC sample, AAL-21380. The QC samples were analyzed with the samples.

COMPOUND	OBSERVED VALUE (ppb/v)	ACCEPTABLE RANGE (ppb/v)
Vinyl Chloride	5.57	4.16 - 6.81
Methyl Bromide	5.61	4.48 - 8.00
Trichlorofluoromethane	5.27	4.30 - 6.80
Methylene Chloride	4.29	3.87 - 7.87
Chloroform	5.39	4.09 - 6.16
1,2-Dichloroethane	5.00	4.21 - 6.38
1,1,1-Trichloroethane	4.88	3.87 - 6.13
Benzene	4.89	3.93 - 6.08
Carbon Tetrachloride	4.92	3.21 - 6.91
1,2-Dichloropropane	5.00	3.26 - 7.19
Trichloroethene	5.37	3.93 - 6.28
Toluene	4.88	3.99 - 6.23
1,2-Dibromoethane	3.99	3.23 - 5.65
Tetrachloroethene	5.04	4.14 - 6.34
Chlorobenzene	5.15	4.33 - 6.21
Ethylbenzene	4.51	3.84 - 5.55
o-Xylene	4.44	4.20 - 6.60

TABLE 7
DUPLICATE XAD-2 CARTRIDGE SAMPLING RESULTS

The following are the results of duplicate/replicate XAD-2 cartridge samples (#4-duplicate and #4-primary) collected from sampling Station #4. All the data reported in this table are estimated values.

COMPOUND	CARTRIDGE #4 (PRIMARY) (ug/m^3)		CARTRIDGE #4 (DUPLICATE) (ug/m^3)		RELATIVE PERCENT DIFFERENCE (%)	AVERAGE (ug/m^3)	
Decane	0.16		0.14		13	0.15	
Undecane	0.19		0.17		11	0.18	
Dodecane	0.08	B	0.07	B	13	0.08	B
Naphthalene	1		0.80		22	0.90	
Tridecane	0.03	L	0.04	L	25	0.04	L
1-Methylnaphthalene	0.13		0.09		36	0.11	
2-Methylnaphthalene	0.14		0.11		25	0.12	
Tetradecane	0.03	L	0.03	L	0	0.03	L
Pentadecane	0.06		0.05		17	0.06	
Hexadecane	0.05		0.03	L	50	0.04	
Heptadecane	0.04		0.05		25	0.04	
Octadecane	0.02	L	0.02	L	0	0.02	L
Phenanthrene	0.04		0.04	L	0	0.04	L
Nonadecane	0.02	L	ND		NA	0.02	L
Fluoranthene	0.02	L	0.01	L	50	0.02	L
Pyrene	0.01	L	ND		NA	0.01	L (Max)
Docosane	0.05		ND		NA	0.05	
Tricosane	0.03	L,B	0.02	L,B	33	0.03	L,B
Tetracosane	0.09	B	0.03	L,B	100	0.06	L,B
Pentacosane	0.21	B	0.08	B	93	0.14	B

Notes: B = Analyte is associated with blank contamination. Value is qualified when the observed concentration in the sample is less than three times the blank level.
ND = Not detected above reporting limit (1.1 ppb/v).
L = Estimated value, below the calibration range
NA = Not applicable, RPD can not be calculated

TABLE 8
METEOROLOGICAL DATA

LOCATION: FORT DEVENS ELEMENTARY SCHOOL - DEVENS, MASSACHUSETTS

DATE: APRIL 21, 1998
SCAN INTERVAL: 5 MINUTES

TIME	BAROMETRIC PRESSURE IN HG 15-MIN AVG.	PERCENT RH % RH 15-MIN AVG	AIR TEMPERATURE DEGREE C 15-MIN AVG	WIND DIRECTION DEGREES 15-MIN AVG	WIND SPEED MPH 15-MIN AVG
07:50	29.94	90	6	NA	0
08:05	29.95	82	8	140	2
08:20	29.95	72	9	228	3
08:35	29.96	68	10	247	4
08:50	29.97	65	11	266	3
09.05	29.97	58	12	255	3
09:20	29.97	54	12	231	3
09:35	29.97	51	13	284	4
09:50	29.97	50	13	258	5
10:05	29.97	48	14	286	7
10:20	29.97	48	14	312	5
10:35	29.97	49	14	270	5
10:50	29.97	43	15	290	6
11:05	29.97	42	14	291	4
11:20	29.96	42	15	341	8
11:35	29.96	42	15	262	7
11:50	29.96	40	15	310	4
12:05	29.96	40	15	296	5

TABLE 8 CONTINUED
METEOROLOGICAL DATA CONTINUED

LOCATION: FORT DEVENS ELEMENTARY SCHOOL - DEVENS, MASSACHUSETTS

DATE: APRIL 21, 1998
SCAN INTERVAL: 5 MINUTES

TIME	BAROMETRIC PRESSURE IN HG 15-MIN AVG.	PERCENT RH % RH 15-MIN AVG	AIR TEMPERATURE DEGREE C 15-MIN AVG	WIND DIRECTION DEGREES 15-MIN AVG	WIND SPEED MPH 15-MIN AVG
12:20	29.96	40	15	228	3
12:35	29.95	33	15	333	6
12:50	29.95	36	16	218	8
13:05	29.94	32	16	286	6
13:20	29.94	31	16	318	11
13:35	29.94	34	16	308	8
13:50	29.94	32	16	330	9
14:05	29.94	34	16	105	4
14:20	29.93	31	17	300	4
14:35	29.94	30	17	298	6
14:50	29.93	28	17	317	6
15:05	29.93	28	17	319	10
15:20	29.93	27	18	323	8
15:35	29.93	27	17	312	8
15:50	29.92	27	17	335	6
16:05	29.92	28	17	338	10

TABLE 9
VOLATILE ORGANIC COMPOUND AIR SAMPLING RESULTS SUMMARY

This table shows a comparison of the data collected on April 21, 1998, from each air sampling station. Only those values detected above the reporting limits are presented. The concentrations reported in Appendix A were rounded-up and presented in this table.

	STATION NUMBER										
COMPOUND	#1 ug/m3	#2 ug/m3	#3 ug/m3	#4 ug/m3	#5 ug/m3	#6 ug/m3	#7 ug/m3	#8 ug/m3	#9 ug/m3	#10 ug/m3	#11 ug/m3
Dichlorodifluoromethane	3	3	3	3	3	3	3	3	3	3	3
Chloromethane	1	1	1	0.8	0.6	1	1	1	1	1	2
Trichlorofluoromethane	235	130	43 E,D	112	114	270	283	253	2	2	2
Methylene Chloride	849 E	84 E	6	10434 E	552 E	4	189 E	29 E	0.6	2	462 E
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	ND	ND	ND	ND	1	ND	ND	0.8	ND	0.9
Methyl-t-Butyl Ether *	ND	ND	0.7	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	2	ND	ND	1	0.7	1	ND	ND
Benzene	0.8 B	0.9 B	0.7 B	0.6 B	0.4 B	0.8 B	0.7 B	0.6 B	0.4 B	0.3 B	ND
Carbon Tetrachloride	ND	ND	0.6	0.6	0.6	ND	ND	0.5	ND	ND	0.6
Toluene *	2	2	2	2	0.9	2	2	2	ND	ND	0.5 B
Ethylbenzene *	ND	ND	ND	ND	ND	ND	0.5	ND	ND	ND	ND
m,p-Xylene *	2	ND	1	1	0.6	2	2	1	ND	ND	ND
o-Xylene	0.6	0.6	ND	ND	ND	0.6	0.6	0.5	ND	ND	ND
4-Ethyl Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.6 B
1,2,4-Trimethylbenzene *	ND	0.6 B	0.6 B	ND	0.7 B	ND	ND	ND	ND	ND	ND
Chloromethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.79
1,4-Dichlorobenzene	1	3	2	3	3	ND	ND	ND	ND	ND	ND

Notes: B = Analyte is associated with blank contamination
ND = not detected above reporting limit (see Appendix A)
E = Estimated value, above the calibration range
* = Target Compound
D = A dilution factor was not applied to bring the value within the calibration range

TABLE 10

ADDITIONAL VOLATILE ORGANIC COMPOUND AIR SAMPLING RESULTS SUMMARY

This table shows a comparison of the data collected on April 21, 1998, from each air sampling station. All the data reported on this table are estimated concentrations. The data reported in Appendix B were rounded-up and presented in this table.

	STATION NUMBER										
COMPOUND	#1 ug/m3	#2 ug/m3	#3 ug/m3	#4 ug/m3	#5 ug/m3	#6 ug/m3	#7 ug/m3	#8 ug/m3	#9 ug/m3	#10 ug/m3	#11 ug/m3
Propane	ND	ND	ND	ND	ND	ND	ND	ND	ND	1 L	2
Isobutane	ND	ND	ND	ND	ND	2 L	ND	ND	ND	ND	0.9 L
trans-2-Butane	1 L	2 L	0.9 L	1 L	1 L	0.8 L	1 L	0.9 L	ND	ND	ND
Isopentane	ND	4	2 L	3 L	2 L	2 L	2 L	2 L	1 L	0.7 L	1 L
n-Pentane	ND	ND	ND	5	ND	ND	ND	ND	ND	ND	ND
2,2-Dimethylbutane	3 L	2 L	1 L	6 L	2 L	1 L	2 L	1 L	ND	ND	0.8 L
Cyclopentane	0.8 L	ND	ND	2 L	ND	ND	ND	ND	ND	ND	ND
2,3-Dimethylbutane	2 L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylpentane *	56	14	10	170 E	17	10	11	7	6	7	16
3-Methylpentane	ND	1 L	1 L	5	1 L	0.9 L	1 L	0.8 L	ND	ND	ND
1-Hexane	ND	ND	ND	4 L	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylpentane	ND	ND	ND	1 L	ND	ND	ND	ND	1 L	ND	1 L
Cyclohexane	ND	1 L	ND	ND	ND	ND	ND	0.7 L	ND	ND	ND
2,3-Dimethylpentane	1 L	2 L	1 L	ND	ND	1 L	ND	1 L	ND	ND	ND
n-Decane *	ND	2 L	2 B,L	ND	3 L	ND	ND	ND	ND	ND	ND
n-Undecane	ND	2 L	2 B,L	ND	3 L	ND	ND	ND	ND	ND	ND

Notes: B = Analyte is associated with blank contamination
ND = not detected above reporting limit (see Appendix B)
E = Estimated value, above the calibration range
L = Estimated value, below the calibration range
* = Target Compound

TABLE 11
SEMI-VOLATILE ORGANIC COMPOUND AIR SAMPLING RESULTS SUMMARY

This table shows a comparison of the data collected on April 21, 1998 from indoor sampling stations #1, #4 and from outside station #11. Only the compounds with reported values above the reporting limit (0.04 ug/m^3) are presented in this table. All the data reported in this table are estimated values.

COMPOUND		STATION #1 ug/m^3		STATION #4 ug/m^3		STATION #11 ug/m^3	
Decane	*	0.43		0.15		ND	
Undecane		0.44		0.18		0.02	L,B
Dodecane	*	0.17		0.08	B	0.02	L,B
Naphthalene	*	1.4		0.90		0.03	L,B
Tridecane		0.16		0.04	L	ND	
1-Methylnaphthalene	*	0.19		0.11		ND	
2-Methylnaphthalene	*	0.10		0.12		ND	
Tetradecane	*	0.19		0.03	L	ND	
Pentadecane		0.23		0.06		ND	
Acenaphthalene		0.02	L	ND		ND	
Hexadecane		0.20		0.04		ND	
Fluorene		0.01	L	ND		ND	
Heptadecane		0.18		0.04		ND	
Octadecane		0.10		0.02	L	ND	
Phenanthrene		0.05		0.04	L	ND	
Nonadecane		0.06		0.02	L	ND	
Eicosane		0.03	L	ND		ND	
Heneicosane		0.02	L	ND		44	
Fluoranthene		ND		0.02	L	ND	
Pyrene		ND		0.01	L	ND	
Docosane		ND		0.05		0.04	L,B
Tricosane		ND		0.03	L,B	0.01	L,B
Tetracosane		0.02	L,B	0.06	L,B	ND	
Pentacosane		0.04	B	0.14	B	0.12	B

Notes: B = Analyte is associated with blank contamination, value estimated
ND = not detected above reporting limit (0.04 ug/m^3)
L = Estimated value, below calibration range
* = Target Compound

June 8, 1998

MEMORANDUM

To: Jerry Keefe (EPA)
Cindy Hanna (EPA)
Peter Golonka (GF)
Rayo Bhumgara (GF)
Tom Rachford (GF)

From: Emily Olds (GF)

Re: Ft. Devens risk assessment for AOC-69W air data

This memo summarizes the assumptions, limitations and tasks under which Gannett Fleming to produced the quick turnaround time, preliminary risk assessment for EPA's AOC-69W air quality data. This project was initiated by EPA on June 3, 1998. A draft deliverable, as defined below, is being delivered to EPA on Monday June 8, 1998.

Gannett Fleming has been tasked to produce a preliminary risk characterization for the air data collected by EPA on April 27, 1998. The following assumptions and limitations apply to this project.

Assumptions and Limitations

1. Data

- Only the Target compounds plus dichlorodifluoromethane, chloromethane, trichlorofluoromethane, 1,1,1-trichloroethane, benzene and 1, 4-dichlorobenzene were evaluated.

- Maximum values were used as exposure point concentrations

- No summary statistics for the data set such as range of detected values, number of positive hits, or average concentrations will be determined

- Data qualified as B will not be used. Data qualified as E or L will be used at the stated concentrations.

- Risks were calculated for both n-decane (VOC) and decane (SVOC)

TABLE 1
FT. DEVINS RISK ASSESSMENT
Ambient Air Sampling Results

Station Number	Date	Dichlorodifluoromethane	Qual.	Chloromethane	Qual.	Trichlorofluoromethane	Qual.	Methyl-t-Butyl Ether	Qual.	1,1,1-Trichloroethane	Qual.
# 1	4/27/98	3		1		235		ND		ND	
# 2	4/27/98	3		1		130		ND		ND	
# 3	4/27/98	3		1		43	E	0.7		ND	
# 4	4/27/98	3		0.8		112		ND		2	
# 5	4/27/98	3		0.6		114		ND		ND	
# 6	4/27/98	3		1		270		ND		ND	
# 7	4/27/98	3		1		283		ND		1	
# 8	4/27/98	3		1		253		ND		0.7	
# 9	4/27/98	3		1		2		ND		1	
# 10	4/27/98	3		1		2		ND		ND	
# 11	4/27/98	3		2		2		ND		ND	

Maxixum Concentration:	3	2	283	0.7	2

Notes:
All parameters in µg/m3 - microgram per cubic meter
B - Analyte is associated with blank contaminaiton
ND - not detected above reporting limit
E - Estimated value, above the calibration range
NA - Not Analyzed

TABLE 1
FT. DEVINS RISK ASSESSMENT
Ambient Air Sampling Results

Station Number	Date	Benzene	Qual.	Toluene	Qual.	Ethylbenzene	Qual.	m, p-Xylene	Qual.	1,2,4-Trimethylbenzene	Qual.	1,4-Dichlorobenzene	Qual.	2-Methylpentane	Qual.
• # 1	4/27/98	0.8	B	2		ND		2		ND		1		2	
• # 2	4/27/98	0.9	B	2		ND		ND		0.6	B	3		14	
# 3	4/27/98	0.7	B	2		ND		1		0.6	B	2		10	
• # 4	4/27/98	0.6	B	2		ND		1		ND		3		170	E
# 5	4/27/98	0.4	B	0.9		ND		0.6		0.7	B	3		17	
# 6	4/27/98	0.8	B	2		ND		2		ND		ND		10	
# 7	4/27/98	0.7	B	2		0.5		2		ND		ND		11	
• # 8	4/27/98	0.6	B	2		ND		1		ND		ND		7	
# 9	4/27/98	0.4	B	ND		ND		ND		ND		ND		6	
# 10	4/27/98	0.3	B	ND		ND		ND		ND		ND		7	
# 11	4/27/98	ND		0.5	B	ND		ND		ND		ND		16	

Maxixum Concentration:	0	2	0.5	2	0	3	170

Notes:
μg/m^3 - microgram per cubic meter
B - Analyte is associated with blank contaminaiton
ND - not detected above reporting limit
E - Estimated value, above the calibration range
NA - Not Analyzed

TABLE 1
FT. DEVINS RISK ASSESSMENT
Ambient Air Sampling Results

Station Number	Date	n-Decane	Qual.	Decane	Qual.	Dodecane	Qual.	Napthalene	Qual.	1-Methylnaphthalene	Qual.	2-Methylnaphthalene	Qual.	Tetradecane	Qual.
# 1	4/27/98	ND		0.43		0.17		1.38 ✓		0.19		0.1		0.19	
# 2	4/27/98	0.002	L	NA		NA		NA		NA		NA		NA	
# 3	4/27/98	0.002	B,L	NA		NA		NA		NA		NA		NA	
# 4	4/27/98	ND		0.15		0.074	B	0.9 ✓		0.112		0.127		0.031	L
# 5	4/27/98	0.003	L	NA		NA		NA		NA		NA		NA	
# 6	4/27/98	ND		NA		NA		NA		NA		NA		NA	
# 7	4/27/98	ND		NA		NA		NA		NA		NA		NA	
# 8	4/27/98	ND		NA		NA		NA		NA		NA		NA	
# 9	4/27/98	ND		NA		NA		NA		NA		NA		NA	
# 10	4/27/98	ND		NA		NA		NA		NA		NA		NA	
# 11	4/27/98	ND		ND		0.015	L,B	0.03	L,B	ND		ND		ND	

Maxixum Concentration:	0.003	0.43	0.17	1.38	0.19	0.127	0.19

Should have had a sample in indoor background location

Notes:
µg/m^3 - microgram per cubic meter
B - Analyte is associated with blank contaminaiton
ND - not detected above reporting limit
E - Estimated value, above the calibration range
NA - Not Analyzed

TABLE 2
FT. DEVINS RISK ASSESSMENT
Selection of Chemicals of Concern

Chemical	# of Samples	Maximum Conc. ($\mu g/m^3$)	Inhalation RBC ($\mu g/m^3$)	Chemical of Concern
Dichlorodifluoromethane	11	3	18	N
Chloromethane	11	2	1	Y
Trichlorofluoromethane	11	283	73	Y
Methyl-t-Butyl Ether	11	0.7	310	N
1,1,1-Trichloroethane	11	2	100	N
Benzene	11	0	0.22	N
Toluene	11	2	42	N
Ethylbenzene	11	0.5	110	N
m, p-Xylene	11	2	730	N
1,2,4-Trimethylbenzene	11	0	0.62	N
1,4-Dichlorobenzene	11	3	0.28	Y
2-Methylpentane	11	170		Y
n-Decane	11	0.003		Y
Decane	3	0.43		Y
Dodecane	3	0.17		Y
Napthalene	3	1.38	0.037	Y
1-Methylnaphthalene	3	0.19		Y
2-Methylnaphthalene	3	0.127	15	Y
Tetradecane	3	0.19		Y

Notes:
RBCs taken from Region III RBC Table 4/15/98
$\mu g/m^3$ - micrograms per cubic meter

TABLE 3
FT. DEVENS RISK ASSESSMENT
Human Health Risk Assessment Exposure Factors
Adolescent Receptor

Parameter	Symbol	Value	Units	Reference
Exposure Frequency	EF	180	days/year	Legal Requirement
Exposure Duration	ED	11	years	EPA (1991)
Body Weight	BW	45	kg	EPA (1991)
Exposure Time	ET	8	hours/day	Professional Judgement
Averaging Time				
Carcinogens	ATc	25550	days	EPA (1989)
Noncarcinogens	ATn	4015	days	Based on Exposure Duration
Inhalation Rate	IR	20	m^3/day	EPA (1991)
Fraction Inhaled	FI	1		Professional Judgement

EPA (1991)- Standard Default Exposure Factors

TABLE 4

FT. DEVENS RISK ASSESSMENT
Human Health Risk Assessment Exposure Factors
School Age Child Receptor

Parameter	Symbol	Value	Units	Reference
Exposure Frequency	EF	180	days/year	Legal Requirement
Exposure Duration	ED	7	years	Professional Judgement
Body Weight	BW	29	kg	EPA (1996)
Exposure Time	ET	8	hours/day	Professional Judgement
Averaging Time				
Carcinogens	ATc	25550	days	EPA (1989)
Noncarcinogens	ATn	2555	days	Based on Exposure Duration
Inhalation Rate	IR	13	m^3/day	EPA (1996)
Fraction Inhaled	FI	1		Professional Judgement

EPA (1996) Exposure Factors Handbook.
EPA (1989) Risk Assessment Guidance for Superfund.

TABLE 5
FT. DEVENS RISK ASSESSMENT
Inhalation Toxicity Values for Non-Carcinogenic Chemicals of Concern
Adolescent Receptor

Chemical	RfD_{oral} (mg/kg/day)	RfD_{inhal} (mg/kg/day)	RfC[(a)] ($\mu g/m^3$)	Reference
Trichlorofluoromethane	3.00E-01	2.00E-01	4.50E+02	EPA (1998)
1,4-Dichlorobenzene		2.29E-01	5.15E+02	EPA (1998)
2-Methylpentane[(b)]	6.00E-02	5.71E-02	1.28E+02	TOXNET
n-Decane			2.00E+03	Massachusetts Contingency Plan[(c)]
Decane			2.00E+03	Massachusetts Contingency Plan[(c)]
Dodecane			2.00E+03	Massachusetts Contingency Plan[(c)]
Napthalene	4.00E-02	1.00E-04	2.25E-01	EPA (1998)
1-Methylnaphthalene[(d)]	4.00E-02	1.00E-04	2.25E-01	EPA (1998)
2-Methylnaphthalene	4.00E-02		9.00E+01	EPA (1998)
Tetradecane			2.00E+03	Massachusetts Contingency Plan[(c)]

Notes:
mg/kg/day - milligrams per kilogram per day
$\mu g/m^3$ - micrograms per cubic meter
(a) RfC calculated using RfD_{inhal} if available - RfD_{oral} used if RFD_{inhal} is not available
(b) 2-methylpentane RfD_{oral} and RfD_{inhal} values based on n-hexane values
(c)Massachusetts Contingency Plan value for C-9 through C-18 Aliphatics used- based on toxicity of n-nonane
(d) 1-Methylnapthalene RfD_{oral} and RfD_{inhal} values based on Napthalene values
EPA (1998) EPA Region III RBC Table, April 15, 1998.

TABLE 6

FT. DEVENS RISK ASSESSMENT

Inhalation Toxicity Values for Non-carcinogenic Chemicals of Concern

School Age Child Receptor

Chemical	RfD_{oral} (mg/kg/day)	RfD_{inhal} (mg/kg/day)	RfC[a] ($\mu g/m^3$)	Reference
Trichlorofluoromethane	3.00E-01	2.00E-01	4.46E+02	EPA (1998)
1,4-Dichlorobenzene		2.29E-01	5.11E+02	EPA (1998)
2-Methylpentane[b]	6.00E-02	5.71E-02	1.27E+02	TOXNET
n-Decane			2.00E+03	Massachusetts Contingency Plan[c]
Decane			2.00E+03	Massachusetts Contingency Plan[c]
Dodecane			2.00E+03	Massachusetts Contingency Plan[c]
Napthalene	4.00E-02	1.00E-04	2.23E-01	EPA (1998)
1-Methylnaphthalene[d]	4.00E-02	1.00E-04	2.23E-01	EPA (1998)
2-Methylnaphthalene	4.00E-02		8.92E+01	EPA (1998)
Tetradecane			2.00E+03	Massachusetts Contingency Plan[c]

Notes:

mg/kg/day - milligrams per kilogram per day

$\mu g/m^3$ - micrograms per cubic meter

(a) RfC calculated using RfD_{inhal} if available - RfD_{oral} used if RFD_{inhal} is not available

(b) 2-methylpentane RfD_{oral} and RfD_{inhal} values based on n-hexane values

(c)Massachusetts Contingency Plan value for C-9 through C-18 Aliphatics used- based on toxicity of n-nonane

(d) 1-Methylnapthalene RfD_{oral} and RfD_{inhal} values based on Napthalene values

EPA (1998) EPA Region III RBC Table, April 15, 1998.

TABLE 7
FT. DEVENS RISK ASSESSMENT
Inhalation Toxicity Values for Carcinogenic Chemicals of Concern
Adolescent Receptor

Chemical	CSF_{oral} (1/mg/kg/day)	CSF_{inhal} (1/mg/kg/day)	$CSF^{(a)}$ (1/µg/m^3)	Reference
Chloromethane	1.30E-02	6.00E-03	2.67E-06	EPA (1998)
1,4-Dichlorobenzene		2.20E-02	9.78E-06	EPA (1998)

Notes:
mg/kg/day - milligrams per kilogram per day
µg/m^3 - micrograms per cubic meter
(a) CSF calculated using CSF_{inhal} if available - CSF_{oral} used if CSF_{inhal} is not available
EPA (1998) EPA Region III RBC Table, April 15, 1998.

TABLE 8
FT. DEVENS RISK ASSESSMENT
Inhalation Toxicity Values for Carcinogenic Chemicals of Concern
School Age Child Receptor

Chemical	CSF_{oral} (1/mg/kg/day)	CSF_{inhal} (1/mg/kg/day)	$CSF^{(a)}$ (1/µg/m^3)	Reference
Chloromethane	1.30E-02	6.00E-03	2.69E-06	EPA (1998)
1,4-Dichlorobenzene		2.20E-02	9.86E-06	EPA (1998)

Notes:
mg/kg/day - milligrams per kilogram per day
µg/m^3 - micrograms per cubic meter
(a) CSF calculated using CSF_{inhal} if available - CSF_{oral} used if CSF_{inhal} is not available
EPA (1998) EPA Region III RBC Table, April 15, 1998.

TABLE 9
FT. DEVENS RISK ASSESSMENT
Calculation of Non-carcinogenic Risks
Adolescent Receptor

Chemical	Air Concentration µg/m^3	Dose µg/m^3	Hazard Quotient
Trichlorofluoromethane	283	4.65E+01	1.03E-01
1,4-Dichlorobenzene	3	4.93E-01	9.57E-04
2-Methylpentane	170	2.79E+01	2.18E-01
n-Decane	0.003	4.93E-04	2.47E-07
Decane	0.43	7.07E-02	3.53E-05
Dodecane	0.17	2.79E-02	1.40E-05
Napthalene	1.38	2.27E-01	1.01E+00
1-Methylnaphthalene	0.19	3.12E-02	1.39E-01
2-Methylnaphthalene	0.127	2.09E-02	2.32E-04
Tetradecane	0.19	3.12E-02	1.56E-05
		Total:	1.47E+00

Note:
µg/m^3 - micrograms per cubic meter

Napthalene in Soil & GW

TABLE 10
FT. DEVENS RISK ASSESSMENT
Calculation of Carcinogenic Risks
Adolescent Receptor

Chemical	Air Concentration µg/m³	Dose µg/m³	Risk
Chloromethane	2	5.17E-02	1.38E-07
1,4-Dichlorobenzene	3	7.75E-02	7.58E-07
		Total:	8.95E-07

Note:
µg/m³ - micrograms per cubic meter

TABLE 11
FT. DEVENS RISK ASSESSMENT
Calculation of Non-carcinogenic Risks
School Age Child Receptor

Chemical	Air Concentration µg/m³	Dose µg/m³	Hazard Quotient
Trichlorofluoromethane	283	4.65E+01	1.04E-01
1,4-Dichlorobenzene	3	4.93E-01	9.65E-04
2-Methylpentane	170	2.79E+01	2.19E-01
n-Decane	0.003	4.93E-04	2.47E-07
Decane	0.43	7.07E-02	3.53E-05
Dodecane	0.17	2.79E-02	1.40E-05
Napthalene	1.38	2.27E-01	1.02E+00
1-Methylnaphthalene	0.19	3.12E-02	1.40E-01
2-Methylnaphthalene	0.127	2.09E-02	2.34E-04
Tetradecane	0.19	3.12E-02	1.56E-05
		Total:	1.48E+00

Note:
µg/m³ - micrograms per cubic meter

TABLE 12
FT. DEVENS RISK ASSESSMENT
Calculation of Carcinogenic Risks
School Age Child Receptor

Chemical	Air Concentration µg/m³	Dose µg/m³	Risk
Chloromethane	2	3.29E-02	8.84E-08
1,4-Dichlorobenzene	3	4.93E-02	4.86E-07
		Total:	5.75E-07

Note:
µg/m³ - micrograms per cubic meter